2022 Edition

ASME A17.1/CSA B44 Handbook

ASME A17.1-2022, Safety Code for Elevators and Escalators

CSA B44:22, Safety Code for Elevators

Kevin L. Brinkman, PE

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The American Society of Mechanical Engineers

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The American Society of Mechanical Engineers
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INTRODUCTION

This is the 14th edition of the ASME A17.1/CSA B44 Handbook. The idea for the Handbook came from Ed Donoghue and has grown from that simple idea to the valued resource we all know today. The history behind the Handbook is important, so I have included Mr. Donoghue's Introduction from the 2013 edition to provide that background.

> *In 1976 I was appointed to the A17 Editorial Committee with Al Land (Chair), William "Bill" Crager (A17 Chair), and Manuel Gutierrez (ASME Secretary). At the time, the A17 Editorial Committee was charged with a total editorial review of the A17.1 Code for the 1978 edition. Every Rule was scrutinized and editorially revised for clarification when appropriate.*
>
> *The Committee met weekly for this massive project. To avoid unintentionally changing the content of a Rule, it was essential that the Committee members had a clear understanding of the technical requirements and their intent. Bill Crager had a long history as a member of the A17 Committee, including 15 years as Committee Chairman. At the meetings, the members would look to Bill for his recollection of why a Rule was in the Code. Bill possessed an encyclopedic knowledge of the history of A17 requirements. His typical response would start by stating, "At the (date) A17 Meeting, the Committee approved the Rule for the following reason." At our next meeting, Bill would arrive with documents from his home file backing up his recollection — including the meeting dates.*
>
> *I quickly came to the conclusion that the "Bill Cragers" on the A17 Committee were mostly retired or would be retiring from Committee activities over the next few years. Their expansive knowledge of the past committee work and the rationale for the A17.1 Rules would no longer be available. This would be a loss not only to the A17 Committee but also to the users of the Code.*
>
> *I concluded that a Handbook for A17.1 would be an invaluable addition to the A17.1 Code, as the NEC® Handbook was an invaluable supporting document for the NEC®. I approached Mel Green, then director of ASME Codes and Standards, with a proposal to write an ASME A17.1 Handbook. He thought the idea had merit, and the first edition of the A17.1 Handbook was published at the time of publication of the 1981 edition of the A17.1 Code. A new edition of the Handbook was published thereafter with each new edition of the A17.1 Code and later the A17.1/B44 Code..." [Ed Donoghue]*

With each passing year, we see experts in the industry retire and we welcome new faces to the Code development process. The Handbook, much like the Code itself, is a living document. Each edition updates and expands upon the information provided in previous editions. I consider it a privilege to author this edition of the Handbook and hope to continue the tradition and build on the foundation that Mr. Donoghue and so many others have helped to create.

—Kevin Brinkman

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FOREWORD

ASME A17.1/CSA B44, Safety Code for Elevators and Escalators, is written by a committee of technically qualified persons with a concern and competence in the subject within the Committee's scope and a willingness to participate in the work of the Committee. The ASME A17 Standards Committee is restricted to a maximum of 35 members of which no more than one-third can be from any single interest category. This requirement serves to ensure balance in the consensus process. In addition, there are over 300 members serving on the Regulatory Advisory Council, National Interest Review Group, Technical Committees, Administrative Committees, and Ad Hoc Committees. Technical revisions to ASME A17.1/CSA B44 are also submitted to the CSA B44 Technical Committee for their concurrence.

This Handbook incorporates the harmonization of ASME A17.1, *Safety Code for Elevators and Escalators*, and CSA B44, *Safety Code for Elevators*. Since 2000, editions of the CSA B44 and ASME A17.1 Codes have been identical, except for application deviations noted in CSA B44. Starting with ASME A17.1-2007/CSA B44-07, a single Code book has been published for use in the United States and Canada. A joint effort of the CSA B44 Technical Committee and the ASME A17 Standards Committee to harmonize requirements between CSA B44 and ASME A17.1 was started in the mid-1990s. The harmonization process compared and studied differences between the two codes over a number of years through discussions by joint ASME/CSA working groups. A harmonized requirement was formulated and proposed for review and approval through formal balloting by both the ASME A17 Standards Committee and the CSA B44 Technical Committee. If any member did not approve a proposed requirement, the member's rationale for disapproval was returned to the working committee for resolution. The working committee either revised the proposal or provided a reason for rejecting the comment. The revised proposal or rejection was once again balloted until negatives were resolved or the Chairman of the ASME A17 Standards Committee ruled consensus had been achieved. Many requirements went through multiple ballots before a consensus was achieved. As a result, requirements in ASME A17.1-2000 and CSA B44-00 and later editions of the Code are different from corresponding Rules and Clauses in the previous editions of ASME A17.1 and CSA B44. The harmonization process identified technical and editorial problems with requirements in both codes and in such cases formulated new requirements. The ASME A17 and CSA B44 Committees recognized that not all requirements could be fully harmonized, in particular requirements based on, or that depended on, other national codes or regulations, such as building, electrical, and fire codes. In such cases, two separate requirements were formulated, one for "jurisdictions enforcing NBCC" (meaning National Building Code of Canada) and another for "jurisdictions not enforcing NBCC" (meaning the United States).

In cases where no agreement on a requirement could be achieved or the publication schedule precluded continuation of discussions, the CSA B44 Technical Committee created Canadian exceptions from the ASME A17.1 requirements, known as Canadian deviations. These Canadian deviations appeared in the CSA B44-00 and CSA B44-04 editions. Both committees continue the harmonization process and endeavor to reduce the number of Canadian deviations in future editions. By January 2006, the list of deviations had shrunk to the point where the ASME A17 Standards Committee felt that all could be incorporated in the next edition of ASME A17.1, with an objective of publishing a single Safety Code for Elevators and Escalators for use in both the United States and Canada. That objective was met with the publication of ASME A17.1-2007/CSA B44-07.

ASME and CSA recognize that the Code must be written in a form suitable for enforcement by state, municipal, and other jurisdictional or regulatory authorities often referred to in the United States as "authorities having jurisdiction (AHJ)" and in Canada as "regulatory authorities (RA)"; as such, the text is concise, without examples or explanations. It is also recognized that this Code cannot cover every situation nor can it cover new technology before it is developed and field experience is gained. For these reasons, ASME agreed that a handbook would be useful to augment the Code by providing a commentary on the Code requirements.

This Handbook contains rationale for ASME A17.1/CSA B44 Code requirements along with explanations, examples, and illustrations of the implementation of requirements. In addition, it contains excerpts from other nationally recognized standards referenced by the Code. This information is intended to provide users of ASME A17.1/CSA B44 with a better understanding of, and appreciation for, the requirements. The net result should be increased safety for owners, manufacturers, installers, maintainers, consultants, the inspection community, and users of equipment covered by ASME A17.1/CSA B44.

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Commentary in this Handbook was compiled from ASME A17 Committee minutes, correspondence, and interpretations, as well as conversations with past and present ASME A17 and CSA B44 committee members.

The original intent for requirements in ASME A17.1 and CSA B44 may be obscure in the Committee's records. Therefore, this Handbook will convey, through text, examples of calculations, tables, and illustrations, the end result of Code requirements as applied to equipment installed today where the original intent cannot be found. It should not be construed that examples and illustrations in this Handbook are the only means of complying with ASME A17.1/CSA B44 Code requirements, or that all illustrations necessarily represent all requirements contained in the Code. Some illustrations simply reflect general industry or specific company practices. With information of this type, it is hoped the reader will develop a better understanding of, and appreciation for, requirements in ASME A17.1/CSA B44.

Commentary contained in this Handbook is the opinion of the authors (both current and previous). It does not necessarily reflect the official position of ASME, the ASME A17 Standards Committee for Elevators and Escalators, CSA, or the CSA B44 Technical Committee. When an official interpretation of an ASME A17.1/CSA B44 requirement is required, the user should submit a request for interpretation to the Secretary of the ASME A17 Standards Committee in accordance with instructions in the Preface to ASME A17.1/CSA B44. Comments and suggestions for this and future editions of the ASME A17.1/CSA B44 Handbook should be sent to the staff secretary noted on the committee's web page, accessible at https://go.asme.org/A17committee.

ASME Elevator and Escalator Courses. ASME Professional Development is a leader in top-quality elevator and escalator education. Courses range from an introduction to elevators and escalators, inspection techniques, equipment modernization code requirements, and maintenance evaluation, to an in-depth review of ASME A17.1/CSA B44 using this Handbook as the course text. There are courses to meet the needs of people with little or no experience in the industry, courses for those who already have elevator and escalator experience, and courses for those who have an extensive background in the industry. To obtain a catalog of course material, contact:

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ABBREVIATIONS

Throughout this Handbook, references are made to the ASME A17 Standards Committee and CSA B44 Technical Committee. The term "ASME A17/CSA B44 Committee" is used for that purpose. References are also made to ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*. The term "ASME A17.1/CSA B44" is used for that purpose. The reader should keep in mind the reference to the "ASME A17/CSA B44 Committee" is not intended to imply there is only one committee.

METRIC

The ASME A17.1/CSA B44 Handbook includes both metric and imperial units. Both are included in the commentary.

ASME A17.1/CSA B44 CODE REVISIONS

A summary of code changes from ASME A17.1-2019/CSA B44:19 through ASME A17.1-2022/CSA B44:22 along with approved balloted rationale are in the front of this Handbook. Revisions are made periodically to the Code to incorporate necessary or desirable changes determined from experience gained from the application of the procedures, and address developments in the elevator art. Approved revisions are published periodically. See Diagram 1 in the Foreword for the flowchart of the ASME A17 revision process. The Committee welcomes proposals from Code users. Such proposals should be as specific as possible, citing Section number(s), proposed wording, pertinent documentation, and a detailed description of the reasons for the proposal. Proposed revisions should be sent to the staff secretary noted on the committee's web page, accessible at https://go.asme.org/A17committee.

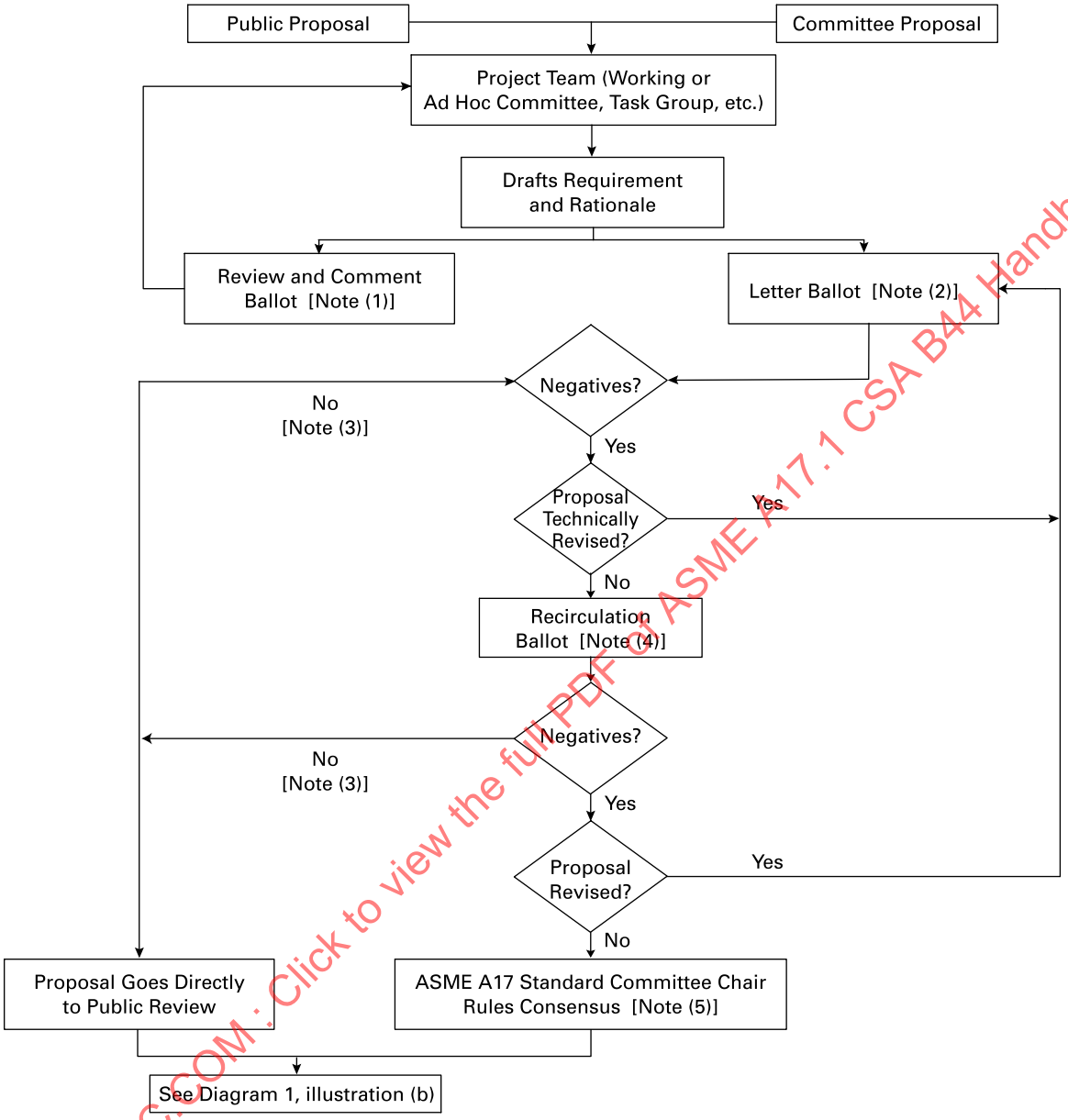
Revisions to ASME A17.1/CSA B44 occur after an intense formal process ensuring due process for all affected parties. The ASME A17 process is illustrated in Diagram 1, illustrations (a) and (b). The CSA process is the same as illustrated in Diagram 1.

ERRATA

Errata to the current ASME A17.1/CSA B44 are published on the ASME A17 Committee web page. Errata to prior editions of the Code are not readily available. The errata to ASME A17.1-2019/CSA B44:19 can be found in this Handbook immediately following Summary of Code Changes.

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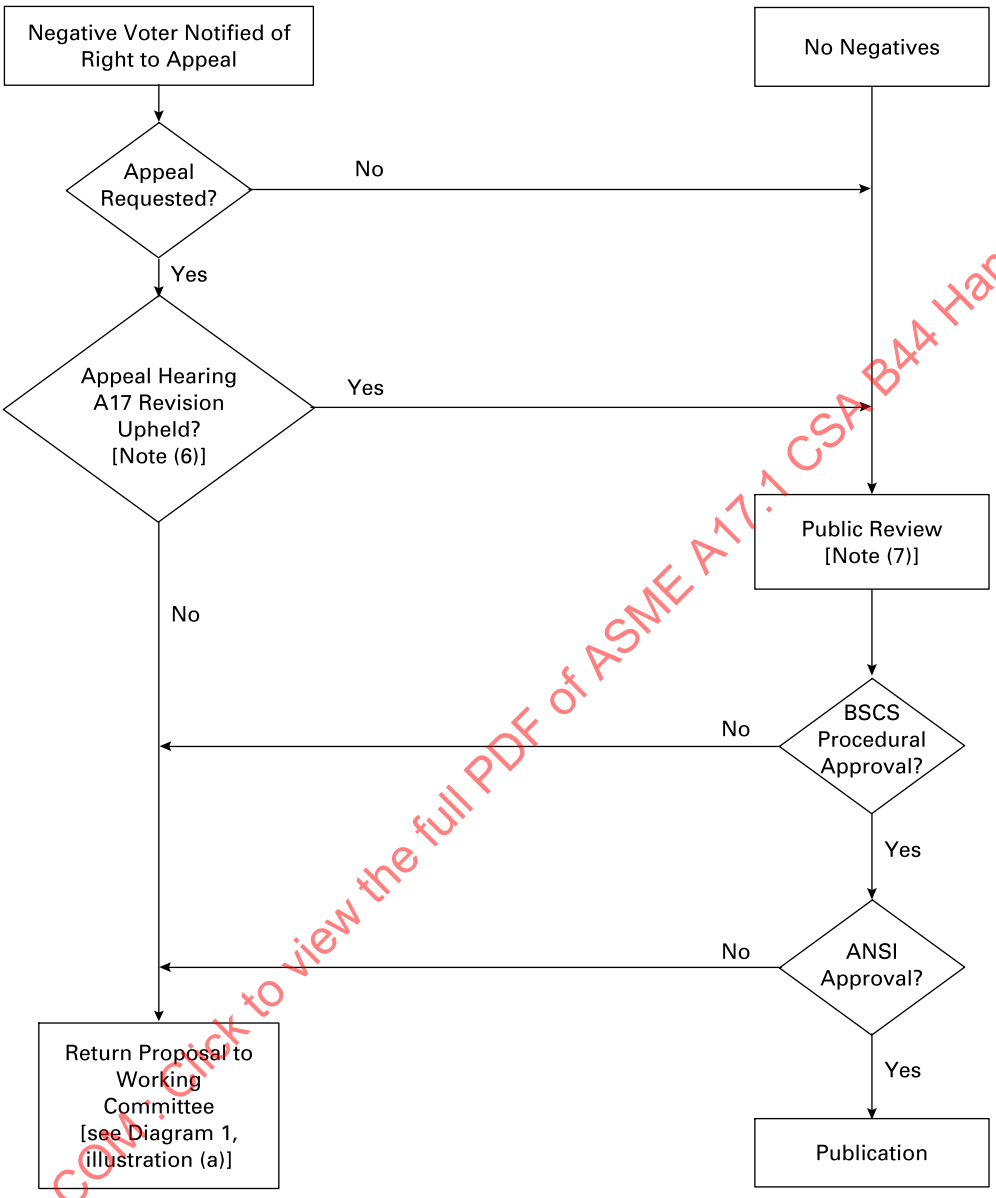
Diagram 1
ASME A17 Technical Revision Flowchart



(a)

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Diagram 1
ASME A17 Technical Revision Flowchart (Cont'd)



(b)

NOTES:

(1) Project team determines who receives Review and Comment Ballot, e.g., Working Committee only, other Working Committees, ASME A17 Standards Committee, NIRG, RAC, and/or CSA B44.
(2) Letter Ballot of ASME A17 Standards Committee, NIRG, RAC, and CSA for distribution to CSA B44 Committee.
(3) All comments must be addressed. Editorial revision allowed with ASME A17 Standards Committee approval.
(4) Secretary contacts all negative voters (this includes ASME A17, CSA B44, RAC, NIRG) and asks them if they want to withdraw their negatives and notifies them of their rights to appeal. If all negatives are withdrawn, proposal proceeds to public review. See Diagram 1, illustration (b). Recirculation Ballot of ASME A17 Standards Committee if any remaining negatives. Ballot may include editorial revisions. Copy of ballot sent to CSA.
(5) Assuming at least two-thirds affirmative vote by ASME A17 Standards Committee on proposed revision.
(6) Three levels of appeal. First appeal to ASME A17 Standards Committee. Second appeal to ASME BSCS. Third appeal to ASME Board on Hearings and Appeals.
(7) Public review comments sent to Working Committee. Working Committee may draft response, revise proposal, or withdraw proposal. If proposal is revised technically, it is subject to first-consideration ballot [see Diagram 1, illustration (a)]. Working Committee action subject to approval of ASME A17 Standards Committee.

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ACKNOWLEDGMENTS

The author gratefully acknowledges the time, effort, and dedication of the many people and organizations that assisted in and contributed to the preparation of this 2022 edition of the ASME A17.1/CSA B44 Handbook.

I especially want to acknowledge and thank the following for their assistance and significant contributions to this edition of the Handbook:

Joe Busse, Fujitec America, Inc., Mason, OH — Sections 2.25 and 2.26

John Carlson, Schindler Elevator Corp., Morristown, NJ — Sections 2.26, 2.27, and 8.14

Doug Henderson, TK Elevator, Middleton, TN — NFPA 70 Highlights, Sections 2.26 and 2.27

David McColl, Otis Elevator Co., Mississauga, ON — CSA C22.1 Highlights

Vincent Robibero, RobiberoV Consultancy, LLC, Spring, TX — Sections 2.26 and 8.14

Many people and organizations have made significant contributions to the Handbook over the years. It would be difficult to list everyone, but individual acknowledgments are included at the beginning of most sections of the Handbook. This book is truly an industry effort and is a testament to all of these contributions.

Of course, none of this would be possible without the years of effort by Ed Donoghue, who came up with the idea for the Handbook and authored every edition prior to 2016. This edition is really just an extension of all the work done previously by Ed and the many other contributors. I extend my sincere thanks and appreciation to Ed for all the encouragement, support, and guidance he provided me during this project. I am truly honored to call him my friend.

Finally, I would like to thank my wife, Vickie, and my family for their patience and understanding for the many hours and weekends needed to prepare the Handbook. It would not have been possible without their support.

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SUMMARY OF CODE CHANGES
ASME A17.1-2019/CSA B44-19
AND ASME A17.1-2022/CSA B44:22

This summary of Code changes identifies the Requirements that have been revised or added in ASME A17.1-2022/CSA B44:22 from those in ASME A17.1-2019/CSA B44-19. The rationale for the revisions are from the public review drafts that closed November 22, 2021; November 29, 2021; and February 8, 2022.

The "Rationale" reflects the balloted position of the ASME A17 Standards Committee and CSA B44 Technical Committee for revising or adding the requirement. The Record number in brackets immediately following each revision or addition is an administrative number used by the ASME A17 Committee.

Section 1.3 Added definition of "flood elevation"

RATIONALE: Provide a definition to specify the lowest safe elevation for the elevator during a flood event.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Section 1.3 Revised definition of "listed/certified"

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

The word "process" in this definition is needed to be consistent with the proposal in 8.14.1(a)(1). [Record 20-2624]

Section 1.3 Added definitions of "power, emergency or standby"; "power, main line"; and "power, normal building"

RATIONALE: Provide definitions for the main line power and the various power supplies used by elevator systems to allow for consistent reference to these items throughout the ASME A17.1/CSA B44 Code sections. [Record 19-1696]

Section 1.3 Added definition of "power supply, auxiliary"

RATIONALE: To provide a definition for "auxiliary power supply" that reflects the limited time duration or performance capability that could be associated with the backup power source. [Record 19-1696]

Section 1.3 Added definition of "remote interaction operation (RIO)"

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To add a definition for "remote interaction operation" to ensure there is a common understanding of the term as it is referenced in the RIO proposal for this interactive functional operation. [Record 20-2624]

Section 1.3 Added definition of "security level rated"

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional

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requirement enhancements are necessary for the needs of their assets.

Added for use in specifying a prescriptive parameter for the security level under Section 8.14. Basis of the definition taken from IEC 62443-4-2. [Record 20-2624]

Section 1.3 Revised definition of "software system failure"

RATIONALE: To clarify that the "intended function" is the safety function prescribed in the Code.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1.).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed, it requires the elevator to be in Inspection Operation when in the "GENERAL" position (see 2.26.14.1.1(g) and 2.26.14.5).

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Section 1.3 Add definitions of "test enable operation," "test enable device (TED)," and "test initiating means"

RATIONALE: To add appropriate definitions for a new operation called "test enable operation" [see 2.26.7(e)] that is consistent with other operations listed in 2.26.7 and necessary for limited and general test specified under 2.26.14.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed, it requires the elevator to be in Inspection Operation when in the "GENERAL" position (see 2.26.14.1.1(g) and 2.26.14.5).

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.1.1.5 Revised

RATIONALE: The design requirements for building elements that support hoistway doors should be applicable to vertical slide and swing type doors. Currently the requirements are only applicable to horizontal slide doors. This also includes the data required on layout drawings.

This requirement has been moved from 2.11.11.9 to 2.1.1.5 as it is more appropriate to include this requirement in the section (Section 2.1) addressing hoistway enclosure design requirements.

2.11.11.9 has been reserved for future use as 2.11.11.10 is cross-referenced throughout ASME A17.1-2019/CSA B44:19. [Record 20-1726]

Requirement 2.1.7 Added

RATIONALE: To provide general illumination throughout the hoistway, in addition to the pit and car top lighting, to improve the visibility for locating the car or counterweight in the hoistway and to improve the situational awareness of a potential fall hazard without reducing the current hoistway lighting requirements. The 50 lx (5 fc) is harmonized with EN 81-20 and ISO 8100-1. The manual switches are provided to allow the lights to be turned on when the control system is locked out and tagged out. To provide additional hoistway lighting to aid firefighters when Firefighters' Emergency Operation (FEO) is in effect. Safe and convenient access from the car top is needed to allow maintenance and/or service of the lighting. [Record 16-3037]

Requirement 2.2.4 Revised

RATIONALE: To allow elevator personnel to safely access elevator pits from the bottom landing. Pit ladders are required to be 400 mm (16 in.) wide and pit ladder side rail clear distance is required to be 115 mm (4.5 in.). When obstructions exist, the side rail clear distance is to be reduced instead of reducing the width of the ladder rungs. In addition, the ladder rungs are to be installed

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above the bottom landing sill as hand hold. [Record 18-0858]

Requirement 2.2.4.2 Revised

RATIONALE: Movement of the car while people were on pit ladders has caused injuries and fatalities. This proposal adds protection for when a person is on a pit ladder, preventing all movement of the car. References were updated to correspond with the addition of the ladder electrical device. The requirement in 2.26.2.38(a) was removed since it is redundant.

Recognition of a SIL rated device was added to Table 2.26.4.3.2. The proposed SIL rating is the same as other similar devices. This proposal complements other proposals under consideration for safely accessing the hoistway and working in the pit. [Record 21-0810]

Requirement 2.2.4.2.7 Added; existing 2.2.4.2.7 and 2.2.4.2.8 renumbered

RATIONALE: Movement of the car while people were on pit ladders has caused injuries and fatalities. This proposal adds protection for when a person is on a pit ladder, preventing all movement of the car. References were updated to correspond with the addition of the ladder electrical device. The requirement in 2.26.2.38(a) was removed since it is redundant.

Recognition of a SIL rated device was added to Table 2.26.4.3.2. The proposed SIL rating is the same as other similar devices. This proposal complements other proposals under consideration for safely accessing the hoistway and working in the pit. [Record 21-0810]

Requirement 2.2.6 Revised

RATIONALE: To correct requirements referenced in 2.2.6. Requirement 2.2.6.3 was eliminated with Record 11-1147. [Record 18-1573]

Requirement 2.2.9 Added

RATIONALE: Locate the detection means to allow normal operation of the elevator before the flood water level in the pit reaches a level where the counterweight and other elevator equipment would be operated in or descend into floodwaters and guard against activation due to non-flood accumulation of water in the pit.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.4.2 Revised

RATIONALE: Clarify runby requirements based on buffer type(s). Remove Table 2.4.2.2 for new elevators since single-speed AC control and rheostatic control do not meet 2.26.11, ICC/ANSI A117.1, and ADAAG. The table has been moved to 8.6.3.12.1. [Record 19-931]

Table 2.4.2.2 Deleted

RATIONALE: Clarify runby requirements based on buffer type(s). Remove table 2.4.2.2 for new elevators since Single speed AC control and Rheostatic Control do not meet 2.26.11, ICC/ANSI A117.1, and ADAAG. The table has been moved to 8.6.3.12.1. [Record 19-931]

Requirement 2.7.6.3 Revised

RATIONALE: To advise Code users that equipment in rooms and spaces may need to be located to suit requirements in ASCE/SEI 24.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.7.6.4.1 Revised

RATIONALE: Revise text to be consistent with the new definitions for “normal building power,” “auxiliary power supply,” and “emergency or standby power.” [Record 19-1696]

Requirement 2.7.6.4.3(a) Revised

RATIONALE: Revise text to be consistent with the new definition for “normal building power.” [Record 19-1696]

Requirement 2.8.1 Revised

RATIONALE: To recognize exceptions in Section 2.8 including 2.8.7.

Given the technology currently used by emergency responders and the safety concern of not having reliable emergency responder communications from inside the elevator cab during an emergency, the safety of the building occupants will be enhanced by allowing equipment used by emergency responders to be installed inside the elevator car and in the elevator hoistway that will improve the reliability of these communications. This equipment is currently not addressed by the ASME A17.1/CSA B44 Code for elevators in the U.S. and Canada. The International Fire Code and International Building Code have been revised to require emergency responder radio coverage (ERRC) in buildings in lieu

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of the firefighters phone jack system. There is a published national standard, UL 2524 for this equipment.

NOTE: NFPA 1225 is replacing NFPA 1221 and was published in 2021. NFPA 1225 just added all elevators, in addition to elevator lobbies, to be considered critical areas in the building requiring 99% first responder radio coverage (see NFPA 1225, Section 18.8.3).

To provide detailed requirements for the installation, use, and access to ERRC equipment installed in the elevator car enclosure for exclusive use by emergency responders where the immunity test required in EN 12016 and ISO 22200 cover the radio frequencies used in the U.S. EN 12016 covers the frequency range of 80 MHz to 1,960 MHz. ISO 22200 covers a range of 80 MHz to 2,170 MHz. This compares to typical fire department frequencies that are in the VHF high band (150 MHz to 160 MHz) or the UHF ultra-high band (450 MHz to 470 MHz). [Record 19-1766]

Requirement 2.8.3.3 Revised

RATIONALE: Automatic sprinklers are prohibited by the building code to be installed in Fire Service Access Elevators' and Occupant Evacuation Elevators' associated spaces. This note will help to prevent the installation of sprinklers for these elevators. [Record 18-2826]

Requirements 2.8.3.3.2 and 2.8.3.3.3 Revised

RATIONALE: Revise text to be consistent with the new definition for "main line power." [Record 19-1696]

Requirements 2.8.7.1, 2.8.7.2, and 2.8.7.3.1 Added

RATIONALE: To allow antennas associated with emergency responder radio coverage (ERRC) equipment in the hoistway, but only when no service is required after installation or a means for access is provided that allows the required service to take place from outside the hoistway. To provide design requirements for protective guard strength and clearance when such guard(s) are installed in the hoistway. See Record 13-1901 for similar requirements relating to fire alarm initiating devices (FAIDs). To provide protection against objects falling through the conduit from the upper access point. The operation of the antenna does not require a perforated guard. A perforated guard could introduce additional safety concerns, therefore it is prohibited.

Given the technology currently used by emergency responders and the safety concern of not having reliable emergency responder communications from inside the elevator cab during an emergency, the safety of the building occupants will be enhanced by allowing equipment used by emergency responders to be installed inside the elevator car and in the elevator hoistway that will improve the reliability of these communications. This equipment is currently not addressed by the ASME A17.1/CSA B44 Code for elevators in the U.S. and Canada. The International Fire Code and International Building Code have been revised to require ERRC in buildings in lieu of the fire fighters phone jack system. There is a published national standard, UL 2524 for this equipment.

NOTE: NFPA 1225 is replacing NFPA 1221 and was published in 2021. NFPA 1225 just added all elevators, in addition to elevator lobbies, to be considered critical areas in the building requiring 99% first responder radio coverage (see NFPA 1225, Section 18.8.3).

To provide detailed requirements for the installation, use, and access to ERRC equipment installed in the elevator car enclosure for exclusive use by emergency responders where the immunity test required in EN 12016 and ISO 22200 cover the radio frequencies used in the U.S. EN 12016 covers the frequency range of 80 MHz to 1,960 MHz. ISO 22200 covers a range of 80 MHz to 2,170 MHz. This compares to typical fire department frequencies that are in the VHF high band (150 MHz to 160 MHz) or the UHF ultra-high band (450 MHz to 470 MHz). [Record 19-1766]

Requirements 2.8.7.3.2, 2.8.7.3.3, and 2.8.7.3.4 Added

RATIONALE: The equipment associated with the emergency responder radio coverage (ERRC) equipment is permitted to be installed in the elevator hoistway but installed in such a manner that all required clearances are satisfied, elevator personnel are protected, and service of this equipment is not carried out from inside the hoistway.

Given the technology currently used by emergency responders and the safety concern of not having reliable emergency responder communications from inside the elevator cab during an emergency, the safety of the building occupants will be enhanced by allowing equipment used by emergency responders to be installed inside the elevator car and in the elevator hoistway that will improve the reliability of these communications. This equipment is currently not addressed by the ASME A17.1/CSA B44 Code for elevators in the U.S. and Canada. The International Fire Code and International Building Code have been revised to require (ERRC) in buildings in lieu of the fire fighters phone jack system. There is a published national standard, UL 2524 for this equipment.

NOTE: NFPA 1225 is replacing NFPA 1221 and was published in 2021. NFPA 1225 just added all elevators, in addition to elevator lobbies, to be considered critical areas in the building requiring 99% first responder radio coverage (see NFPA 1225, Section 18.8.3).

To provide detailed requirements for the installation, use, and access to ERRC equipment installed in the elevator car enclosure for exclusive use by emergency responders where the immunity test required in EN 12016 and ISO 22200 cover the radio frequencies used

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in the U.S. EN 12016 covers the frequency range of 80 MHz to 1,960 MHz. ISO 22200 covers a range of 80 MHz to 2,170 MHz. This compares to typical fire department frequencies that are in the VHF high band (150 MHz to 160 MHz) or the UHF ultra-high band (450 MHz to 470 MHz). [Record 19-1766]

Requirement 2.11.7.2.2 Revised

RATIONALE: To provide the ability to design glass doors with additional steel reinforcement if desired. The current glass area of 60% minimum limits the area that supports the glass to 40%. By reducing the minimum glass area to 50% we increase the area that is available to support. [Record 20-1125]

Requirement 2.11.11.9 Deleted and moved to 2.1.1.5

RATIONALE: The design requirements for building elements that support hoistway doors should be applicable to vertical slide- and swing-type doors. Currently the requirements are only applicable to horizontal slide doors. This also includes the data required on layout drawings.

This requirement has been moved from 2.11.11.9 to 2.1.1.5 as it is more appropriate to include this requirement in the section, Section 2.1, addressing hoistway enclosure design requirements.

2.11.11.9 has been reserved for future use as 2.11.11.10 is cross-referenced throughout ASME A17.1-2019/CSA B44:19. [Record 20-1726]

Requirements 2.11.15, 2.11.16, 2.11.17, and 2.11.18 Revised

RATIONALE: To ensure marking requirements for jurisdictions enforcing the NBCC are aligned with those currently specified in ASME A17.1/CSA B44. [Record 18-1583]

Requirement 2.13.4.2.1 Revised

RATIONALE: The change to 2.13.4.2.1(c) clarifies that the reopening device system, specifically the detection of objects in the door path, has to be rendered inoperative. Reducing the kinetic energy is required when door protection system is rendered inoperative. It is not necessary to reduce the kinetic energy when the approaching object detection means (3D) is rendered inoperative until reset when the detection of objects in the door path (2D) occurs. [Record 20-1005]

Requirement 2.13.5 Revised

RATIONALE: To include appropriate reference standards for the detection means addressed by the Code. [Record 20-1005]

Requirement 2.13.5.2 Revised

RATIONALE: The ASME A17.1-2019/CSA B44:22 rationale for the 20 s time interval in requirement 2.13.5.2 (a) was "to provide a method for not unduly delaying the elevator when objects inadvertently transverse the approaching object detection zone," but when the elevator lobby has many building occupants, they will inadvertently transverse the door approaching detection zone while moving through the lobby without entering the elevator resulting in undue delay. This change uses the door path detection means to validate the travel direction of an object detected in the door approaching detection zone. Should at any time, including once the doors begin to close, an object be sensed in the door path detection zone, then the doors will reopen and the door approach protection is made operative. The value of 3 s corresponds to a slow walking pace from the initial edge of the approach zone [500 mm (20 in.)] to the door path detection zone. If the door path detection means fails to sense the object after a minimum of 3 s, then the doors can begin to close at normal speed, because the door path detection means is still operative as protection for passengers. [Record 20-1005]

Requirement 2.13.5.3 Revised

RATIONALE: In order not to restrict any applicable technologies, this language is being rewritten into performance language. Previous requirements primarily applied to photoelectric devices. Other devices may require different detection properties of the target to validate their operation. Based upon the application of these devices, the target should simulate what they need to detect (i.e., properties of a human being). [Record 20-1005]

Requirement 2.13.5.3.1 Revised

RATIONALE: To clarify that it is a moving target with a minimum speed. The moving target is required to be detected at some point in the defined area, but it is not required that in every point of the defined area will detect the moving target. The detection shall occur prior to the target moving to within 225 mm (9 in.) of the closing door. [Record 20-1005]

Requirement 2.13.5.4 Revised

RATIONALE: In order not to restrict any applicable technologies, this language is being rewritten into performance language. Previous requirements primarily applied to photoelectric devices. Other devices may require different detection properties of the target to validate their operation. Based upon the application of these devices, the target should simulate what they need to detect (i.e., properties of a human being). [Record 20-1005]

Requirement 2.13.5.5 Revised

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RATIONALE: To provide consistency with the language of requirement 2.13.3.4.9. The self-monitoring means for objects in the door path (2.13.5.4) and approaching objects (2.13.5.3) is to reduce the kinetic energy of the impact of door strikes. The reduced door speed will be noticeable and should alert maintenance and management personnel. [Record 20-1005]

Requirement 2.14.1.9.1(g) Added

RATIONALE: To permit emergency responder radio coverage equipment to be installed in the elevator car enclosure for exclusive use by emergency responders. The International Fire Code and International Building Code have been revised to require emergency responder radio coverage (ERRC) in buildings in lieu of the fire fighters phone jack system.

Given the technology currently used by emergency responders and the safety concern of not having reliable emergency responder communications from inside the elevator cab during an emergency, the safety of the building occupants will be enhanced by allowing equipment used by emergency responders to be installed inside the elevator car and in the elevator hoistway that will improve the reliability of these communications. This equipment is currently not addressed by the ASME A17.1/CSA B44 Code for elevators in the U.S. and Canada. The International Fire Code and International Building Code have been revised to require ERRC in buildings in lieu of the fire fighters phone jack system. There is a published national standard, UL 2524 for this equipment.

NOTE: NFPA 1225 is replacing NFPA 1221 and was published in 2021. NFPA 1225 just added all elevators, in addition to elevator lobbies, to be considered critical areas in the building requiring 99% first responder radio coverage (see NFPA 1225, Section 18.8.3).

To provide detailed requirements for the installation, use, and access to ERRC equipment installed in the elevator car enclosure for exclusive use by emergency responders where the immunity test required in EN 12016 and ISO 22200 cover the radio frequencies used in the U.S. EN 12016 covers the frequency range of 80 MHz to 1,960 MHz. ISO 22200 covers a range of 80 MHz to 2,170 MHz. This compares to typical fire department frequencies that are in the VHF high band (150 MHz to 160 MHz) or the UHF ultra-high band (450 MHz to 470 MHz). [Record 19-1766]

Requirement 2.14.5.7.4 Revised

RATIONALE: Revise text to be consistent with the new definitions for “auxiliary power supply” and “normal building power.” [Record 19-1696]

Requirement 2.14.5.9.2 Revised

RATIONALE: To provide the ability to design glass doors with additional steel reinforcement if desired. The current glass area of 60% minimum limits the area that supports the glass to 40%. By reducing the minimum glass area to 50% we increase the area that is available to support. [Record 20-1125]

Requirement 2.14.7.1.3 Revised

RATIONALE: Revise text to be consistent with the new definition for “main line power.” [Record 19-1696]

Requirement 2.15.6.4 Revised

RATIONALE: The changes to 2.15.6.4 address the outdated wood platform requirements within PS 1-74. Remove Exterior type due to changes within PS 1 plywood changes from PS 1-74 to PS 1-09. Since PS 1-09 removed the PS 1-74 Interior type bonded with interior glue and Interior type bonded with intermediate bonded glue classifications, there is no need to add an additional requirement for specifying the bonding classification type. Both are required to be exposed to dry and wet weather, but Exposure 1 is designed for short-term exposure to moisture, such as during construction, and Exterior is designed for long-term moisture exposure. The PS 1-09 bonding classifications Exposure 1 and Exterior are both exterior bonding and have the same test requirements. Only difference, Exposure 1 is allowed to have a slightly higher failure rate. Also, the CSA O151 bonding tests and failure requirements are similar with PS 1-09 Exposure 1 testing requirements. Conclusion: Both Exposure 1 and Exterior bonding classifications are suitable for elevator use. [Record 18-2575]

Requirement 2.17.12 Revised

RATIONALE: ASTM E8 was never intended to address bearings. [Record 19-172]

Requirement 2.19.1.1 Revised

RATIONALE: To mirror requirement 2.19.2.1(a) as this represents the same situation. To clarify the requirement and enable safe sheave shaft design arrangements. [Record 19-175]

Requirement 2.19.2.1 Revised

RATIONALE: To clarify the requirement and enable safe sheave shaft design arrangements. [Record 19-175]

Requirement 2.19.3.3 Revised

RATIONALE: Based on collaboration between the ASME A17 Mechanical Design Committee and the ASME A17 Inspections Committee the determination was that the data plate technical data entries are not useful to elevator personnel. The emergency brake should be labeled for

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identification purposes, but adequacy of application should be demonstrated by acceptance test and periodic tests.

Furthermore, the Maintenance Control Program (MCP) should cover emergency brake maintenance and repair procedures in lieu of location on the data plate. [Record 09-1761]

Requirements 2.20.8.1, 2.20.8.2, and 2.20.8.3 Revised

RATIONALE: To update the references. [Record 20-1184]

Requirement 2.20.8.2 Revised

RATIONALE: To prevent a car at a landing from starting when the broken suspension means is actuated. To use the same Section 1.3 defined term "next available landing" as used in requirement 2.20.8.3. To remove the condition of only when moving for registered demand. To acknowledge the car may not stop in a controlled manner due to the "bird nesting" of the broken suspension means and that the car may not be able to reach the next available landing. To minimize entrapments by requiring the car to attempt to run to the next available landing and automatically open the doors. [Record 18-0867]

Requirement 2.20.8.3 Revised

RATIONALE: To require safety operations to be operative with 60% or greater residual strength. With an initial minimum factor of safety described in Table 2.20.3, the suspension means have enough strength at 60% to operate the limited additional trips during an emergency.

By requiring Phase I recall operation, the arriving firefighters can immediately account for elevators instead of consuming manpower to investigate cars shutdown away from the lobby. Removing elevators from firefighters during Phase II operation will have a significant impact on their effectiveness by significantly increasing time to access the floor(s) on fire, reduce the ability to quickly rescue the injured, and reduce the ability to move mobility-limited occupants away from dangerous conditions.

To require Flood Detection Operation to move the car above the safe flood elevation during a flood event to mitigate injury to passengers and equipment damage.

To require Occupant Evacuation Operation (OEO) so as to not reduce evacuating capacity of a building during an emergency and to not increase demand on stairways that are being used by firefighters.

To require Earthquake Operation to evacuate passenger from an elevator and to move the car away from a counterweight derailment.

To prevent a car at a landing from starting when actuated and to minimize entrapment by automatically opening the doors if at a landing. [Record 18-0867]

Requirement 2.22.4.8 Revised

RATIONALE: Updated cross-reference for revised proposal. [Record 19-931]

Requirement 2.24.3 Revised

RATIONALE: Brake components have to conform with driving machine factors of safety. [Record 17-3271]

Requirement 2.24.8.3 Revised

RATIONALE: Brake components have to conform with driving machine factors of safety. [Record 17-3271]

Requirement 2.24.8.5 Revised

RATIONALE: Revised driving machine brake data and marking plate requirements to address adjustable and nonadjustable brakes and to agree with 8.6.4.6.2. Added classifications for adjustable brakes and nonadjustable brakes. Added different methods of sealing adjustable and nonadjustable brakes. Revised 8.6.1.2.2 onsite documentation requirements to include unique or product-specific procedures or methods required for nonadjustable brakes and to agree with 8.11.1.7. Revised 8.6.4.20.4 to address nonadjustable brakes. Revised 8.6.4.6.1 and clarified 8.6.4.6.2 for driving machine brakes related to holding and decelerating capacity (see 2.24.8.3). 2.24.8.3 clearly requires that the driving machine brake must be capable of decelerating the empty car in the up direction within defined parameters. This has been in ASME A17.1/CSA B44 since 2000. Capacity has a common definition that includes "the amount that something can produce." [Record 19-2457]

Requirement 2.24.8.7, including 2.24.7.8.1, 2.27.8.4.2, and 2.27.8.4.3 Added

RATIONALE: Revised driving machine brake data and marking plate requirements to address adjustable and nonadjustable brakes and to agree with 8.6.4.6.2. Added classifications for adjustable brakes and nonadjustable brakes. Added different methods of sealing adjustable and nonadjustable brakes. Revised 8.6.1.2.2 onsite documentation requirements to include unique or product-specific procedures or methods required for nonadjustable brakes and to agree with 8.11.1.7. Revised 8.6.4.20.4 to address nonadjustable brakes. Revised 8.6.4.6.1 and clarified 8.6.4.6.2 for driving machine brakes related to holding and decelerating capacity (see 2.24.8.3). 2.24.8.3 clearly requires that the driving machine brake must be capable of decelerating the empty car in the up direction within defined parameters. This has been in ASME A17.1/CSA B44 since 2000. Capacity has a common definition that includes "the amount that something can produce." [Record 19-2457]

Requirement 2.26.1.4.2 Revised

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RATIONALE: To clarify that the transfer switch is permitted to be included in the portable unit. [Record 19-2777]

Requirement 2.26.1.7.1 Revised

RATIONALE: To require a unique software identifier (USI) update when there are changes to test enable operation.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out"). (See 2.26.14.1)

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)]

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position. (see 2.26.14.1.1(g) and 2.26.14.5)

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed, which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirements 2.26.1.7.1 and 2.26.1.7.2 Revised

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To point to the requirements for the means to permit on-site software download or to modify parameters of executable software requiring a USI and to add additional critical software functions not covered in the current Code. [Record 20-2624]

Requirement 2.26.2 Revised

RATIONALE: To create an abbreviation for electrical protective devices to formalize commonly used vernacular.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is setup ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)]

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position (see 2.26.14.1.1(g) and 2.26.14.5).

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.26.2.38 Revised

RATIONALE: Movement of the car while people were on pit ladders has caused injuries and fatalities. This proposal adds protection for when a person is on a pit ladder, preventing all movement of the car. References were updated to correspond with the addition of the ladder electrical device. The requirement in 2.26.2.38(a) was removed since it is redundant.

Recognition of a SIL rated device was added to Table 2.26.4.3.2. The proposed SIL rating is the same as other similar devices. This proposal complements other proposals under consideration for safely accessing the hoistway and working in the pit. [Record 21-0810]

Requirement 2.26.4.2 Revised

RATIONALE: Requirement 2.26.4.2 has been a source of concern for some readers. Some have interpreted the clause to mean that all electrical equipment must be listed/certified and labeled/marked using CSA B44.1/ASME A17.5. The second sentence of the clause was an attempt to help the reader understand when CSA B44.1/ASME A17.5 is applicable, but there is still ambiguity within the current 2.26.4.2 wording as related to the scope of CSA B44.1/ASME A17.5.

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The scope of CSA B44.1/ASME A17.5 indicates that it is intended to apply to electrical equipment for elevators, escalators, moving walks, dumbwaiters, material lifts, and elevating devices for persons with physical disabilities, including

(a) motor controllers
(b) motion controllers
(c) operation controllers
(d) operating devices
(e) all other electrical equipment not listed/certified and labelled/marked according to another product safety standard or code

CSA B44.1/ASME A17.5 does not include appropriate requirements for every imaginable type of component that exists, and was never intended to be applied to devices for which component standards already exist, only for the specific elevator type equipment enumerated in (a) through (d) and to devices for which no safety standard currently exists, as indicated in (e).

Requirement 1.5 of CSA B44.1/ASME A17.5 also includes a statement that the Standard does not apply to devices rated for connection to extra-low-voltage Class 2 supply circuits. Many have interpreted this to mean that any component rated 30 V rms or less need not comply with CSA B44.1/ASME A17.5 (or any other standard).

In reality, requirement 1.5 of CSA B44.1/ASME A17.5 applies only to devices that are in extra-low-voltage Class 2 circuits, which are very specifically defined in the Canadian and National Electrical Codes, and require very special installation considerations, including separation of Class 2 circuits from all other circuits. Furthermore, even when a circuit is a Class 2 circuit, if failure of the circuit or a device in the circuit will introduce a life hazard (such as rendering an electrical protective device ineffective), it must be treated as a Class 1 circuit (see CSA C22.1, rule 16-010), and any of the requirements for Class 1 circuits are applicable, including the need for devices to be listed/certified.

This proposal expands requirement 2.26.4.2 to encompass all of these considerations, which will more clearly communicate the requirements for listing/certification of electrical equipment. The base requirement is that electrical equipment shall be listed/certified and labeled/marked. The new requirements 2.26.4.2.1 through 2.26.4.2.3 clarify which devices must comply with CSA B44.1/ASME A17.5, which devices must comply with other approved component standards applicable to the country where the equipment is installed (e.g., Canada or the U.S.), and which devices are not required to be listed/certified.

Expanding requirement 2.26.4.2 as proposed will result in a more uniform understanding of the listing/certification requirement for all stakeholders and reduce the likelihood that noncompliant devices will be used in low-voltage circuits that could affect the safety of an elevator system. [Record 18-531]

Requirement 2.26.4.3 and Table 2.26.4.3.2 Revised

RATIONALE: To provide the requirements for the test enable device pertaining to electrical equipment and wiring.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position (see 2.26.14.1.1(g) and 2.26.14.5).

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.26.4.3.1 Revised

RATIONALE: Movement of the car while people were on pit ladders has caused injuries and fatalities. This proposal adds protection for when a person is on a pit ladder, preventing all movement of the car. References were updated to correspond with the addition of the ladder electrical device. The requirement in 2.26.2.38(a) was removed since it is redundant.

Recognition of a SIL rated device was added to Table 2.26.4.3.2. The proposed SIL rating is the same as other similar devices. This proposal complements other proposals under consideration for safely accessing the hoistway and working in the pit. [Record 21-0810]

Table 2.26.4.3.2 Revised

RATIONALE: Movement of the car while people were on pit ladders has caused injuries and fatalities. This proposal adds protection for when a person is on a pit ladder, preventing all movement of the car. References were updated to correspond with the addition of the ladder electrical device. The requirement in 2.26.2.38(a) was removed since it is redundant.

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Recognition of a SIL rated device was added to Table 2.26.4.3.2. The proposed SIL rating is the same as other similar devices. This proposal complements other proposals under consideration for safely accessing the hoistway and working in the pit. [Record 21-0810]

Requirement 2.26.4.5 Revised

RATIONALE: Revise text to be consistent with the new definition for “main line power.” [Record 19-1696]

Requirement 2.26.5 Revised

RATIONALE: To add clarity to the Code via a reference in 2.26.5 that points to an exception to a portion of the requirement that exists in another section of the Code. [Record 17-2250]

Requirements 2.26.5 and 2.26.5.1 Revised and added, respectively

RATIONALE: To provide an exception to allow the door closed button to function on Phase II operation during a false triggering of the door monitoring means where the hoistway door has become uncoupled from the car door allowing the hoistway door to close while the car door remains open. This protects from stranding a firefighter at a fire floor by allowing the fault condition to be cleared by closing the car door with the constant pressure door closed button.

NOTE: Requirement 2.27.3.3.9 was added to the 2022 edition of the Code. See Record 17-2250.

Editorially revised using the term "door locked detection means," to be consistent with the newly defined term in Record 09-500, which has been approved for ASME A17.1-2019/CSA B44:19.

Editorially revised to eliminate the redundancy of clause (3), which is just a combination of clauses (1) and (2). Renumbered clause (4) to (3). [Record 13-806]

Requirement 2.26.5.2 Added

RATIONALE: To add a separate requirement addressing the monitoring of the position of the car door in the case of automatic car doors with manually operated swing hoistway doors.

To clarify the monitoring is not required for the closed position of the swing hoistway door, but for the retiring cam interlock device (see 2.12.2.5). [Record 13-806]

Requirement 2.26.7 Revised

RATIONALE:

(a) To update the title to indicate a more performance-based requirement.

(b) To expand the requirement to allow hardware, software, and parameters to be involved with rendering electrical protective devices ineffective but only under the provisions of this new requirement 2.26.14 [see 2.26.7(f)].

(c) Editorial change to place the 2.26.7 exceptions in a list for clarification.

(d) Correct the reference for the electrical protective devices that can be bypassed by a hoistway access switch in (b).

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up (“Armed”) to have an electrical protective device made ineffective (“Jumped out”) (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)]

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5]

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the “LIMITED” position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the “OFF” position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.26.9.3.1(d) Revised

RATIONALE: Single failure protection is already addressed in 2.26.9.3.1(a) through 2.26.9.3.1(e) for various modes of operation. Change to 2.26.9.3.1(d) made to identify new requirements in 2.26.14 for single failure protection of test enable operation to prevent car operation other than from inspection operating devices or the test initiating means and not permit power operation of the hoistway door and car door or gate.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up (“Armed”) to have an electrical protective device made ineffective (“Jumped out”) (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

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(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5)

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for trouble-shooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.26.9.3.1(f) Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To require single failure protection of the means that will prevent changes to executable software or safety related parameters. [Record 20-2624]

Requirement 2.26.11 Revised

RATIONALE: This proposal intends to revise nomenclature for ICC/ANSI A117.1 so that the entire ASME A17.1/CSA B44 document reflects the accurate characters used by both the referenced standard and ASME A17.1/CSA B44, Section 9.1. [Record 21-1058]

Requirement 2.26.12.3 Revised

RATIONALE: This proposal intends to revise nomenclature for ICC/ANSI A117.1 so that the entire ASME A17.1/CSA B44 document reflects the accurate characters used by both the referenced standard and ASME A17.1/CSA B44, Section 9.1. [Record 21-1058]

Requirements 2.26.13 and 2.26.13.1 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

Provide notification to on-site elevator personnel that remote interaction operation (RIO) functionality is provided. [Record 20-2624]

Requirement 2.26.13.2 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To identify actions RIO is permitted to perform when an elevator is on automatic operation. [Record 20-2624]

Requirement 2.26.13.2 Notes (1) and (2) added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To specify the possible interactive functions of RIO during automatic operation and help to prevent miscommunication of requested changes to secured floor(s) between authorized persons in the building with those utilizing RIO. [Record 20-2624]

Requirement 2.26.13.3 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to

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elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To specify restrictions for RIO for electric elevators. [Record 20-2624]

Requirement 2.26.13.3(i) Note added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To provide guidance that there should not be conflict in the information displayed in other building information systems, such as building management systems or traffic displays, on the status of the automatic operation of the elevators. [Record 20-2624]

Requirement 2.26.13.4 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To specify restrictions for RIO for electric elevators. [Record 20-2624]

Requirement 2.26.13.5 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To specify design criteria on RIO. [Record 20-2624]

Requirement 2.26.13.5 Note added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To provide guidance that there should not be conflict in the information displayed in other building information systems, such as building management systems or traffic displays, on the status of the automatic operation of the elevators. [Record 20-2624]

Requirement 2.26.13.6 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To specify personnel restrictions when utilizing RIO. [Record 20-2624]

Requirement 2.26.14 Added

RATIONALE: To allow test enable operation to make one or more electrical protective devices ineffective for limited and/or general tests but only within specific control conditions reducing the need for hard wire jumpers that could be accidently left in place. This new requirement expands the list of means currently in 2.26.7(a) through 2.26.7(e) to add test enable operation. Test

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enable operation is similar to the other means that are currently permitted to make electrical protective devices ineffective for maintenance, troubleshooting, inspection, and tests. This is done in a safe-state operating mode, and without the need to manage the use of wire jumpers that could be inadvertently left in place. Also, to allow making ineffective electrical protective devices implemented with new technology, such as SIL rated devices for the same purposes, that cannot be simply bypassed with wire jumpers. To clarify that the test enable operation cannot reset any electrical protective devices that require a manual reset and traction-loss detection means during a limited or general test.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirements 2.26.14.1 and 2.26.14.2 Added

RATIONALE: To provide the requirements for the test enable device pertaining to function, location, marking and security, and electrical equipment and wiring.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)]

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620].

Requirements 2.26.14.3 and 2.26.14.3.1 through 2.26.14.3.6 Added

RATIONALE: To define the scope and function of the electrical protective devices that can be made ineffective for the "LIMITED" position of the test enable device and the electrical protective devices that apply to the applicable test. To distinguish that limited tests are for testing and inspection purposes only.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5]

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.26.14.3.7 Added

RATIONALE: To ensure that the electrical protective devices were functional before the test is initiated and to ensure that all the corrective actions are taken prior to resetting a safety device that requires a manual reset.

The following are safety benefits provided in this proposed permissive Code change:

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(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5]

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.26.14.3.8 Added

RATIONALE: To alert elevator personnel that Phase I Emergency Recall Operation has initiated while utilizing TED.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.26.14.3.9 Added

RATIONALE: To ensure that a car in motion during a limited test, is brought to an emergency stop if any seismic event actuates the seismic device or counterweight displacement device.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5]

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.26.14.4 Added

RATIONALE: To define the scope and function of the electrical protective devices that can and cannot be made ineffective for the "General" position of the test enable device and the limitations that apply to the applicable test.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

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(f) Provides enhanced safety features not present with the use of jumpers which are also used for trouble-shooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.26.14.5 Added

RATIONALE: To define the conditions under which any test that is under the purview of test enable operation is to be terminated except where permitted in other sections of the Code.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for trouble-shooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.26.14.6 Added

RATIONALE: To require monitoring when the test initiating means is causing any electrical protective device to be made ineffective by test enable operation. In the general test mode the car is under the control of constant pressure Inspection Operation.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for trouble-shooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.26.14.7 Added

RATIONALE: To define the documentation that is required when test enable operation is provided and to require that the associated test enable device is identified in on-wiring diagrams and on-site.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5)

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for trouble-shooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.27.1.1.3 Revised

RATIONALE: Elevator occupant interaction with the car operating panel is by pressing buttons on the panel, therefore it is self-evident to initiate a call for help requires pressing the phone button. The phone symbol in Table 2.26.12.1 is the minimum essential information required to operate the communication system. The proposal clarifies that it is permitted to provide additional operating instructions, if needed, on or adjacent to the phone push button.

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The message display panel is not addressed by any reference code, standard, or specification in Part 9 of this Handbook, therefore it is added here. The character font size is identical to the proven accessibility requirements for similar direct interactive systems such as required for automatic teller machines and are machines as specified in ADA/ABAAG and ICC/ANSI A117.1. The font style is identical to general visual character required in ICC/ANSI A117.1-2017, section 703.2.3. [Record 19-2267]

Requirement 2.27.1.1.3 Revised

(a) To clarify that a phone push button is always required to be on the car station that contains the "FIRE OPERATION" key switch so when the hearing-impaired message display is not located on that car operating panel a visually impaired passenger can still be accommodated. The message display added in ASME A17.1-2019/CSA B44:19 was not intended to reduce the access to the emergency communication phone push button for a visually impaired passenger who will try to locate a phone push button by touch on a car operating panel.

(b) To clarify there was never a prohibition preventing multiple phone push buttons. All phone push buttons without a message display are required to have a visual indication to acknowledge communication is established.

(c) The message display location was incorporated into 2.27.1.1.3(c) to eliminate redundant language. A message display is not required to be on the same panel that contains the "FIRE OPERATION" key switch. [Record 21-0166]

Requirement 2.27.1.1.3(a) Revised

RATIONALE: This proposal intends to revise nomenclature for ICC/ANSI A117.1 so that the entire ASME A17.1/CSA B44 document reflects the accurate characters used by both the referenced standard and ASME A17.1/CSA B44, Section 9.1. [Record 21-1058]

Requirement 2.27.1.1.4 Revised

(a) To clarify that a phone push button is always required to be on the car station that contains the "FIRE OPERATION" key switch so when the hearing-impaired message display is not located on that car operating panel a visually impaired passenger can still be accommodated. The message display added in ASME A17.1-2019/CSA B44:19 was not intended to reduce the access to the emergency communication phone push button for a visually impaired passenger who will try to locate a phone push button by touch on a car operating panel.

(b) To clarify there was never a prohibition preventing multiple phone push buttons. All phone push buttons without a message display are required to have a visual indication to acknowledge communication is established.

(c) The message display location was incorporated into 2.27.1.1.3(c) to eliminate redundant language. A message display is not required to be on the same panel that contains the "FIRE OPERATION" key switch. [Record 21-0166]

Requirement 2.27.1.1.4(g) Added

RATIONALE: There is a need for security and consistency in a location within the buildings for communications means to aid emergency personnel upon arrival at an incident in high-rise buildings and where there is no fire command center or central alarm and control facility, for quicker accessibility to the communications to the entrapped passengers. Past inquiries (Records 13-1790 and 09-2221) raised questions on location and communication between emergency personnel and trapped passengers. The harmonization of the ASME A17.1 and CSA B44 Codes introduced the ability to communicate with trapped passengers from a location within the building accessible to emergency personnel. The technology changes in how to communicate with the deaf, hard of hearing, speech impaired, and blind have highlighted this need. [Record 19-2266]

Requirement 2.27.2 Revised

RATIONALE: Revise text to be consistent with the new definitions for "normal building power" and "emergency or standby power." Also, editorial change from "capable of operating" to "sufficient to operate." Also, editorial change to remove "the" from the ASME A17.1-2019/CSA B44:19 revised 2.27.2.4.1. [Record 19-1696]

Requirement 2.27.2.1.1 Added

RATIONALE: To provide information within the Code to better define the standby power requirements for occupant evacuation elevators. [Record 18-0872]

Requirement 2.27.2.2.1 Added

RATIONALE: To require that an elevator that is operating under Occupant Evacuation Operation be restored to that operation when there is a failure and subsequent restoration of electrical power. See requirement 2.27.3.4 for a similar requirement. [Record 18-0872]

Requirement 2.27.2.4.4 Revised

RATIONALE: To ensure the emergency power recall level is above the safe minimum elevation during a flood event.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into

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floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.27.2.4.4 Revised

RATIONALE: To clarify that Firefighters' Emergency Operation or Occupant Evacuation Operation are not in conflict with test enable operation.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.XX.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirements 2.27.2.4.4 and 2.27.2.4.5 Revised

RATIONALE: To clarify that since each elevator with OEO is supplied by both normal power and Type 60 (the transfer switch will not be without power for more than 60 seconds)/Class 2 (must operate for a minimum of 2 hours at rated load)/Level 1 (have enhanced reliability and features) standby power, all elevators designated for occupant evacuation should continue to run simultaneously on OEO, without interruption. Additional changes to address additional occupant evacuation elevators as defined by the building code operating on OEO that are not required by building code for occupant evacuation. [Record 18-0872]

Requirement 2.27.2.5 Revised

RATIONALE: Revise text to be consistent with the new definitions for "emergency or standby power" and "main line power." Also, editorial changes were made. [Record 19-1696]

Requirement 2.27.3 Revised

RATIONALE: To ensure the alternate recall level, during a flood event, is above the safe minimum elevation (or the highest available landing). In most situations firefighters will access the elevators at the designated level. The deletion of the "designated level" will minimize the delay of firefighters in accessing the elevator when a flood is not occurring.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.27.3.1 Revised

RATIONALE: To provide updated reference to Flood Detection Operation.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.27.3.1.1 Revised

RATIONALE To specify an acceptable range for the height of the fire recall switch above the finished floor to be readily accessible to firefighters. This is based on established heights for phone jacks in NFPA 72. [Record 20-1715]

Requirement 2.27.3.1.6 Revised

RATIONALE: To clarify that the prescribed operation is initiated when the fire recall switch is placed in the "ON" position and not that the operation takes place only while the switch is maintained in the "ON" position. See also Record 16-1297. [Record 17-1011]

Requirement 2.27.3.1.6(n) Revised

RATIONALE: Revise text to be consistent with the new definition for "normal building power" and "emergency or standby power." [Record 19-1696]

Requirement 2.27.3.2 Revised

RATIONALE: To address the scenario where a hoistway smoke detector is required to activate the smoke relief equipment upon smoke detection to vent the hoistway. This detector should also be required to activate Phase I recall. The term "smoke relief equipment" is used in NFPA 72. [Record 19-2268]

Requirements 2.27.3.2.1 and 2.27.3.2.2 Revised

RATIONALE: If the pit sprinkler required by NFPA 13 does not cause unsafe elevator operation per section 2.8.3.3.2, the elevator should not be required to recall on Phase I

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Emergency Recall Operation and therefore it should not be necessary to install a FAID in the pit. Per NFPA 13 when sprinklers are required in the pit they must be installed not more than 600 mm (24 in.) above the pit floor.

Also, per NFPA 72-2019, Section 21.3.7, the FAID installed in the pit must be accessible from outside the hoistway. Any time the elevator is taken out of service for testing, inspection, or repair of the pit FAID, it may be out of service for a long period of time, which may prevent access for the building occupants.

The exclusion of the pit FAIDs, as proposed, will increase safety, will eliminate difficult coordination for building owners between elevator mechanics and fire alarm personnel, and will prevent potential disruption to building occupants in need of the elevator. [Record 18-2825]

Requirement 2.27.3.2.6 Revised

RATIONALE: For automatic elevators, to require that the visual signal must not change from intermittent illumination to continuous illumination until the fire recall switch is turned to reset. To ensure that the change in the status of the visual signal does not change with the change in status of the FAID. The intent of the flashing indicator was to let firefighters know that the Phase I recall was initiated from a location where there is elevator equipment and the elevator equipment may be compromised. [Record 20-1143]

Requirement 2.27.3.3.1 Revised

RATIONALE: To provide updated reference to Flood Detection Operation.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.27.3.3.1(n) Revised

RATIONALE: Revise text to be consistent with the new definitions for "normal building power" and "emergency or standby power." [Record 19-1696]

Requirement 2.27.3.3.2 Revised

RATIONALE: Revise text to be consistent with the new definitions for "normal building power," "emergency or standby power," and "auxiliary power supply." [Record 19-1696]

Requirement 2.27.3.3.4 Revised

RATIONALE: Revise text to be consistent with the new definitions for "normal building power," "emergency or standby power," and "auxiliary power supply." [Record 19-1696]

Requirement 2.27.3.3.5 Revised

RATIONALE: If Phase I had been activated by the FAID at the designated level the car should not exit Phase II at the designated level unless the recall level is changed by the fire recall switch(es). Once the elevator exits Phase II, the elevator will then revert to Phase I or automatic operation. [Record 21-0783]

Requirement 2.27.3.3.9 Added

RATIONALE: To allow the firefighters, only when on Phase II Emergency In-Car Operation, to maintain maximum control of the elevator by being able to close the car door in the event that a faulty hoistway door contact is falsely indicated due to the car and hoistway doors being decoupled. Here the problem is not a faulty door contact but a mechanical problem with the hoistway door coupling means. In this scenario the firefighter is stuck in the car with the car door fully open, with the hoistway door fully closed and with the hoistway door interlock contact made up but not faulty. Under this proposal, if the door close button remains active, the firefighter is able to clear the fault with continuous pressure on the door close button to close the car door. With both doors now closed, the firefighters will be able to evaluate the situation and exercise their judgement, i.e., continue using the elevator noting an issue with the hoistway/car door coupling at one floor or move to a safe floor to exit the elevator.

If a faulty hoistway door contact existed on any operation prior to calling for Phase II Emergency In-Car Operation, the elevator would be shut down and not available for Phase II Emergency In-Car Operation in the first place.

For the door coupling issue that this proposal addresses, the faulty door contact monitor would detect the problem on any operation other than Phase II Emergency In-Car Operation the first time the elevator stops at the floor with the defective door coupling means. The only way to recover the car is to be on Phase II Emergency In-Car Operation and use the door close button to fully close the car door. This is only possible if the decoupling problem occurs while on Phase II Emergency In-Car Operation. In that case, the apparent faulty door contact is not overridden or ignored but cleared. Under this proposal the faulty door contact-monitoring function will remain active at all times. Instead it is the disabling the door close button after the condition is detected when on Phase II Emergency In-Car Operation that is at issue. If the car doors are open in any scenario, the car will not run. In addition, a faulty car door contact will still be

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detected on Phase II Emergency In-Car Operation. [Record 17-2250]

Requirement 2.27.3.4 Revised

RATIONALE: Revise text to be consistent with the new definitions for "normal building power" and "emergency or standby power." [Record 19-1696]

Requirement 2.27.3.4 Revised

RATIONALE: For the car doors to remain open when power is removed requires the mechanical resistance of the door operator and/or car doors to overcome the closing force of the mechanical door closers used to comply with requirement 2.11.3. 1. Modern door operators are designed for minimal wear therefore provide little mechanical resistive force. The door closers can in certain cases mechanically fully close both the car and hoistway doors when power is removed. This change restores control of the car to the firefighter should this occur. To clarify that once the car recovers on "HOLD" operation it shall conform to the requirements of 2.27.3.3.2. [Record 20-1142]

Requirement 2.27.4.2 Revised

For automatic elevators, to require that the visual signal must not change from intermittent illumination to continuous illumination until the fire recall switch is turned to reset. To ensure that the change in the status of the visual signal does not change with the change in status of the FAID. The intent of the flashing indicator was to let firefighters know that the Phase I recall was initiated from a location where there is elevator equipment and the elevator equipment may be compromised. [Record 20-1143]

Requirement 2.27.6 Revised

RATIONALE: To clarify that Firefighters' Emergency Operation or Occupant Evacuation Operation are not in conflict with test enable operation.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for trouble-shooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 2.27.6 Revised

RATIONALE: To coordinate with revisions made in 2.27.12.1(e) to ensure that the audible signal is activated during Flood Detection Operation.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.27.10 Revised

RATIONALE: To prohibit any class of freight elevators and hydraulic elevators from being designated as Fire Service Access Elevators or Firefighters' Elevators. NFPA 13 requires sprinklers in the hoistway for freight elevators and sprinklers in machine rooms of hydraulic elevators while the building code prohibits sprinklers in the hoistway and machine rooms for Fire Service Access Elevators. [Record 18-2826]

Requirement 2.27.10.1 Revised

RATIONALE: To provide general illumination throughout the hoistway, in addition to the pit and car top lighting, to improve the visibility for locating the car or counterweight in the hoistway and to improve the situational awareness of a potential fall hazard without reducing the current hoistway lighting requirements. The 50 lx (5 fc) is harmonized with EN 81-20 and ISO 8100-1. The manual switches are provided to allow the lights to be turned on when the control system is locked out and tagged out. To provide additional hoistway lighting to aid firefighters when FEO is in effect. Safe and convenient access from the car top is needed to allow maintenance and/or service of the lighting. [Record 16-3037]

Requirement 2.27.10.1 Revised

RATIONALE: Editorially revised to provide guidance for identifying Fire Service Access Elevators. [Record 20-174]

Requirement 2.27.11.2.2 Revised

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RATIONALE: This proposal intends to revise nomenclature for ICC/ANSI A117.1 so that the entire ASME A17.1/CSA B44 document reflects the accurate characters used by both the referenced standard and ASME A17.1/CSA B44, Section 9.1. [Record 21-1058]

Requirement 2.27.11.6.1 Revised

RATIONALE: To assist in the use of elevators, the phrase "press button for evacuation" on the variable message displays is more instructive to the occupants that a landing call must be placed in order for the elevator system to be used. Once the landing call is placed, the appropriate ETA will be displayed on the variable message display. The ETA being displayed after that landing call has been registered is a byproduct of the demand and only information for the potential passenger to help make a decision on which route to take, stairs or elevator. [Record 20-1675]

Requirement 2.27.11.6.2 Revised

RATIONALE: This proposal intends to revise nomenclature for ICC/ANSI A117.1 so that the entire ASME A17.1/CSA B44 document reflects the accurate characters used by both the referenced standard and ASME A17.1/CSA B44, Section 9.1. [Record 21-1058]

Requirements 2.27.12, 2.27.12.1, and 2.27.12.2 Added

RATIONALE: To provide general requirements and provide limitations on what components related to an emergency responder radio coverage (ERRC) can be installed in the elevator car enclosure.

Given the technology currently used by emergency responders and the safety concern of not having reliable emergency responder communications from inside the elevator cab during an emergency, the safety of the building occupants will be enhanced by allowing equipment used by emergency responders to be installed inside the elevator car and in the elevator hoistway that will improve the reliability of these communications. This equipment is currently not addressed by the ASME A17.1/CSA B44 Code for elevators in the U.S. and Canada. The International Fire Code and International Building Code have been revised to require ERRC in buildings in lieu of the fire fighters phone jack system. There is a published national standard, UL 2524 for this equipment.

NOTE: NFPA 1225 is replacing NFPA 1221 and was published in 2021. NFPA 1225 just added all elevators, in addition to elevator lobbies, to be considered critical areas in the building requiring 99% first responder radio coverage (see NFPA 1225, Section 18.8.3).

To provide detailed requirements for the installation, use, and access to ERRC equipment installed in the elevator car enclosure for exclusive use by emergency responders where the immunity test required in EN 12016 and ISO 22200 cover the radio frequencies used in the U.S. EN 12016 covers the frequency range of 80 MHz to 1,960 MHz. ISO 22200 covers a range of 80 MHz to 2,170 MHz. This compares to typical fire department frequencies that are in the VHF high band (150 MHz to 160 MHz) or the UHF ultra-high band (450 MHz to 470 MHz). [Record 19-1766]

Requirement 2.27.12.3 Added

RATIONALE: To provide specific requirements and restrictions for emergency responder radio coverage (ERRC) antennas when installed in the elevator car.

Given the technology currently used by emergency responders and the safety concern of not having reliable emergency responder communications from inside the elevator cab during an emergency, the safety of the building occupants will be enhanced by allowing equipment used by emergency responders to be installed inside the elevator car and in the elevator hoistway that will improve the reliability of these communications. This equipment is currently not addressed by the ASME A17.1/CSA B44 Code for elevators in the U.S. and Canada. The International Fire Code and International Building Code have been revised to require ERRC in buildings in lieu of the fire fighters phone jack system. There is a published national standard, UL 2524 for this equipment.

NOTE: NFPA 1225 is replacing NFPA 1221 and was published in 2021. NFPA 1225 just added all elevators, in addition to elevator lobbies, to be considered critical areas in the building requiring 99% first responder radio coverage (see NFPA 1225, Section 18.8.3).

To provide detailed requirements for the installation, use, and access to ERRC equipment installed in the elevator car enclosure for exclusive use by emergency responders where the immunity test required in EN 12016 and ISO 22200 cover the radio frequencies used in the U.S. EN 12016 covers the frequency range of 80 MHz to 1,960 MHz. ISO 22200 covers a range of 80 MHz to 2,170 MHz. This compares to typical fire department frequencies that are in the VHF high band (150 MHz to 160 MHz) or the UHF ultra-high band (450 MHz to 470 MHz). [Record 19-1766]

Requirement 2.27.12.4 Added

RATIONALE: To provide specific requirements and restrictions for emergency responder radio coverage (ERRC) repeater units when installed in the elevator car.

Given the technology currently used by emergency responders and the safety concern of not having reliable emergency responder communications from inside the elevator cab during an emergency, the safety of the building occupants will be enhanced by allowing equipment used by emergency responders to be installed inside the elevator car and in the elevator hoistway that will improve the reliability of these communications. This

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equipment is currently not addressed by the ASME A17.1/CSA B44 Code for elevators in the U.S. and Canada. The International Fire Code and International Building Code have been revised to require ERRC in buildings in lieu of the fire fighters phone jack system. There is a published national standard, UL 2524 for this equipment.

NOTE: NFPA 1225 is replacing NFPA 1221 and was published in 2021. NFPA 1225 just added all elevators, in addition to elevator lobbies, to be considered critical areas in the building requiring 99% first responder radio coverage (see NFPA 1225, Section 18.8.3).

To provide detailed requirements for the installation, use, and access to ERRC equipment installed in the elevator car enclosure for exclusive use by emergency responders where the immunity test required in EN 12016 and ISO 22200 cover the radio frequencies used in the U.S. EN 12016 covers the frequency range of 80 MHz to 1,960 MHz. ISO 22200 covers a range of 80 MHz to 2,170 MHz. This compares to typical fire department frequencies that are in the VHF high band (150 MHz to 160 MHz) or the UHF ultra-high band (450 MHz to 470 MHz). [Record 19-1766]

Requirement 2.27.12.5 Added

RATIONALE: To allow authorized personnel to access the equipment under prescribed conditions.

Given the technology currently used by emergency responders and the safety concern of not having reliable emergency responder communications from inside the elevator cab during an emergency, the safety of the building occupants will be enhanced by allowing equipment used by emergency responders to be installed inside the elevator car and in the elevator hoistway that will improve the reliability of these communications. This equipment is currently not addressed by the ASME A17.1/CSA B44 Code for elevators in the U.S. and Canada. The International Fire Code and International Building Code have been revised to require emergency responder radio coverage (ERRC) in buildings in lieu of the fire fighters phone jack system. There is a published national standard, UL 2524 for this equipment.

NOTE: NFPA 1225 is replacing NFPA 1221 and was published in 2021. NFPA 1225 just added all elevators, in addition to elevator lobbies, to be considered critical areas in the building requiring 99% first responder radio coverage (see NFPA 1225, Section 18.8.3).

To provide detailed requirements for the installation, use, and access to ERRC equipment installed in the elevator car enclosure for exclusive use by emergency responders where the immunity test required in EN 12016 and ISO 22200 cover the radio frequencies used in the U.S. EN 12016 covers the frequency range of 80 MHz to 1,960 MHz. ISO 22200 covers a range of 80 MHz to 2,170 MHz. This compares to typical fire department frequencies that are in the VHF high band (150 MHz to 160 MHz) or the UHF ultra-high band (450 MHz to 470 MHz). [Record 19-1766]

Requirements 2.27.13, 2.27.13.1(a), and 2.27.13.1 (b) Added

RATIONALE: To ensure that the cars recall to a level above the minimum safe elevation determined by ASCE/SEI 24 (or the highest available landing). For jurisdictions not enforcing the NBCC change to the alternate level for proper interaction with Firefighters' Emergency Operation.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.27.13.1(c) Added

RATIONALE: To ensure that the passengers are not entrapped due to a failure caused by the counterweight descending into flood waters at high speed.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.27.13.1(d) Added

RATIONALE: To ensure that an elevator cannot be dispatched on automatic operation to a floor below the safe minimum elevation during a flood event.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.27.13.1(e) Added

RATIONALE: To provide a warning signal to passengers and elevator personnel during a flood event. Audible signal to be a minimum duration of 30 s and to provide the same audible signal as 2.27.6 for elevator personnel.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.27.13.1(f) Added

RATIONALE: To require manual reset of flood detection means by elevator personnel on-site.

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To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.27.13.2 Added

RATIONALE: To ensure that an elevator cannot be taken to a floor by elevator personnel below the safe minimum elevation and that the counterweight does not descend into flood waters.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.27.13.3 Added

RATIONALE: To ensure safe Earthquake Emergency Operation during a flood event.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.27.13.4 Added

RATIONALE: OEO remains in effect but when Flood Detection Operation is initiated that elevator is no longer able to evacuate passengers safely therefore that elevator shall indicate it is unavailable to the fire alarm system.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 2.28.1(i) Revised

RATIONALE: The design requirements for building elements that support hoistway doors should be applicable to vertical slide and swing-type doors. Currently the requirements are only applicable to horizontal slide doors. This also includes the data required on layout drawings.

This requirement has been moved from 2.11.11.9 to 2.1.1.5 as it is more appropriate to include this requirement in the section (Section 2.1) addressing hoistway enclosure design requirements.

2.11.11.9 has been reserved for future use as 2.11.11.10 is cross-referenced throughout ASME A17.1-2019/CSA B44:19. [Record 20-1726]

Requirement 2.28.1(l) Added

RATIONALE: To require that layout drawings indicate the location of access panels to emergency responder radio coverage (ERRC) antennas installed in the hoistway.

Given the technology currently used by emergency responders and the safety concern of not having reliable emergency responder communications from inside the elevator cab during an emergency, the safety of the building occupants will be enhanced by allowing equipment used by emergency responders to be installed inside the elevator car and in the elevator hoistway that will improve the reliability of these communications. This equipment is currently not addressed by the ASME A17.1/CSA B44 Code for elevators in the U.S. and Canada. The International Fire Code and International Building Code have been revised to require (ERRC) in buildings in lieu of the fire fighters phone jack system. There is a published national standard, UL 2524 for this equipment.

NOTE: NFPA 1225 is replacing NFPA 1221 and was published in 2021. NFPA 1225 just added all elevators, in addition to elevator lobbies, to be considered critical areas in the building requiring 99% first responder radio coverage (see NFPA 1225, Section 18.8.3).

To provide detailed requirements for the installation, use, and access to ERRC equipment installed in the elevator car enclosure for exclusive use by emergency responders where the immunity test required in EN 12016 and ISO 22200 cover the radio frequencies used in the U.S. EN 12016 covers the frequency range of 80 MHZ to 1,960 MHz. ISO 22200 covers a range of 80 MHz to 2,170 MHz. This compares to typical fire department frequencies that are in the VHF high band (150 MHz to 160 MHz) or the UHF ultra-high band (450 MHz to 470 MHz). [Record 19-1766]

Requirement 2.28.1(m) Added

RATIONALE: To provide location on the layout drawing for the hoistway lighting to ensure correct running clearances and illumination requirements are achieved. [Record 16-3037]

Requirement 2.28.1(n) Added

RATIONALE: To require the minimum flood elevation on layout drawings.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 3.7.1 Revised

RATIONALE: To advise Code users that equipment in rooms and spaces may need to be located to suit requirements in ASCE/SEI 24.

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To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 3.18.4.1 Revised

RATIONALE: Reference in ASME A17.1/CSA B44, 3.18.4.1 to requirement 8.10.3.2.2(s) should be revised to 8.10.3.2.2(z). [Record 18-2957]

Requirement 3.22.1.1 Revised

RATIONALE: The requirement addressing elastomeric buffers within another requirement that itself is intended to address the requirements for spring buffers, as evidenced by the reference to 2.22.3.2 in the charging paragraph (3.22.1.2), creates unnecessary confusion. The hydraulic elevator requirements for elastomeric buffers are captured in the opening 3.22.1 by reference to Section 2.22, which includes 2.22.5 ("Elastomeric Buffers"). The reference to

8.2.3.2 is to ensure that the buffer reaction supports are sufficiently designed to consider the impact to the pit floor and buffer support structure, but these requirements are already captured in 3.1.1, which also references 8.2.3. [Record 21-0961]

Requirement 3.24.3.3 Revised

RATIONALE: To simplify checking the liquid level. [Record 16-861]

Requirement 3.26.1(j) Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To specify requirements for RIO for hydraulic elevators. [Record 20-2624]

Requirement 3.26.1.6 Revised

RATIONALE: To allow means necessary for limited and general tests to be applied to hydraulic elevators.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 3.26.3.1.4(a) Revised

RATIONALE: Revise text to be consistent with the new definition for "main line power." [Record 19-1696]

Requirements 3.26.10 and 3.26.10.1 Revised

RATIONALE: Revise text to be consistent with the new definition for "normal building power." [Record 19-1696]

Requirement 3.26.11.1 Revised

RATIONALE: To require a USI update when there are changes to test enable operation.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)]

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

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(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for trouble-shooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 3.26.11.1 Revised

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To add safety relevant functions to executable software requiring a USI and to add additional critical software functions not covered in the current Code. [Record 20-2624]

Requirement 3.26.11.2 Revised

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To point to the requirements for the means to permit on-site software download or to modify parameters of executable software requiring a USI. [Record 20-2624]

Requirement 3.26.12 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To specify restrictions for RIO for hydraulic elevators. [Record 20-2624]

Section 3.27 and Requirements 3.27.1 and 3.27.2 Revised

RATIONALE: Requirement 3.26.3.1.4 permits the anti-creep operation, depending upon the availability of the electric power supply to move the elevator. When the normal power fails and emergency or standby power system is not capable of moving all elevators simultaneously, the power is available to all elevators for door operation but the selection to run is transferred between elevators. When a hydraulic elevator is unselected to run, anticreep operation will not function therefore the doors are to automatically close when the elevator is not selected to run.

Because power is available to all cars, the door open button is required to be operative should someone enter an elevator just prior to being unselected. When the elevator is not selected to run, the door open button is used to exit the elevator and the doors are required to automatically close when the button is released after a short period of time to allow the passenger to exit.

If an elevator fails to run for 30 s for any reason, the selection to run is transferred to another elevator to minimize the delay of evacuating trapped passengers in other elevators. The doors are required to be open when selected or reopen if reselected when at the fire recall level to allow firefighters access for Phase II operation. [Record 20-1141]

Requirement 3.27.5 Added

RATIONALE: To require Flood Detection Operation on hydraulic elevators while making the necessary distinctions between hydraulic and electric elevators including door operation and functions unique to hydraulic elevators.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 3.28.1(p) Added

RATIONALE: To require the minimum flood elevation on layout drawings.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

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Requirement 4.1.26.7 Revised

RATIONALE: To provide an editorial change to Section 4.1 applying to rack-and-pinion elevators.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 4.2.15.11 Revised

RATIONALE: Revise text to be consistent with the new definitions for "normal building power" and "emergency or standby power." [Record 19-1696]

Requirement 4.2.17.1(i) Revised

RATIONALE: To provide an editorial change to Section 4.2 applying to screw column elevators.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 5.1.21.1 Revised

RATIONALE: Revise text to be consistent with the new definitions for "normal building power" and "auxiliary power supply." [Record 19-1696]

Requirement 5.2.1.20 Revised

RATIONALE: To allow alternate suspension means and align requirements with Section 2.20. [Record 18-1574]

Requirement 5.2.1.20.1 Revised

RATIONALE: To allow alternate suspension means and align requirements with Section 2.20. [Record 18-1574]

Requirement 5.2.1.20.1.1 Title added

RATIONALE: To allow alternate suspension means and align requirements with Section 2.20. [Record 18-1574]

Requirement 5.2.1.20.2 Revised

RATIONALE: To allow alternate suspension means and align requirements with Section 2.20. [Record 18-1574]

Requirement 5.2.1.26(f) Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To exclude RIO use on limited-use/limited-application elevators until such time that the ASME A17 Limited-Use/Limited-Application Elevator Committee develops requirements, limitations, etc., for the application of RIO. [Record 20-2624]

Requirement 5.3.1.9.4 Revised

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RATIONALE: To add requirements to ensure adequate lighting at the car operating panel during a power failure using either auxiliary lighting or auxiliary power for the existing lighting. [Record 18-2968]

Requirement 5.3.1.11.1 Revised

RATIONALE: To provide a standard means of measuring the net car platform area as it is currently not defined. [Record 18-979]

Figure 5.3.1.11.1 Added

RATIONALE: To provide a standard means of measuring the net car platform area as it is currently not defined. [Record 18-979]

Requirement 5.3.1.19.9 Revised

RATIONALE: Revise text to be consistent with the new definition for "normal building power." [Record 19-1696]

Requirements 5.3.1.20.1 and 5.3.1.20.2 Revised

RATIONALE: Revise text to be consistent with the new definition for "normal building power" and the use of "a source of emergency power" as used in 2.27.1.1.5. Renumbered in ASME A117.1-2019/CSA B44:19 from 5.3.1.19 to 5.3.1.20. [Record 19-1696]

Requirement 5.3.2.4.4 Revised

RATIONALE: Revise text to be consistent with the new definition for "main line power." [Record 19-1696]

Requirements 5.5.1.25 and 5.5.1.25.5 Revised and added, respectively

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To exclude RIO use on sidewalk elevators until such time that the ASME A17 Hand and Sidewalk Elevator Committee develops requirements, limitations, etc., for the application of RIO. [Record 20-2624]

Requirements 5.6.1.25 and 5.6.1.25.6 Revised and added, respectively

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To exclude RIO use on roof top elevators until such time that the ASME A17 Hand and Sidewalk Elevator Committee develops requirements, limitations, etc., for the application of RIO. [Record 20-2624]

Requirement 5.7.19.7 Revised

RATIONALE: To provide an editorial change to Section 5.7 applying to special purpose personnel elevators.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 5.7.21 Revised

RATIONALE: Revise text to be consistent with the new definitions for "normal building power" and "auxiliary power supply." [Record 19-1696]

Section 5.9 Scope revised

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RATIONALE: To modify Section 5.9 to include requirements for rack-and-pinion mine elevators. [Record 19-106]

Requirement 5.9.2.2 Added

RATIONALE: To better describe a standard railing by referencing the requirements in ASME A17.1/CSA B44. Modification of this section is being proposed to make the language consistent with that typically used in ASME A17.1/CSA B44. [Record 18-2497]

Requirement 5.9.20.2 Added

RATIONALE: Prohibit auxiliary devices permanently attached to the suspension ropes, which are not specified in Section 2.20, that could cause localized corrosion on the suspension ropes in the mine environment or interfere with the required suspension rope examinations. [Record 18-2496]

Requirement 5.9.26 Revised

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To exclude RIO use on mine elevators until such time that the ASME A17 Mine Elevator Committee develops requirements, limitations, etc., for the application of RIO. [Record 20-2624]

Requirement 5.9.26.3 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To exclude RIO use on mine elevators until such time that the ASME A17 Mine Elevator Committee develops requirements, limitations, etc., for the application of RIO. [Record 20-2624]

Requirement 5.9.27 Revised

RATIONALE: Revise text to be consistent with the new definitions for “normal building power” and “emergency or standby power.” [Record 19-1696]

Requirement 5.9.32 Added

RATIONALE: Elevators not complying with Section 5.9 are not safe for use by miners. [Record 19-1354]

Requirement 5.9.33 Added

RATIONALE: Rack-and-pinion elevators installed at mines can be exposed to inadvertent obstructions in the open hoistway. The strength requirements for supplemental mechanical safety devices (i.e., safety hooks, see Diagram 4.1.25.1) will prevent the elevator car pinion and safety pinion from disengaging from the rack under the force of the drive motor and gravity if a hoistway obstruction is struck by the elevator car. [Record 19-106]

Requirement 5.10.1.21.1 Revised

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To exclude RIO use on electric and hydraulic elevators used for construction until such time that the ASME A17 Elevators Used for Construction Committee develops requirements, limitations, etc., for the application of RIO. [Record 20-2624]

Requirement 6.1.3.3.11 Revised

RATIONALE: To add clarifying diagrams for escalator ceiling intersection guards. [Record 15-1375]

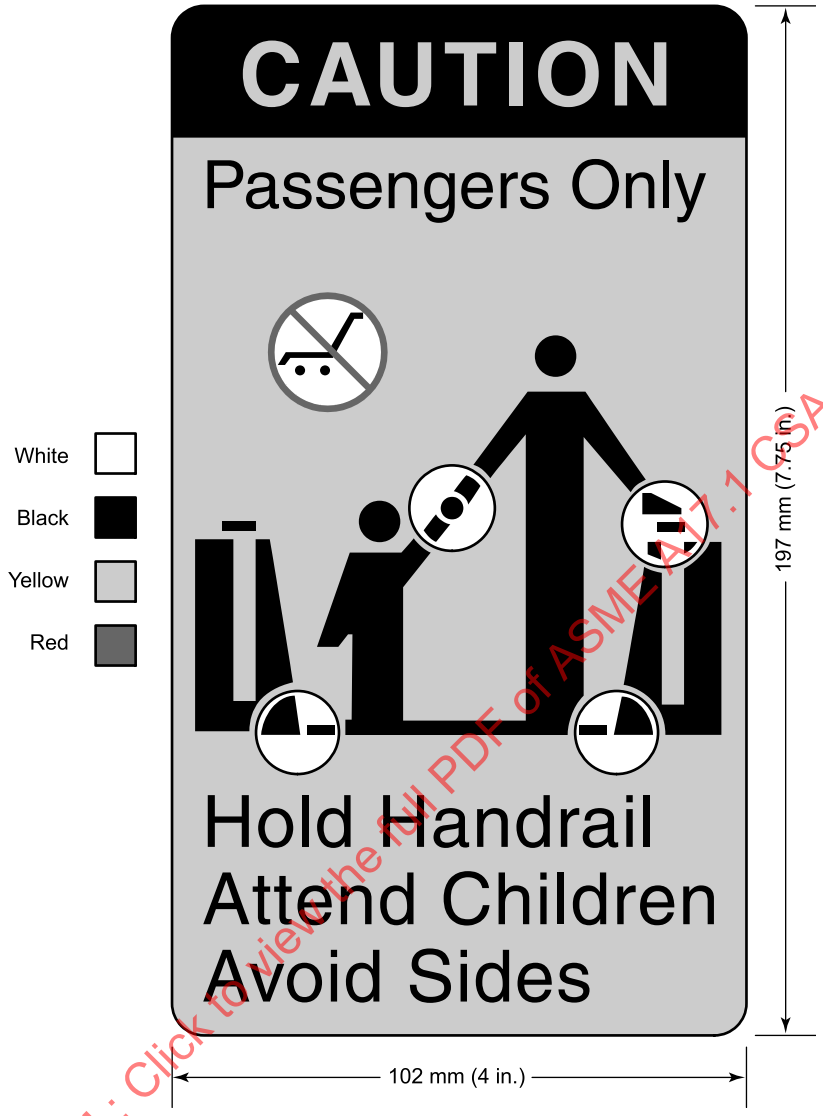
Requirement 6.1.3.4.5 Revised

RATIONALE:

(a) Stability While Riding the Walk. Handrails on escalators and moving walks provide stability for riders on the walk. Height is a key factor for accessibility of reach to take

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Diagram 2
Caution Sign



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hold of the handrail. Reach range is the governing requirement for the ability to take hold of a handrail. Requirements for reach range are specified in accessibility codes. The 2010 Federal ADA Section 308 provides unobstructed side and forward reach requirements for children and adults with disabilities as follows:

(1) Reach range, minimum to maximum, for children ages 9 yr through 12 yr: 400 mm to 1 120 mm (16 in. to 44 in.)

(2) Reach range, minimum to maximum, for adults with disabilities: 380 mm to 1 220 mm (15 in. to 48 in.)

(b) Caution Sign. ASME A17.1/CSA B44 requirements 6.1.6.9.1 and 6.2.6.9.1 require the caution sign in Diagram 2 at the entrances and of the conveyance. Note the young child is not shown holding the handrail but rather holding the adult.

(c) Deterrence Against Misuse. Serious accidents/incidents relevant to both escalator and moving walk handrail height largely involve falls by persons leaning over the handrail or taking a joy ride on top of it. Intuitively the 1 100-mm (43-in.) maximum height permitted under EN 115 provides a greater deterrent to climbing on the handrail than the 1 000-mm (39-in.) limit permitted in the current ASME A17.1/CSA B44 Code.

(d) EN 115 Safety of Escalators and Moving Walks — Part 2

(1) Outside the U.S. and Canada, EN 115 is the predominant code for escalators and moving walks adopted throughout most of the world.

Summary of Handrail Height Comparisons

Code Reference	2010 Federal ADA Sect. 308 (Children 9 yr to 12 yr)	2010 Federal ADA Sect. 308 (Persons With Disabilities)	EN 115 (5.5.2.1)	Pre-ASME A17.1-2000 (902.2)	ASME A17.1-2000 and Later (6.2.3.3.2)
Requirements	1 120 mm (44 in.) maximum	1 220 mm (48 in.) maximum	1100 mm (43 in.)	1 070 mm (42 in.)	1 000 mm (39 in.)
	400 mm (16 in.) minimum	300 mm (15 in.) minimum	900 mm (35 in.)	760 mm (30 in.)	900 mm (35 in.)

(2) For this reason, there are perhaps tens or hundreds of thousands more escalators and moving walks in operation under the EN 115 Code than all the units installed in North America under the ASME A17.1-2000 and later editions.

The EN 115 requirement 5.5.2.1 specifies the balustrade height range from the pallet to the top of the handrail to be 900 mm to 1 100 mm (35.4 in. to 43.31 in.).

(e) Summary of Handrail Height Comparisons. See table.

It can be seen from the table above that the EN 115 maximum vertical height requirement would be well within the maximum height requirements for ADA for children and ADA for persons with disabilities. [Record 20-1564]

Requirement 6.1.5.3.1 Revised

RATIONALE: To require the brake data plate to conform with the new requirements added in ASME A17.1-2019/CSA B44:19, requirement 8.13.1. [Record 20-2919]

Requirement 6.1.5.3.5 Added

RATIONALE: In order to provide an additional means to bring an escalator to a controlled stop in the event of over speed situations resulting from malfunctioning machine braking, a requirement for an auxiliary brake, on higher rise escalators, compliant with machine brake requirements is created. It is to be actuated by overspeed conditions, or, when located on the main shaft and utilized to fulfill main drive shaft brake requirements when it is required, by the drive chain device. The simultaneous application of the driving-machine brake and auxiliary brake should only occur in an overspeed situation. When actuated by a properly operating broken drive chain device, the machine brake is effectively disconnected from the step band. Controlling the escalator in the event of an overspeed situation by applying the auxiliary and machine brakes outweighs the potential hazard of a higher deceleration than normal stop. The auxiliary brake is applied after the escalator is stopped to mechanically exercise the brake components in an effort to ensure reliability. [Record 15-2890]

Requirement 6.1.6.3.2 Revised

RATIONALE: In order to provide an additional means to bring an escalator to a controlled stop in the event of overspeed situations resulting from malfunctioning machine braking, a requirement for an auxiliary brake, on higher rise escalators, compliant with machine brake requirements is created. It is to be actuated by overspeed conditions, or, when located on the main shaft and utilized to fulfill main drive shaft brake requirements when it is required, by the drive chain device. The simultaneous application of the driving-machine brake and auxiliary brake should only occur in an overspeed situation. When actuated by a properly operating broken drive chain device, the machine brake is effectively disconnected from the step band. Controlling the escalator in the event of an overspeed situation by applying the auxiliary and machine brakes outweighs the potential hazard of a higher deceleration than normal stop. The auxiliary brake is applied after the escalator is stopped to mechanically exercise the brake components in an effort to ensure reliability. [Record 15-2890]

Requirement 6.1.6.3.4 Revised

RATIONALE: In order to provide an additional means to bring an escalator to a controlled stop in the event of overspeed situations resulting from malfunctioning machine braking, a requirement for an auxiliary brake, on higher rise escalators, compliant with machine brake requirements is created. It is to be actuated by overspeed conditions, or, when located on the main shaft and utilized to fulfill main drive shaft brake requirements when it is required, by the drive chain device. The simultaneous application of the driving-machine brake and auxiliary brake should only occur in an overspeed situation. When actuated by a properly operating broken drive chain device, the machine brake is effectively disconnected from the step band. Controlling the escalator in the event of an overspeed situation by applying the auxiliary and machine brakes outweighs the potential hazard of a higher deceleration than normal stop. The auxiliary brake is applied after the escalator is stopped to mechanically exercise the brake components in an effort to ensure reliability. [Record 15-2890]

Requirement 6.1.6.4 Revised

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RATIONALE: To make the requirements mandatory. [Record 20-1563]

Requirement 6.1.6.12 Revised

RATIONALE: To provide an editorial change to Section 6.1 applying to escalators.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5]

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective device to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for trouble-shooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirements 6.1.7.4.1 and 6.2.7.4.2 Revised

RATIONALE: Revise text to be consistent with the new definition for "main line power." [Record 19-1696]

Requirement 6.2.3.1 Revised

RATIONALE: The angle of inclination requirement in the walk section was originally written with the assumption that the building floor surface at the landings is always horizontal and specified a maximum angle of inclination of the walk landing to the horizontal. It is not the case that the floors are always horizontal, resulting in a possible excessive angle between the floor and the walk landings, and the requirement is changed to correct for this condition. [Record 18-153]

Requirement 6.2.3.2.2 Revised

RATIONALE:

(a) Stability While Riding the Walk. Handrails on escalators and moving walks provide stability for riders on the walk. Height is a key factor for accessibility of reach to take hold of the handrail. Reach range is the governing requirement for the ability to take hold of a handrail. Requirements for reach range are specified in accessibility codes. The 2010 Federal ADA Section 308 provides unobstructed side and forward reach requirements for children and adults with disabilities as follows:

(1) Reach range, minimum to maximum, for children ages 9 yr through 12 yr: 400 mm to 1 120 mm (16 in. to 44 in.)

(2) Reach range, minimum to maximum, for adults with disabilities: 380 mm to 1 220 mm (15 in. to 48 in.)

(b) Caution Sign. ASME A17.1/CSA B44 requirements 6.1.6.9.1 and 6.2.6.9.1 require the caution sign in Diagram 2 at the entrances and of the conveyance. Note the young child is not shown holding the handrail but rather holding the adult.

(c) Deterrence Against Misuse. Serious accidents/incidents relevant to both escalator and moving walk handrail height largely involve falls by persons leaning over the handrail or taking a joy ride on top of it. Intuitively the 1 100-mm (43-in.) maximum height permitted under EN 115 provides a greater deterrent to climbing on the handrail than the 1 000-mm (39-in.) limit permitted in the current ASME A17.1/CSA B44 Code.

(d) EN 115 Safety of Escalators and Moving Walks — Part 2

(1) Outside the U.S. and Canada, EN 115 is the predominant code for escalators and moving walks adopted throughout most of the world.

(2) For this reason, there are perhaps tens or hundreds of thousands more escalators and moving walks in operation under the EN 115 Code than all the units installed in North America under the ASME A17.1-2000 and later editions.

The EN 115 requirement 5.5.2.1 specifies the balustrade height range from the pallet to the top of the handrail to be 900 mm to 1 100 mm (35.4 in. to 43.31 in.).

(e) Summary of Handrail Height Comparisons. See table.

It can be seen from the table above that the EN 115 maximum vertical height requirement would be well within the maximum height requirements for ADA for children and ADA for persons with disabilities. [Record 20-1564]

Requirement 6.2.3.5.1 Revised

RATIONALE: The current Nonmandatory Appendix I, Figure I-10 contains a mixture of dimensional information from 6.2.3.5.1 for pallet-type treadways and 6.2.3.6.2 for belt-type treadways. ASME A17.1/CSA B44 currently only references the figure in 6.2.3.5.1. The revised graphic clarifies the requirements for the two different treadway types and adds the reference to Figure I-10 in 6.2.3.6.2 for consistency with reference included in 6.2.3.5.1. Requirement 6.2.3.5.1 is revised for consistency of SI and U.S. Customary units between 6.2.3.5.1 and 6.2.3.6.2. [Record 20-2917]

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Summary of Handrail Height Comparisons

Code Reference	2010 Federal ADA Sect. 308 (Children 9 yr to 12 yr)	2010 Federal ADA Sect. 308 (Persons With Disabilities)	EN 115 (5.5.2.1)	Pre-ASME A17.1-2000 (902.2)	ASME A17.1-2000 and Later (6.2.3.3.2)
Requirements	1 120 mm (44 in.) maximum	1 220 mm (48 in.) maximum	1100 mm (43 in.)	1 070 mm (42 in.)	1 000 mm (39 in.)
	400 mm (16 in.) minimum	300 mm (15 in.) minimum	900 mm (35 in.)	760 mm (30 in.)	900 mm (35 in.)

Requirement 6.2.3.6.2 Revised

RATIONALE: The current Nonmandatory Appendix I, Figure I-10 contains a mixture of dimensional information from 6.2.3.5.1 for pallet-type treadways and 6.2.3.6.2 for belt-type treadways. ASME A17.1/CSA B44 currently only references the figure in 6.2.3.5.1. The revised graphic clarifies the requirements for the two different treadway types and adds the reference to Figure I-10 in 6.2.3.6.2 for consistency with reference included in 6.2.3.5.1. Requirement 6.2.3.5.1 is revised for consistency of SI and U.S. Customary units between 6.2.3.5.1 and 6.2.3.6.2. [Record 20-2917]

Requirement 6.2.5.3.1 Revised

RATIONALE: To require the brake data plate to conform with the new requirements added in ASME A17.1-19/CSA B44:19, requirement 8.13.1. [Record 20-2919]

Requirement 6.2.6.3.8 Revised

RATIONALE: In reviewing the ASME A17.1/CSA B44 changes to permit dynamic braking (TN 12-1111) updates, there appears to be an error on the devices identified as permitting dynamic braking. 6.2.6.3.8 was amended to permit dynamic braking in the final version of TN 12-1111. Given that the motor is required for dynamic braking, this appears to be an error (note also that 6.1.6.3.10 does not permit use of dynamic braking). 6.2.6.3.8 needs to revert to its ASME A17.1-2016/CSA B44:16 language or be modified. Dynamic braking cannot stop the moving walk when the motor becomes disconnected from the gear reducer. Reverting to the ASME A17.1-2016/CSA B44:16 does not preclude application of dynamic braking to the disconnected motor for purposes of stopping the free-spinning motor rotor. Electrical power must be removed from the drive machine brake which must be connected to the gear reducer per 6.1.5.3.1(e) and 6.2.5.3.1(e) when the drive motor is attached to a gear reducer by means other than a continuous shaft, mechanical coupling, or toothed gearing. [Record 18-2967]

Requirement 6.2.6.4 Revised

RATIONALE: To make the requirements mandatory. [Record 20-1563]

Requirement 6.2.6.12 Revised

RATIONALE: To provide an editorial change to Section 6.2 applying to moving walks.

General Rationale: The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 7.2.4.1 Revised

RATIONALE: Add safeties to dumbwaiters and their counterweights when provided with only one suspension means. [Record 17-1511]

Requirement 7.2.6.1.1 Revised

RATIONALE: Provide reference to the requirement for safeties when only one suspension means is provided. [Record 17-1511]

Requirement 7.2.6.7 Title revised

RATIONALE: Correct section title to match title of 2.20.8. [Record 18-1150]

Requirement 7.2.8 Revised

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RATIONALE: Clarify that solid bumpers are permitted and include the necessary requirements from Section 2.22. [Record 17-1497]

Requirement 7.2.8.1 Revised

RATIONALE: Changed language to exclude 2.22.1.1.1. Previously, the introductory language excluded 2.22.1 entirely. 2.22.1 has now been included in the requirement, so 2.22.1.1.1 needs to be excluded. Corrected table reference. Prior language incorrectly excluded Table 7.2.8.1 when it should have been included. [Record 17-1497]

Requirement 7.2.8.2 Revised

RATIONALE: Changed language to exclude 2.22.1.1.2. Previously, the introductory language in 7.2.8 excluded 2.22.1 entirely. 2.22.1 has now been included in the requirement, so 2.22.1.1.2 needs to be excluded. Clarified speed requirement for the use of oil buffers. Corrected table reference. Prior language incorrectly excluded Table 7.2.8.2 when it should have been included. [Record 17-1497]

Requirement 7.2.8.3 Added

RATIONALE: Clarify the solid bumpers are permitted and shall conform to the requirements in 2.22.2. [Record 17-1497]

Requirement 7.2.8.4 Added

RATIONALE: Allow elastomeric buffers to be used on dumbwaiters. [Record 17-1497]

Requirement 7.2.12 revised

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To exclude RIO use on electric dumbwaiters without automatic transfer devices until such time that the ASME A17 Dumbwaiter and ATD Committee develops requirements, limitations, etc., for the application of RIO. [Record 20-2624]

Requirement 7.3.11.3.4 Revised

RATIONALE: Revise text to be consistent with the new definition for “main line power.” [Record 19-1696]

Requirement 7.4.9 Revised

RATIONALE: The exception to include 2.7.5.1 was incorrect in TN 05-833. TN 05-833 had four letter ballots and a final editorial revision that was approved by a consensus ruling.

In the first letter ballot of TN 05-833 (LB #05-804), requirement 7.4.9.3 of this proposal was two separate requirements: 7.4.9.4 and 7.4.9.5. See below.

7.4.9.2 Requirement 2.7.4.1 does not apply to Type A material lifts.

7.4.9.3 Requirement 2.7.4.5 does not apply to Type A material lifts.

7.4.9.4 Requirement 2.7.5.1 applies only to Type A material lifts, where a separate machine room is provided and complete bodily entry is necessary. Where a separate machine room is not provided or complete bodily entry is not necessary, requirement 2.7.5.1 does not apply, and permanently installed electric lighting shall be provided in all machinery spaces and control spaces. The lighting control switch shall be located within easy reach of the access to such spaces.

7.4.9.5 Requirement 2.7.x does not apply to Type A material lifts. If maintenance or inspections of the elevator driving-machine brake or an emergency brake, or of elevator motion controllers or motor controllers located in the hoistway, is to be carried out from inside the car or from the car top, a means shall be provided to prevent uncontrolled and unexpected vertical car movement resulting from maintenance or inspection that can be dangerous for personnel on the car top. If maintenance or inspections of the elevator driving-machine brake or an emergency brake or of elevator motion controllers or motor controllers is to be carried out from the pit, a mechanical device shall be provided to stop the car to create a vertical clearance as required by 7.4.6.1.3. A platform located in the car, on the car, or in the hoistway shall be permitted for access to and maintenance and inspection of equipment in machinery spaces or control spaces in the hoistway and shall comply with 2.7.x.3.1 through 2.7.x.3.4. Requirement 7.4.9.4 addresses when permanent lighting is required. In ASME A17.1-2004, 2.7.5.1 addressed machine room lighting requirements.

Requirement 7.4.9.5 addresses car movement when working on the brakes. In this first proposal the final location for some of the references in Section 2.7 are indicated with an “x” as in 2.7.x, 2.7.x.3.1, and 2.7.x.3.4

In the second letter ballot of TN 05-833 (LB #05-1344) the text of 7.4.9.4 and 7.4.9.5 remains the same but the Code references are changed. This section is also

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renumbered slightly as 7.4.9.2 and 7.4.9.3 appear to be merged. 7.4.9.4 became 7.4.9.3 but 7.4.9.5 was not renumbered. See below.

7.4.9.2 Requirement 2.7.4 does not apply to Type A material lifts.

7.4.9.3 Requirement 2.7.5.1 applies only to Type A material lifts, where a separate machine room is provided and complete bodily entry is necessary. Where a separate machine room is not provided or complete bodily entry is not necessary, requirement 2.7.9.1 does not apply, and permanently installed electric lighting shall be provided in all machinery spaces and control spaces. The lighting control switch shall be located within easy reach of the access to such spaces.

7.4.9.5 Requirement 2.7.5 does not apply to Type A material lifts. If maintenance or inspections of the material lift driving-machine brake or an emergency brake, or of material lift motion controllers or motor controllers located in the hoistway, is to be carried out from inside the car or from the car top, a means shall be provided to prevent uncontrolled and unexpected vertical car movement resulting from maintenance or inspection that can be dangerous for personnel on the car top. If maintenance or inspections of the material lift driving machine brake or an emergency brake or of material lift motion controllers or motor controllers is to be carried out from the pit, a mechanical device shall be provided to stop the car to create a vertical clearance as required by 7.4.6.1.3. A platform located in the car, on the car, or in the hoistway shall be permitted for access to and maintenance and inspection of equipment in machinery spaces or control spaces in the hoistway and shall comply with 2.7.5.3.1 through 2.7.5.3.4.

In this second letter ballot, in requirement 7.4.9.3, the references to 2.7.5.1 were not correctly changed. The first reference to 2.7.5.1 was not changed while the second reference was changed to 2.7.9.1. This appears to be where the error in the Code started. The first reference should have been changed to 2.7.9.1 also.

In the third letter ballot of TN 05-833 (LB #06-555) the text previously in 7.4.9.3 and 7.4.9.5 was merged into 7.4.9.3. Due to the error in changing references just mentioned an error occurs. See below.

7.4.9.3 Requirement 2.7.5 does not apply to Type A material lifts except requirement 2.7.5.1 applies only to Type A material lifts, where a machine room is provided and full bodily entry is necessary. If maintenance or inspections of the material lift driving-machine brake or an emergency brake, or of material lift motion controllers or motor controllers located in the hoistway, is to be carried out from inside the car or from the car top, a means shall be provided to prevent uncontrolled and unexpected vertical car movement that poses a hazard to maintenance or inspection personnel. If maintenance or inspections of the material lift driving-machine brake or an emergency brake or of material lift motion controllers or motor controllers is to be carried out from the pit, a mechanical device shall be provided to stop the car to create a vertical clearance as required by 7.4.6.1.3. A platform located in the car, on the car, or in the hoistway shall be permitted for access to and maintenance and inspection of equipment in machinery spaces or control spaces in the hoistway and shall comply with 2.7.5.3.1 through 2.7.5.3.4.

The reference to 2.7.5.1 should be a reference to 2.7.9.1 and does not make sense here. This exception needs to be removed.

The final letter ballot and editorial revision for consensus ruling continue to use the same text. [Record 20-1768]

Requirement 7.5.2.6 Revised

RATIONALE: Require both Type A and Type B material lifts to comply with the deflection requirements for the safety of materials being loaded on and off and the material handler. Previously, there was no requirement for deflection for Type A material lifts. [Record 19-14]

Requirements 7.5.6.2 and 7.5.6.6 Revised

RATIONALE: To align ASME A17.1/CSA B44 with the requirements of ASME B29.1. ASME B29.1 uses only the minimum ultimate tensile strength (MUTS) as the strength requirement. [Record 20-1769]

Requirements 7.5.8 and 7.5.8.1 Revised

RATIONALE: Language changed to be the same as language used in Section 2.22. [Record 17-1497]

Requirement 7.5.8.3 Added (remaining items renumbered)

RATIONALE: Include permission to use elastomeric buffers. [Record 17-1497]

Requirement 7.5.12.1 Revised

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

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To exclude RIO use on Type A electric material lifts without automatic transfer devices until such time that the ASME A17 Dumbwaiter and ATD Committee develops requirements, limitations, etc., for the application of RIO. [Record 20-2624]

Requirement 7.5.12.2 Revised

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To exclude RIO use on Type B electric material lifts without automatic transfer devices until such time that the ASME A17 Dumbwaiter and ATD Committee develops requirements, limitations, etc., for the application of RIO. [Record 20-2624]

Requirement 7.6.8.1 Revised

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To exclude RIO use on hydraulic material lifts without automatic transfer devices until such time that the ASME A17 Dumbwaiter and ATD Committee develops requirements, limitations, etc., for the application of RIO. [Record 20-2624]

Requirement 8.1.2 Revised

RATIONALE: This proposal is to correct an incorrect reference to pit access doors that resulted from changes approved and published in ASME A17.1-2007/CSA B44:07. [Record 18-2811]

Requirement 8.1.2(aa) Added

RATIONALE: To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 8.1.4 Revised

RATIONALE: Revise text to be consistent with the new definition for "emergency or standby power." Also, remove the word "access" from the Note as it does not make sense even though this may not be within the scope of the proposal. [Record 19-1696]

Section 8.3(b)(8) Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To define the engineering test required in 8.14.1 for cybersecurity for elevator components. [Record 20-2624]

Requirement 8.3.16 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To define the engineering test required in 8.14.1 for cybersecurity for elevator components. [Record 20-2624]

Section 8.4 Revised

RATIONALE: Add requirements from NBCC-2015. NBCC-2005 removed based on information provided by a Canadian code expert that this edition is no longer being enforced. [Record 21-1541]

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Requirement 8.4.1.1 Title revised

RATIONALE: To be consistent with the verbiage used in the remainder of the Code. For example, see 2.3.2.3, 2.5.1.2, 2.7.5.2.1, 2.7.2.4, 8.7.2.27.6(b), and 8.7.3.31.7 (b). [Record 18-2792]

Requirement 8.4.1.1.3 Revised

RATIONALE: To be consistent with the verbiage used in the remainder of the Code. For example, see 2.3.2.3, 2.5.1.2, 2.7.5.2.1, 2.7.2.4, 8.7.2.27.6(b), and 8.7.3.31.7 (b). [Record 18-2792]

Requirement 8.4.5.1 Revised

RATIONALE: To editorially simplify the requirement and to combine car and counterweight retainer requirements under one rule since the requirements are identical. [Record 16-0304]

Requirement 8.4.5.2.1 Added (subsequent requirements renumbered) and existing requirement 8.4.5.2.1 revised (now 8.4.5.2.2)

RATIONALE: To add the design force levels as defined in 8.4.13 and 8.4.14 to the requirement 8.4.5.2.2 list.

NOTE: 8.4.13 does not define F_p, instead it references the component force level based on ground motion parameters such as A_v or Z_v. [Record 16-0304]

Existing requirement 8.4.5.2.2 Revised (now 8.4.5.2.3) and Figure 8.4.5.2.3 added

RATIONALE: Figure is added to clarify the relationship of the various dimensions that relate to this requirement. [Record 16-0304]

Requirement 8.4.7.1 Revised

RATIONALE: To add the design force levels as defined in 8.4.13 and 8.4.14 to the requirement 8.4.5.2.1 list.

NOTE: 8.4.13 does not define F_p, instead it references the component force level based on ground motion parameters such as A_v or Z_v. [Record 16-0304]

Requirement 8.4.7.2 Revised

RATIONALE: Requirement 8.4.7.2 is struck out entirely in the proposal. Existing requirements 8.4.5.2.1 and 8.4.5.2.2 are modified and a new requirement, 8.4.5.2.3, is added. [Record 16-0304]

Requirement 8.4.10.1.1(i)(6) Revised

RATIONALE: Revise text to be consistent with the new definitions for "normal building power" and "auxiliary power supply." [Record 19-1696]

Requirement 8.4.10.1.3 Revised

RATIONALE: To add test enable operation priority over seismic with the other manual operations.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1)

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)]

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position. [see 2.26.14.1.1(g) and 2.26.14.5]

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5)

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 8.4.10.1.3(d) Added

RATIONALE: To advise that hoistway scan operation does not operate during Flood Detection Operation.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Requirement 8.4.12.2.2(b) Revised

RATIONALE: To correct the moment of inertia variables in this requirement, which are incorrectly designated as I_x when they should be I_y. This is consistent with the variable definition of I_y in 8.4.12.2.2 and its own title, "Force Normal to the (y-y) Axis of the Rail." Further, this nomenclature follows the intent of the preceding requirement's title and nomenclature, requirement 8.4.12.2.1, "Force Normal to the (x-x) Axis of the Rail." [Record 21-0850]

Section 8.5 Revised

RATIONALE: Model building codes no longer designate seismic zones or affected peak velocity accelerations nor velocity-related seismic zones. [Record 20-2514]

Section 8.5 Revised

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RATIONALE: Add requirements from NBCC-2015. NBCC-2005 removed based on information provided by a Canadian code expert that this edition is no longer being enforced. [Record 21-1541]

Requirement 8.5.1 Revised

RATIONALE: 8.5.1 is incorrect to apply the seismic load, related to the passenger load, to the escalator balustrade in the vertical direction rather than the horizontal direction as originally intended. In addition, it is appropriate to distribute the balustrade horizontal force of a fully loaded escalator evenly between the two balustrades at the handrails. Changes are made to correct. [Record 17-3230]

Table 8.5.5 Revised

RATIONALE: The NBCC edition is irrelevant to this table. [Record 21-1541]

Requirement 8.6.1.1.3 Revised

RATIONALE: Add the system to monitor and prevent automatic operation of passenger and freight elevators with faulty door contact circuits (also known as door lock monitoring) retroactively to the electric/hydraulic maintenance sections, modeled after modified ASME A17.1/CSA B44 and New York City requirements.

Door contact monitoring requirement 2.26.5 has been in the ASME A17.1/CSA B44 Code since 2000. However, there are potentially hundreds of thousands of existing elevators that lack this crucial safety function. These systems are designed to prevent fatal accidents caused by an elevator running with the car door/gate and/or the landing door open. Multiple component suppliers have developed solutions to meet the needs of jurisdictions that have mandated all existing elevators in their jurisdiction to be updated with this safety function. The safety benefits far outweigh the costs.

Note on requirement 2.26.5: As modified by Record 13-806 that covers swing doors and TN 17-2250 that covers New York City FEO Phase II exception. [Record 20-1186]

Requirement 8.6.1.2.2 Revised

RATIONALE:

(a) To clarify that the personnel for which the unique software identifier documentation is intended are elevator personnel and to provide the correct reference to the on-site documentation. See Record 09-872.

(b) To provide the correct reference to the required documentation for the engineering test of skirt panel deflection in the on-site documentation. See Record 16-1623. [Record 19-1763]

Requirement 8.6.1.2.2 Revised

RATIONALE: To add the requirement for on-site documentation in Section 8.6. To add to the documents to be permanently kept on-site, the new requirement in 8.6.1.2.2(g), and the addition of the TED to the wiring diagram requirements.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 8.6.1.2.2 Revised

RATIONALE: To clarify the requirement for written procedures for inspection and test not described in ASME A17.2 in addition to the four specific required items.

To remove duplicate language and add clarity on the written checkout and written procedure requirements that the Code has.

Add new written checkout procedures identified for ASME A17.1-2019/CSA B44:19.

Appropriately move requirements for written procedures in the correct section. [Record 20-1184]

Requirement 8.6.1.2.2 Revised

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional

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requirement enhancements are necessary for the needs of their assets.

To require on-site procedures for the means to accept executable software having a USI and related parameters, the one or more means to disable RIO actions and connectivity, and for cybersecurity maintenance and inspection. [Record 20-2624]

Requirement 8.6.1.2.2(b) Revised

RATIONALE: To refer to additional unique or product-specific procedures or methods in 8.6.1.2.2(b). [Record 17-197]

Requirements 8.6.1.2.2(b)(5) and 8.6.1.2.2(b)(6) Added

RATIONALE: Revised driving-machine brake data and marking plate requirements to address adjustable and nonadjustable brakes and to agree with 8.6.4.6.2. Added classifications for adjustable brakes and nonadjustable brakes. Added different methods of sealing adjustable and nonadjustable brakes. Revised 8.6.1.2.2 on-site documentation requirements to include unique or product specific procedures or methods required for nonadjustable brakes and to agree with 8.11.1.7. Revised 8.6.4.20.4 to address nonadjustable brakes. Revised 8.6.4.6.1 and clarified 8.6.4.6.2 for driving-machine brakes related to holding and decelerating capacity (see 2.24.8.3). 2.24.8.3 clearly requires that the driving machine brake must be capable of decelerating the empty car in the up direction within defined parameters. This has been in ASME A17.1/CSA B44 since 2000. Capacity has a common definition that includes "the amount that something can produce." [Record 19-2457]

Requirement 8.6.1.2.2(b)(7) Added

RATIONALE: These requirements have been added or revised in order to have inspection and testing requirements for dynamic braking on escalators and moving walks that have been approved for ASME A17.1-2019/CSA B44:19. See approved TN 12-1111. [Record 19-107]

Requirement 8.6.1.2.2(c)(3) Revised

RATIONALE: ASME A17.1-2016/CSA B44:16 added requirement for testing OEO, emergency communication, and hoistway/car door opening restriction (8.6.4.19.15). These applied to electric elevators, but not hydraulic. This proposal adds the same requirements to hydros. [Record 19-1337]

Requirement 8.6.1.2.2(c)(8) Added

RATIONALE: These requirements have been added or revised in order to have inspection and testing requirements for dynamic braking on escalators and moving walks that have been approved for ASME A17.1-2019/CSA B44:19. See approved TN 12-1111. [Record 19-107]

Requirement 8.6.1.2.2(e)(5) Added

RATIONALE: This testing is needed to ensure safe operation of this critical safety system. Procedures are required for proper testing. The requirement is written to be applicable if TN 13- 806 (regarding swing doors) and/or TN 17-2250 (FEO Phase II exception) and TN 20-1184 (revision of 8.6.1.2.2) are approved. [Record 20-2537]

Requirement 8.6.1.4.1 Revised

RATIONALE: In 8.6.1.4.1(b) and 8.6.1.4.1(c), to make language specific to the edition in which it was first used, to clarify that "yr" is years and in 8.6.1.4.1(c) to provide an editorial correction where an "or" was left out of original text. [Record 18-2482]

Requirement 8.6.1.4.1(a)(5) Added

RATIONALE: As a result of a ballot comment noting the alternative test results were being referenced in the incorrect 8.6.1.2.2 location, this proposal is to require alternative test results to be located in 8.6.1.4.1(c)(5) by adding the language.

There are virtually no differences in the testing methods of a driving-machine brake and an emergency brake. The allowance to use alternative testing on the driving-machine brake should also be provided for testing the emergency brake. [Record 15-397]

Requirement 8.6.1.4.1(a) Revised

RATIONALE: The reference in 8.6.1.4.1(d) is to test tags complying with 2.16.3.3 for marking plates. With the changes for ASME A17.1-2019/CSA B44:19, this reference in 2.16.3.3 is to 8.13.1 (permanent plates), which is not correct. The correct reference is to 8.13.3 for marking plates, as was the reference in previous editions. [Record 19-1027]

Requirement 8.6.1.6.1 Revised

RATIONALE: To provide a more descriptive representation of the status of the elevator when an electric protective device can be made ineffective.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

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(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for trouble-shooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirements 8.6.1.6.3(b) and 8.6.1.6.3(f) Revised

RATIONALE: 8.6.1.6.3(b) to clarify jumpers refers to wire jumpers. 8.6.1.6.3 (f) to distinguish the allowance of troubleshooting with test enable operation and to ensure no test initiating device is left in a test enable position, and therefore no test initiating means is capable of bypassing an electrical protective device. To also ensure the elevator is checked for proper operation before returning to normal service when the TED is returned to the "OFF" position.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1)].

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for trouble-shooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 8.6.1.6.5 Revised

RATIONALE: To provide the same level of protection for elevator personnel regardless of the jurisdiction if a fire extinguisher is required. [Record 20-1180]

Requirement 8.6.1.7.2 Revised

RATIONALE: To update these requirements to reflect the addition of Section 8.13 in ASME A17.1-2019/CSA B44:19. Also to standardize the requirements of the binational Code. [Record 20-2562]

Requirements 8.6.1.7.3 and 8.10.1.4 Revised

RATIONALE: The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for trouble-shooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 8.6.2.3 Revised

RATIONALE: To update these requirements to reflect the addition of Section 8.13 in ASME A17.1-2019/CSA B44:19. Also to standardize the requirements of the binational Code. [Record 20-2562]

Requirement 8.6.3.1 Revised

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC

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62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To ensure replacement of internet-connected or connectivity-enabled device(s) or elevator controller(s) meets the requirements of 8.14.1. [Record 20-2624]

Requirement 8.6.3.4.4 Revised

RATIONALE: To update these requirements to reflect the addition of Section 8.13 in ASME A17.1-2019/CSA B44:19. Also to standardize the requirements of the binational Code. [Record 20-2562]

Requirement 8.6.3.10 Revised

RATIONALE:

(a) To define tank replacement as a replacement.

NOTE: For an alteration; 8.7.3.29 requires conformance to Section 3.24.

(b) To define anticreep device replacement as a replacement.

NOTE: For an alteration; 8.7.3.31.3 requires conformance to 3.26.3.1. [Record 08-1345]

Requirement 8.6.3.11 Revised

RATIONALE: To differentiate replacement of identical components from those of a different design, which is an alteration.

When replacement with same occurs the requirements of 8.6.3.11 apply.

Testing requirements are included to add the requirement that was omitted in the ASME A17.1-2000 (requirement 1006.4 in ASME A17.1-1996 required testing for the valve required in 1005.2a, which was a relief valve test comparable to ASME A17.1-2022/CSA B44:22, requirement 8.6.5.14.1) and to ensure identical replacements operate in the manner intended. Bring greater clarity to 8.6.3.11 replacement and provide a reference to the alteration requirement 8.7.3.24.

Title consistent with Section 3.19. [Record 08-1345]

Requirement 8.6.3.12 Revised

RATIONALE: Correct a reference that was not updated when this section was renumbered for ASME A17.1b-2009/CSA B44b-09.

Clarify the methods or combination of methods that may be used for maintaining the required clearances.

Move requirements to shorten and to track the first shortening of suspension means into the maintenance section and replace with a note. [Record 19-931]

Table 8.6.3.12.1 Added

RATIONALE: Correct a reference that was not updated when this section was renumbered for ASME A17.1b-2009/CSA B44b-09.

Clarify the methods or combination of methods that may be used for maintaining the required clearances.

Move requirements to shorten and to track the first shortening of suspension means into the maintenance section and replace with a note. [Record 19-931]

Requirement 8.6.3.16 Added

RATIONALE: Revised driving-machine brake data and marking plate requirements to address adjustable and nonadjustable brakes and to agree with 8.6.4.6.2. Added classifications for adjustable brakes and nonadjustable brakes. Added different methods of sealing adjustable and nonadjustable brakes. Revised 8.6.1.2.2 on-site documentation requirements to include unique or product specific procedures or methods required for nonadjustable brakes and to agree with 8.11.1.7. Revised 8.6.4.20.4 to address nonadjustable brakes. Revised 8.6.4.6.1 and clarified 8.6.4.6.2 for driving-machine brakes related to holding and decelerating capacity (see 2.24.8.3). 2.24.8.3 clearly requires that the driving-machine brake must be capable of decelerating the empty car in the up direction within defined parameters. This has been in ASME A17.1/CSA B44 since 2000. Capacity has a common definition that includes "the amount that something can produce." [Record 19-2457]

Requirements 8.6.3.17, 8.6.3.17.1, and 8.6.3.17.2 Added

RATIONALE: To allow for direct replacement of machines and to provide inspection and testing requirements. The intention is to allow exception to the alteration requirement only when the same type machine with the same form, fit, and function is used.

Allow for the direct replacement of a controller, with an identical and available controller, when the original controller has been damaged (e.g., controller destroyed by fire or water). The controller will need to meet the Code to which it was originally installed or last altered. [Record 08-1345]

Requirement 8.6.4.2.3 Revised

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional

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requirement enhancements are necessary for the needs of their assets.

To separately specify executable software verification for electric and hydraulic elevators. [Record 20-2624]

Requirements 8.6.4.6.1 and 8.6.4.6.2 Revised

RATIONALE: Revised driving-machine brake data and marking plate requirements to address adjustable and nonadjustable brakes and to agree with 8.6.4.6.2. Added classifications for adjustable brakes and nonadjustable brakes. Added different methods of sealing adjustable and nonadjustable brakes. Revised 8.6.1.2.2 on-site documentation requirements to include unique or product specific procedures or methods required for nonadjustable brakes and to agree with 8.11.1.7. Revised 8.6.4.20.4 to address nonadjustable brakes. Revised 8.6.4.6.1 and clarified 8.6.4.6.2 for driving machine brakes related to holding and decelerating capacity (see 2.24.8.3). 2.24.8.3 clearly requires that the driving-machine brake must be capable of decelerating the empty car in the up direction within defined parameters. This has been in ASME A17.1/CSA B44 since 2000. Capacity has a common definition that includes "the amount that something can produce." [Record 19-2457]

Requirement 8.6.4.6.3 Revised

RATIONALE: Add the appropriate cross-reference to the applicable testing requirement mirroring driving-machine brake requirement 8.6.4.6.2. Note that TN 15-397 adds alternative testing for the emergency brake. [Record 20-160]

Requirement 8.6.4.6.4 and 8.6.4.6.5 Added

RATIONALE: Providing requirements making efforts to mitigate/eliminate injuries and damage to equipment due to contamination of a driving-machine and/or emergency brake. To ensure that the brakes and any equipment that may affect these brakes are maintained such that contamination of the braking surfaces is corrected during routine maintenance. [Record 18-1417]

Requirement 8.6.4.11 Revised

RATIONALE: Utilize requirement 8.6.4.11.1 to ensure sufficient car top clearance. Utilize requirement 8.6.4.11.2 to ensure runby values. Provide a cross-reference that shortening of suspension means must be recorded and dated. [Record 19-931]

Requirement 8.6.4.13.1(l) Revised

RATIONALE: Revise text to be consistent with the new definition for "auxiliary power supply." [Record 19-1696]

Requirement 8.6.4.19.7 Revised

RATIONALE: Revise text to be consistent with the new definition for "emergency or standby power." [Record 19-1696]

Requirement 8.6.4.19.12 Revised

RATIONALE: To update the references. [Record 20-1184]

Requirement 8.6.4.19.20 Revised

RATIONALE: To update the references. [Record 20-1184]

Requirement 8.6.4.19.21 Added

RATIONALE: This testing is needed to ensure safe operation of this critical safety system. Procedures are required for proper testing. The requirement is written to be applicable if TN 13- 806 (regarding swing doors) and/or TN 17-2250 (FEO Phase II exception) and TN 20-1184 (revision of 8.6.1.2.2) are approved. [Record 20-2537]

Requirement 8.6.4.20.1(b)(2) Revised

RATIONALE: Editorial revision to ASME A17.1/CSA B44 references to 8.6.4.20.1, 8.6.4.20.3, 8.6.4.20.4, and 8.6.4.20.10 periodic test record. Ensure language referencing requirement 8.6.1.7.2 accurately reflects the title of the requirement. [Record 18-2587]

Requirement 8.6.4.20.2 Revised

RATIONALE: To update these requirements to reflect the addition of Section 8.13 in ASME A17.1-2019/CSA B44:19. Also to standardize the requirements of the binational Code. [Record 20-2562]

Requirement 8.6.4.20.3(a) Revised

RATIONALE: Editorial revision to ASME A17.1/CSA B44 references to 8.6.4.20.1, 8.6.4.20.3, 8.6.4.20.4, and 8.6.4.20.10 periodic test record. Ensure language referencing requirement 8.6.1.7.2 accurately reflects the title of the requirement. [Record 18-2587]

Requirement 8.6.4.20.4 Revised

RATIONALE: Revised driving-machine brake data and marking plate requirements to address adjustable and nonadjustable brakes and to agree with 8.6.4.6.2. Added classifications for adjustable brakes and nonadjustable brakes. Added different methods of sealing adjustable and nonadjustable brakes. Revised 8.6.1.2.2 on-site documentation requirements to include unique or product specific procedures or methods required for nonadjustable brakes and to agree with 8.11.1.7. Revised 8.6.4.20.4 to address nonadjustable brakes. Revised 8.6.4.6.1 and clarified 8.6.4.6.2 for driving-machine brakes related to holding and decelerating capacity (see 2.24.8.3). 2.24.8.3 clearly requires that the driving-

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machine brake must be capable of decelerating the empty car in the up direction within defined parameters. This has been in ASME A17.1/CSA B44 since 2000. Capacity has a common definition that includes "the amount that something can produce." [Record 19-2457]

Requirement 8.6.4.20.4(b)(2) Revised

RATIONALE: Editorial revision to ASME A17.1/CSA B44 references to 8.6.4.20.1, 8.6.4.20.3, 8.6.4.20.4, and 8.6.4.20.10 periodic test record. Ensure language referencing requirement 8.6.1.7.2 accurately reflects the title of the requirement. [Record 18-2587]

Requirement 8.6.4.20.10(b)(2) Revised

RATIONALE: Editorial revision to ASME A17.1/CSA B44 references to 8.6.4.20.1, 8.6.4.20.3, 8.6.4.20.4, and 8.6.4.20.10 periodic test record. Ensure language referencing requirement 8.6.1.7.2 accurately reflects the title of the requirement. [Record 18-2587]

Requirement 8.6.4.20.11 Revised

RATIONALE: As a result of a ballot comment noting the alternative test results were being referenced in the incorrect 8.6.1.2.2 location, this proposal is to require alternative test results to be located in 8.6.1.4.1(c)(5) by adding the language.

There are virtually no differences in the testing methods of a driving-machine brake and an emergency brake. The allowance to use alternative testing on the driving-machine brake should also be provided for testing the emergency brake. [Record 15-397]

Requirement 8.6.4.24 Added

RATIONALE: Add the system to monitor and prevent automatic operation of passenger and freight elevators with faulty door contact circuits (also known as door lock monitoring) retroactively to the electric/hydraulic maintenance sections, modeled after modified ASME A17.1/CSA B44 and New York City requirements.

Door contact monitoring requirement 2.26.5 has been in ASME A17.1/CSA B44 since 2000. However, there are potentially hundreds of thousands of existing elevators that lack this crucial safety function. These systems are designed to prevent fatal accidents caused by an elevator running with the car door/gate and/or the landing door open. Multiple component suppliers have developed solutions to meet the needs of jurisdictions that have mandated all existing elevators in their jurisdiction to be updated with this safety function. The safety benefits far outweigh the costs.

Note on requirement 2.26.5: As modified by Record 13-806 that covers swing doors and TN 17-2250 that covers New York City FEO Phase II exception. [Record 20-1186]

Requirement 8.6.5.14.3 Revised

RATIONALE: The requirement was duplicated in the Code. The revision editorially combines the duplicative language. [Record 19-1339]

Requirements 8.6.5.14.3(k) through 8.6.5.14.3(m) Added

RATIONALE: ASME A17.1-2016/CSA B44-16 added requirement for testing OEO, emergency communication and hoistway/car door opening restriction (8.6.4.19.15). These applied to electric elevators, but not hydraulic. This proposal adds the same requirements to hydraulic elevators. [Record 19-1337]

Requirement 8.6.5.14.6 Revised

RATIONALE: The requirement was duplicated in the Code. The revision editorially combines the duplicative language. [Record 19-1339]

Requirement 8.6.5.14.9 Revised

RATIONALE: To update the references. [Record 20-1184]

Requirement 8.6.5.14.11 Added

RATIONALE: Provide periodic inspection and testing requirements for plunger grippers. [Record 17-193]

Requirement 8.6.5.14.9 Revised

RATIONALE: To update the references. [Record 20-1184]

Requirement 8.6.5.14.12 Added

RATIONALE: This testing is needed to ensure safe operation of this critical safety system. Procedures are required for proper testing. The requirement is written to be applicable if TN 13- 806 (regarding swing doors) and/or TN 17-2250 (FEO Phase II exception) and TN 20-1184 (revision of 8.6.1.2.2) are approved. [Record 20-2537]

Requirement 8.6.5.16.4 Revised

RATIONALE: To update the references. [Record 20-1184]

Requirement 8.6.5.17 Revised

RATIONALE: The requirement pertains to maintenance, but it is listed after the Category 5 tests, which could be misleading. The title of the requirement was revised for clarity. [Record 20-2336]

Requirement 8.6.5.18 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by

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adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To separately specify executable software verification for electric and hydraulic elevators. [Record 20-2624]

Requirement 8.6.5.19 Added

RATIONALE: Add the system to monitor and prevent automatic operation of passenger and freight elevators with faulty door contact circuits (also known as door lock monitoring) retroactively to the electric/hydraulic maintenance sections, modeled after modified ASME A17.1/CSA B44 and New York City requirements

Door contact monitoring requirement 2.26.5 has been in ASME A17.1/CSA B44 since 2000. However, there are potentially hundreds of thousands of existing elevators that lack this crucial safety function. These systems are designed to prevent fatal accidents caused by an elevator running with the car door/gate and/or the landing door open. Multiple component suppliers have developed solutions to meet the needs of jurisdictions that have mandated all existing elevators in their jurisdiction to be updated with this safety function. The safety benefits far outweigh the costs.

Note on requirement 2.26.5: As modified by Record 13-806 that covers swing doors and TN 17-2250 that covers New York City FEO Phase II exception. [Record 20-1186]

Requirement 8.6.7.9.7 Added

RATIONALE: The pits of rack-and-pinion elevators installed in mines naturally accumulate debris and water which can interfere with the proper draining of water accumulated inside the supporting structure and contribute to the deterioration of the supporting structure. [Record 19-106]

Requirement 8.6.7.9.8 Added

RATIONALE: Establish retirement criteria for rack-and-pinion mine elevators. [Record 20-272]

Requirement 8.6.8.15.4(b) Revised

RATIONALE: These requirements have been added or revised in order to have inspection and testing requirements for dynamic braking on escalators and moving walks that has been approved for ASME A17.1-2019/CSA B44:19. See approved TN 12-1111. [Record 19-107]

Requirement 8.6.8.15.4(c) Added

RATIONALE: These requirements have been added or revised in order to have inspection and testing requirements for dynamic braking on escalators and moving walks that has been approved for ASME A17.1-2019/CSA B44:19. See approved TN 12-1111. [Record 19-107]

Requirement 8.6.8.15.24 Revised to 8.6.8.16

RATIONALE: Requirement 8.6.8.15 is for Category 1 testing of the escalators and moving walks while 8.6.8.15.24 is a maintenance item. It is suggested the paragraph be moved away from the Category 1 procedures to avoid confusion. [Record 19-2498]

Requirement 8.6.8.15.26 Revised

RATIONALE: To update the references. [Record 20-1184]

Requirement 8.6.11.4.2 Revised

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To enhance existing requirement that cleaning procedures must include instruction to secure elevator from all automatic operation. [Record 20-2624]

Requirement 8.6.11.10.1 Revised

RATIONALE: As a result of a ballot comment noting the alternative test results were being referenced in the incorrect 8.6.1.2.2 location, this proposal is to require alternative test results to be located in 8.6.1.4.1(c)(5) by adding the language.

There are virtually no differences in the testing methods of a driving-machine brake and an emergency brake. The allowance to use alternative testing on the driving-machine brake should also be provided for testing the emergency brake. [Record 15-397]

Requirement 8.6.11.10.3 Revised

RATIONALE: To update the references. [Record 20-1184]

Requirement 8.6.11.10.3 Revised

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RATIONALE: As a result of a ballot comment noting the alternative test results were being referenced in the incorrect 8.6.1.2.2 location, this proposal is to require alternative test results to be located in 8.6.1.4.1(c)(5) by adding the language.

There are virtually no differences in the testing methods of a driving-machine brake and an emergency brake. The allowance to use alternative testing on the driving-machine brake should also be provided for testing the emergency brake. [Record 15-397]

Requirement 8.6.11.10.4 Revised

RATIONALE: As a result of a ballot comment noting the alternative test results were being referenced in the incorrect 8.6.1.2.2 location, this proposal is to require alternative test results to be located in 8.6.1.4.1(c)(5) by adding the language.

There are virtually no differences in the testing methods of a driving-machine brake and an emergency brake. The allowance to use alternative testing on the driving-machine brake should also be provided for testing the emergency brake. [Record 15-397]

Requirement 8.6.11.11 Revised

RATIONALE: To update the references. [Record 20-1184]

Requirement 8.6.11.16 Added, including Note

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

In order to ensure that occupants are not stranded on a floor where hall calls become disabled by authorized personnel through RIO, a message should be sent to the authorized personnel by the elevator system that the floor will be disabled. The authorized personnel have to acknowledge this message and are expected to check that the floor is unoccupied before disabling the hall calls. [Record 20-2624]

Requirement 8.7.1.8 Revised

RATIONALE: This change allows for consistency between U.S. and Canadian requirements. [Record 21-0975]

Requirement 8.7.1.10 Revised

RATIONALE: To update the references. [Record 20-1184]

Requirement 8.7.1.11 Added

RATIONALE: To add seismic requirements to be completed as part of an alteration to elevators. Seismic requirements were first introduced in ASME A17.1-1993. In jurisdictions enforcing the NBCC, prior to harmonization in ASME A17.1-2007/CSA B44-07, seismic requirements for elevators were found in the NBCC or required by the authority having jurisdiction. [Record 17-1631]

Requirement 8.7.1.12 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To ensure that the alteration of an internet connected, or connectivity enabled device(s) of elevator controller(s) meet the requirements of 8.14.1. This requirement appeared in the public review draft as 8.7.3.31.15, but it was editorially renumbered to 8.7.1.12 prior to publication. [Record 20-2624]

Requirement 8.7.2.1(i) Added

RATIONALE: To add specific seismic requirements for guarding snag points and seismic inspection. [Record 17-1631]

Requirement 8.7.2.1.2 Revised

RATIONALE: To add seismic requirements for a new elevator installed in an existing hoistway and seismic inspection. [Record 17-1631]

Requirement 8.7.2.1.3 Revised

RATIONALE: To add specific seismic requirements for guarding snag points and seismic inspection. [Record 17-1631]

Requirement 8.7.2.1.4 Revised

RATIONALE: To add specific seismic requirements for guarding snag points and seismic inspection. [Record 17-1631]

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Requirement 8.7.2.2 Revised

RATIONALE: To add specific seismic requirements for compensating rope sheaves and seismic inspection. [Record 17-1631]

Requirement 8.7.2.5 Revised

RATIONALE: To add specific seismic requirements for car and counterweight clearances and seismic inspection. [Record 17-1631]

Requirement 8.7.2.14 Revised

RATIONALE: To add specific seismic requirements for top emergency exit and seismic inspection. [Record 17-1631]

Requirement 8.7.2.14.1 Revised

RATIONALE: To provide 8.7.2 alteration requirements for platform aprons where compliance for Section 2.19 is additionally altered or installed. In consideration of potential existing pit depth limitation, the apron length exceptions to full length uses existing language currently found in ASME A17.1/CSA B44 requirements 8.7.2.15.2, 8.7.2.16, and 8.7.2.16.4. This proposal is intended to provide a consistent application of 2.15.9 for alterations subject to 8.7.2. [Record 18-2462]

Requirement 8.7.2.15.1 Revised

RATIONALE: To add specific seismic requirements for top emergency exit and guiding members and position restraints and seismic inspection. [Record 17-1631]

Requirement 8.7.2.15.2 Revised

RATIONALE: To add specific seismic requirements for top emergency exit and guiding members and position restraints and seismic inspection. [Record 17-1631]

Requirement 8.7.2.16.1 Revised

RATIONALE: To add specific seismic requirements for top emergency exit and seismic inspection. [Record 17-1631]

Requirement 8.7.2.16.2 Revised

RATIONALE: To add specific seismic requirements for top emergency exit and seismic inspection. [Record 17-1631]

Requirement 8.7.2.16.3 Revised

RATIONALE: To add specific seismic requirements for top emergency exit and seismic inspection. [Record 17-1631]

Requirement 8.7.2.16.4 Revised

RATIONALE: To add specific seismic requirements for intermediate rail bracket spacing and rail joints and fishplates and seismic inspection. [Record 17-1631]

Requirement 8.7.2.17.2 Revised

RATIONALE: To provide 8.7.2 alteration requirements for platform aprons where compliance for Section 2.19 is additionally altered or installed. In consideration of potential existing pit depth limitation, the apron length exceptions to full length uses existing language currently found in ASME A17.1/CSA B44 requirements 8.7.2.15.2, 8.7.2.16, and 8.7.2.16.4. This proposal is intended to provide a consistent application of 2.15.9 for alterations subject to 8.7.2. [Record 18-2462]

Requirements 8.7.2.20 Revised

RATIONALE: To provide 8.7.2 alteration requirements for platform aprons where compliance for Section 2.19 is additionally altered or installed. In consideration of potential existing pit depth limitation, the apron length exceptions to full length uses existing language currently found in ASME A17.1/CSA B44 requirements 8.7.2.15.2, 8.7.2.16, and 8.7.2.16.4. This proposal is intended to provide a consistent application of 2.15.9 for alterations subject to 8.7.2. [Record 18-2462]

Requirement 8.7.2.21 Revised

RATIONALE: To add specific seismic requirements for retainers for suspension members and guarding of snag points and seismic inspection. [Record 17-1631]

Requirement 8.7.2.22 Revised

RATIONALE: To add specific seismic requirements for counterweight design and guiding members and position restraints for counterweights and seismic inspection. [Record 17-1631]

Requirement 8.7.2.22.4 Added

RATIONALE: Adding alteration and additional inspection and test requirements for the addition of alteration of compensation means. [Record 18-1140]

Requirement 8.7.2.24 Revised

RATIONALE: To add specific seismic requirements for counterweight design and guiding members and position restraints for counterweights and seismic inspection. [Record 17-1631]

Requirement 8.7.2.25 Revised

RATIONALE: To provide 8.7.2 alteration requirements for platform aprons where compliance for Section 2.19 is additionally altered or installed. In consideration of

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potential existing pit depth limitation, the apron length exceptions to full length uses existing language currently found in ASME A17.1/CSA B44 requirements 8.7.2.15.2, 8.7.2.16, and 8.7.2.16.4. This proposal is intended to provide a consistent application of 2.15.9 for alterations subject to 8.7.2. [Record 18-2462]

Requirement 8.7.2.25.1(a) Revised

RATIONALE: To add specific seismic requirements for retainers for suspension members and driving machines and sheaves and seismic inspection. [Record 17-1631]

Requirement 8.7.2.25.1(b) Revised

RATIONALE: To add specific seismic requirements for retainers for suspension members and driving machines and sheaves and seismic inspection. [Record 17-1631]

Requirement 8.7.2.25.1(c) Revised

RATIONALE: To add specific seismic requirements for retainers for suspension members and driving machines and sheaves and seismic inspection. [Record 17-1631]

Requirement 8.7.2.25.2(a) Revised

RATIONALE: To add specific seismic requirements for retainers for suspension members and driving machines and sheaves and seismic inspection. [Record 17-1631]

Requirement 8.7.2.25.2(b) Revised

RATIONALE: To add specific seismic requirements for retainers for suspension members and driving machines and sheaves and seismic inspection. [Record 17-1631]

Requirement 8.7.2.27.4 Revised

RATIONALE: Adding a requirement providing references in alterations when the change would be designated as a replacement and provide the appropriate requirement. [Record 08-1345]

Requirement 8.7.2.27.4 Revised

RATIONALE: To provide 8.7.2 alteration requirements for platform aprons where compliance for Section 2.19 is additionally altered or installed. In consideration of potential existing pit depth limitation, the apron length exceptions to full length uses existing language currently found in ASME A17.1/CSA B44 requirements 8.7.2.15.2, 8.7.2.16, and 8.7.2.16.4. This proposal is intended to provide a consistent application of 2.15.9 for alterations subject to 8.7.2. [Record 18-2462]

Requirement 8.7.2.27.4 Revised

RATIONALE: Revise text to be consistent with the new definition for “emergency or standby power.” [Record 19-1696]

Requirement 8.7.2.27.4(f) Added

RATIONALE: To add specific seismic requirements for seismic inspection. [Record 17-1631]

Requirement 8.7.2.27.5 Revised

RATIONALE: To provide 8.7.2 alteration requirements for platform aprons where compliance for Section 2.19 is additionally altered or installed. In consideration of potential existing pit depth limitation, the apron length exceptions to full length uses existing language currently found in ASME A17.1/CSA B44 requirements 8.7.2.15.2, 8.7.2.16, and 8.7.2.16.4. This proposal is intended to provide a consistent application of 2.15.9 for alterations subject to 8.7.2. [Record 18-2462]

Requirement 8.7.2.27.5(o) Added

RATIONALE: To add specific seismic requirements for retainers for suspension members, guarding of snag points, top emergency exits, guiding members and position restraints for car frames, compensating rope sheave assembly, guiding members and position restraints for counterweights, intermediate rail bracket spacing, rail joints and fishplates, driving machines, and sheaves and Emergency Operation and signaling devices. Include the addition of seismic inspection requirements, where they are added or altered. [Record 17-1631]

Requirement 8.7.2.27.6 Revised

RATIONALE: To provide 8.7.2 alteration requirements for platform aprons where compliance for Section 2.19 is additionally altered or installed. In consideration of potential existing pit depth limitation, the apron length exceptions to full length uses existing language currently found in ASME A17.1/CSA B44 requirements 8.7.2.15.2, 8.7.2.16, and 8.7.2.16.4. This proposal is intended to provide a consistent application of 2.15.9 for alterations subject to 8.7.2. [Record 18-2462]

Requirement 8.7.2.27.6(q) Added

RATIONALE: To add specific seismic requirements for retainers for suspension members, guarding of snag points; top emergency exits, guiding members and position restraints for car frames, compensating rope sheave assembly, guiding members and position restraints for counterweights, intermediate rail bracket spacing, rail joints and fishplates, driving machines and sheaves, and Emergency Operation and signaling devices. Include the addition of seismic inspection requirements, where they are added or altered. [Record 17-1631]

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Requirement 8.7.2.27.10 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To specify the requirements that apply when remote interaction operation is added to or altered on an existing electric elevator system. [Record 20-2624]

Requirement 8.7.2.28 Revised

RATIONALE: To add specific seismic requirements for Emergency Operation and signaling devices and seismic inspection. [Record 17-1631]

Requirement 8.7.2.28 Revised

RATIONALE: Revise text to be consistent with the new definition for "emergency or standby power." [Record 19-1696]

Requirement 8.7.3.3 Revised

RATIONALE: To add specific seismic requirements for guarding of equipment-rope retainers and counterweight design and seismic inspection. [Record 17-1631]

Requirement 8.7.3.14 Revised

RATIONALE: To add specific seismic requirements for guarding of equipment including rope retainers, guiding members, and position restraints for cars and for counterweight design and seismic inspection. [Record 17-1631]

Requirement 8.7.3.23.1 Revised

RATIONALE: To add specific seismic requirements for hydraulic jack, overspeed and plunger gripper, and piping supports and seismic inspection. [Record 17-1631]

Requirement 8.7.3.23.2 Revised

RATIONALE: To add specific seismic requirements for hydraulic jack, overspeed and plunger gripper, and piping supports and seismic inspection. [Record 17-1631]

Requirement 8.7.3.23.3 Revised

RATIONALE: To add specific seismic requirements for hydraulic jack, overspeed and plunger gripper, and piping supports and seismic inspection. [Record 17-1631]

Requirement 8.7.3.23.5 Revised

RATIONALE: To add specific seismic requirements for guarding of equipment including rope retainers, car frame traveling sheave position restraint locations, car frame design, counterweight design, hydraulic jacks, overspeed valve and plunger gripper, piping supports, and support of tanks. Include the addition of seismic inspection requirements, where they are added or altered. [Record 17-1631]

Requirement 8.7.3.23.6 Revised

RATIONALE: To add specific seismic requirements for hydraulic jack, overspeed and plunger gripper, piping supports and support of tanks, and seismic inspection. [Record 17-1631]

Requirement 8.7.3.23.7 Revised

RATIONALE: To add specific seismic requirements for overspeed and plunger gripper and piping supports. Include seismic inspection. [Record 17-1631]

Requirement 8.7.3.24 Revised

RATIONALE: To add specific seismic requirements for overspeed and plunger gripper and piping supports and seismic inspection. [Record 17-1631]

Requirement 8.7.3.25.1 Revised

RATIONALE: To add specific seismic requirements for guarding of equipment-rope retainers and seismic inspection. [Record 17-1631]

Requirement 8.7.3.25.2 Revised

RATIONALE: To add specific seismic requirements for guarding of equipment-rope retainers and seismic inspection. [Record 17-1631]

Requirement 8.7.3.26 Revised

RATIONALE: To add specific seismic requirements for counterweights design and seismic inspection. [Record 17-1631]

Requirement 8.7.3.31.5 Revised

RATIONALE: Adding a requirement providing references in alterations when the change would be designated as a replacement and provide the appropriate requirement. [Record 08-1345]

Requirement 8.7.3.31.5 Revised

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RATIONALE: To add specific seismic requirements for seismic inspection. [Record 17-1631]

Requirement 8.7.3.31.5 Revised

RATIONALE: Revise text to be consistent with the new definition for "emergency or standby power." [Record 19-1696]

Requirement 8.7.3.31.6 Revised

RATIONALE: To add specific seismic requirements for guarding of equipment rope retainers, car frame traveling sheave position restraints location, car frame design, counterweights design, hydraulic jacks, overspeed valve and plunger gripper, piping supports, support of tanks, and Emergency Operation and signaling devices. Include the addition of seismic inspection requirements, where they are added or altered. [Record 17-1631]

Requirement 8.7.3.31.7 Revised

RATIONALE: To add specific seismic requirements for guarding of equipment-rope retainers, car frame traveling sheave position restraints location, car frame design, counterweights design, hydraulic jacks, overspeed valve and plunger gripper, piping supports, support of tanks, and Emergency Operation and signaling devices. Include the addition of seismic inspection requirements, where they are added or altered. [Record 17-1631]

Requirement 8.7.3.31.7 Revised

RATIONALE: To correct incorrect reference. [Record 18-2454]

Requirement 8.7.3.31.8 Revised

RATIONALE: To add specific seismic requirements for Emergency Operation and signaling devices and seismic inspection. [Record 17-1631]

Requirement 8.7.3.31.8 Revised

RATIONALE: Revise text to be consistent with the new definition for "emergency or standby power." [Record 19-1696]

Requirement 8.7.3.31.14 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To specify the requirements that apply when remote interaction operation is added to or altered on an existing hydraulic elevator system. [Record 20-2624]

Requirement 8.7.6.1.7 Revised

RATIONALE: To affirm and clarify the exception permitted to 6.1.3.6.5 (flat steps) specified in general requirements (8.7.6.1.1). [Record 17-1089]

Requirement 8.7.6.1.9 Revised

RATIONALE: To clarify that "the truss" in this requirement means truss structural members corresponding/equivalent to "members on which the support of the...escalator depends" referenced in 8.7.1.4 and 8.7.1.5. Parts or members that are a part of or affixed to the truss, but are not structural or supporting the escalator, would not require compliance with 8.7.1.4 and 8.7.1.5. Conformance to 8.7.1.5 is a necessary additional requirement for modification of structural members.

The installation of a new escalator into an existing truss shall conform to all of the requirements of Section 6.1.

Installation of a new escalator including the truss is a new installation and not an alteration. [Record 17-1089]

Requirement 8.7.6.1.11 Revised

RATIONALE: In accordance with the ASME A17 Escalator and Moving Walk Committee, any alteration that increases the rated load, rated speed, or both shall conform to Section 6.1. [Record 17-1089]

Requirement 8.7.6.1.13 Revised

RATIONALE: Editorial change for clarity. [Record 17-1089]

Requirement 8.7.6.2.9 Revised

RATIONALE: To clarify that "the truss" in this requirement means truss structural members corresponding/equivalent to "members on which the support of the...moving walk depends" referenced in 8.7.1.4 and 8.7.1.5. Parts or members that are a part of or affixed to the truss, but are not structural or supporting the escalator, would not require compliance with 8.7.1.4 and 8.7.1.5. Conformance to 8.7.1.5 is a necessary additional requirement for modification of structural members. [Record 17-1089]

Requirement 8.7.6.2.11 Revised

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RATIONALE: In accordance with the ASME A17 Escalator and Moving Walk Committee, any alteration that increases the rated load, rated speed, or both shall conform to Section 6.2. [Record 17-1089]

Requirement 8.7.6.2.13 Revised

RATIONALE: Editorial change for clarity. [Record 17-1089]

Requirement 8.7.6.2.14 Revised

RATIONALE: Editorial change for clarity. [Record 17-1089]

Requirement 8.7.6.2.18 Revised

RATIONALE: To add requirements for alterations on entrances and egresses on moving walks consistent with escalators. [Record 17-1089]

Requirement 8.7.7.1.7 Revised

RATIONALE: To affirm and clarify the exception permitted to 6.1.3.6.5 (Flat Steps) specified in general requirements (8.7.6.1.1). [Record 17-1089]

Requirement 8.9.3 Revised

RATIONALE: To conform to the new requirements for permanent marking plates and tags. Update references to comply with current requirements. This will bring these items into sync with ASME A17.1-2019/CSA B44:19 and new Section 8.13. [Record 18-2567]

Requirement 8.10(ss) Added

RATIONALE: None provided. [Record 17-1631]

Requirement 8.10.1.1.4 Revised

RATIONALE: To conform to the new requirements for permanent marking plates and tags. Update references to comply with current requirements. This will bring these items into sync with ASME A17.1-2019/CSA B44:19 and new Section 8.13. [Record 18-2567]

Requirement 8.10.2.2.1 Revised

RATIONALE: To add the requirement that written checkout procedures are required to be part of the on-site documentation and are to be left on the job site after their use for turnover testing. [Record 20-1184]

Requirement 8.10.2.2.1(t) Added

RATIONALE: This testing is needed to ensure safe operation of this critical safety system. Procedures are required for proper testing. The requirement is written to be applicable if TN 13-806 (regarding swing doors) and/or TN 17-2250 (FEO Phase II exception) and TN 20-1184 (revision of 8.6.1.2.2) are approved. [Record 20-2537]

Requirement 8.10.2.2.2 Revised

RATIONALE: To update the references. [Record 20-1184]

Requirements 8.10.2.2.2(s) and 8.10.2.2.2(t) Revised

RATIONALE: To correct the incorrect reference from 2.26.6 to 2.26.7.

And to provide an editorial change to 8.10.2 applying to acceptance inspection and test for new electric elevator installations, correct a bad reference, and require verification of the functioning of the test enable device, its marking, and identification when this device is provided.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1)

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5]

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5)

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirements 8.10.2.2.2(uu) and 8.10.2.2.2(ww) Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

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To provide acceptance inspection for RIO and 8.14.1. [Record 20-2624]

Requirement 8.10.2.2.3(k) Revised

RATIONALE: Revise to include testing information based on approved revisions to ASME A17.1/CSA B44 per Record 17-338 to verify the percent counterweight overbalance. [Record 18-2578]

Requirement 8.10.2.2.3(n) Revised

RATIONALE: Corrected reference number. Update references to comply with current requirements. This will bring these items into sync with ASME A17.1-2019/CSA B44:19 and new Section 8.13. [Record 18-2567]

Requirement 8.10.2.2.4(n) Added

RATIONALE: Added inspection of motor controllers not installed in a machine room, control room, machinery space, or control space. [Record 20-1287]

Requirement 8.10.2.2.5(c) Revised

RATIONALE: Corrected wrong reference number. Update references to comply with current requirements. This will bring these items into sync with ASME A17.1-2019/CSA B44:19 and new Section 8.13. [Record 18-2567]

Requirement 8.10.2.2.5(b)(4) Revised

RATIONALE: Corrected wrong reference number. Update references to comply with current requirements. This will bring these items into sync with ASME A17.1-2019/CSA B44:19 and new Section 8.13. [Record 18-2567]

Requirement 8.10.2.2.8 Revised

RATIONALE: To add the requirement that written checkout procedures are required to be part of the on-site documentation and are to be left on the job site after their use for turnover testing. [Record 20-1184]

Requirement 8.10.2.3.2(l) Revised

RATIONALE: Revise text to be consistent with the new definition for "emergency or standby power." [Record 19-1696]

Requirement 8.10.2.3.2(ii) Revised

RATIONALE: Adding alteration and additional inspection and test requirements for the addition of alteration of compensation means. [Record 18-1140]

NOTE: Changes are based on the approved Record 17-443.

Requirements 8.10.2.3.2(ss) and 8.10.2.3.2(tt) Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To provide acceptance inspection for RIO and 8.14.1. [Record 20-2624]

Requirements 8.10.2.4, 8.10.2.4.1(a), and 8.10.2.4.1(b) Added

RATIONALE:

(a) To acknowledge that there are tests in these sections for specific replacements.

(b) To provide inspection and testing requirements for the direct replacement of an electric elevator driving machine.

(c) To provide inspection and testing requirements for the direct replacement of an electric elevator controller with a spare due to a controller loss. [Record 08-1345]

Requirement 8.10.3.2.1(q) Revised

RATIONALE: Revise text to be consistent with the new definitions for "emergency or standby power" and "auxiliary power supply." [Record 19-1696]

Requirement 8.10.3.2.1(t) Added

RATIONALE: This testing is needed to ensure safe operation of this critical safety system. Procedures are required for proper testing. The requirement is written to be applicable if TN 13- 806 (regarding swing doors) and/or TN 17-2250 (FEO Phase II exception) and TN 20-1184 (revision of 8.6.1.2.2) are approved. [Record 20-2537]

Requirement 8.10.3.2.2(s) Revised

RATIONALE: To provide an editorial change to requirement 8.10.3.2.2 applying to acceptance inspection and test for new hydraulic elevator installations and require verification of the functioning of the test enable device, its marking and identification when this device is provided.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

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(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirements 8.10.3.2.2(kk) and 8.10.3.2.2(ll) Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To provide acceptance inspection for RIO and 8.14.1. [Record 20-2624]

Requirement 8.10.3.2.2(pp) Added

RATIONALE: To provide an editorial change to requirement 8.10.3.2.2 applying to acceptance inspection and test for new hydraulic elevator installations and require verification of the functioning of the test enable device, its marking and identification when this device is provided.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirement 8.10.3.2.4(j) Revised

RATIONALE: Revise text to be consistent with the new definition for "emergency or standby power." [Record 19-1696]

Requirements 8.10.3.2.4 and 8.10.3.2.5 Revised

RATIONALE: To add the requirement that written checkout procedures are required to be part of the on-site documentation and are to be left on the job site after their use for turnover testing. Update Code requirement references. [Record 20-1184]

Requirement 8.10.3.3.2 Added

RATIONALE: None provided. [Record 17-1631]

Requirement 8.10.3.3.2(l) Revised

RATIONALE: Revise text to be consistent with the new definition for "emergency or standby power." [Record 19-1696]

Requirements 8.10.3.3.2(qq) and 8.10.3.3.2(rr) Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To provide acceptance inspection for RIO and 8.14.1. [Record 20-2624]

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Requirements 8.10.3.4, 8.10.3.4.1(a), 8.10.3.4.2, 8.10.3.4.3(a), and 8.10.3.4.3(b) Added

RATIONALE:

(a) To acknowledge that there are tests in these sections for specific replacements.

(b) To provide inspection and testing requirements for the direct replacement of a hydraulic controller with a spare due to a controller loss.

(c) To provide inspection and testing requirements for the replacement of an anticreep leveling device.

(d) To provide inspection and testing requirements for the replacement of valves, pressure piping, or fittings; and relief valves. [Record 08-1345]

Requirement 8.10.4.1.1 Revised

RATIONALE: Corrected references. Update references to comply with current requirements. This will bring these items into sync with ASME A17.1-2019/CSA B44:19 and new Section 8.13. [Record 18-2567]

Requirement 8.10.4.1.1 Revised

RATIONALE: To add the requirement that written checkout procedures are required to be part of the on-site documentation and are to be left on the job site after their use for turnover testing. [Record 20-1184]

Requirement 8.10.4.1.1(a)(7) Revised

RATIONALE: To add testing requirements for requirements 6.1.6.7 and 6.2.6.8 added in ASME A17.1/CSA B44. [Record 18-2576]

Requirement 8.10.4.1.2 Revised

RATIONALE: To require a written checkout procedure to verify the handrail speed monitor complies with 6.1.6.4 and 6.2.6.4. [Record 18-2573]

Requirement 8.10.4.1.1(a)(7) Added

RATIONALE: To add testing requirements for requirements 6.1.6.7 and 6.2.6.8 added in ASME A17.1/CSA B44. [Record 18-2576]

Requirement 8.10.4.1.2(d) Revised

RATIONALE: These requirements have been added or revised in order to have inspection and testing requirements for dynamic braking on escalators and moving walks that has been approved for the ASME A17.1-2019/CSA B44:19. See approved TN 12-1111. [Record 19-107]

Requirement 8.10.4.2.1 Revised

RATIONALE: Requirement 8.7.1.7 pertains to repairs and replacements. 8.10.4.2.1 should refer the user of the Code to 8.7.1.8 to verify Code data plate information pertinent to an alteration just as seen for electric and hydraulic type elevators. [18-1393]

Requirement 8.11.1.7 Revised

RATIONALE: Update Code requirement references. [Record 20-1184]

Requirements 8.11.2.1.1(q) and 8.11.2.1.1(r) Revised

RATIONALE: Revise text to be consistent with the new definitions for "emergency or standby power" and "auxiliary power supply." [Record 19-1696]

Requirement 8.11.2.1.2 Revised

RATIONALE: Update Code requirement references. [Record 20-1184]

Requirements 8.11.2.1.2(qq) and 8.11.2.1.2(rr) Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the iInternet. This proposal enhances safety by adding cyber-security requirements to limit access to elevator control systems via the iInternet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the iInternet. The proposal also provides guidance to users of this Ccode to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To provide periodic inspection for RIO and 8.14.1. [Record 20-2624]

Requirement 8.11.2.1.4(l) Revised

RATIONALE: Revise text to be consistent with the new definition for "emergency or standby power." [Record 19-1696]

Requirement 8.11.2.1.4(p) Added

RATIONALE: Added inspection of motor controllers not installed in a machine room, control room, machinery space, or control space. [Record 20-1287]

Requirement 8.11.3.1.1 Revised

RATIONALE: Update Code requirement references. [Record 20-1184]

Requirement 8.11.3.1.1(q) Revised

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RATIONALE: Revise text to be consistent with the new definition for “emergency or standby power.” [Record 19-1696]

Requirement 8.11.3.1.4 Revised

RATIONALE: Revise text to be consistent with the new definition for “emergency or standby power.” [Record 19-1696]

Requirements 8.11.2.1.2(qq) and 8.11.2.1.2(rr) Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To provide periodic inspection for RIO and 8.14.1. [Record 20-2624]

Requirement 8.11.2.1.4(p) Added

RATIONALE: Added inspection of motor controllers not installed in a machine room, control room, machinery space, or control space. [Record 20-1287]

Requirement 8.11.3.1.1 Revised

RATIONALE: Update Code requirement references. [Record 20-1184]

Requirement 8.11.3.1.2(ee) Added

RATIONALE: To provide an editorial change to requirement 8.11.3.1.2 applying to periodic inspection and test for hydraulic elevator installations and require verification of the functioning of the test enable device, its marking and identification when this device is provided.

The following are safety benefits provided in this proposed permissive Code change:

(a) Provides a single consistent visual location to identify that the controller is set up (“Armed”) to have an electrical protective device made ineffective (“Jumped out”) (see 2.26.14.1).

(b) Provides visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) When any electrical protective device is bypassed it requires the elevator to be in Inspection Operation when in the "GENERAL" position [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only the electrical protective devices specified in 2.26.14.3.1 can be bypassed which requires the elevator to not be in normal operation. This allows the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the “LIMITED” position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requires all electrical protective devices to become effective when TED is switched to the “OFF” position.

(f) Provides enhanced safety features not present with the use of jumpers which are also used for trouble-shooting, maintenance, repair, adjustments, rescue, testing, and inspection. [Record 02-3620]

Requirements 8.11.3.1.2(ff) and 8.11.3.1.2(gg) Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To provide periodic inspection for RIO and 8.14.1. [Record 20-2624]

Requirement 8.11.3.1.5 Revised

RATIONALE: Provide periodic inspection and testing requirements for plunger grippers. [17-193]

Requirement 8.11.3.1.5(d) Revised

RATIONALE: Corrected wrong reference number. Update references to comply with current requirements. This will bring these items into sync with ASME A17.1-2019/CSA B44:19 and new Section 8.13. [Record 18-2567]

Requirement 8.11.4.1(w) Added

RATIONALE: These requirements have been added or revised in order to have inspection and testing requirements for dynamic braking on escalators and moving walks that has been approved for ASME A17.1-2019/CSA B44:19. See approved TN 12-1111. [Record 19-107]

Requirement 8.12.1 Revised

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RATIONALE: To provide a Code reference from 8.12.1 to Flood Detection Operation, requirements 2.27.12 and 3.27.5.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Section 8.14 Added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To alert users of this Code to review the risk of cyber threats to help determine the appropriate measures for their particular asset needs.

To provide one or more manual means to disable RIO actions and connectivity.

To add requirements for a means that is accessible only to elevator personnel on-site that will prevent changes from a remote source of executable software requiring a USI or changes in related parameters addressed in 2.26.1.7, 3.26.11 without the use of the means by elevator personnel. [Record 20-2624]

Part 9 Reference documents updated

RATIONALE: The above changes to 2.15.6.4 address the outdated wood platform requirements within PS 1-74. Remove Exterior type due to changes within PS 1 plywood changes from PS 1-74 to PS 1-09. Since PS 1-09 removed the PS 1-74 Interior type bonded with interior glue and Interior type bonded with intermediate bonded glue classifications, there is no need to add an additional requirement for specifying the bonding classification type. Both are required to be exposed to dry and wet weather, but Exposure 1 is designed for short-term exposure to moisture, such as during construction, and Exterior is designed for long-term moisture exposure. The PS 1-09 bonding classifications Exposure 1 and Exterior are both exterior bonding and have the same test requirements. Only difference, Exposure 1 is allowed to have a slightly higher failure rate. Also, the CSA O151 bonding tests and failure requirements are similar with PS 1-09 Exposure 1 testing requirements. Conclusion: both Exposure 1 and Exterior bonding classifications are suitable for elevator use. [Record 18-2575]

Part 9 References revised

RATIONALE: In order not to restrict any applicable technologies, this language is being rewritten into performance language. Previous requirements primarily applied to photoelectric devices. To include appropriate reference standards for the detection means addressed by the Code. [Record 20-1005]

Part 9 Reference documents added

RATIONALE: To provide guidance on the properties of targets that are suitable for the design of the detection of objects in the door path as well as approaching object detection means. [Record 20-1853]

Part 9 Reference documents added

RATIONALE: Currently, there are no requirements in ASME A17.1/CSA B44 that address connecting an elevator control to the internet. This proposal enhances safety by adding cybersecurity requirements to limit access to elevator control systems via the internet. The proposal also defines what control elements are permitted and not permitted to be accessed if the elevator control were connected to the internet. The proposal also provides guidance to users of this Code to use the cyber threat risk assessment of the referenced IEC 62443 series of standards to determine if additional requirement enhancements are necessary for the needs of their assets.

To add referenced IEC standards on cybersecurity [Record 20-2624]

Section 9.1 Revised

RATIONALE: Update to the correct reference designation and edition.

To provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24, to prevent the elevator cab from descending into floodwaters; also, to prevent any other elevator equipment from descending into floodwaters. [Record 13-1893]

Section 9.1 Revised

RATIONALE: To provide the standard that is referenced in the proposal.

NOTE: NFPA 1225 is replacing NFPA 1221 and was published in 2021. The new NFPA 1225 title is “Standards for Emergency Services Communications.”

Given the technology currently used by emergency responders and the safety concern of not having reliable emergency responder communications from inside the elevator cab during an emergency, the safety of the

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building occupants will be enhanced by allowing equipment used by emergency responders to be installed inside the elevator car and in the elevator hoistway that will improve the reliability of these communications. This equipment is currently not addressed by the ASME A17.1/CSA B44 Code for elevators in the U.S. and Canada. The International Fire Code and International Building Code have been revised to require emergency responder radio coverage (ERRC) in buildings in lieu of the fire fighters phone jack system. There is a published national standard, UL 2524 for this equipment.

NOTE: NFPA 1225 is replacing NFPA 1221 and was published in 2021. NFPA 1225 just added all elevators, in addition to elevator lobbies, to be considered critical areas in the building requiring 99% first responder radio coverage (see NFPA 1225, Section 18.8.3).

To provide detailed requirements for the installation, use, and access to ERRC equipment installed in the elevator car enclosure for exclusive use by emergency responders where the immunity test required in EN 12016 and ISO 22200 cover the radio frequencies used in the U.S. EN 12016 covers the frequency range of 80 MHz to 1,960 MHz. ISO 22200 covers a range of 80 MHz to 2,170 MHz. This compares to typical fire department frequencies that are in the VHF high band (150 MHz to 160 MHz) or the UHF ultra-high band (450 MHz to 470 MHz). [Record 19-1766]

Section 9.1 Revised

RATIONALE: Added terms for emergency responder radio coverage (ERRC) equipment.

Given the technology currently used by emergency responders and the safety concern of not having reliable emergency responder communications from inside the elevator cab during an emergency, the safety of the building occupants will be enhanced by allowing equipment used by emergency responders to be installed inside the elevator car and in the elevator hoistway that will improve the reliability of these communications. This equipment is currently not addressed by the ASME A17.1/CSA B44 Code for elevators in the U.S. and Canada. The International Fire Code and International Building Code have been revised to require ERRC in buildings in lieu of the fire fighters phone jack system. There is a published national standard, UL 2524 for this equipment.

NOTE: NFPA 1225 is replacing NFPA 1221 and was published in 2021. NFPA 1225 just added all elevators, in addition to elevator lobbies, to be considered critical areas in the building requiring 99% first responder radio coverage (see NFPA 1225, Section 18.8.3).

To provide detailed requirements for the installation, use, and access to ERRC equipment installed in the elevator car enclosure for exclusive use by emergency responders where the immunity test required in EN 12016 and ISO 22200 cover the radio frequencies used in the U.S. EN 12016 covers the frequency range of 80 MHz to 1,960 MHz. ISO 22200 covers a range of 80 MHz to 2,170 MHz. This compares to typical fire department frequencies that are in the VHF high band (150 MHz to 160 MHz) or the UHF ultra-high band (450 MHz to 470 MHz). [Record 19-1766]

Nonmandatory Appendix E Revised

RATIONALE: Nonmandatory Appendix E is being updated to include additional requirements for destination-oriented elevator systems, including the use of touch screens and related features, such as consoles and function buttons, along with verbal announcements. For many years, Nonmandatory Appendix E has been harmonized closely with ICC/ANSI A117.1. However, the following proposals are based on requirements in the California Building Code (CBC), which is the only code in North America to add these types of requirements so far. An effort has been made to retain harmonization with ICC/ANSI A117.1 as much as possible. Items shown in green highlight are added to be consistent with new ICC/ANSI A117.1 proposals. [Record 20-1249]

Nonmandatory Appendix E Introduction revised

RATIONALE: To correct typographical error. [Record 20-1249]

Nonmandatory Appendix E, E-2 Revised

RATIONALE: To add definitions for the "hall call console" and "accessibility function button" to destination-oriented elevator systems. [Record 20-1249]

Nonmandatory Appendix E, Table E-5.1 Revised

RATIONALE: This proposal intends to revise nomenclature for ICC/ANSI A117.1 so that the entire ASME A17.1/CSA B44 document reflects the accurate characters used by both the referenced standard and ASME A17.1/CSA B44, Section 9.1. [Record 21-1058]

Nonmandatory Appendix E, E-9.1 Revised

RATIONALE: Correction of numbering. Clauses E-9.5 through E-9.7 do not exist. [Record 20-1249]

Nonmandatory Appendix E, E-9.3.2 Revised

RATIONALE: To recognize the need for indicating "R" for "rear" entrances, which were not previously addressed. Note that in French the letter "A" is use for *arriere*. Currently Nonmandatory Appendix E requires the use of the number (#) button to indicate minus (−). The CBC requires the use of the minus (−) symbol. This proposal is to permit either symbol to be used. [Record 20-1249]

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Nonmandatory Appendix E, E-9.3.2.1(a) Added

RATIONALE: In existing buildings, the convention for numbering of floors may already be established and should not need to be revised. Where special names such as "mezzanine" are used, the entire word should be announced, not just the first letter. [Record 20-1249]

Nonmandatory Appendix E, E-9.3.2.1(b) Added

RATIONALE: To provide an exception for buildings where a certain floor number is not to be used.

The allowance of nonsuccessive floor numbering requires no additional clarification. [Record 20-1249]

Nonmandatory Appendix E, E-9.3.2.1 Renumbered as E-9.3.2.2

RATIONALE: Renumber existing E-9.3.2.1 to E-9.3.2.2 to accommodate new E-9.3.2.2. No change to requirement. [Record 20-1249]

Nonmandatory Appendix E, E-9.4 Revised

RATIONALE: To clarify the position of the dot on the number five key. Feedback from sight impaired representative on the Committee indicated that if the dot is not centered, it impairs quick location of the number five key. [Record 20-1249]

Nonmandatory Appendix E, E-9.11.1 Revised

RATIONALE: Removed the term two-way and clarified the instruction marking requirement revised to make this section consistent with the terminology used in 2.27.1.1 of the ASME A17.1-2019/CSA B44:19. [Record 20-1249]

Nonmandatory Appendix E, E-9.11.2 Revised

RATIONALE: Add a more precise reference. [Record 20-1249]

Nonmandatory Appendix E, E-18.1 Revised

RATIONALE: To include a reference to the numbering sequence requirement and editorial correction. [Record 20-1249]

Nonmandatory Appendix E, E-18.1.1, E-18.1.1.1, E-18.1.1.2, and E-18.1.1.3 Added

RATIONALE: Add new requirements for the hall call console and its location and features. For floors with large traffic flows, i.e., building entry floors or transfer floors, extra consoles can be added as necessary and be wall mounted or at turnstiles and pedestals. This is identical to the proposal for ICC/ANSI A117.1.

The requirement should not prohibit the addition of a pedestal mounted or other consoles in the landing areas, other than wall mounted. If pedestal units are accepted elsewhere in the building, there is no reason to exclude them in elevator lobbies. Large busy lobbies typically have units in multiple locations and pedestal units are applied. The minimum accessibility function is to provide a standard wall-mounted unit adjacent to the car that will be assigned. [Record 20-1249]

Nonmandatory Appendix E, E-18.2 Revised

RATIONALE: To clarify the height requirement of the accessibility function button and requirement for mechanical motion deleted to eliminate conflict with E-15.4, which permits audible signal instead of button motion.

To provide an area allowance for wheeled mobility device users that is in line with CSA B651-18 and the allowance that is expected to be included in the new edition of NBCC. To clarify the position of the dot on the number five key.

Feedback from sight impaired representative on the Committee indicated that if the dot is not centered, it impairs quick location of the number five key.

Currently, Nonmandatory Appendix E requires the use of the number (#) button to indicate minus (-). The CBC requires the use of the minus (-) symbol. This proposal is to permit either symbol to be used.

Added the word "Accessibility" to clarify the purpose of the function button. [Record 20-1249]

Nonmandatory Appendix E, E-18.2.1 Added

RATIONALE: To add requirements for touch screens. Information and instruction should be determined by the designer as to when and what is appropriate for the implementation and the situation. There is no need to be overly prescriptive in what information is provided. [Record 20-1249]

Nonmandatory Appendix E, E-18.2.2, E-18.2.2.1, and E-18.2.2.2 Added

RATIONALE: To add requirements for display screens and their features.

The display screen is active without the activation of the accessibility function button and the information provided is application specific for the current situation so there is no need to be overly prescriptive.

Changed "designation" versus "characters" for clarity and "when applicable" to be more relevant. There is no need to reference itself, delete the last sentence in 18.2.2. [Record 20-1249]

Nonmandatory Appendix E, E-18.2.2.3 Added

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RATIONALE: To clarify that the extended display time is conditional on the accessibility function button activation. [Record 20-1249]

Nonmandatory Appendix E, E-18.2.3 Added

RATIONALE: To add requirements for verbal announcements to be provided when the accessibility function button is activated.

Information and instruction should be determined by the designer as to when and what is appropriate for the implementation and the situation. There is no need to be overly prescriptive in what information is provided.

Adding "when applicable" and adding "synthesized speech" which is permitted for other voice systems like bank ATMs so it should be included here.

Minimum of 75 dBA is too loud on most upper floors in nearly every building and would be unacceptable in every upper floor in a hotel application. Originally, CBC requirement limited automatic control or 75 dB minimum to just the ground floor elevator lobby. Current CBC, 11B-411, requirement 2.1.2.5 only requires this 75 dB in lobbies where ambient levels vary. Requirement simplified to ensure it is loud enough compared to ambient with a maximum volume. This is consistent with proposed ICC/ANSI A117.1 requirements. [Record 20-1249]

Nonmandatory Appendix E, E-18.2.4, E-18.2.4.1, E-18.2.4.1.2, and E-18.2.4.1.3 Added

RATIONALE: To specify the arrangement for hall call consoles including keypad and touch screen arrangements and their locations.

Revised to a minimum of 760 mm (30 in.) to align with the proposed ICC/ANSI A117.1 change.

[Record 20-1249]

Nonmandatory Appendix E, E-18.2.4.4 Added

RATIONALE: The 25-deg angle is logical for a wall-mounted console but those on a security turnstile or kiosk could be at different angles. The accessibility unit is identified as the wall-mounted unit in E18.1.1.1 which provides the adjacent car, only this unit should be required to comply. Add the last sentence to reaffirm this is not required on other additional console configurations. [Record 20-1249]

Nonmandatory Appendix E, E-18.2.5, E-18.2.5.1, E-18.2.5.1.1, and E-18.2.5.1.2 Added

RATIONALE: To specify the arrangement of additional buttons and features of the hall call console and their identification.

If additional buttons are provided, then they must comply with all the tactile, braille, size, etc., to be accessible, therefore it is unnecessary for a touch screen to prohibit these buttons while the same button is permitted on a button keypad. Eliminate circular reference.

The spacing is to provide a distinction for a blind operator to identify the raised dot number five button and the other standard phone keypad buttons from any additional button provided. There is no need to be overly prescriptive in how additional buttons are arranged or spaced or located once the boundary spacing criteria of 1.5 times the spacing of the phone button keypad spacing is established. All additional buttons are required to comply with all the accessibility requirements of tactile, braille, size, etc., so any additional identification or location criteria is unnecessary. Add "clause" to be consistent with use in Nonmandatory Appendix E. [Record 20-1249]

Nonmandatory Appendix E, E-18.2.5.2 Added

RATIONALE: To provide requirements for verbal instructions to enter destination floors when the accessibility function button is activated. [Record 20-1249]

Nonmandatory Appendix E, E-18.2.6 Added

RATIONALE: The 25-deg angle is logical for a wall-mounted console but those on a security turnstile or kiosk could be at different angles. The accessibility unit is identified as the wall mounted unit in E18.1.1.1 which provides the adjacent car, only this unit should be required to comply. Add the last sentence to reaffirm this is not required on other additional console configurations. [Record 20-1249]

Nonmandatory Appendix E, E-18.2.6.1 Added

RATIONALE: To specify that an adjacent car should be assigned to a call to assist persons using the accessibility function button to find the selected car.

Without the clarification it implies accessibility operation would be denied if the adjacent car(s) is unavailable. [Record 20-1249]

Nonmandatory Appendix E, E-18.3.1 Revised

RATIONALE: To use the term "group" instead of "bank" to be consistent with the rest of the Code. [Record 20-1249]

Nonmandatory Appendix E, E-18.3.3 Added

RATIONALE: To provide verbal announcements at the car entrance when the car arrives to answer the call.

Requirements for volume characteristics are consistent with other announcements. Adding "synthesized speech" which is permitted for other voice systems like bank ATMs so it should be included here. Editorially revised for clarity.

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Minimum of 75 dBA is too loud on most upper floors in nearly every building and would be unacceptable in every upper floor in a hotel application. Originally CBC requirement limited this automatic control or 75 dB minimum to just the ground floor elevator lobby. Current CBC, 11B-411, requirement 2.1.2.5 only requires this 75 dB in lobbies where ambient levels vary. Requirement simplified to ensure it is loud enough compared to ambient, with a maximum volume. This is consistent with proposed ICC/ANSI A117.1 requirements. [Record 20-1249]

Nonmandatory Appendix E, E-18.5.3 Revised

RATIONALE: To provide verbal announcements in the car when the car stops to answer the call. Requirements for volume characteristics are consistent with other announcements.

Deleted the high volume for consistency with the other sections. High ambient sound level conditions should be extremely rare inside an elevator cab since the noise would be from the passengers. Having a 75 dBA minimum would be excessive in most cases inside the enclosed space of an elevator cab. [Record 20-1249]

Nonmandatory Appendix E, E-18.6 Revised

RATIONALE: To provide identification of cars with an alphabetic identification, or alpha-numeric identification, if necessary. From an accessibility criterion if alphanumeric designations are permitted and acceptable then they should always be permitted without any conditions on the number of elevators. [Record 20-1249]

Nonmandatory Appendix E, E-20.2.1 Revised

RATIONALE: New display requirement for the ASME A17.1-2019/CSA B44:19 in-car message display to be used by an elevator occupant who may not be able to communicate audibly to emergency personnel. The visibility of the display is a range to accommodate a wheelchair user through a standing adult. The distance from the car panel through the height range, defines the operational viewing angle of the display and is consistent with forward reach range for a wheelchair user in ICC/ANSI A117.1, Appendix E. [Record 20-1249]

Nonmandatory Appendix E, E-20.8 Added

RATIONALE: New display requirement for the ASME A17.1-2019/CSA B44:19 in-car message display to be used by an elevator occupant who may not be able to communicate audibly to emergency personnel. The visibility of the display is a range to accommodate a wheelchair user through a standing adult. The distance from the car panel through the height range, defines the operational viewing angle of the display and is consistent with forward reach range for a wheelchair user in ICC/ANSI A117.1, Appendix E. [Record 20-1249]

Nonmandatory Appendix I, Figures I-4 and I-5 Revised

RATIONALE: To add clarifying diagrams for escalator ceiling intersection guards. [Record 15-1375]

Nonmandatory Appendix I, Figure I-10 Revised

RATIONALE: The current Nonmandatory Appendix I, Figure I-10 contains a mixture of dimensional information from 6.2.3.5.1 for pallet-type treadways and 6.2.3.6.2 for belt-type treadways. ASME A17.1/CSA B44 currently only references the figure in 6.2.3.5.1. The revised graphic clarifies the requirements for the two different treadway types and adds the reference to Figure I-10 in 6.2.3.6.2 for consistency with reference included in 6.2.3.5.1. 6.2.3.5.1 is revised for consistency of SI and U.S. Customary units between 6.2.3.5.1 and 6.2.3.6.2. [Record 20-2917]

Nonmandatory Appendix I, Figures I-13 and I-14 Revised

RATIONALE: To add clarifying diagrams for escalator ceiling intersection guards. [Record 15-1375]

Nonmandatory Appendix I, Figure I-15 Added

RATIONALE: These requirements have been added or revised in order to have inspection and testing requirements for dynamic braking on escalators and moving walks that has been approved for ASME A17.1-2019/CSA B44:19. See approved TN 12-1111. [Record 19-107]

Nonmandatory Appendix N, Table N-2 Revised

RATIONALE: Revise text to be consistent with the new definition for “emergency or standby power.” [Record 19-1696]

Nonmandatory Appendix S, Figure S-13 Revised

RATIONALE: To provide guidance on the properties of targets that are suitable for the design of the detection of objects in the door path as well as approaching object detection means. [Record 20-1853]

Nonmandatory Appendix V Revised

RATIONALE: To ensure that the floor numbering and signage schemes in occupant evacuation elevator buildings provide the occupants with accurate information for assessing the time required to egress the building by using the exit stairway. The location of the additional signage is significant at the exit stairways, so an occupant knows if they should instead try to locate the elevators for evacuation. [Record 18-1641]

Nonmandatory Appendix V Revised

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RATIONALE: Revise text to be consistent with the new definition for "emergency or standby power." [Record 19-1696]

Nonmandatory Appendix X, Tables X-1 and X-2 Revised

RATIONALE: To add door monitoring systems to the lists and renumber accordingly. [Record 19-1327]

Nonmandatory Appendix X, Table X-2 Revised

RATIONALE: Revise text to be consistent with the new definition for "emergency or standby power." [Record 19-1696]

Nonmandatory Appendix Y, Table Y-1 Revised

RATIONALE: Update appendix and references based on proposal. Add permanent records requirement 8.6.1.4.1 (d). [Record 20-1184]

Index Revised

RATIONALE: To correct the index to reflect the proposed changes to 8.4.1. [Record 18-2792]

Index Revised

RATIONALE: Revise text to be consistent with the new definition for "main line power." [Record 19-1696]

ASME A17.1-2019/CSA B44:19 ERRATA

The following errata for the 2019 edition of the ASME A17.1/CSA B44 Code have been posted on the ASME website under the ASME A17 Committee Page and were current at the time the Handbook was being prepared. The ASME A17 Committee Page can be found at https://go.asme.org/A17committee.

Section 1.3 Errata correction

dispatching device, elevator automatic: a device, the principal function of which is to either

(a) operate a signal in the car to indicate when the car should leave a designated landing or

(b) actuate its starting mechanism when the car is at a designated landing

Requirement 2.11.15.2 Errata correction

2.11.15.2 Other Entrance Assemblies. Other entrance assemblies of the three basic types (see 2.11.14) shall qualify for labeling or listing/certification

(a) when composed of panel(s), frame, and hardware of the same type as tested and not exceeding the overall height and width of any panel and frame of the largest size tested or

(b) when such panel(s), frame, and hardware are modified, and test or technical data demonstrates that the modifications will meet the performance requirements of the test procedure in 8.3.3

All other elements of the assembly shall conform to all other applicable requirements of this Code.

Requirement 2.12.2.4.6 Errata correction

2.12.2.4.6 Interlocks used with multisection doors shall conform to the following requirements:

(a) They shall lock all sections of the door but shall be permitted to be applied to only one section of the door, provided the device used to interconnect the door sections is arranged so that locking one section will prevent the opening of all sections.

(b) Where used with vertically sliding biparting counterbalanced doors, they shall be arranged so that the interlock closed and locked detection means are mechanically held in the open or unlocked position by the door or devices attached thereto, unless the door is in the closed position.

(c) Where used with center-opening horizontally swinging doors, either

(1) both door panels shall be equipped with interlocks or

(2) where the door panels are arranged so that one panel can be opened only after the other panel has been opened, the interlock is not required on the section that opens last, if that door panel is provided with a door closed detection means conforming to 2.14.4.2.3, 2.14.4.2.4, or 2.14.4.2.5, and 2.26.2.15, except that the terms "door or gate" and "car door or gate" shall be replaced with the term "hoistway door" or "hoistway door section," and the term "accessible from within the car" shall be replaced with the term "accessible from the landing side when the hoistway doors are closed," and the term "made ineffective from within the car" shall be replaced with "made ineffective from the landing side when the hoistway doors are closed."

(d) Where used with combination horizontally sliding and swinging doors, either

(1) the sliding and swinging panels shall both be equipped with interlocks or

(2) where the sliding and swinging panels are interconnected in conformity with the requirements of 2.11.13.5, the interlock is not required on the swinging panel, provided the interlock on the sliding panel is designed and installed so that the car cannot be operated unless the sliding and swinging panels are both locked in the closed position, as defined in 2.12.2.2.

(e) Where a door closer, used with a combination sliding and swinging door, is arranged to be disconnected to allow the sliding panel to swing, it shall be designed and installed so that it shall not cause the interlock detection means to detect the closed and locked position when the door closer is disconnected and released.

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Requirement 2.12.7.2.4 Errata correction

2.12.7.2.4 The switch shall either

(a) use contacts that are positively opened mechanically; their openings shall not be solely dependent on springs or

(b) be SIL rated with a SIL equal to or greater than the SIL indicated for the applicable device shown in Table 2.26.4.3.2

Requirement 2.12.7.3.3 Errata correction

2.12.7.3.3 The operation of a hoistway access switch at the landing shall permit movement of the car with the hoistway door located adjacent to the switch at the landing unlocked or not in the closed position, and with only the car door or gate associated with this hoistway door unlocked or not in the closed position, subject to the following requirements:

(a) The operation of the hoistway access switch at the landing shall not render ineffective the hoistway door interlock or electric contact at any other landing, nor shall the car move if any other hoistway door is unlocked.

(b) The car shall not be operated at a speed greater than 0.75 m/s (150 ft/min). For elevators with static control, a means independent from the normal means to control the speed shall be provided to limit the speed of the car on Hoistway Access Operation to a maximum of 0.75 m/s (150 ft/min), should the normal means to control this speed (mechanical, electrical, or solid-state devices) fail to do so.

The car speed-sensing device used for the means to limit the speed of the car while operating in response to an access switch shall be permitted to be either a separate car speed-sensing device from that of the normal speed control system or the same car speed-sensing device, provided that a separate means is used to continuously verify the proper operation of this speed-sensing device. Where the same car speed-sensing device is used, the detection of a failure of this car speed-sensing device while operating in response to an access switch shall cause the power to be removed from the driving-machine motor and brake.

The car speed-sensing device(s) and, where required, the verification means described above, shall conform to the following:

(1) a common actuating means (e.g., a driving-machine shaft, brake drum) shall be permitted, provided that it is not dependent on the following connection types, unless the connection is continuously monitored:

(-a) traction (excluding the traction between the drive sheave and suspension means and the traction between the governor and governor rope),

(-b) friction (except for interference fits), or

(-c) a flexible coupling where positive engagement is not assured between coupling halves

Where monitoring is required, the monitoring shall detect a failure that prevents conformance with this requirement while operating in response to an access switch and shall cause the electric power to be removed from the elevator driving-machine motor and brake.

(2) a common member (e.g., tape, target, wire) that is sensed by both speed-sensing devices shall be permitted, provided that

(-a) the member is monitored so that when its presence is not detected while operating in response to an access switch, this shall cause the electric power to be removed from the elevator driving-machine motor and brake

(-b) the common member is securely mounted in such a manner that horizontal movement of the car shall not affect the operation of the sensors

(3) a common mounting means shall be permitted

(c) If the lowest landing is the normal means of access to the pit, the hoistway access switch shall enable the car to move in the up direction to a point between 2 130 mm (84 in.) and 2 450 mm (96 in.) from the floor level to the bottom of the platform guard, unless the travel of the car limits such movement.

(d) The movement of the car initiated and maintained by the access switch at a landing other than the lowest landing shall be limited in the down direction to a travel not greater than the height of the car crosshead above the car platform, and limited in the up direction to the distance the platform guard extends below the car platform.

(e) The hoistway access switch at the landing shall only control the movement of the car within the zone specified in (c) or (d). Control circuits related to, or operated by, the hoistway access switches shall comply with 2.26.9.3.1(c) through 2.26.9.3.1(e) and 2.26.9.4.

Requirement 2.14.1.2.4 Errata correction

2.14.1.2.4 Panels attached to the car enclosure for decorative or other purposes shall either

(a) not be unfastened from inside the car by the use of common tools or

(b) be permitted to be removed from inside the car when perforations, exceeding that which would reject a ball 13 mm (0.5 in.) in diameter, in the enclosure used for panel hanging or support have permanent means to prevent straight-through passage beyond the running clearance

Requirement 2.14.1.5.1(b)(1) Errata correction

2.14.1.5.1 Top emergency exits shall conform to the following requirements:

(a) The top emergency exit opening shall have an area of not less than 0.26 m^2 (400 $in.^2$) and shall measure not less than 400 mm (16 in.) on any side.

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(b) The top emergency exit and suspended ceiling opening, if any, shall be located to provide a clear passageway, unobstructed by fixed equipment located in or on top of the car. Equipment is permitted directly above the exit opening, provided that

(1) it is not less than 1 070 mm (42 in.) above the top of the car or

(2) the exit is located to allow unobstructed passage of a parallelepiped volume measuring 300 mm × 500 mm × 1 500 mm (12 in. × 20 in. × 59 in.) at an angle not less than 60 deg from the horizontal (see Nonmandatory Appendix C)

Requirement 2.25.4.1.1 Errata correction

2.25.4.1.1 If the normal terminal stopping device fails to slow down the car at the terminal as intended, the emergency terminal speed-limiting device shall reduce the car and counterweight speed such that the rated buffer striking speed is not exceeded. The emergency terminal speed-limiting device shall remove power from the driving-machine motor and brake and shall either

(a) apply an emergency brake(s) conforming to 2.19.3 in combination with the removal of power from the driving-machine motor and brake (see also 2.25.4.1.3) or

(b) apply an emergency brake(s) conforming to 2.19.3 if removal of power from the driving-machine motor and brake fails to reduce the car and counterweight speed as intended

Requirement 2.25.4.2.2 Errata correction

2.25.4.2.2 The emergency terminal stopping device shall function independently of the normal terminal stopping device and the normal speed control system such that the failure of the normal terminal stopping device and/or the failure of the normal speed control system shall not prevent the emergency terminal stopping device from functioning as specified, except that

(a) for both the position-sensing device of the emergency terminal stopping device and the position-sensing device of the normal terminal stopping device

(1) a common actuating means (e.g., a cam) that is not physically part of the position-sensing devices shall be permitted

(2) a common member (e.g., tape, target, or wire) that is sensed by both the emergency terminal stopping device and normal terminal stopping means shall be permitted, provided that both of the following apply:

(-a) the member is monitored such that when its presence is not detected, this shall cause the electric power to be removed from the elevator driving-machine motor and brake

(-b) the common member is securely mounted in such a manner that horizontal movement of the car shall not affect the operation of the sensors

(3) a common mounting means shall be permitted for the position-sensing devices of the emergency terminal stopping device and the normal terminal stopping device

(b) The car speed-sensing device used for the emergency terminal stopping device shall be permitted to be either a separate car speed-sensing device from that of the normal speed control system or the same car speed-sensing device, provided that a separate means is used to continuously verify the proper operation of this speed-sensing device. Where the same car speed-sensing device is used, the detection of a failure of this car speed-sensing device shall cause the power to be removed from the driving-machine motor and brake.

The car speed-sensing device(s) and, where required, the verification means described above, shall conform to the following:

(1) A common actuating means (e.g., a driving-machine shaft or brake drum) shall be permitted, provided that it is not dependent on any of the following connection types, unless the connection is continuously monitored:

(-a) traction (excluding the traction between the drive sheave and suspension means and the traction between the governor and governor rope),

(-b) friction (except for interference fits), or

(-c) a flexible coupling where positive engagement is not assured between coupling halves

Where monitoring is required, the monitoring shall detect a failure that prevents conformance with this requirement and shall cause the electric power to be removed from the elevator driving-machine motor and brake.

(2) A common member (e.g., tape, target, or wire) that is sensed by both speed-sensing devices shall be permitted, provided that

(-a) the member is monitored such that when its presence is not detected, this shall cause the electric power to be removed from the elevator driving-machine motor and brake

(-b) the common member is securely mounted in such a manner that horizontal movement of the car shall not affect the operation of the sensors

(3) A common mounting means shall be permitted.

Requirement 2.26.1.5.1 Errata correction

2.26.1.5.1 When switching to either “BYPASS” or the “OFF” position, the switches shall either

(a) have contacts that are positively opened mechanically; their opening shall not be solely dependent on springs or

(b) be SIL rated with a SIL equal to or greater than the SIL indicated for the applicable device shown in Table 2.26.4.3.2

Requirement 2.26.9.5.1 Errata correction

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2.26.9.5.1 Two means shall be provided to remove power independently from the driving-machine motor. At least one shall conform to either (a) or (b).

(a) An electromechanical contactor arranged to either

(1) open each time the car stops or

(2) open, at the latest, each time the car reverses direction, except for releveling; it shall be verified at each stop that there is no current flow exceeding normal leakage current through the other means

(b) An E/E/PES with a SIL not less than the highest SIL value of the applicable function as shown in Table 2.26.4.3.2 for the electrical protective devices involved and shall be listed/certified to a SIL rating that is in accordance with the applicable requirements of IEC 61508-2 and IEC 61508-3. It shall be identifiable on wiring diagrams (see 8.6.1.6.3) with part identification, SIL, and certification identification information that shall be in accordance with the certifying organization's requirements.

Assemblies containing SIL rated devices shall be labeled or tagged with the statement: "Assembly contains SIL rated devices. Refer to Maintenance Control Program and wiring diagrams prior to performing work."

Requirement 3.19.2.7 Errata correction

3.19.2.7 Where the hydraulic machine is located in the hoistway and any piping, tubing, or fitting permitted by 3.19.2.4 is located outside the hoistway, means shall be provided to

(a) protect the specified piping, tubing, or fittings from damage, which would cause unsafe elevator operation or

(b) prevent uncontrolled movement of the elevator in the event of failure of the specified piping, tubing, or fittings

Requirement 4.2.11.1 Errata correction

4.2.11.1 For elevators driven by an alternating-current squirrel cage induction motor and having a down speed not more than 0.37 m/s (75 ft/min), the car safety and governor are not required if another safety device is provided to either

(a) limit the down speed of the car with rated load to not over 0.87 m/s (175 ft/min) in the event of failure of the driving means or

(b) limit the fall of the elevator in the event of failure of the driving nut to a distance not exceeding 13 mm (0.5 in.), by using a safety nut or other equivalent means

Requirement 4.2.12 Errata correction

4.2.12 Safety Nut and Data Tag

4.2.12.1 A safety nut is required on all screw machines that utilize a driving nut made of a material other than metal and shall be permitted to be provided on all screw machines. The safety nut shall be made of metal and designed to withstand the impact without damage if the driving nut should fail.

4.2.12.2 A metal data tag shall be securely attached to each screw machine equipped with a safety nut bearing the following data:

(a) date of installation of driving and safety nuts

(b) spacing between driving and safety nuts

Requirement 5.2.2.1.1 Errata correction

5.2.2.1.1 Top-of-Car Clearances. The top-of-car clearance shall conform to 3.4.4 and either 3.4.5 or 5.2.1.4.4.

Requirement 5.7.16 Errata correction

5.7.16 Car and Counterweight Buffers

Car and counterweight buffers shall either

(a) conform to the applicable requirements of 2.22.1.1.1, 2.22.1.2, 2.22.2, and 2.22.3 or

(b) be designed and installed so that they will not be fully compressed when struck by the car with its rated load at the governor tripping speed. Kinetic energy from the drive unit and the effect of the counterweight shall be taken into account in the design. The effect of the counterweight, where used, shall also be taken into account in the design calculations. The requirements of 2.22.3.2 do not apply to car buffers.

Requirement 6.1.5.3.1 Errata correction

6.1.5.3.1 Escalator Driving-Machine Brake

(a) Each escalator driving machine shall be provided with an electrically released and mechanically or magnetically applied brake. If the brake is magnetically applied, a ceramic permanent magnet shall be used. There shall be no intentional time delay designed into the application of the brake, except as permitted in 6.1.5.3.4(b).

(b) The brake shall be applied automatically if the electrical power supply is interrupted. The brake shall be capable of stopping the down-running escalator with any load up to the brake rated load [see 6.1.3.9.3(a)(2) or 6.1.3.9.3(b)(2)]. The brake shall hold the stopped escalator with any load up to the brake rated load [see 6.1.3.9.3(a)(1) or 6.1.3.9.3(b)(1)].

(c) Driving-machine brakes shall stop the down-running escalator steps at an average rate not greater than 0.91 m/s^2 (3 ft/s^2) as measured over the total retardation time. No peak horizontal retardation value exceeding 0.91 m/s^2 (3 ft/s^2) shall have a time duration greater than 0.125 s (see Nonmandatory Appendix I, Figure I-11). (See also 6.1.6.3.6.)

(d) The escalator brake shall be provided with a data plate conforming to 8.13.1 that is readily visible and located on the machine brake, and when necessary, a duplicate data plate with the certification mark shall

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be placed adjacent to the machine brake. The data plate shall indicate

(1) brake torque and related data as follows:

(-a) for fixed-torque brakes, the range of brake torque that complies with 6.1.5.3.1 and 6.1.6.3.6

(-b) for variable-torque brakes, the minimum brake torque for a loaded escalator and the minimum stopping distance for the unloaded escalator that comply with 6.1.5.3.1 and 6.1.6.3.6

(2) the method of measuring the torque, designated "BREAKAWAY" or "DYNAMIC," based on the method used when measuring the torque

(3) the location where the torque is to be measured, e.g., "MOTOR SHAFT," "MACHINE INPUT SHAFT," "MAIN DRIVESHAFT"

(4) the type of brake, i.e., fixed or variable torque

(5) the maximum stopping distance with rated load in the down direction that corresponds to the minimum distance between either

(-a) the comb and the step when the step is positioned to activate any of the safety devices required in 6.1.6.3.6, 6.1.6.3.9, 6.1.6.3.11, or 6.1.6.5 or

(-b) the activation point of the dynamic skirt panel obstruction device (see 6.1.6.3.16) and the entrance of the skirt panel into the balustrade

(e) Where means other than a continuous shaft, mechanical coupling, or toothed gearing is used to connect the motor to a gear reducer, the escalator driving-machine brake shall be located on the gear reducer or main driveshaft.

Requirement 6.1.5.3.2 Errata correction

6.1.5.3.2 Main Driveshaft Braking. If the escalator driving-machine brake is separated from the main driveshaft by chain used to connect the driving machine to the main driveshaft, either

(a) a mechanically applied or permanent magnet brake capable of stopping and holding a down-running escalator with brake rated load (see 6.1.3.9.3) shall be provided on the main driveshaft or

(b) multiple and separate chains, each with an individual drive-chain device in accordance with 6.1.6.3.4 and each with connection to the escalator driving-machine brake(s) and/or other brake(s) with capacity capable of stopping and holding a down-running escalator with brake rated load (see 6.1.3.9.3), shall be provided

Requirement 6.1.6.3.13 Errata correction

6.1.6.3.13 Comb-Step Impact Devices. Devices shall be provided that will cause the opening of the power circuit to the escalator driving-machine motor and brake if either

(a) a horizontal force not greater than 1 780 N (400 lbf) in the direction of travel is applied at either side, or not greater than 3 560 N (800 lbf) at the center of the front edge of the combplate or

(b) a resultant vertical force not greater than 670 N (150 lbf) in the upward direction is applied at the center of the front of the combplate

These devices shall be the manual-reset type.

Requirement 6.2.6.3.11 Errata correction

6.2.6.3.11 Comb-Pallet Impact Devices. Devices shall be provided that will cause the opening of the power circuit to the moving walk driving-machine motor and brake if either

(a) a horizontal force not greater than 1 780 N (400 lbf) in the direction of travel is applied at either side, or not greater than 3 560 N (800 lbf) at the center of the front edge of the combplate or

(b) a resultant vertical force not greater than 670 N (150 lbf) in the upward direction is applied at the center of the front of the combplate

These devices shall be the manual-reset type.

Requirement 8.3.14.3.4 Errata correction

8.3.14.3.4 Static Test. After completion of the endurance test in 8.3.14.3.1, an engineering test shall be made consisting of a static force of 1 000 N (225 lbf) applied over a period of 300 s with the force increasing incrementally. The force shall be applied in the opening direction of the door and at a location as near to the restricting element as possible, but not to exceed 300 mm (12 in.).

Requirement 8.4.8.2.6 Errata correction

8.4.8.2.6 Rail Forces

(a) The horizontal seismic forces used to determine guide-rail stresses and deflections are as follows:

(1) For jurisdictions enforcing seismic zones, either

(-a) $0.5W_p$ (zone 3 or greater) or

(-b) $0.25W_p$ (zone 2)

(2) For jurisdictions enforcing IBC/NBCC

(-a) F_p when calculating deflection

(-b) $0.7F_p$ when calculating stress

(b) For installations where the guide rails bear the vertical loads imposed by machines, sheaves, or hitches, the following vertical loads will be considered to be acting simultaneously in addition to those above:

(1) For jurisdictions enforcing seismic zones, either

(-a) $0.25W_p$ (zone 3 or greater) or

(-b) $0.125W_p$ (zone 2)

(2) For jurisdictions enforcing IBC/NBCC

(-a) F_v when calculating deflection

(-b) $0.7F_v$ when calculating stress

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where W_p is defined in 8.4.15(b), and F_p and F_v are defined in 8.4.14.

NOTE: The forces above are the result of both any equipment attached to the rail and the tensions developed in the suspension ropes by the car and counterweight.

Requirement 8.6.4.20.3 Errata correction

8.6.4.20.3 Oil Buffers

(a) Car oil buffers shall be tested to determine conformance with the applicable requirements by either

(1) running the car onto the buffer with rated load at rated speed or

(2) subject to approval by the authority having jurisdiction, either

(-a) running the car with any load, from no load up to rated load onto the buffer at rated speed when the requirements of 8.6.11.10 are complied with, provided that when applied the method verifies that the buffer performs or is capable of performing in compliance with (a), except as specified in (b) and (c) (Item 5.9.2.1). Counterweight oil buffers shall be tested by running the counterweight onto its buffer at rated speed with no load in the car, except as specified in (b) and (c) (Item 5.9.2.1) or

(-b) running the car onto the buffer with any load, from no load up to rated load, and at less than rated speed, when the requirements of 8.6.11.10 are complied with, provided that when applied, the method verifies that the buffer performs or is capable of performing in compliance with (a)

(b) For reduced-stroke buffers, this test shall be made at the reduced striking speed permitted (Item 5.9.2.1).

(c) This test is not required where a Type C safety is used (see 8.6.4.20.1).

(d) In making these tests, the normal and emergency terminal stopping devices shall be made temporarily inoperative. The final terminal stopping devices shall remain operative and be temporarily relocated, if necessary, to permit compression of the buffer during the test.

(e) After completion of the test, a metal tag, indicating the date of the test, together with the name of the person or firm who performed the test, shall be attached to the buffer [Item 5.3.2(b)].

(f) Counterweight oil buffers shall be tested by running the counterweight onto its buffer at rated speed with no load in the car, except as specified in (b) and (c) (Item 5.9.2.1), or at reduced speed if the requirements of 8.6.11.10 are met.

(g) A periodic test record as required in 8.6.1.7.2 shall be provided.

Requirement 8.7.2.27.4 Errata correction

8.7.2.27.4 Controllers. When the replacement of the controller does not meet the requirements of 8.6.3.17.2(b), it shall be treated as an alteration and meet the following requirements:

(a) Where a motion controller is installed, without any change in the type of motion control, and without replacing the existing operation control, the installation shall conform to the following:

(1) Requirements 2.7.2, 2.7.9, and 8.7.2.7.2 for the newly installed equipment

(2) Requirements 2.26.4.2 and 8.7.2.8 for the newly installed equipment

(3) Section 2.19, except 2.19.2.2(a)(1) through 2.19.2.2(a)(3) is not required if the Code at the time of the original installation was prior to ASME A17.1-2000

(4) Requirement 2.26.9 for the newly installed equipment

(5) Section 2.29 for elevators in the same group

(6) Requirement 2.15.9, except the car platform guard (apron) shall conform to 2.15.9 only to the extent the existing pit shall permit, but in no case less than the leveling or truck zone plus 75 mm (3 in.).

For inspection and test requirements, see 8.10.2.3.2(s).

(b) Where an operation controller is installed, and the type of operation control, if automatic remains automatic, or, if nonautomatic remains continuous pressure, car switch, or other type of operation where the movement or stopping of the car is under the manual control of the operator (nonautomatic), and the existing motion control equipment is retained, the installation shall conform to the following:

(1) Requirements 2.7.2, 2.7.9, and 8.7.2.7.2 for the newly installed equipment

(2) Requirements 2.26.4.2 and 8.7.2.8 for the newly installed equipment

(3) Requirements 2.26.9.3.1(d), 2.26.9.3.1(e), 2.26.9.3.2, and 2.26.9.4 for the newly installed equipment

(4) Section 2.29 for elevators in the same group

NOTE: Where the installation of an operation control alters emergency operation and signaling devices, the requirements of 8.7.2.28 apply.

For inspection and test requirements, see 8.10.2.3.2(s).

(c) Where both a motion controller and an operation controller are installed without any change in the type of motion control as described in (a) and without any change in the type of operation control as described in (b), the installation shall conform to the following:

(1) Requirements 2.7.2, 2.7.9, and 8.7.2.7.2 for the newly installed equipment

(2) Requirements 2.26.4.2 and 8.7.2.8 for the newly installed equipment

(3) Section 2.19

(4) terminal stopping devices shall conform to Section 2.25

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(5) the newly installed operating devices and control equipment shall conform to 2.26.1.2, 2.26.1.4 through 2.26.1.6, 2.26.2 through 2.26.9, and 2.26.11

(6) Requirement 2.27.2 [as modified by 8.7.2.28(b) and 8.7.2.28(f)] applies when emergency power is provided

(7) in jurisdictions not enforcing the NBCC, 2.27.3 through 2.27.9 [as modified by 8.7.2.28(c) through 8.7.2.28(f)] apply when either

(-a) travel is 8 m (25 ft) or more above or below the designated landing or

(-b) Firefighters' Emergency Operation was required or provided at the time of installation

(8) in jurisdictions enforcing the NBCC, 2.27.3 through 2.27.9 [as modified by 8.7.2.28(c) through 8.7.2.28(f)] apply only if Firefighters' Emergency Operation was required or provided at the time of installation

(9) Section 2.29 for elevators in the same group

(10) Requirement 2.15.9, except the car platform guard (apron) shall conform to 2.15.9 only to the extent the existing pit shall permit, but in no case less than the leveling or truck zone plus 75 mm (3 in.).

For inspection and test requirements, see 8.10.2.3.2(s).

(d) Where a controller for the operation of hoistway doors, car doors, or car gates is installed, see 8.7.2.12.

For inspection and test requirements, see 8.10.2.3.2(u).

(e) Where a controller for the elevator operation on emergency or standby power or Firefighters' Emergency Operation is installed, see 8.7.2.28.

(f) If seismic requirements apply, see 8.4.10.1 and 8.7.1.11.

For inspection and test requirements for seismic alterations or additions see 8.10.2.3.2(ss).

Requirement 8.7.3.31.5 Errata correction

8.7.3.31.5 Controllers. When the replacement of the controller does not meet the requirements of 8.6.3.17.2(b), it shall be treated as an alteration and meet the following requirements:

(a) Where a motion controller is installed, without any change in the type of motion control, and without replacing the existing operation control, the installation shall conform to the following:

(1) Requirements 2.7.2, 2.7.9, and 8.7.2.7.2 for the newly installed equipment

(2) Requirements 2.26.4.2 and 8.7.2.8 for the newly installed equipment

(3) Requirement 2.26.9 for the newly installed equipment

(4) Section 2.29 for elevators in the same group

For inspection and test requirements, see 8.10.3.3.2(s).

(b) Where an operation controller is installed, and the type of operation control, if automatic remains automatic, or if nonautomatic remains continuous pressure, car switch, or other type of operation where the movement or stopping of the car is under the control of the operator (nonautomatic), and the existing motion control equipment is retained, the installation shall conform to the following:

(1) Requirements 2.7.2, 2.7.9, and 8.7.2.7.2 for the newly installed equipment

(2) Requirements 2.26.4.2 and 8.7.2.8 for the newly installed equipment

(3) Requirements 2.26.9.3 and 2.26.9.4 for the newly installed equipment

(4) Section 2.29 for elevators in the same group

NOTE: Where the installation of an operation control alters emergency operation and signaling devices, the requirements of 8.7.3.31.8 apply.

For inspection and test requirements, see 8.10.3.3.2(s).

(c) Where both a motion controller and an operation controller are installed without any change in the type of motion control as described in (a) and without any change in the type of operation control as described in (b), the installation shall conform to the following:

(1) Requirements 2.7.2, 2.7.9, and 8.7.2.7.2 for the newly installed equipment.

(2) Requirements 2.26.4.1, 2.26.4.2, and 8.7.2.8 for the newly installed equipment.

(3) Terminal stopping devices shall conform to Section 3.25.

(4) The newly installed operating devices and control equipment shall conform to Section 3.26. Requirements of 2.26.1.1, 2.26.1.3, and 2.26.12 do not apply.

(5) Requirement 2.27.2 [as modified by 8.7.3.31.8(b) and 8.7.3.31.8(f)] applies when emergency power is provided.

(6) In jurisdictions not enforcing the NBCC, 3.27.1 through 3.27.4 [as modified by 8.7.3.31.8(c) through 8.7.3.31.8(f)] and 2.27.3 through 2.27.9 [as modified by 8.7.2.28(c) through 8.7.2.28(f)] apply when either

(-a) travel is 8 m (25 ft) or more above or below the designated landing or

(-b) Firefighters' Emergency Operation was required on the installation or provided at the time of installation

(7) In jurisdictions enforcing the NBCC, 3.27.1 through 3.27.4 [as modified by 8.7.3.31.8(c) through 8.7.3.31.8(f)] and 2.27.3 through 2.27.9 [as modified by 8.7.2.28(c) through 8.7.2.28(f)] apply only if Firefighters' Emergency Operation was required or provided at the time of installation.

(8) Section 2.29 for elevators in the same group.

For inspection and test requirements, see 8.10.3.3.2(s).

(d) Where a controller for the operation of hoistway doors, car doors, or car gates is installed, see 8.7.3.12.

For inspection and test requirements, see 8.10.3.3.2(q).

(e) Where a controller for the elevator operation on emergency or standby power or Firefighters' Emergency Operation is installed, see 8.7.3.31.8.

(f) If seismic requirements apply, see 8.4.10 and 8.7.1.11.

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For inspection and test requirements for seismic alterations or additions, see 8.10.2.3.2(tt).

Requirement 8.9.3 Errata correction

8.9.3 Material Construction

The Code Data Plate shall be such material and construction that the letters and figures stamped, etched, cast, or otherwise applied to the face shall remain permanently and readily legible. The height of the letters and figures shall be not less than 3.2 mm (0.125 in.).

All data plates not located in the controller shall be provided with either

(a) a durable means that prevents common contaminants (such as paint, adhesives, oil, and grease) from adhering to the Code Data Plate parent surface and permits the removal of these contaminants, without obscuring the Code-required data or

(b) letters and figures that are raised or depressed a minimum of 0.8 mm (0.03125 in.) from the plate surface face and have a minimum character-stroke width of 0.5 mm (0.02 in.)

If the plates are exposed to weathering or a chemical atmosphere, then a durable means shall be provided to protect the information from deterioration while permitting the information to be easily read.

The Code Data Plate shall conform to 8.13.1.

Existing Code Data Plates that comply with the edition of the Code under which they were installed and have legible accurate information do not have to be changed to comply with these material and construction requirements.

Requirement 8.10.2.2.2 Errata correction

8.10.2.2.2 Machine Rooms, Machinery Spaces, and Control Rooms/Spaces

NOTE: A machinery space outside the hoistway containing an electric driving machine and a motor controller is a machine room (Section 2.7).

(a) Location of Rooms/Spaces (2.7.6.1 and 2.7.6.2)

...

(cc) Traction Sheaves (Item 2.25)

(1) diameter (2.24.2.1, 2.24.2.2, and 2.24.2.4)

(2) grooves (2.24.2.1)

(3) traction limits (2.16.6, 2.20.8.1, and 2.24.2.3) shall be verified

(-a) During an emergency stop initiated by any of the electrical protective devices listed in 2.26.2 (except 2.26.2.13), at the rated speed in the down direction, with passenger elevators and freight elevators permitted to carry passengers carrying 125% of their rated load, or with freight elevators carrying their rated load, there shall be sufficient traction to safely stop and hold the load.

(-b) Traction shall slip, or the driving machine shall stall, if either the car or the counterweight bottoms on its buffer.

(-c) Conformance with the traction-loss detection means specified in 2.20.8.1 shall be demonstrated by either

(-1) causing relative motion between the drive sheave and suspension means by bottoming either the car or the counterweight [see (-b)] or

(-2) an alternative test provided in the on-site documentation [see 8.6.1.2.2(c)(4)] or by the installer and acceptable to the authority having jurisdiction

NOTE: [8.10.2.2.2(cc)(3)(-b) and 8.10.2.2.2(cc)(3)(-c)]: Demonstration need not involve an actual loss of traction, for example, where the method of protection used to meet 2.20.8.1 prevents a loss of traction.

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Part 1
General

SECTION 1.1
SCOPE

ASME A17.1/CSA B44, Safety Code for Elevators and Escalators, and ASME A17.7/CSA B44.7, Performance-Based Safety Code for Elevators and Escalators, are the accepted guides for design, construction, installation, operation, inspection, testing, maintenance, alteration, and repair of elevators, dumbwaiters, escalators, moving walks, and material lifts. They are the basis in total or in part for elevator codes used throughout the United States and Canada.

ASME A17.1/CSA B44 and ASME A17.7/CSA B44.7 are only guides unless adopted as law or regulation by an authority having jurisdiction.

Local jurisdictions may, in their adopting legislation, occasionally revise and/or include requirements in addition to those found in ASME A17.1/CSA B44 and ASME A17.7/CSA B44.7. It is therefore advisable to check with the local jurisdiction before applying code requirements in any area.

Requirement 1.1.1(c) was revised in ASME A17.1-2013/CSA B44-13 to clarify that devices with hoisting and lowering mechanisms equipped with a car serving two or more landings and restricted to the carrying of materials but not classified as a dumbwaiter or material lift are not covered by the Code.

Requirement 1.1.2 outlines examples of equipment not covered by ASME A17.1/CSA B44 and ASME A17.7/CSA B44.7. Requirement 1.1.3 specifies those Parts and requirements of the Code that apply only to new installations, as well as those that apply to both new and existing installations. Requirement 1.1.3 was revised in ASME A17.1-2019/CSA B44:19 to include Section 8.12 because the International Building Code requires existing buildings to comply with ASCE 24 under certain conditions that would in turn affect new and existing elevators installed in an existing building.

SECTION 1.2
PURPOSE AND EXCEPTIONS

ASME A17.1/CSA B44 requirements provide a framework for standards of safety for current products whose technologies have become state-of-the-art and commonplace. Throughout their long histories, the ASME A17 and CSA B44 Committees have shown responsiveness in preparing new requirements to address new designs and technologies.Throughout their long histories, the ASME A17 and CSA B44 Committees have shown responsiveness in preparing new requirements to address new designs and technologies.

However, elevator technology is advancing at a rapid pace. The advent and wide use of the Essential Safety Requirements (ESRs) of the Lifts Directive in the European Union (EU) has accelerated the pace of change. As safe elevators based on new technology become available, worldwide demand for these products increases. Elevator codes based on prescriptive language take time to change, given the nature of the consensus process upon which they are based. This hampers introduction of new technology into jurisdictions without a uniform, structured process acceptable to AHJ.

ASME A17.1-2004 and CSA B44-04 recognized the need for a method to introduce new technology. The preface to those Codes stated the following:

> **Application of Requirements to New Technology**
>
> Where present requirements are not applicable or do not describe new technology, the authority having jurisdiction should recognize the need for exercising latitude and granting exceptions where the product or system is equivalent in quality, strength or stability, fire resistance, effectiveness, durability, and safety to that intended by the present Code requirements.

This issue was further addressed in Section 1.2 of both Codes, which states the following:

> The specific requirements of this Code may be modified by the authority having jurisdiction based upon technical documentation or physical performance verification to allow alternative arrangements that will assure safety equivalent to that which would be provided by conformance to the corresponding requirements of this Code.

While the purposes of these provisions in the Codes are clear, implementation was difficult, as there was no uniform process for establishing equivalent safety that could be readily applied. The ASME A17 and CSA B44

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Committees recognized that a uniform process would be of assistance to AHJs in establishing safe application of new technology. At the same time, such a process would be valuable to an equipment provider.

The inhibiting effects of prescriptive-based codes on the adoption of new ideas are well known. Many countries have replaced prescriptive-based building codes of long standing with performance-based building codes. Australia pioneered this concept many years ago, and the model building codes in the United States took a similar approach shortly thereafter. The European Common Market followed suit.

In the United States, performance-based codes have been an objective of the National Fire Protection Association (NFPA) for many years. NFPA has a performance-based alternative to the *Life Safety Code*®, *NFPA 101*®. As recently as 2001, the International Code Council (ICC) approved a performance-based building code as an alternative to the International Building Code (IBC). The *NFPA 5000*®*, Building Construction and Safety Code*®, also incorporates performance-based alternatives. In Canada, the National Building Code of Canada (NBCC) includes performance-based requirements.

NOTE: NFPA *101*®, Life Safety Code®, *NFPA 5000*®, and Building Construction and Safety Code® are registered trademarks of the National Fire Protection Association (NFPA), Quincy, MA.

Publication of the Lifts Directives by the European Union (EU) in 1997 was a major step toward implementing a process for developing safety requirements for new technology. The Lifts Directive allows two ways of establishing the safety of elevators. The first is to show compliance with the prescriptive EN81 Code. The second is to show compliance with "Essential Safety Requirements" (ESRs). ESRs are performance-based requirements relating directly to the safety of elevators for users and non-users. Verification that the ESRs have been met is by a risk assessment of the particular design being verified. Conformity assessment is established by a "Notified Body," which is a government-accredited organization that has been qualified by the government of one of the EU countries. The country government "notifies" the European Commission that this body is qualified to carry out conformity assessments. Conformity assessments by Notified Bodies obtained in any one EU country are valid for all members of the EU, and in practice are recognized by authorities beyond the EU jurisdiction. Similar approaches are in the process of adoption by other countries, including Australia and China.

Several recent international advances have proved difficult to introduce in North America. One example is the use of machine-room-less (MRL) elevators, which have been safely operating in EU countries and other parts of the world for many years. The elevator industry in North America recognized the need for MRL elevators in this marketplace, but due to the code development process, it took 8 yr for ASME A17.1/CSA B44 to recognize MRL elevators.

It was clear that if more effective processes were not introduced, North America would gradually fall behind the rest of the world as technology innovators. There is also a continuing need for "prescriptive codes," such as ASME A17.1/CSA B44 for standard products. The availability of a uniform process for new technology allows for timely introduction of innovative products and consequently allows prescriptive codes to "catch up" as innovative products become standard products.

In September 2002 at a joint meeting of the ASME A17 and CSA B44 Committees, National Elevator Industry, Inc. (*NEII*®) and the National Elevator Escalator Association (NEEA) proposed a working committee be established to draft a Performance-Based Safety Code for Elevators and Escalators to establish safety requirements for new technology. The proposal was approved and a bi-national New Technology Committee (reporting to the ASME Standards Committee) was approved with U.S. and Canadian representatives. In March 2007, ASME A17.7/CSA B44.7, was published.

1.2.1 Purpose

As of ASME A17.1-2007/CSA B44-07, the Code formally recognized compliance with ASME A17.7/CSA B44.7 as being equivalent to meeting the requirements in ASME A17.1/CSA B44. In other words, a new or innovative product that cannot comply with the requirement(s) in ASME A17.1/CSA B44 but does satisfy ASME A17.7/CSA B44.7 is considered compliant with ASME A17.1/CSA B44. This was a major departure from past Code requirements that only recognized compliance with the requirement stated in ASME A17.1/CSA B44.

Alternatively, if you did not comply, an exception (variance) from an AHJ was required. The AHJ could be asked to grant an exemption from the requirement(s) in ASME A17.1/CSA B44 using the procedures in 1.2.2. The ASME A17 and CSA B44 Committees still envision the use of Exception (1.2.2) for one-of-a-kind and unique applications. However, for innovative new technology, ASME A17.7/CSA B44.7 should be used.

ASME A17.7/CSA B44.7 provides a structured approach for introducing new technology products to the marketplace. The approach is based on Global Essential Safety Requirements (GESRs) that have to be satisfied and a risk assessment process to ensure GESRs are met. An Accredited Elevator/Escalator Certification Organization (AECO), in conjunction with an equipment designer, will examine the process and provide documentation. The AECO is responsible for certifying design compliance with ASME A17.7/CSA B44.7.

The GESRs at the heart of ASME A17.7/CSA B44.7 are based on ISO 22559-1, Safety requirements for lifts (elevators) — Part 1: Global essential safety requirements (GESRs). ASME A17.7/CSA B44.7 also includes safety

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parameters (SPs) consistent with ASME A17.1/CSA B44 code requirements. SPs are provided to help the users of ASME A17.7/CSA B44.7 satisfy applicable GESRs. The ASME A17.7/CSA B44.7 risk assessment requirement ensures that risks are identified and sufficiently mitigated. A risk assessment methodology such as ISO/TS 14798, Lifts (elevators, escalators and moving walks — Risk assessment and reduction methodology, or equivalent is necessary to verify compliance with the applicable GESRs. Risk assessment requires a balanced team of suitably qualified experts with a trained facilitator. The ISO TS 14798, Lifts (elevators), escalators and moving walks — Risk assessment and reduction methodology, methodology is described in ASME A17.7/CSA B44.7. ASME A17.7/CSA B44.7 provides a method for selecting applicable GESRs and provides a detailed example of the process.

To ensure the process has been properly followed and potential hazards identified and addressed, ASME A17.7/CSA B44.7 requires a Code Compliance Document (CCD). The CCD must include the risk assessment, design and test data, as well as information pertaining to inspection and maintenance.

The CCD will be examined by an AECO, which will issue a certificate of conformance when satisfied that ASME A17.7/CSA B44.7 requirements have been properly met. The AHJ can also directly examine the CCD and certify the design for its own jurisdiction.

AECOs must be independent organizations with a high degree of technical competence. They are required to be accredited and audited by the American National Standards Institute (ANSI) or the Standards Council of Canada (SCC) to a level defined by ASME A17.7/CSA B44.7. The AECOs in turn will audit products they have certified to ensure the products comply with the CCD.

This process provides a structured roadmap for new technology to safely enter the marketplace.

At the time this edition of the Handbook was being written, ANSI had accredited two AECOs, and SCC had accredited one. Accredited AECOs are

(a) Liftinstituut, www.liftinstituut.com

(b) Underwriters Laboratories (UL), LLC, www.ul.com

Additional information on ASME A17.7/CSA B44.7, including where adopted, accredited AECOs, etc., can be found at www.neii.org.

1.2.2 Exceptions to ASME A17.1/CSA B44

This requirement recognizes that it is not always possible to comply with all the provisions in ASME A17.1/CSA B44. The AHJ has the right and responsibility to grant exception when equivalent safety can be demonstrated. See also Handbook commentary on Section 1.2 and 1.2.2.2.

1.2.2.2 Some ASME A17.1/CSA B44 Code requirements differ depending on whether the Code is being enforced in jurisdictions not enforcing the NBCC or those enforcing the NBCC. Equivalency was not considered or evaluated by either Committee and in some instances the requirement may not be equivalent. The differences are usually due to geographic assignments of responsibility (e.g., elevator code vs. building code, etc.). The user should not assume that differing requirements are equivalent. AHJs and RAs should keep this in mind when an application for a variance is based on compliance with the requirements applicable in jurisdictions enforcing or not enforcing the NBCC.

SECTION 1.3
DEFINITIONS

This Section defines the terms used in the Code. These may be words with unique meanings when used in the context of elevators. For example, the word “safety” is used as a noun to identify a device for stopping and holding the elevator in the event of overspeed. The user of the Code should become familiar with all terms contained in Section 1.3. Where terms are not defined, they have ordinarily accepted meanings or application as the context may imply.

Words used in the present tense may also include the future. Words in the masculine gender include the feminine and neuter. Words in the feminine and neuter gender include the masculine. The singular number may also include the plural and the plural number includes the singular.

Many interpretation requests can be avoided if time is taken to become familiar with the definitions in this Section.

Performance terminology: Industry standards for dimensional, performance, application, and electrical, and evaluation of building transportation equipment are published in *NEII*®-1, *Building Transportation Standards and Guidelines*. Performance terms are defined and measurement standards specified.

NEII®-1 incorporates the Code requirements in ASME A17.1/CSA B44, IBC, NFPA 70®, etc. It is an invaluable reference for architects, engineers, consultants, building owners and managers, elevator manufacturers, contractors, and suppliers. *NEII*®-1 can be found at www.neii.org. Access to *NEII*®-1 is available at no cost.

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Part 2
Electric Elevators

SCOPE

Part 2 applies to new traction and winding-drum electric elevators. Other types of elevators, such as hydraulic, private residence, screw-column, sidewalk, hand, inclined, rack-and-pinion, shipboard, rooftop, limited-use/limited-application, special purpose personnel elevators, elevators used for construction, dumbwaiters, and material lifts reference many of the requirements in Part 2 in their respective Sections of ASME A17.1/CSA B44. Part 2 requirements may also apply when an alteration is made as required by Section 8.7.

Electric elevators must comply with Section 5.1 (or Section 5.4 if installed in a private residence) if installed at an angle of 70 deg or less from the horizontal.

SECTION 2.1
CONSTRUCTION OF HOISTWAYS AND HOISTWAY ENCLOSURES

2.1.1 Hoistway Enclosures

2.1.1.1 Fire-Resistive Construction. Fire-resistive construction controls the spread of fire, and inhibits the migration of hot gases and smoke from one floor or area to another.

The building code is an ordinance that sets forth requirements for building design and construction. Where such an ordinance has not been enacted, compliance with a model code such as the International Building Code (IBC); *NFPA 5000®, Building Construction and Safety Code*; or the National Building Code of Canada (NBCC) is required:

Most building codes in the United States are based on a model building code. The National Building Code (NBC) began publication in 1905. In its later years, it was developed and published by the Building Officials and Code Administrators International (BOCA) and was widely adopted in the Northeast and Midwest. Prior to the 1984 edition, it was known as the Basic Building Code. The Basic Building Code was first published in the 1950s. The 1984 edition was titled the Basic/National Building Code. These changes in titles reflect an agreement between BOCA and the American Insurance Association, which from 1905 through 1976 published the NBC. The Standard Building Code (SBC), formerly Southern Standard Building Code, began publishing in the mid-1940s. It was developed and published by the Southern Building Code Congress International (SBCCI) and was widely adopted in the Southern states. The Uniform Building Code (UBC) began publishing in the late 1920s. It was developed and published by the International Conference of Building Officials (ICBO) and was widely adopted west of the Mississippi River. These building codes, now referred to as the legacy codes, are still used in some jurisdictions.

In the spring of 2000, the three U.S. model building codes collaborated to publish the International Building Code (IBC), which was promulgated by the International Code Council (ICC). The IBC has replaced the previously mentioned model codes since that time. In 2003, the National Fire Protection Association (NFPA) published NFPA 5000®, Building Construction and Safety Code. To the author's knowledge, no major jurisdiction in the United States or Canada had adopted NFPA 5000® as of the publication of this Handbook. The model building code used in Canada is the NBCC, which is promulgated by the National Research Council of Canada.

Building codes regulate the properties of materials and the methods of construction as they pertain to the hazards presented by various occupancies. They are based on the findings of previous experiences such as fires, earthquakes, and structural collapses. Requirements found in building codes that have an impact on fire protection include enclosures of vertical openings such as stair shafts, elevator hoistways (shafts), pipe chases, exit requirements, flame spread requirements for interior finishes, fire alarm requirements, and sprinkler requirements.

The evaluation of the risk to a building with respect to fire resistance has been a goal of building codes, fire codes, and insurance underwriters for years. For this reason, building codes have classified construction types and controlled the size of buildings based on the potential fire hazard. Each building code identifies various construction types, and although each code may classify the various types of construction differently, the classification system is essentially the same for all. Originally, there were only two classifications, “fireproof” and “nonfireproof.” These terms were misleading, especially since “fireproof” conveyed a false sense of security. Thus, the term “fire-resistive” was coined to provide a more realistic assessment of the resistance of buildings to the effects of a fire. The use of this term also allows

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for the identification of relative fire resistance, resulting in five basic construction classifications: fire-resistive; noncombustible or limited-combustible; heavy timber; ordinary; and wood frame.

With the advent of modern construction systems that mix traditional materials such as wood and steel with new materials such as plastics, this descriptive classification system also became misleading. Thus, most of the building codes adopted a numerical or alphabetical type of identification for construction classifications. This system is more general and does not relate to a construction technique but rather to fire protection performance.

In building construction, the interior walls and partitions act as barriers to the spread of fire. Proper construction of these barriers provides an effective means to protect against the spread of fire. Firewalls are customarily self-supporting and are designed to maintain structural integrity even in case of complete collapse of the structure on either side of the firewall. A fire partition normally possesses somewhat less fire resistance than a firewall and does not extend from the basement through a roof, as does a firewall. Usually, a fire partition is used to subdivide a floor or an area and is erected to extend from one floor to the underside of the floor above. Fire partitions are constructed of noncombustible, limited-combustible, or protected combustible materials and are attached to, and supported by, structural members having a fire-resistance rating at least equal to that of the partition. Elevator hoistway enclosure walls are normally fire partitions with a fire-resistance rating of 2 h. In some types of construction, other fire-resistance ratings are specified by the building code.

Current practice is to use an hourly rating designation. Elevator hoistway fire-resistive entrances have been commonly rated at 1½ h, but may be rated at 3 h, 1 h, or ¾ h. In the past, alphabetical designations were used. Class A openings are in walls separating buildings or dividing a building into fire areas. Class B openings are in enclosures of vertical communication through buildings (stairs, hoistways, etc.). There are also C, D, and E class openings. Typically, both the hourly rating and a letter designation are specified. The letter designation normally applied to fire-resistance-rated elevator entrances is "B." Today, the "B" may not have much value, but since some codes still refer to the letter classification system, the letter has been retained by most manufacturers. Opening protection (entrances) in fire-resistive enclosures are generally required to have less resistance to fire than is provided by the wall. Thus the requirement for 1½-h fire-resistance rating for an entrance in 2-h fire-resistance-rated construction. This standard was established years ago because easily ignited combustibles are not normally found on the opposite side of the entrance.

Elevator hoistway entrances are an important fire control means. They need to be closed and structurally sound on any floor involved in a fire. A labeled entrance (see 2.11.15) ensures that the hoistway entrance doors meet the fire safety requirements specified by the Code. A detailed discussion of the testing of fire-resistive entrances is contained in the Handbook commentary on 2.11.14.

Drywall construction is a wall system that has replaced the use of masonry wall construction. The early elevator entrance installations in drywall were similar to masonry installations, but in order to ensure the integrity of the entrance to drywall interface, fire door assemblies were subjected to the 1½-h test. Successful tests showed that the drywall entrance provided the building occupants with the same measure of safety provided by entrances in masonry construction. Floor-to-floor or floor-to-beam struts are now a typical industry standard with drywall applications as shown in Diagram 2.1.1.1(a). Brackets are placed within the entrance frame to accept the "J" strut that is furnished by the drywall contractor. The "J" strut, including its proper fastening to the entrance frame as well as the drywall, is of vital importance in assuring a proper entrance to drywall interface. There usually is no difference in the door panels. The drywall fire test is usually run in a standard gypsum wall. This established a minimum jamb depth of 133 mm or 5¼ in. as shown in Diagram 2.1.1.1(b). Diagram 2.1.1.1(b) provides a cutaway view of the drywall interface. Entrance frames installed in drywall must be fire-tested and labeled for said construction if a fire-resistive entrance is required.

Hall call fixture boxes and hall position fixture boxes, etc, occur in every elevator shaft wall. These boxes often penetrate the hoistway wall and will invalidate the fire rating unless proper protection is provided. Diagrams 2.1.1.1(c) and 2.1.1.1(d) show two examples of fixture boxes in a 2-h fire-resistive wall. Both designs have successfully passed the 2-h fire endurance test specified in ASTM E119. For additional information, contact the United States Gypsum Corp. (see Part 9 of this Handbook).

The requirements for partitions between a fire-resistive hoistway and a machine room, control room, machinery, or control spaces outside the hoistway having fire-resistive enclosures are illustrated in Diagram 2.1.1.1(e).

While ASME A17.1/CSA B44 has no requirements for elevator lobbies, the model building codes do for some occupancy and construction classifications.

The 2012 International Building Code (IBC) included requirements for Fire Service Access Elevators (FSAE) that were based on work done by the ASME A17 Task Group on the Use of Elevators by Firefighters. These requirements were expanded for the 2015 edition of the Code and include the following:

(a) Shunt trips are prohibited on the elevator system.

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(b) At least two FSAEs with a minimum capacity of 1 600 kg or 3,500 lb are required to serve each occupied floor of a building that has an occupied floor more than 36.6 m or 120 ft above the lowest level of fire department vehicle access.

(c) Automatic sprinklers are prohibited in elevator machine rooms, machinery spaces, control rooms, control spaces, and hoistways.

(d) A method to prevent water from infiltrating into the hoistway must be provided.

(e) FSAEs must open into 14-m^2 or 150-ft^2 minimum elevator lobbies enclosed with smoke barriers with a 1-h fire-resistance rating.

(f) FSAE lobbies must have direct access to an interior exit stairway or ramp.

(g) Both the hoistway and wiring or cables that provide normal and standby power and that are located outside of the hoistway or machine room must have a minimum 2-hr fire-resistance rating.

(h) All FSAE must be identified with a minimum 76-mm- or 3-in.-high symbol of a firefighter's helmet, located on each side of the hoistway doorframes.

NFPA 5000® includes similar requirements in its Section 11.14, "Elevators for Occupant Controlled Evacuation Prior to Phase I Emergency Recall Operation."

2.1.1.2 Non-Fire-Resistive Construction. Where the building code (see Handbook commentary on 2.1.1.1) permits non-fire-resistive construction, this requirement applies. Diagram 2.1.1.2 illustrates the application of the requirements contained in 2.1.1.2.2. The hoistway enclosure may consist of one or more walls that must be fire rated and others that are not fire rated. Laminated glass is required by 2.1.1.2.2(d) because it will not shatter if broken, not for fire protection reasons. Organic-coated glass, or wired or tempered glass are not acceptable alternatives to laminated glass. See Handbook commentary (8.6.11.4) on cleaning of observation elevator glass. Those requirements apply to both new and existing observation elevators.

2.1.1.3 Partially Enclosed Hoistways. Observation and nonobservation elevators may not require fully enclosed hoistways. If a portion of the hoistway enclosure is required to be fire resistive, it must conform to the requirements of 2.1.1.1. Other portions of the enclosure would have to conform to the requirements of 2.1.1.2. See Diagram 2.1.1.3.

Hoistways do not need to be fully enclosed, but protection must be provided adjacent to areas permitting the passage of people. Many different forms of protection have been provided over the years. Additionally 2.5.1.5 specifies a maximum clearance that must be maintained between the car sill and the adjacent enclosure or fascia plate. This requirement prohibits a design where there is no adjacent hoistway wall or fascia opposite a car entrance, unless a car door interlock conforming to 2.14.4.2.3 is provided and the car door meets the requirements of 2.5.1.5.3. These requirements are equivalent to the structural requirement for hoistway doors. See Handbook commentary on 2.5.1.5.

The requirement protects the public from coming into contact with elevator equipment.

2.1.1.4 Multiple Hoistways. The maximum number of elevators permitted in a single hoistway is controlled by the building code (see Section 1.3) in order to limit the potential of a fire disabling all elevator service in a structure.

Most U.S. building codes require that where there are three or fewer elevators in a building, they can be in the same hoistway enclosure. When there are four elevators, they must be in at least two separate hoistway enclosures. When there are more than four elevators, not more than four can be in the same hoistway enclosure. Limiting the number of elevators increases the chance that during a fire one or more hoistways may be usable by firefighters running elevators on Phase II operation.

Diagram 2.1.1.4 illustrates the multiple hoistway requirements in the U.S. model building codes.

2.1.1.5 Strength of Enclosure. If the wall is load bearing (masonry, brick, concrete block, etc.), the hoistway-entrance operating mechanisms and locking devices can be supported by the wall. When the wall is not load bearing (gypsum drywall, gypsum block, etc.), the hoistway-entrance operating mechanism and locking devices must be supported by other building structure (structural steel, floor, etc.). See Diagrams 2.1.1.5(a) and 2.1.1.5(b).

Requirement 2.1.1.5 was revised in ASME A17.1-2022/CSA B44-22 to relocate requirements for building components that support hoistway doors. The requirements were moved from 2.11.11.9, which only applies to horizontally sliding doors, to this section, which is a more appropriate location to ensure the requirements also apply for vertically sliding and swing-type doors.

Elevator pressure measurements were made by United States Gypsum Research in three typical Chicago high-rise structures. The buildings involved were United States Gypsum Building (18 stories); the First National Bank Building (65 stories); and the John Hancock Building (100 stories). These buildings encompass elevators having velocities ranging from 3.5 m/s or 700 ft/min to 9 m/s or 1,800 ft/min.

The maximum elevator hoistway pressure measured was 5.15 lbf/ft^2 in a single operating hoistway at the John Hancock Building. In a multiple three-car hoistway, a maximum pressure of 1.35 lbf/ft^2 was measured.

The following recommendations are derived from these tests. Loads were calculated according to the following formula:

(a) For shafts with one or two elevators:

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(Imperial Units)

$$P_s = P_c + (2/3)(V_e/400)^{1.32}$$

(b) For shafts with three or more elevators:

(Imperial Units)

$$P_s = P_c + (2/3)(V_e/1{,}000)^{1.32}$$

where

P_c = code design pressure or designed static pressure for surrounding partitions with elevators, lbf/ft^2
P_s = design pressure or negative pressure in shaft, lbf/ft^2
V_e = elevator velocity, ft/min

Elevator Velocity, ft/min	1 or 2 Elevators Per Shaft, lbf/ft^2	3 Plus Elevators Per Shaft, lbf/ft^2
0 to 180	5.0	5.0
181 to 1,000	7.5	5.0
1,001 to 1,800	10.0	7.5
Over 1,800	15.0	7.5

This information is intended only as a guide and is taken from the United States Gypsum Corp. Technical Data Sheet. Hoistway pressure is dependent on variable factors such as hoistway size, elevator speed, number of elevators per hoistway, outside wind velocity, temperature, etc. See Diagram 2.1.1.5(c).

2.1.2 Construction at Top and Bottom of the Hoistway

2.1.2.1 Construction at Top of Hoistway. Generally, the building code requirements can be summarized as follows:

(a) Where a hoistway extends into the top floor of a building, fire-resistive hoistway, space enclosures, where required, shall be carried to the underside of the roof if the roof is of fire-resistive construction.

(b) Where a hoistway does not extend into the top floor of a building, the top of the hoistway shall be enclosed with fire-resistive construction having a fire-resistance rating of at least equal to that required for hoistway enclosure.

The requirement to extend the hoistway 900 mm or 3 ft above a non-fire-resistive roof is required to protect the roof in case of a fire. The 900 mm or 3 ft of hoistway above the roof will act as a heat sink if hot gases from a fire enter the hoistway. If a heat sink is not provided, the roof could ignite from the buildup of heat in the top of the hoistway. Fire-resistive construction at the roof over just the hoistway does not meet this requirement.

The construction above a hoistway not extending to the top floor of a building must have the same fire-resistive rating as required for the hoistway enclosure walls in 2.1.1.1. When a 2-h fire-resistive hoistway enclosure is provided, 2-h fire-resistive construction is required over the hoistway. Similarly, a 1-h enclosure requires 1-h construction. The local building code should be reviewed as it may contain additional or different requirements. In the design and construction of a building, this is one item that is often overlooked. and Diagram 2.1.2.1 illustrates these requirements.

2.1.2.2 Construction at Bottom of Hoistway. If ground water is evident at a building site, the pit design should incorporate a means of keeping the water from entering the pit. Also, see 2.2.2 and 8.6.4.7.

2.1.2.3 Strength of Pit Floor. The pit floor structure must be strong enough for both the compressive load and tension loads caused by compensating sheave tie down or other device tie-downs. The impact loads are based on 125% of rated speed since the governor-safety system will prevent higher impacts from occurring.

2.1.2.3(d) and 2.1.2.3(e) These requirements address additional loads that may be transmitted to the pit floor such as a machine mounted on the rail, or dead end hitches attached to the rail.

2.1.3 Floor Over Hoistways

2.1.3.1 General Requirements. A floor is not required at the top of the hoistway when the elevator machine is located below or at the side of the hoistway, and where elevator equipment can be serviced and inspected from outside the hoistway or from the top of the car. When an elevator machine is located over the hoistway, a floor is not required below secondary deflecting sheaves, if the elevator equipment can be serviced and inspected from the top of the car or from outside the hoistway. Access from the top of an adjacent car would not be considered to be from outside the hoistway and does not conform to the requirements.

2.1.3.2 Strength of Floor. The structural requirements provide for a floor capable of supporting the normal loads that may be anticipated during maintenance and repair of elevator equipment.

2.1.3.4 Area to Be Covered by Floor. A machine room at the top with a hoistway having a cross-sectional area more than 10 m^2 or 108 ft^2 does not require a floor covering the entire area over the hoistway. In this case, the floor only needs to extend 600 mm or 2 ft beyond the general contour of the machine, sheaves, or other equipment and to the entrance to the machinery space.

This requirement does not require a minimum clearance of 600 mm or 2 ft between the general contour of the machine, sheaves, governor, or other equipment

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to a wall. If more than 600 mm or 2 ft clearance is provided, the floor must extend a minimum of 600 mm or 2 ft; if less than 600 mm or 2 ft is provided to the wall, the floor must extend to the wall. There are minimum maintenance clearance requirements specified in 2.7.2.2. Minimum clearance requirements about electrical equipment are dictated by the National Electrical Code® (see 2.26.4).

Where the floor does not cover the entire area of the hoistway, the open sides must be provided with a standard railing and toe board (see 2.10.2) to protect the elevator personnel and authorized persons from falling down the hoistway and to protect from objects being accidentally kicked off the machine room floor and falling down the hoistway.

2.1.4 Control of Smoke and Hot Gases

The majority of deaths in fires are a result of smoke asphyxiation. In the MGM fire, for example, 70 of the 84 deaths occurred on the upper floors where smoke concentration was the greatest. This could be attributed to stack effect, which is a phenomenon that exists in high-rise buildings. Stack effect describes the movement of air inside and outside a building. During a fire, the presence of stack effect generally results in the movement of smoke and combustion products from lower levels to upper levels of the building. Stack effect may also have an adverse effect on elevator door closing, and it may be necessary to sense pressure differentials to ensure door closing.

An incident that illustrates how crucial this situation can be occurred during a time of low temperatures and high-wind conditions. The winds blew out a revolving door on the first floor of a high-rise building. The ensuing stack effect was so severe that the elevator doors at the first floor of an eight-car group could not close, thus rendering the entire group of cars out of service. This could have been even more serious in the event of a fire.

Prior to 2015, all of the U.S. model building codes required venting of elevator hoistways. Most required venting of the hoistway for elevators serving three or more stories. Some local codes permit venting by means of floor grates into the machine room with mechanical or natural venting from the machine room to the outside. The U.S. model building codes prohibit this practice and require the hoistway to be vented directly to the outside of the building. They permit venting through the machine room only through enclosed ducts. Some building codes require cable slots and other openings between the machine room and hoistway to be sleeved from the machine room floor to a point not less than 305 mm or 12 in. below the hoistway vent to inhibit the passage of smoke into the machine room. See Diagram 2.1.4. When this requirement exists, caution should be taken, since overhead clearances are affected. Most building codes now state that holes in machine room floors are only permitted for the passage of ropes, cables, or other moving elevator equipment and shall be limited so as to provide no greater than 50 mm or 2 in. clearance on all sides.

Some building codes allow the vents to be closed with dampers that are automatically opened when a smoke detector in any elevator lobby and/or at the top of the hoistway is activated. These smoke detectors may be the same smoke detectors that initiate Phase I Emergency Recall Operation. The dampers should also be designed to fail safe and open in case of power failure.

The 2015 IBC and some local codes eliminated venting and now require pressurization of the hoistway to a specified minimum positive pressure above the elevator lobby. When a pressurized hoistway is provided, it should contain a vent that would open automatically in the event of power failure or smoke buildup in the hoistway.

Due to changes in the 2015 IBC, numerous local regulations, and the rapid developments in this area, it would be wise to check local code requirements.

2.1.5 Windows and Skylights

Windows and skylights are permitted in the machine rooms and control rooms. Skylights are also permitted in the hoistway. Windows are prohibited in the hoistway except in jurisdictions enforcing NBCC, as a fireman entering a building through a window in a fire situation may not realize that he is in the elevator hoistway and that there is no floor on which to stand. A glass curtain wall is not considered a window and is permitted in the hoistway by 2.1.1.2.1(d).

The building code should be consulted for the detailed requirements on window and skylight glazing, framing and sash construction, and guarding. This requirement does not apply in Canada as it is outside the scope of the elevator code. See NBCC.

2.1.6 Projections, Recesses, and Setbacks in Hoistway Enclosures

The intent of these requirements is to prevent a person from standing on the top surfaces of a projection, recesses, or setbacks, or laying tools or equipment on top surfaces (not to eliminate a shear hazard). This requirement also applies to mullions for glass curtain walls. Bevels are not required on nonhorizontal projections such as diagonal bracing with an angle greater than 75 deg from the horizontal, except where they intersect with beams or columns. Projections and setbacks may be screened instead of beveled. The requirements for screening material are the same as 5.10.1.1.1. See Diagram 2.1.6.2.

Guarding the underside of projections on sides of hoistways not used for loading and unloading is not required.

2.1.6.2(b) The top surface of separator beams is not required to be beveled. It is not possible to stand on a 75-deg beveled ledge adjacent to a wall. However,

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beveling the top surface of a separator beam would not stop a person from standing on it.

2.1.7 Illumination of Hoistways

Requirement 2.1.7 was added in ASME A17.1-2022/CSA B44:22 to provide general illumination throughout the hoistway. The illumination is intended to make it easier for elevator personnel to locate the car and counterweight in the hoistway and increase situational awareness of a potential fall hazard. The lighting level is harmonized with the requirements in EN 81-20 and ISO 8100-1. The requirements allow the same lighting source to be used for general illumination and for the lighting needed for other operations including Occupant Evacuation Operation (OEO), FSAE, and Firefighters' Emergency Operation (FEO). Manual switches allow the lights to be turned on by elevator personnel when working in the hoistway.

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Diagram 2.1.1.1(a)
Typical Drywall Struts

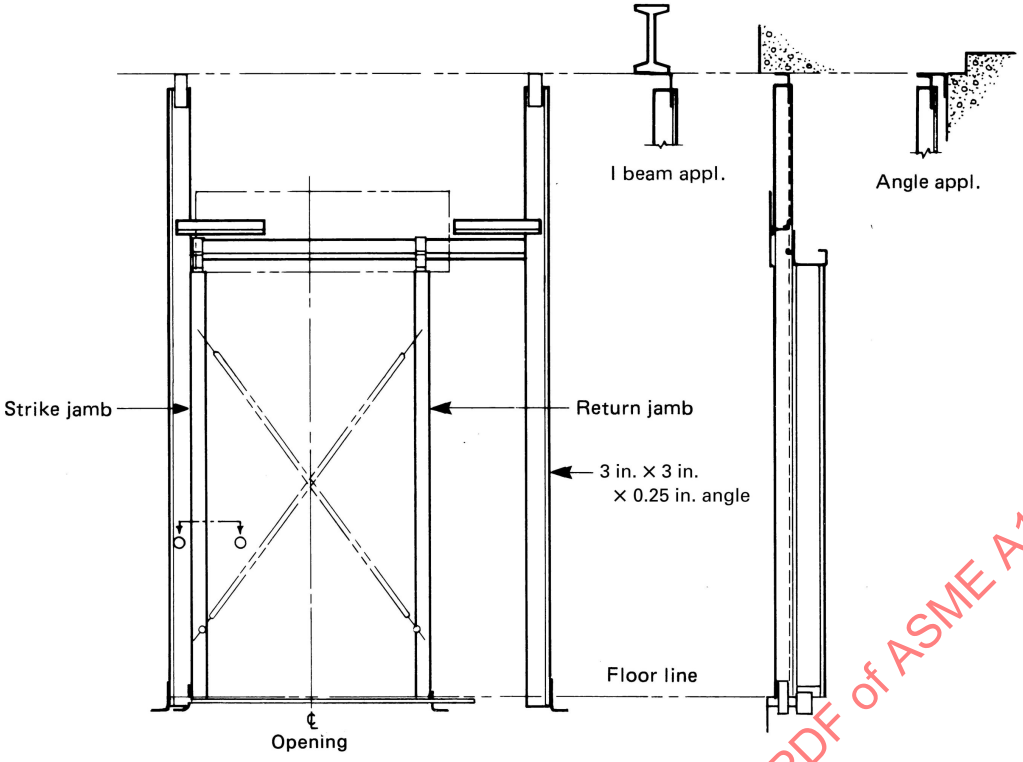
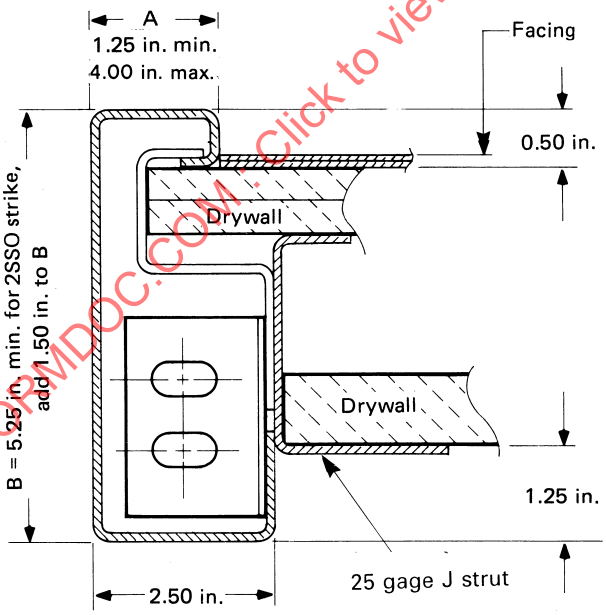
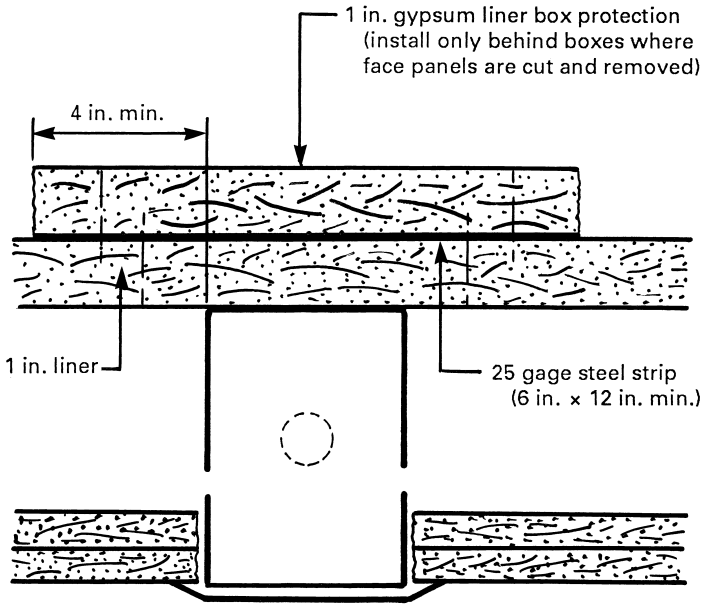


Diagram 2.1.1.1(b)
Typical Door Jamb Detail



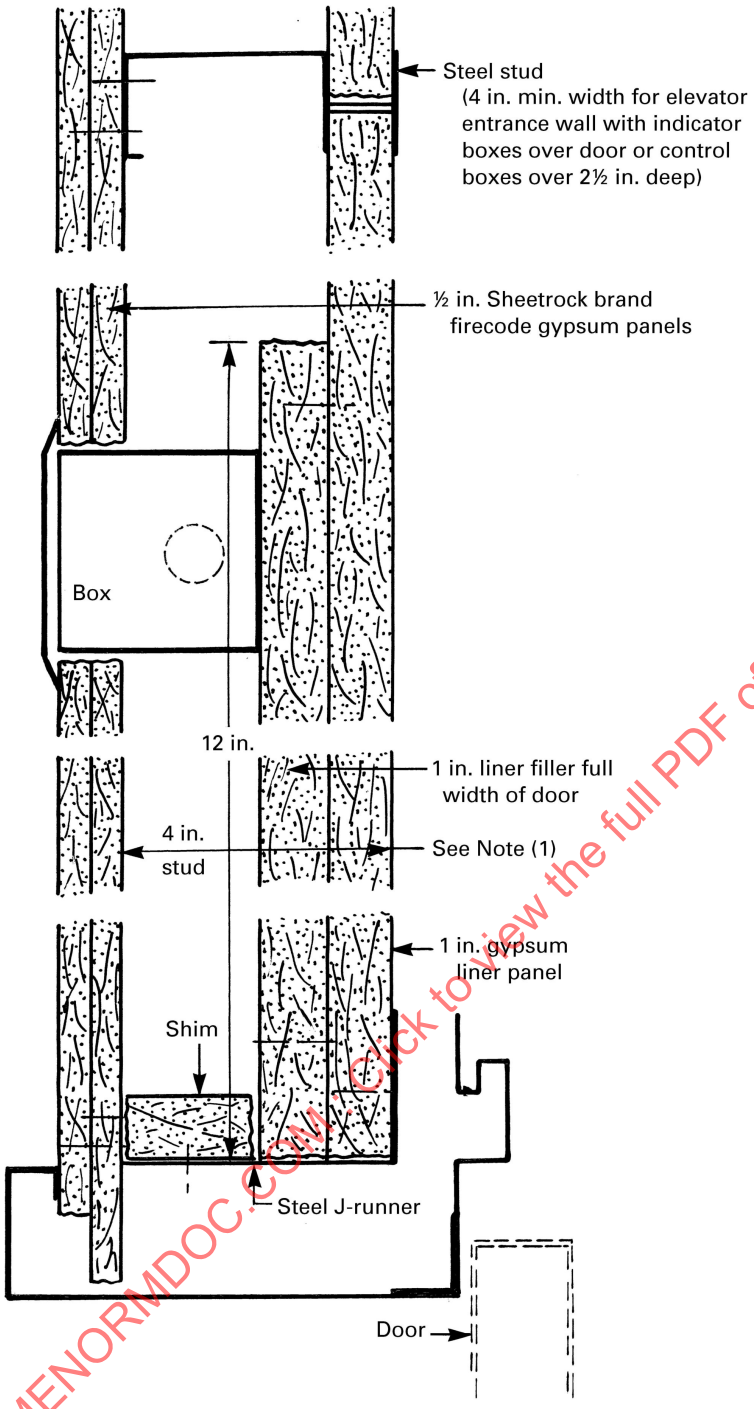
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Diagram 2.1.1.1(c)
Typical Fixture Box in 2-h Fire-Resistive Wall



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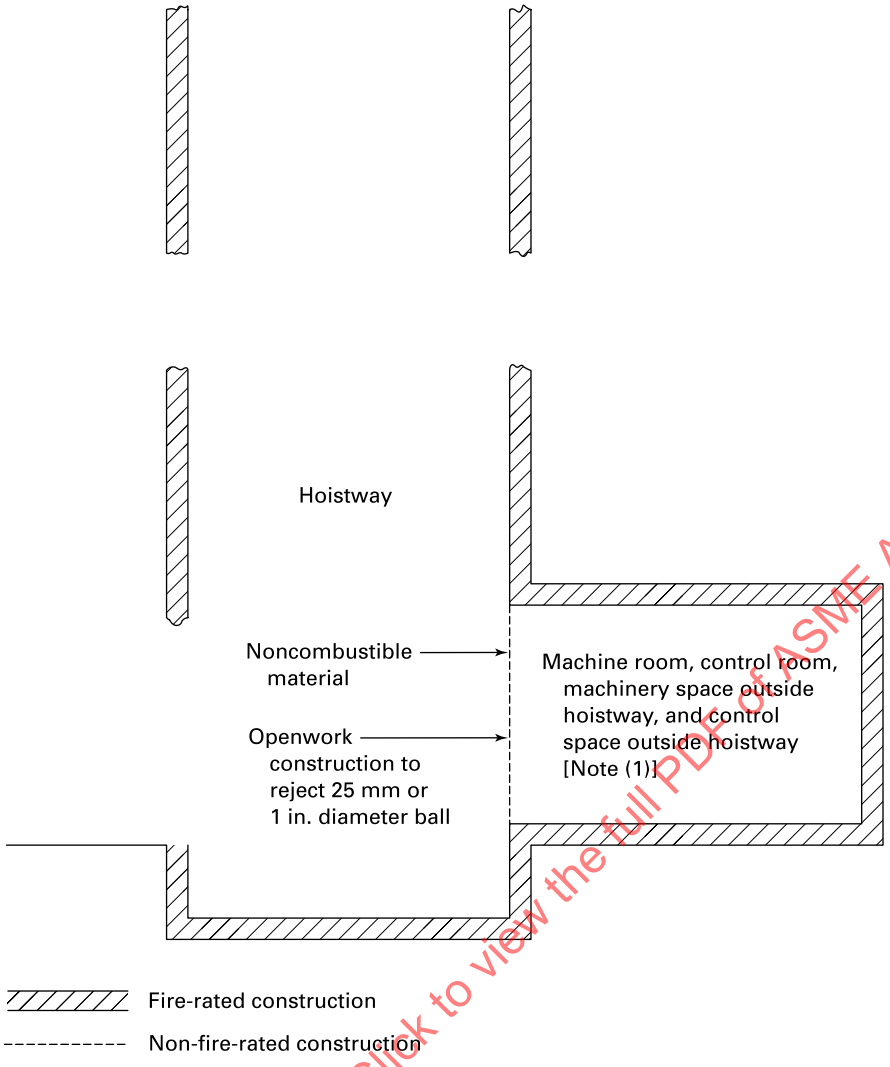
Diagram 2.1.1.1(d)
Typical Fixture Box in 2-h Fire-Resistive Wall



NOTE: (1) Fillers and shims are required only for 1½ h (B) doors over 7 ft high or for control or indicator box protection.

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Diagram 2.1.1.1(e)
Separation Between Machine Room, Control Room, Machinery Space, and Control Space/Hoistway



NOTE: (1) These areas may be located at other locations below top of hoistway.

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Diagram 2.1.1.2
Non-Fire-Resistive Hoistway Construction

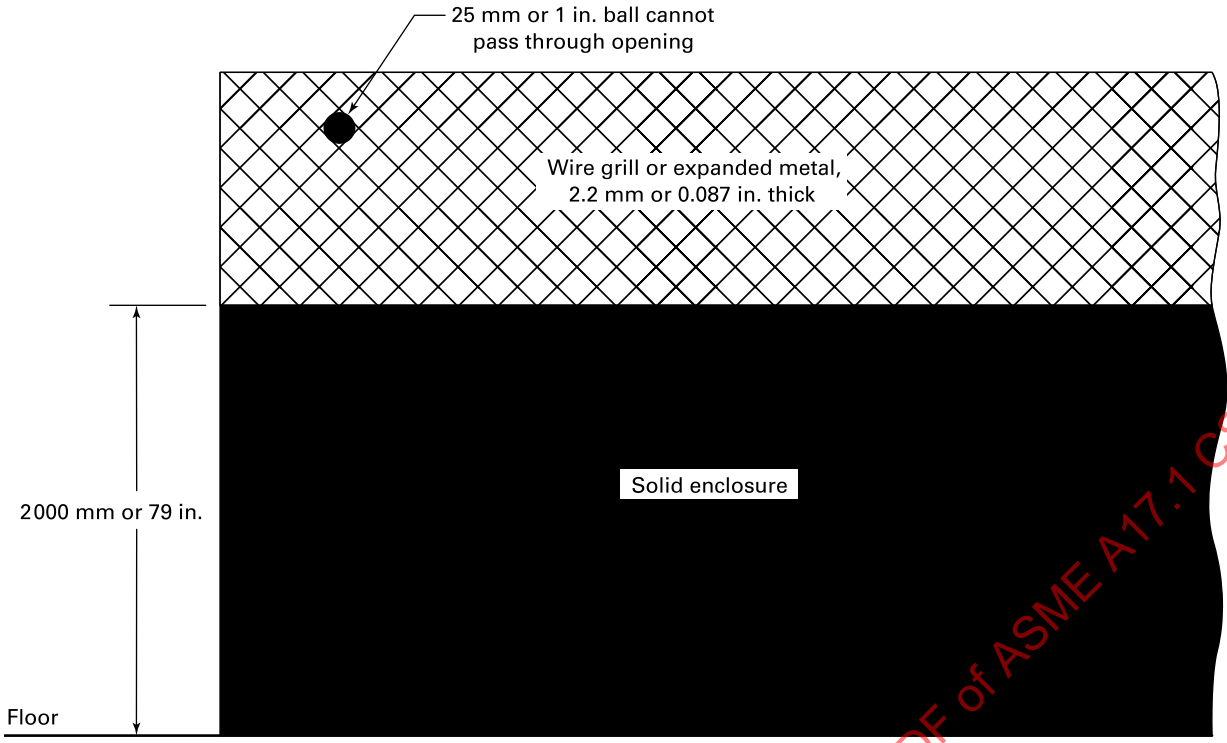
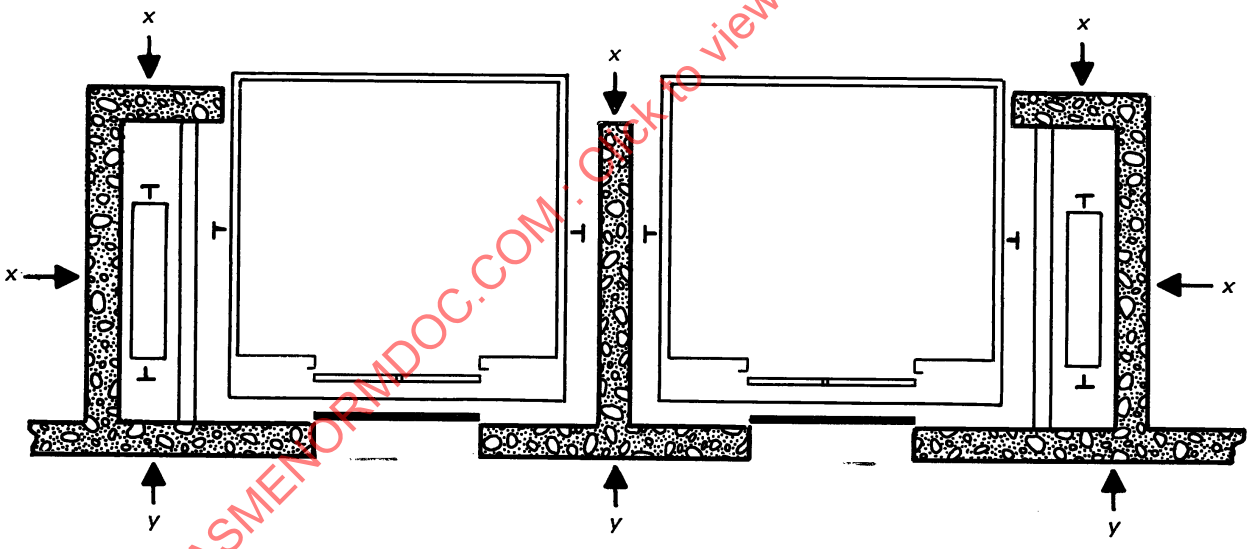


Diagram 2.1.1.3
Typical Observation Elevator Hoistway Arrangement



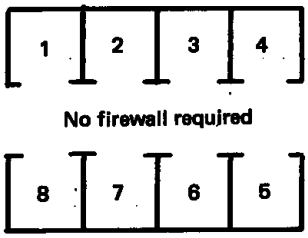
Observation Elevator

GENERAL NOTE:
x = non-fire-rated
y = fire-rated

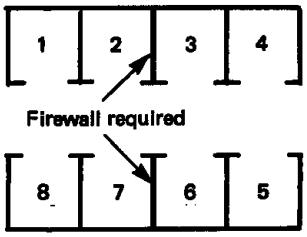
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Diagram 2.1.1.4
Illustration of Multiple Hoistway Requirements in United States Model Codes

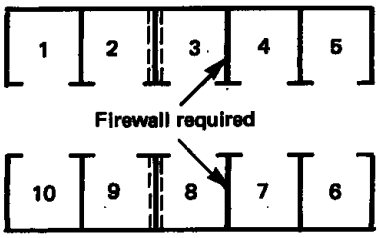
I. MULTIPLE ELEVATOR GROUPS [ASSUME 20 STORY BUILDING (20 FLOORS)]



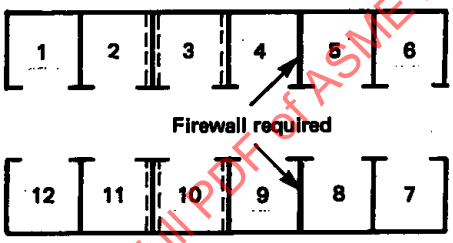
A1. Two Groups (4 cars each)
All cars serve all floors



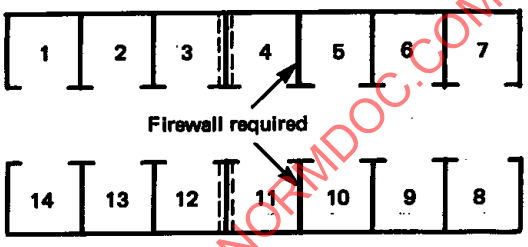
A2. Two Groups (4 cars each)
Low rise (1 – 2 – 3 – 4), all serve same floors (1 through 10).
High rise (5 – 6 – 7 – 8), all serve same floors (1, 10 through 20).



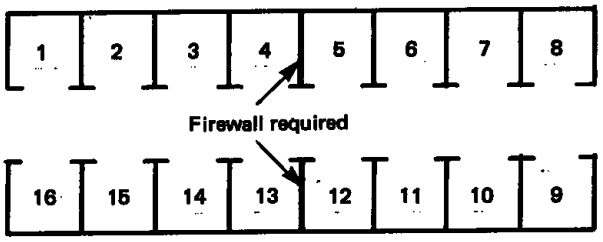
B. Two Groups (5 cars each)
All cars serve all floors, or
Low rise group (1 – 2 – 3 – 4 – 5), all cars serve same floors (1 through 10), plus
High rise group (6 – 7 – 8 – 9 – 19), all cars serve same floors (1, 10 through 20).



C. Two Groups (6 cars each)
All cars serve all floors, or
Low rise group (1 – 2 – 3 – 4 – 5 – 6), all serve same floors (1 through 10), plus
High rise group (7 – 8 – 9 – 10 – 11 – 12), all serve same floors (1, 10 through 20).



D. Two Groups (7 cars each)
All cars serve all floors, or
Low rise group (1 through 7), all serve same floors (1 through 10), plus
High rise group (8 through 14), all serve same floors (1, 10 through 20).

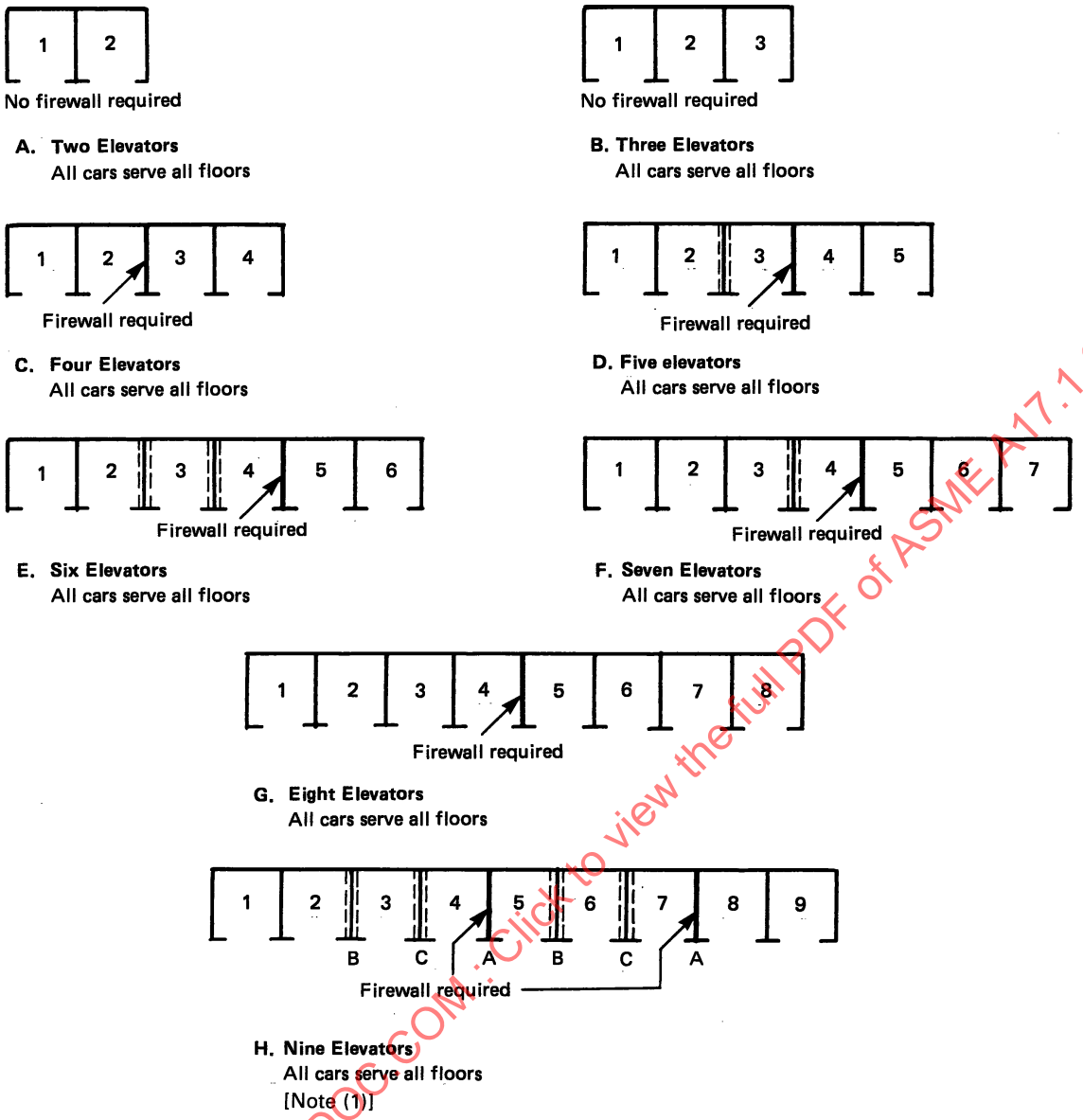


E. Two Groups (8 cars each)
All cars serve all floors, or
Low rise group (1 through 8), all serve same floors (1 through 10), plus
High rise group (9 through 16), all serve same floors (1, 10 through 20).

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Diagram 2.1.1.4
Illustration of Multiple Hoistway Requirements in United States Model Codes (Cont'd)

II. SINGLE GROUP

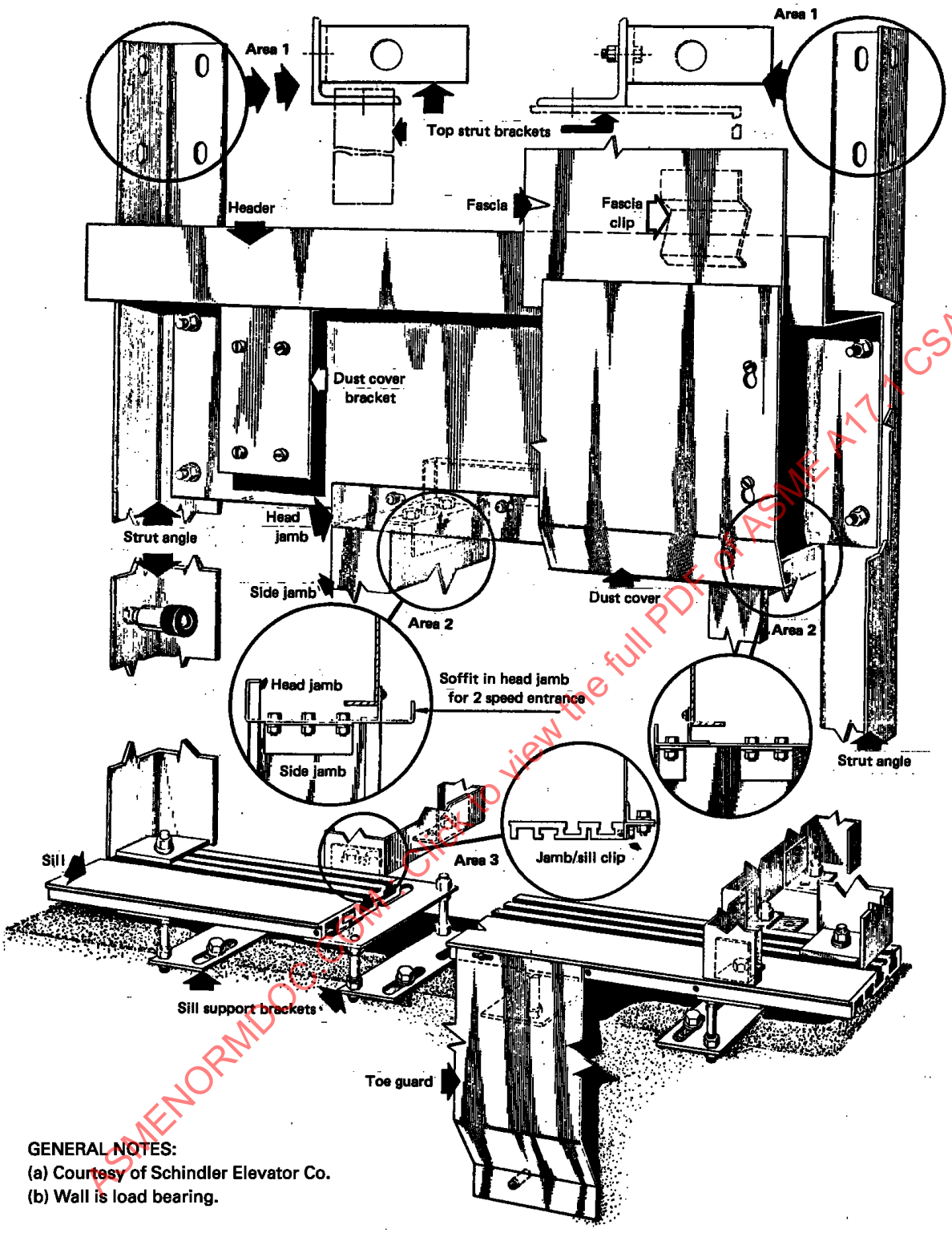


GENERAL NOTES:
(a) Not more than four elevators are located in one hoistway.
(b) Grouped elevators (Part I) serve same floors (same portion of building).
(c) Alternate firewall locations are shown dotted.
(d) It is recommended that not less than two elevators be located in one hoistway. While 2.1.1.4 does not require this, isolating one car into a single hoistway should be avoided for evacuation reasons. With two elevators in a single hoistway, side emergency exits on each car can be used to evacuate passengers if one of the cars becomes stalled between floors.

NOTE: (1) Alternate firewall locations B-B or C-C may be used in lieu of firewall location A-A in sketch H.

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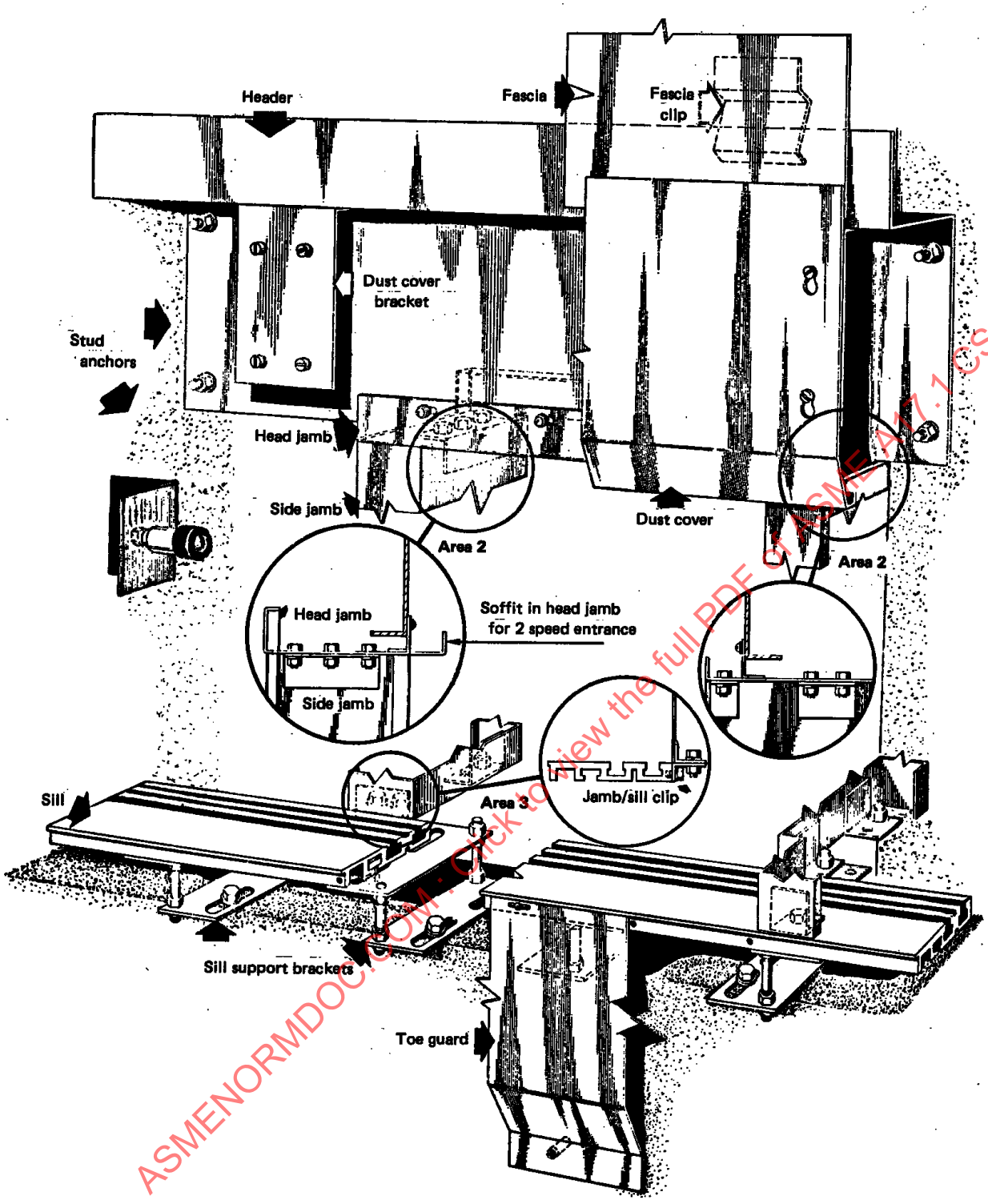
Diagram 2.1.1.5(a)
Passenger Elevator Entrance Arrangement



GENERAL NOTES:
(a) Courtesy of Schindler Elevator Co.
(b) Wall is load bearing.

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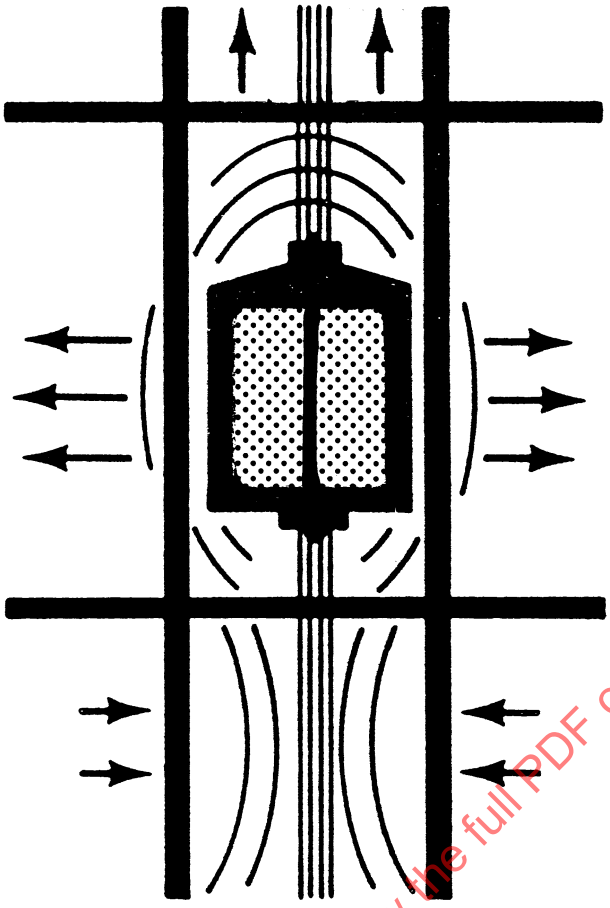
Diagram 2.1.1.5(b)
Passenger Elevator Entrance Arrangement



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GENERAL NOTES:
(a) Courtesy of Schindler Elevator Co.
(b) Wall is load bearing.

Diagram 2.1.1.5(c)
Piston Effect of Elevators Resulting in Oscillation of Hoistway Walls



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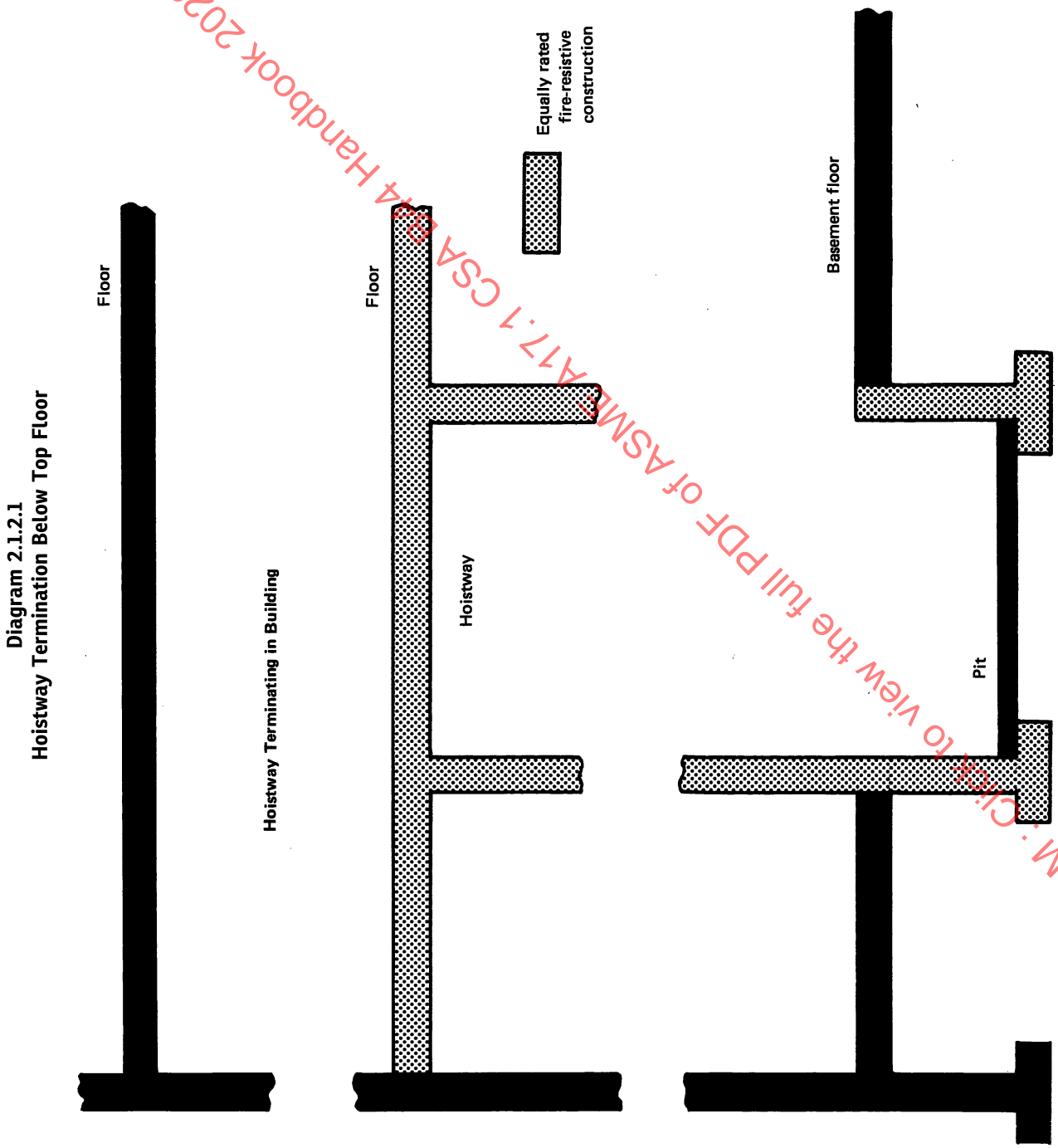
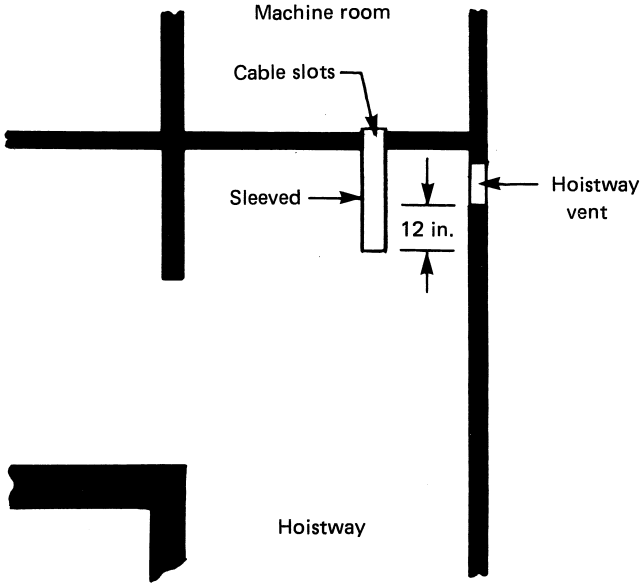


Diagram 2.1.2.1
Hoistway Termination Below Top Floor

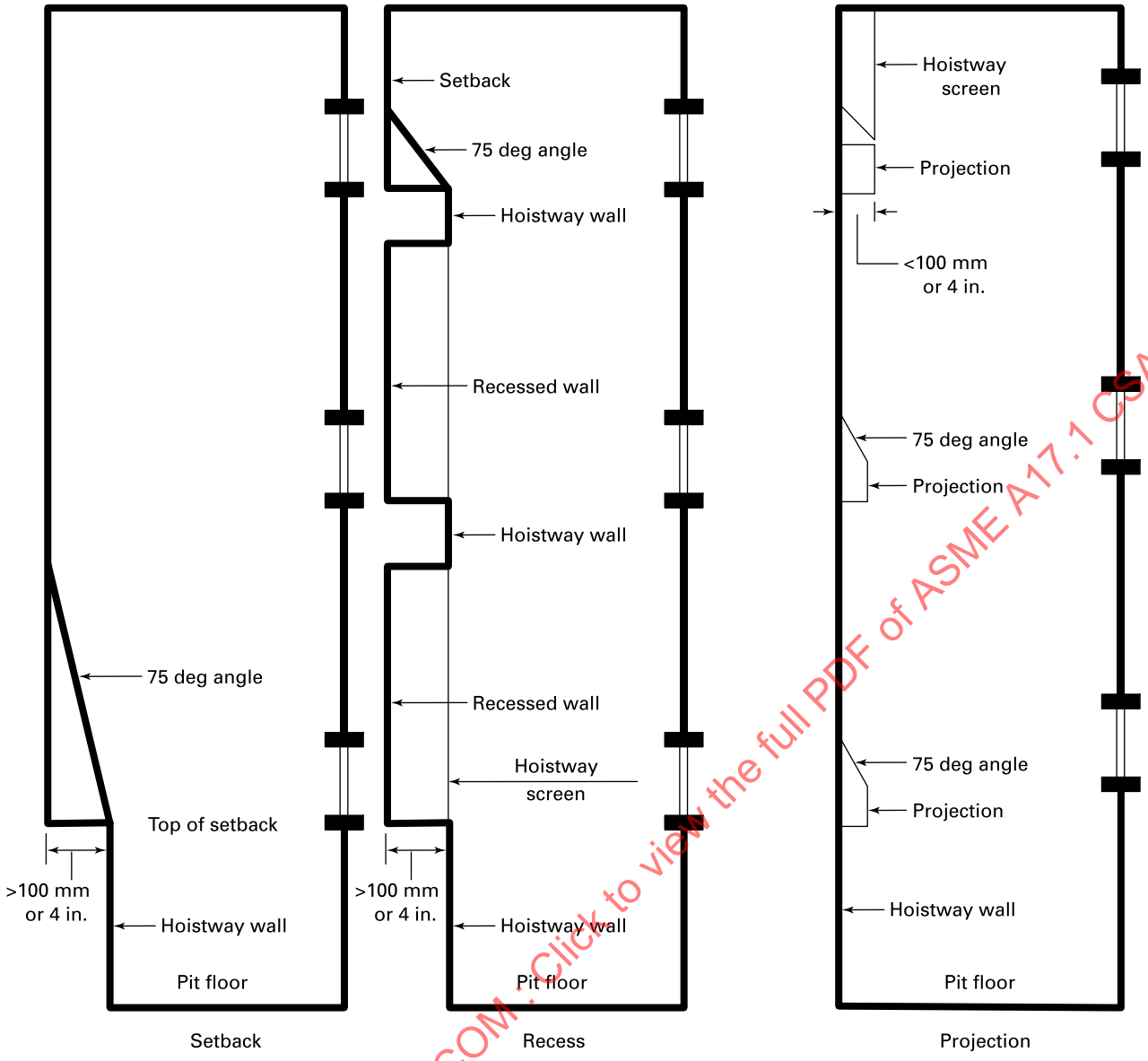
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Diagram 2.1.4
United States Model Code Rope Slot Sleeving Requirements



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Diagram 2.1.6.2
Hoistway Setback, Projection, and Recess



GENERAL NOTE: Courtesy of Zack McCain, Jr., P.E.

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SECTION 2.2
PITS

See Diagram 2.2.

2.2.2 Design and Construction of Pits

When the hoistway is enclosed with fire-resistive construction, the pit must also be enclosed with fire-resistive construction not less than that which is required for the hoistway. If the hoistway enclosure is rated for 2 h, the pit enclosure must be rated for at least 2 h. The fire-resistance rating of the pit access door must be as specified in the building code (see Section 1.3). See Handbook commentary on 2.1.1.1 and 2.1.1.2.

The intent of 2.2.2.4 is to eliminate the possibility of sewer gases entering the hoistway. Compliance is typically achieved by having the sump pump or drain discharge into the open air outside the pit and hoistway. The Committee is aware that this requirement poses a need in many jurisdictions to provide an oil water separator or equivalent protection as required by the plumbing code. As an example, the 2009 International Plumbing Code, requirement 1003.4 states

> At repair garages, car-washing facilities, at factories where oily and flammable liquid wastes are produced, and in hydraulic elevator pits, separators shall be installed into which all oil-bearing, grease-bearing, or flammable wastes shall be discharged before emptying into the building drainage system or other point of disposal.
> **Exception:** An oil separator is not required in hydraulic elevator pits where an *approved* alarm system is installed. However, the need of firefighters to use elevators in a fire situation outweighs the cost associated with compliance to the plumbing code requirements.

Structural frames for buffers, compensating sheaves, and frames that are on top of the floor are permitted. The requirement refers to the floor only and not equipment mounted on it. A hydraulic jack casing extending above the floor is also permitted.

A sump pump or drain is required in every pit for elevators provided with firefighters' service (see 2.2.2.5). Water from building sprinkler systems or other sources (i.e., water from fire suppression) should not be allowed to accumulate in a pit. This provision is intended to assist in maintaining elevator service during a fire emergency. It requires a means to continuously prevent the accumulation of water that does not require human intervention. If a sump pump is utilized, it must be permanently installed. Requirement 2.2.2.5 specifies the minimum capacity of a sump pump/drain at 3,000 gal/h or 11.4 m^3, which is the output from a typical sprinkler head. This may not guarantee a pit free from water but will give firefighters additional time to use the elevator before water in the pit may interfere with the elevator operation.

Requirement 2.2.2.5 was revised in ASME A17.1-2019/CSA B44:19 to specify that the minimum capacity was not per elevator but per hoistway, independent of the number of cars in the hoistway. Requiring the capacity per elevator was deemed excessive.

Sumps in pit floors must be covered to reduce a tripping hazard to maintenance and inspection personnel.

2.2.3 Guards Between Adjacent Pits

A guard or standard railing is required only when adjacent pit floors are at different levels. The guard or railing is to protect the mechanic or inspector from falling due to the differences in elevations between adjacent pit floors. See also Handbook commentary on standard railing in 2.10.2.

2.2.4 Pit Access

When the pit floor is more than 900 mm or 35 in. below the sill of the pit access door, a fixed retractable or nonretractable ladder must be installed. If access to the pit in a multiple hoistway is through the lowest landing (hoistway) door and a ladder is required, then a ladder must be provided for each elevator in the multiple hoistway. A single ladder is not acceptable.

ASME A17.1/CSA B44 requirements are based on the relevant OSHA regulations 29 CFR 1910.27(c)(4).

American National Standards for Ladders — Fixed-Safety Requirements (ANSI A14.3) is the source standard for 29 CFR 1910.27. See Diagram 2.2.4 for the recommended location of pit ladders.

2.2.4.2 The 115-mm or 4.5-in. dimension behind the ladder has withstood the test of time and complies with OSHA 1925.1053(a)(13). See Diagrams 2.2.4.2(a) and 2.2.4.2(b).

Requirement 2.2.4.2 was revised in ASME A17.1-2022/CSA B44:22, including the addition of 2.2.4.2.7, to add an electrical device to the ladder to detect the presence of someone on the ladder and prevent movement of the elevator car. The requirement is written to allow flexibility in the design of the device to include detection of weight, movable guards, or other means to detect a person. The change was initiated to mitigate hazards associated with personnel on the ladder when the car moves. The change also included updating of references and addition of SIL ratings.

2.2.4.6 See Diagram 2.2.4.6.

2.2.5 Illumination of Pits

Caution should be taken when installing lighting fixtures in the pit. The fixture and its lamp must be mounted in a location where they will not be struck by a car or counterweight when on their fully compressed buffers. The light switch must be accessible from the

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access door to allow for turning on the lights before accessing the pit.

A duplex receptacle is required in the pit by the National Electrical Code® and Canadian Electrical Code (see 2.26.4). A duplex receptacle is required as power is often necessary for droplights and power tools used for servicing elevators. The National Electrical Code® Section 620-85 and Canadian Electrical Code, Section 38-085 require that all receptacles in the pit be provided with ground-fault circuit interrupter protection, with the exception of a single receptacle supplying a permanently installed sump pump.

2.2.5.2 The guard on the light bulb shall be sufficient to prevent breakage and accidental contact by a person working in the pit.

2.2.6 Stop Switch in Pits

A pit stop switch must be provided for every elevator to allow elevator personnel to control the movement of the elevator before entering the pit. Pit stop switches must be of the manually operated and enclosed type, have red operating handles or buttons, be conspicuously and permanently marked "STOP," indicate the stop and run positions, and be positively opened mechanically. The opening of the switches must not be solely dependent on springs. The switch must be located adjacent to the nearest point of access and where access to the pit is through the lowest landing hoistway door approximately 450 mm or 18 in. above the floor level of the access landing.

OSHA requires, under certain conditions, that equipment being worked on be locked-out and tagged-out of service. Locking a pit stop switch such as shown in Diagram 2.2.6 is not sufficient to meet the OSHA requirements for lockout and tagout as the elevator system would still be energized. Only the main line disconnect switch should be used to de-energize the electrical power source as required by the OSHA locked-out and tagged-out requirements. Detailed information on the proper lockout/tagout procedure can be found in the Elevator Industry Field Employees' Safety Handbook. Procurement information can be found in Part 9 of this Handbook.

In a pit where the point of access is more than 1 700 mm or 67 in. above the pit floor, two pit stop switches that are wired in series must be provided: one approximately 450 mm or 18 in. above the access floor, and the second 1 200 mm or 47 in. above the pit floor. This allows personnel entering the pit to engage the upper stop switch 450 mm or 18 in. above the access floor, then descend the pit ladder to the pit floor and engage the lower switch located 1 200 mm or 47 in. above the pit floor. If operation of the elevator is then necessary, elevator personnel can ascend the pit ladder and place the upper stop switch in the run position. The elevator can then be controlled from the lower stop switch. When leaving the pit, the upper stop switch is to be placed in the stop position before the lower stop switch is placed in the run position.

Some pits may be classified as a "confined space" by OSHA CFR 1926.21 or a "permit required confined space" by OSHA CFR 1910.146. Detailed information on the application of OSHA confined space regulations applicable to elevator pits can be found at www.neii.org.

Requirement 2.2.6 was revised in ASME A17.1-2022/CSA B44:22 to correct references used in this section.

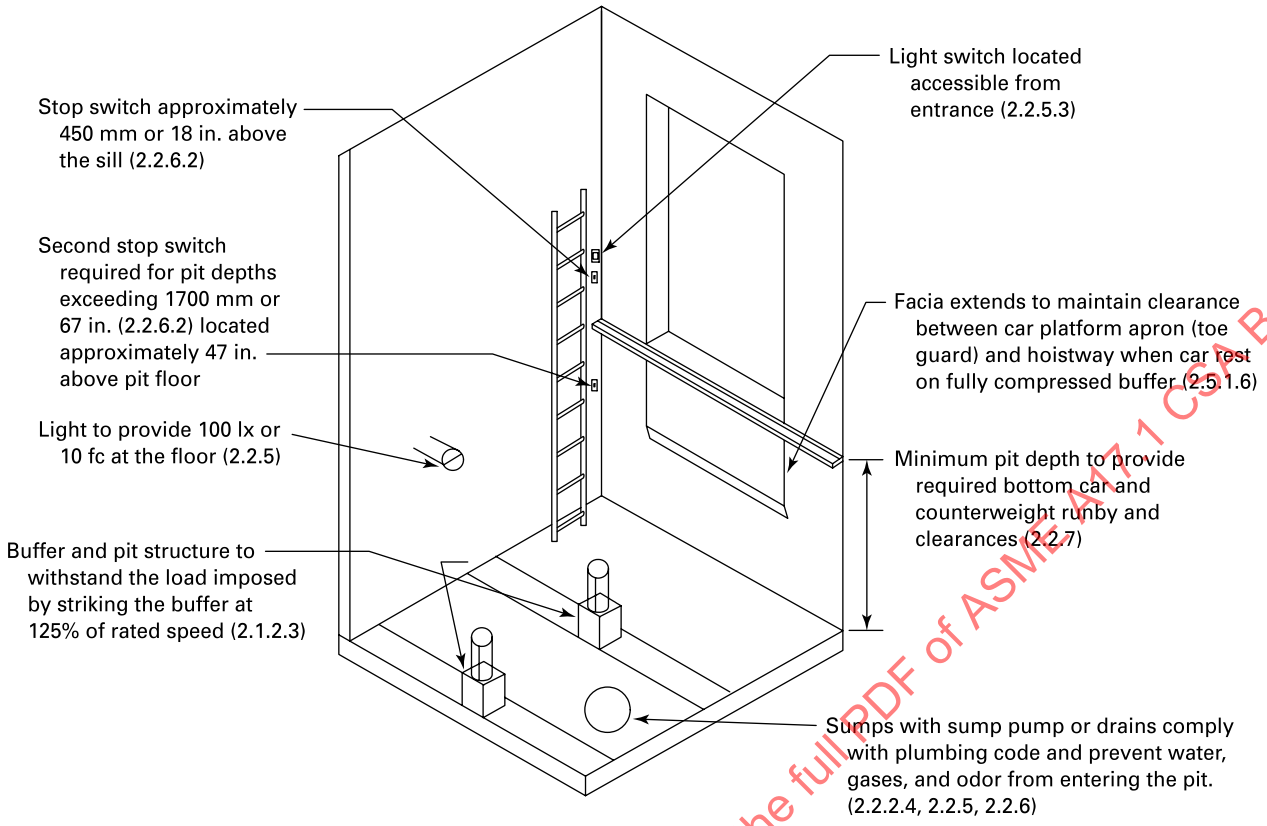
2.2.6.2 The last sentence of Rule 106.1f in ASME A17.1-1996 [requirement 2.2.6.3 in ASME A17.1-2000 (CSA B44-00) through ASME A17.1-2010/CSA B44-10] required two pit stop switches where the pit depth exceeds 1 676 mm or 66 in. [which changed to 1 700 mm or 67 in. in ASME A17.1-2000 (CSA B44-00) through ASME A17.1-2010/CSA B44-10]. The two pit stop switches required in this situation were mandated to be wired in series. Requirement 2.2.6.3 in ASME A17.1-2000 (CSA B44-00) through ASME A17.1-2010/CSA B44-10 appeared to apply not only to deep pits but also to the situation in 2.2.6.1 involving multiple hoistways (and therefore, multiple stop switches — one for each elevator pit). Requirement 2.2.6.3 was deleted in ASME A17.1-2013/CSA B44-13, and 2.2.6.2 was clarified to eliminate confusion as to exactly where the requirements apply.

2.2.9 Flood Detection Means

Requirement 2.2.9 was added in ASME A17.1-2022/CSA B44:22 to provide a location for the flood detection means required as part of the Flood Detection Operation added in 2.27.13. The detection means is located where it will detect the presence of water in the pit and prevent normal operation of the elevator before the water reaches a level where the counterweight or other equipment would operate in or descend into the flood water. See also Handbook commentary on 2.27.13.

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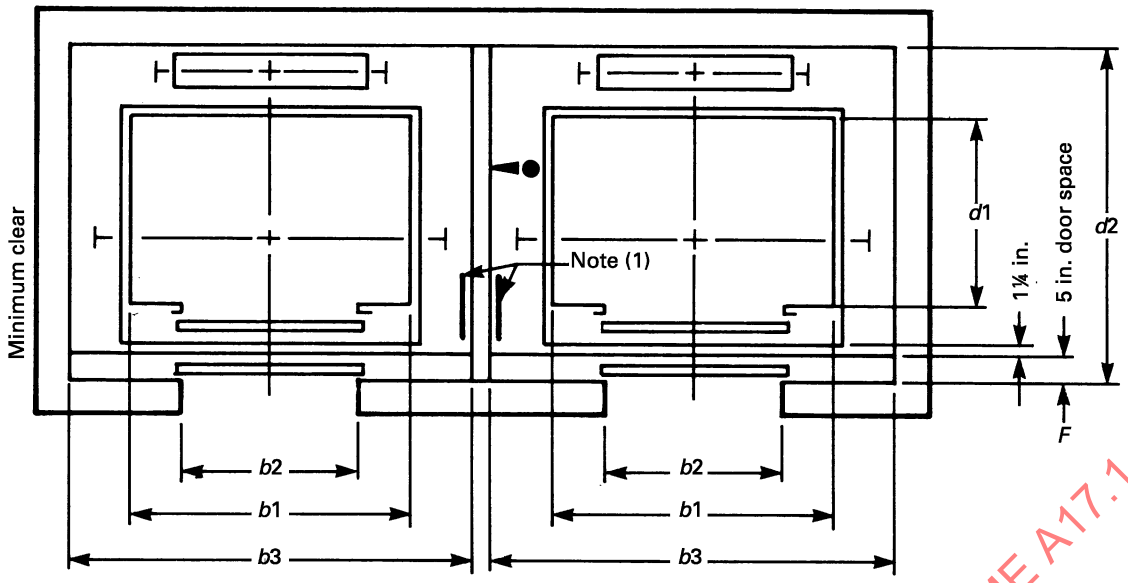
Diagram 2.2
Pit Requirements



GENERAL NOTE: Courtesy of Zack McCain, Jr., P.E.

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Diagram 2.2.4
Typical Pit Ladder Locations

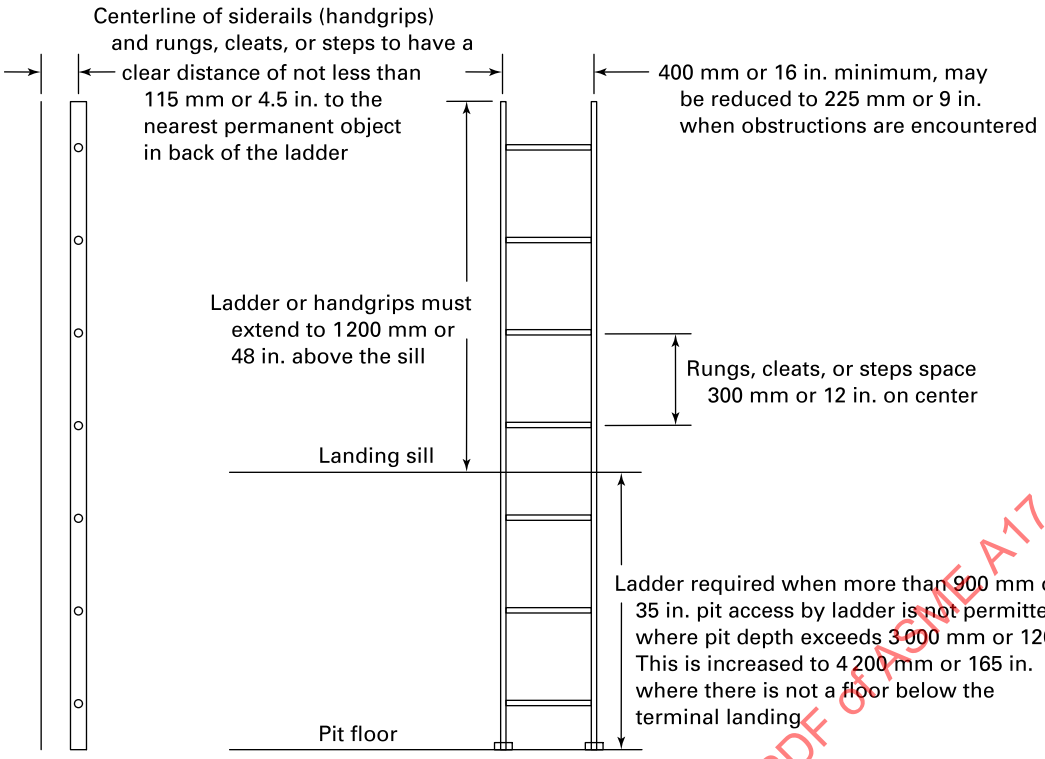


GENERAL NOTE: Courtesy of Building Transportation Standards and Guidelines, *NEII*®-1, © 2000–2022, National Elevator Industry, Inc., Centreville, VA.

NOTE: (1) Pit ladder not by elevator supplier. Hoistway width allows for the installation of a pit ladder with a clearance of 4½ in. from centerline of rungs. When additional clearance is required, alternative provisions need to be considered.

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Diagram 2.2.4.2(a)
Pit Nonretractable Ladder Requirements



GENERAL NOTE: Courtesy of Louis M. Capuano, Elevator Engineering Services, LLC.

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Diagram 2.2.4.2(b)
Means to Unlock the Pit Egress Door

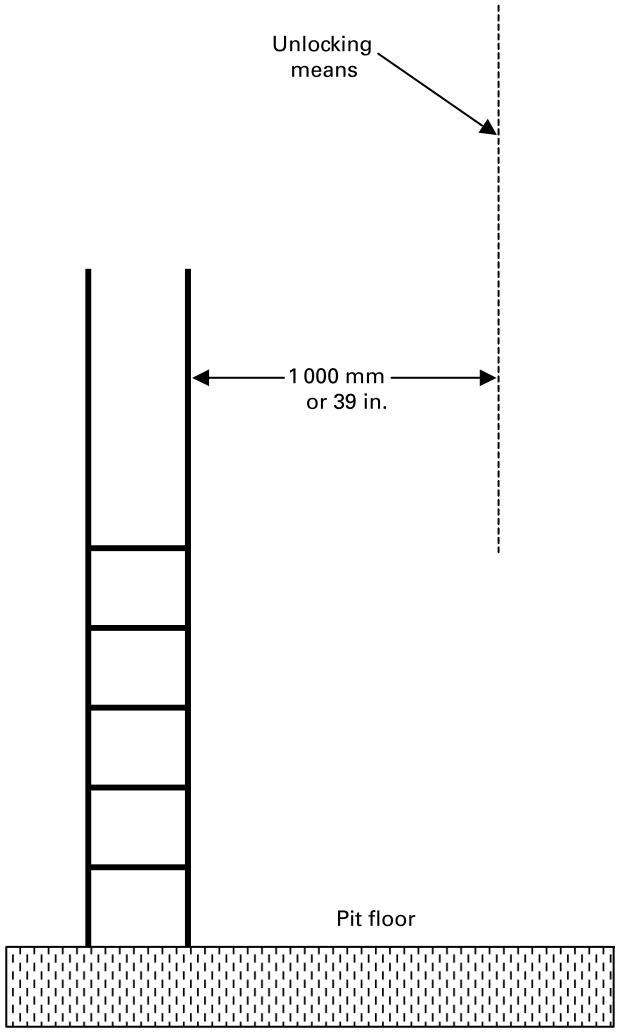
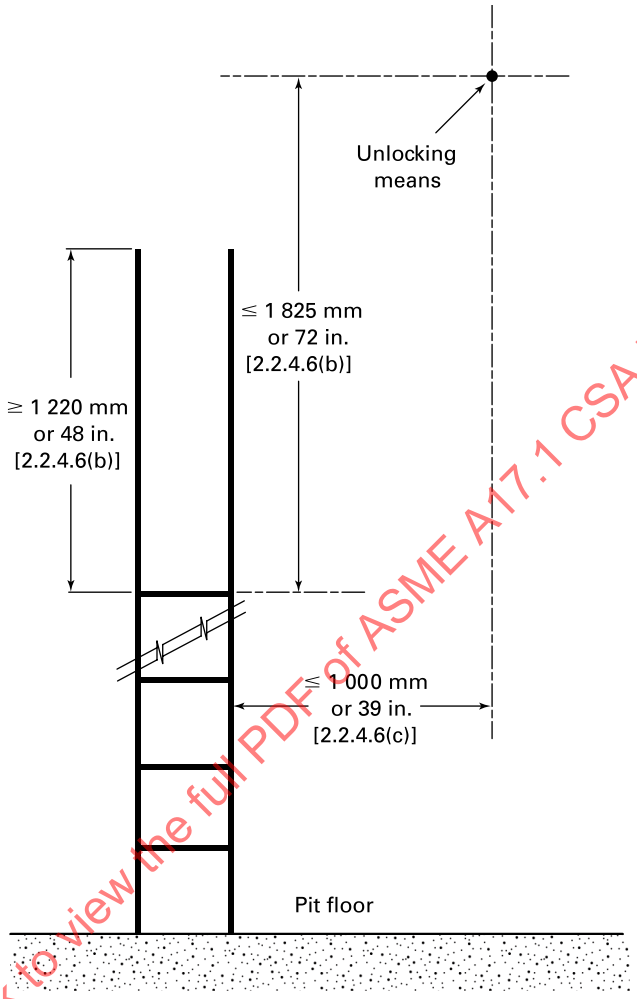


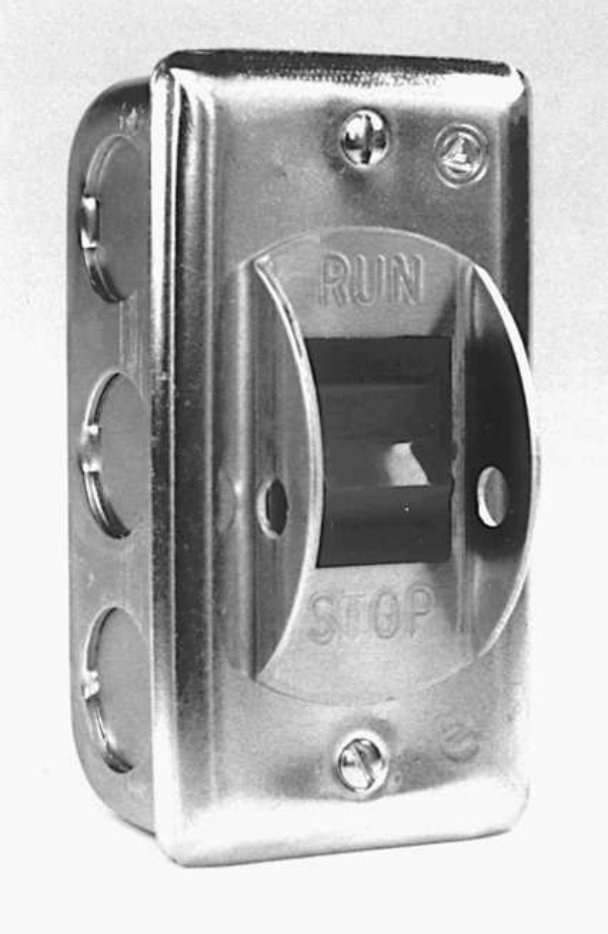
Diagram 2.2.4.6
Relationship of Pit Ladder to Hoistway Door Unlocking Means



GENERAL NOTE: Courtesy of Louis M. Capuano, Elevator Engineering Services, LLC.

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Diagram 2.2.6
Lockable Pit Stop Switch



GENERAL NOTE: Courtesy of Nylube Products Co.

SECTION 2.3
LOCATION AND GUARDING OF COUNTERWEIGHTS

2.3.1 Location of Counterweights

Counterweights located in the hoistway of the elevator they serve facilitate the inspection and maintenance of the counterweight and its suspension means. The term "mechanical compensation" as used in this requirement refers to physically connecting the bottom of the car to the bottom of the counterweight. When counterweights are located in remote (separate) hoistways, the requirements of 2.3.3 provide access for inspection and maintenance. Counterweights with mechanical compensation or with a counterweight safety must be located in the same hoistway with the elevator they serve.

2.3.2 Counterweight Guards

The counterweight guards protect elevator personnel from accidentally stepping into a counterweight runway. When the counterweight cannot descend less than 2 130 mm or 84 in. above the pit floor, no guard is required, as an individual will not be struck by the counterweight while standing on the pit floor.

The height of the guards ensures protection, but does not obscure the equipment, in order to facilitate inspection and maintenance. Perforations allow for visual inspection behind the guard yet provide protection against accidental intrusion into the counterweight runway. See Diagram 2.3.2.

2.3.2.1

2.3.2.1(a) This requirement was revised in ASME A17.1-2013/CSA B44-13 to recognize that suspension means as well as compensating ropes or chains can alert personnel to the presence of the counterweight runway.

2.3.2.3 Guarding of Counterweights in a Multiple-Elevator Hoistway. In a multiple hoistway where a counterweight is located between two cars, a guard the full length of the hoistway is required between the counterweight and adjacent car. The guard protects elevator personnel from coming into accidental contact with the counterweight of the adjacent car. See Diagram 2.3.2.3.

2.3.3 Remote Counterweight Hoistways

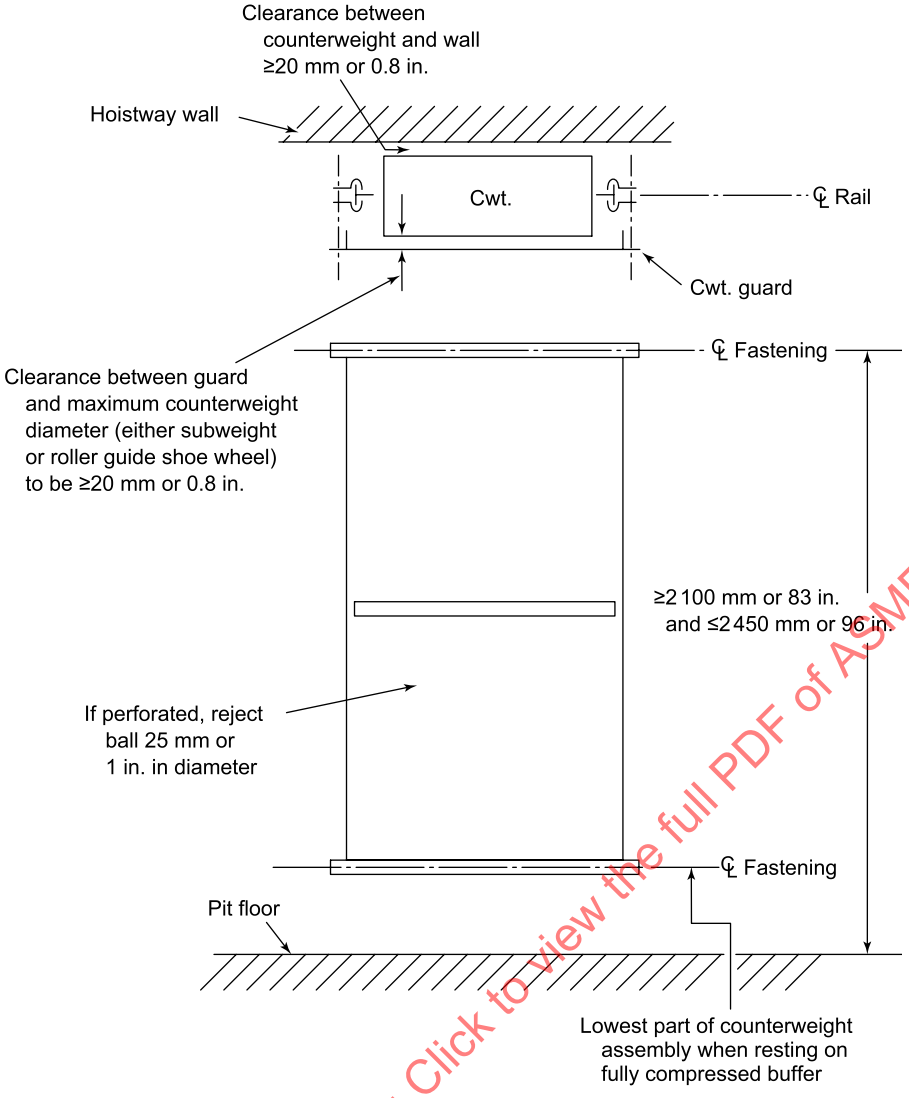
This requirement applies only to elevators that do not have mechanical compensation or counterweight safeties. When a separate counterweight hoistway is provided, fire protection must be maintained, and safe, convenient access for maintenance and inspection personnel must be provided. Additionally, the requirements protect the public from moving counterweights. Also, see Handbook commentary on referenced requirements.

2.3.4 Counterweight Runway Enclosures

This requirement permits the screening of the counterweight runway from the remainder of the hoistway. This screen may run the full height of the hoistway. Provisions are required to allow removal of the screen for inspection of the counterweight rails, brackets, suspension means, etc.

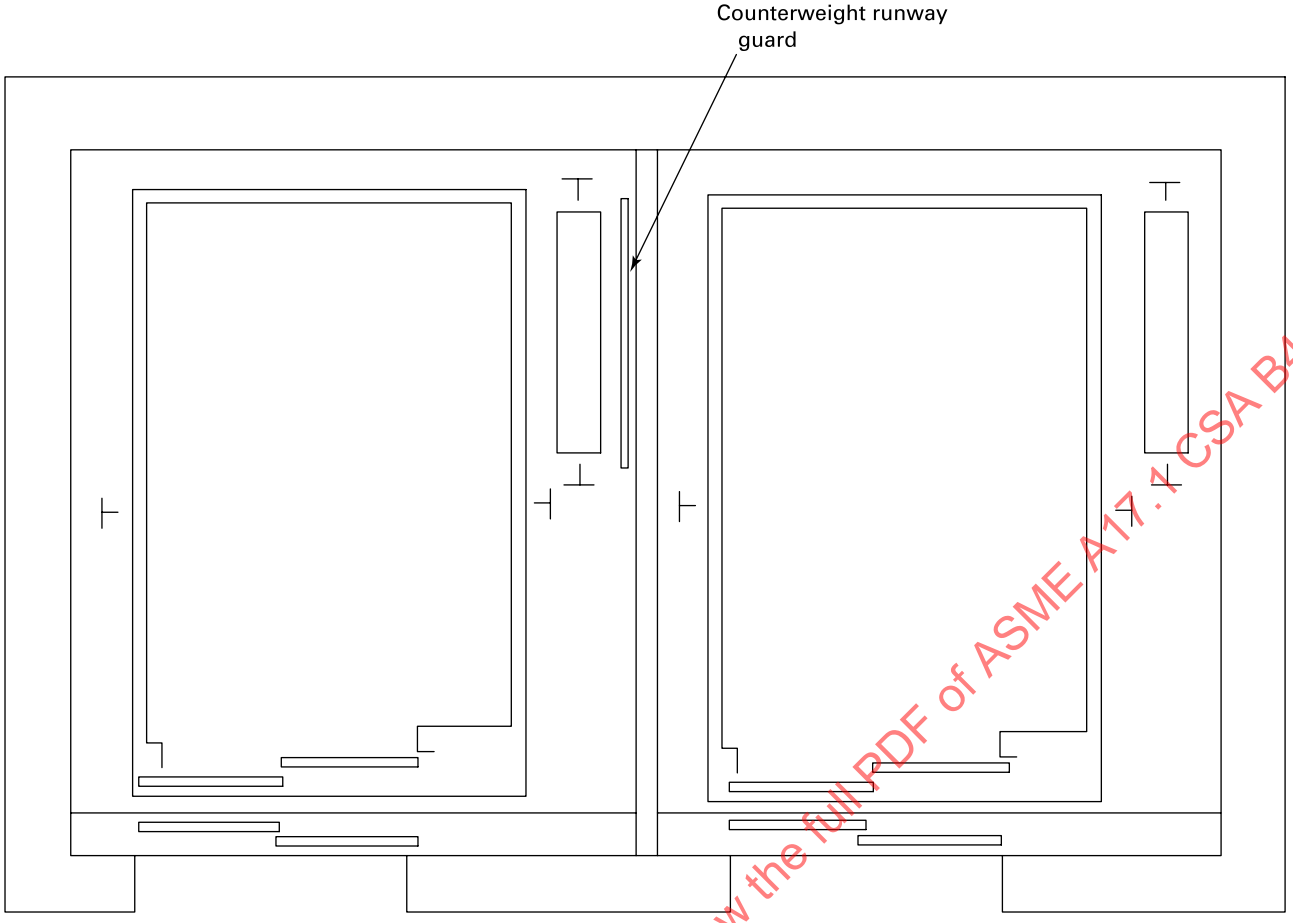
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Diagram 2.3.2
Counterweight Pit Guards



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Diagram 2.3.2.3
Guarding of Counterweights in Multiple Hoistways



GENERAL NOTE: Courtesy of Louis M. Capuano, Elevator Engineering Services, LLC.

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SECTION 2.4
VERTICAL CLEARANCES AND RUNBYS FOR CARS AND COUNTERWEIGHTS

2.4.1 Bottom Car Clearances

The purpose of this requirement is to provide refuge space below the car when it is resting on its fully compressed buffer or solid bumper. The 600-mm or 24-in. measurement specified in 2.4.1.1 is taken to the pit floor even though there may be a pit channel running across the pit floor. However, the 600-mm or 24-in. and 1 070-mm or 42-in. minimum heights specified in 2.4.1.3 would be measured from the top of the channel. See Diagrams 2.4.1(a) and 2.4.1(b).

2.4.1.6 Markings and warning signs are required in areas where a car is on its fully compressed buffer and the vertical clearance is less than 600 mm or 24 in. Elevator personnel need to be warned where there is a low-clearance condition. If the only area where the 600-mm or 24-in. vertical clearance is not provided is the area below the platform guard and/or guiding members, then markings and warnings are not required.

2.4.2 Minimum Bottom Runby for Counterweighted Elevators

Requirement 2.4.2.1(a) permits the reduction of runby where justified by practical difficulties. Requirement 2.4.2.1(b) permits the elimination of runby, providing that spring-return oil buffers are used. See also Handbook commentary on 2.4.3.

Requirement 2.4.2 was revised in ASME A17.1-2022/CSA B44:22, and Table 2.4.2.2 was deleted, to clarify the runby requirements and delineate between requirements for installation, maintenance, and replacement. The change also eliminated the exception for rheostatic and single-speed AC controls, since they cannot meet the requirements in 2.26.11 or accessibility codes. Information from the table has been moved to 8.6.3.12.1.

2.4.2.2 This requirement was revised in ASME A17.1-2016/CSA B44-16 to add elastomeric buffers.

2.4.3 Minimum Bottom Runby for Uncounterweighted Elevators

In 2.4.2 and 2.4.3, bottom car runby is defined as the distance between the car buffer striker plate and the striking surface of the car buffer or solid bumper when the car floor is level with the bottom terminal landing. Bottom counterweight runby is defined as the distance between the counterweight buffer striker plate and the striking surface of the counterweight buffer or solid bumper when the car floor is level with the top terminal landing. Sufficient distance is allowed by this requirement for the elevator to stop normally without striking the buffers or solid bumpers.

Bottom runby is control dependent, because landing accuracy is control dependent. With rheostatic control, the speed is varied by changing the resistance and/or reactance in the armature and/or field circuit of the driving machine motor. Since the elevator is stopped on the brake with this type of control, the runby requirement increases with the rated speed. A modern control system has a closer tolerance for landing accuracy. The requirements in Table 2.4.2.2 were empirically derived. Normal suspension means stretch should be taken into account during installation keeping in mind the runby.

The runby specified in 2.4.2 and 2.4.3 may be reduced below that which is specified after the installation is accepted. The requirements for maintenance of runby are specified in 8.6.4.11. See also Handbook commentary on 8.6.4.11.

2.4.4 Maximum Bottom Runby

If additional runby were allowed, evacuation from a stalled elevator could be dangerous and/or impossible. See Diagrams 2.4.1(a) and 2.4.4.

2.4.5 Counterweight Runby Data Plate

The data plate notifies elevator personnel of the maximum designed counterweight runby dimension. If the runby exceeds this maximum value, it could allow the car to strike the overhead and reduce the vertical clearance of top-of-car refuge space.

2.4.6 Maximum Upward Movement of the Car

The maximum upward movement differs depending on the type of counterweight buffers that are used, and whether or not compensating means tie-down is provided.

When a reduced stroke buffer is provided, the portion of the maximum upward movement is calculated using the stroke of the reduced stroke buffer. This recognizes that when a reduced stroke buffer is used that 2.25.4, Emergency Terminal Stopping Means, reduces the car and counterweight speed so as not to exceed the rated buffer striking speed.

Maximum upward movement provides adequate space for elevator personnel when they are on the top-of-car enclosure and warns them when the clearance is inadequate. ISO 15534-3-2000 anthropometric data was used to establish sufficient space on top of the car to accommodate parts of the human body when a car is at its maximum upward movement.

2.4.6.1 Counterweighted Elevators

2.4.6.1.1 This requirement was revised in ASME A17.1-2016/CSA B44-16 to add elastomeric buffers.

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2.4.7 Top-of-Car Clearances

This requirement provides adequate space for elevator personnel when they are on top-of-car enclosure and to warn them when the clearance is inadequate. ISO 15534-3-2000 anthropometric data was used to establish sufficient space on top of the car to accommodate parts of the human body when a car is at its maximum upward movement.

A clearance of not less than 1100 mm or 43 in. is required from above the enclosure top to a horizontal plane along the lowest projection directly above the car top projection. This clearance is measured within the handrail when provided, where a person would stand. This clearance harmonizes with hydraulic elevator clearance requirements and recognizes a larger refuge area than previously addressed.

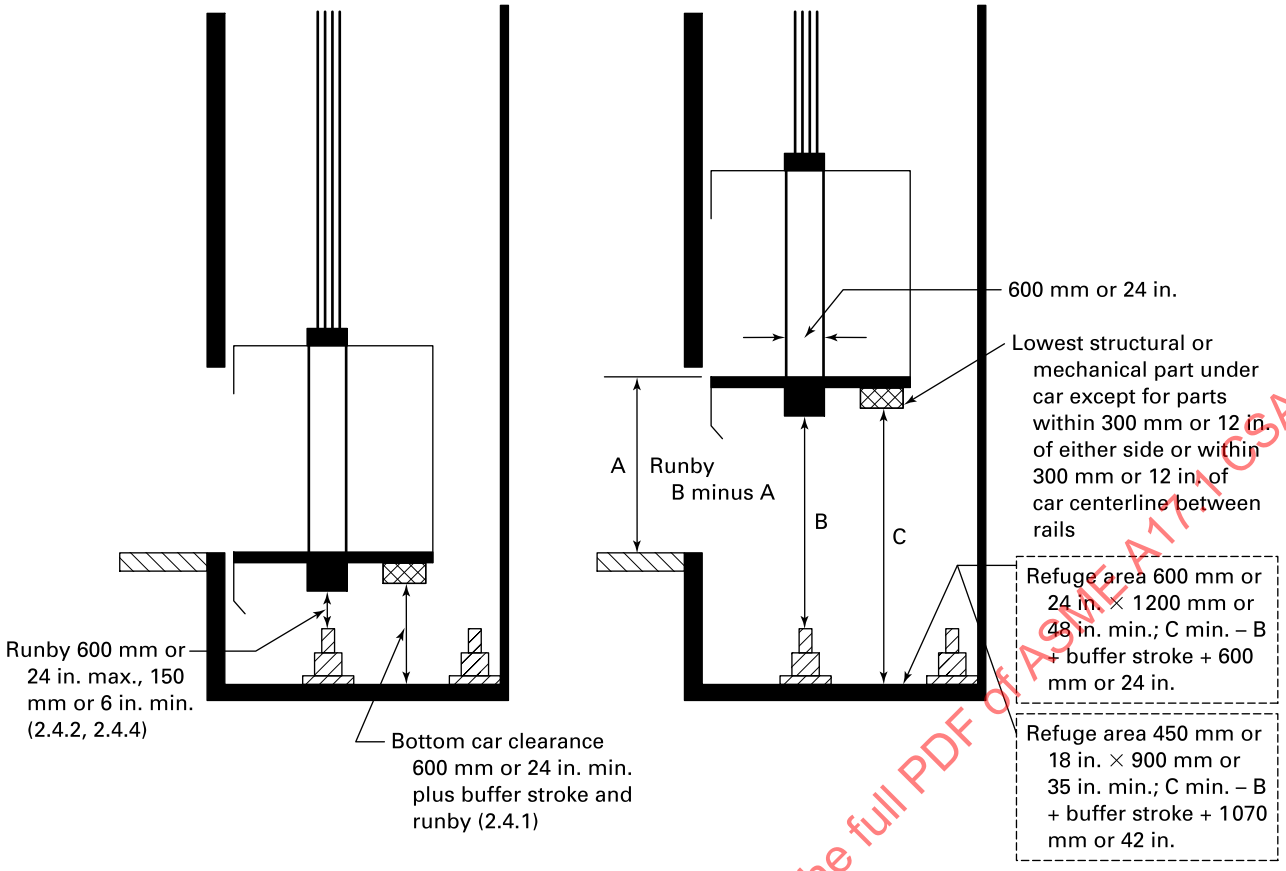
See Diagrams 2.4.7(a) through 2.4.7(f). Figure G-1 was revised in ASME A17.1-2016/CSA B44-16 to ensure protection of elevator personnel against shearing hazards throughout the hoistway between the top rail and intermediate rail of the standard railing and fixed equipment passed or approached by the standard railing as the car moves throughout the hoistway. These changes are reflected in Diagram 2.4.7(a).

2.4.8 Top of Counterweight Clearances

Top of counterweight clearance is defined as the shortest vertical distance between any part of the counterweight structure and the nearest part of the overhead structure or any other obstruction when the car floor is level with the bottom terminal landing. The top of counterweight clearance requirement is dependent on the jump of the counterweight when the car strikes its buffer.

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Diagram 2.4.1(a)
Bottom Car Clearances and Runby

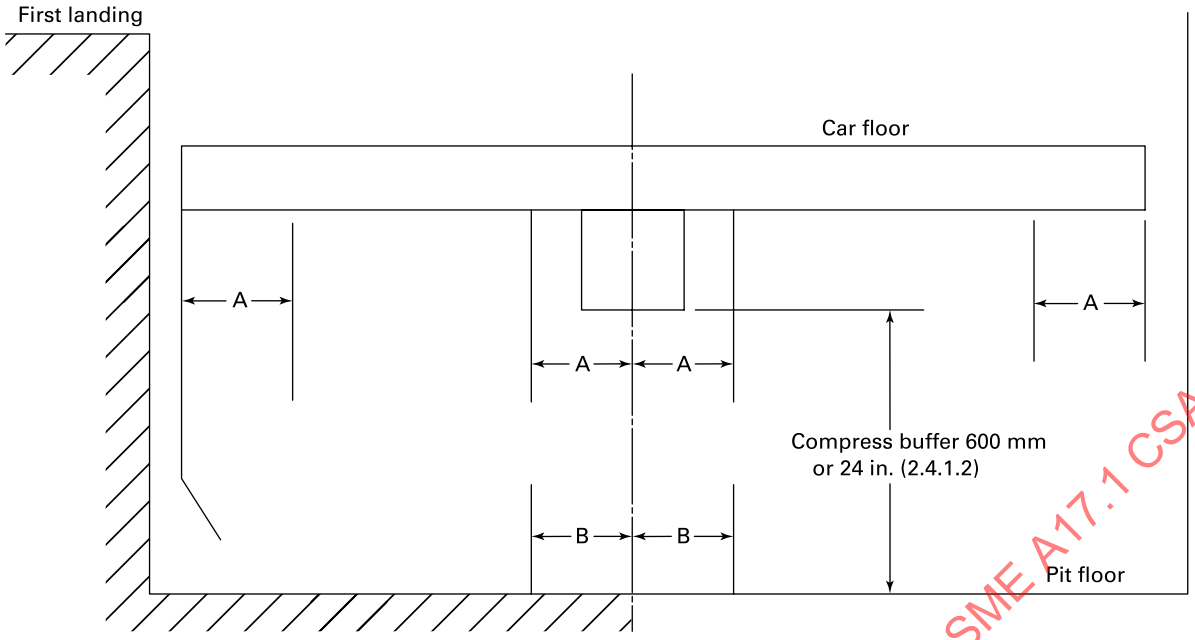


Counterweighted Elevators

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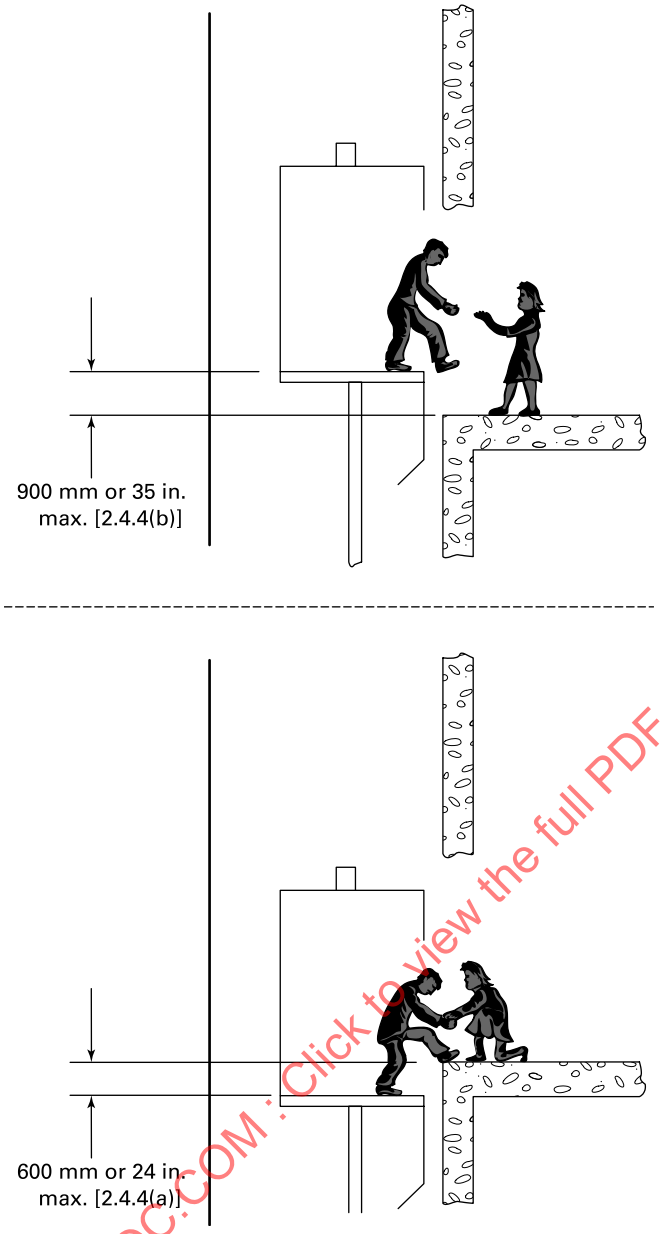
Diagram 2.4.1(b)
Bottom Car Clearance Does Not Apply



GENERAL NOTES:
(a) A = 300 mm or 12 in. equipment permitted on car in this area as long as it does not strike anything when car is on fully compressed buffer [2.4.1.2(a) and (b)].
(b) B = 300 mm or 12 in. equipment permitted on pit floor in this area as long as it is not struck by car, plunger follower guide, or other equipment when car is on fully compressed buffer [2.4.1.2(c)].
(c) See also minimum refuge space requirement (2.4.1.3).

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Diagram 2.4.4
Maximum Top and Bottom Runby



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Diagram 2.4.7(a)
Top-of-Car Clearance Requirements (2.4.7.1 and 2.14.1.7.2)

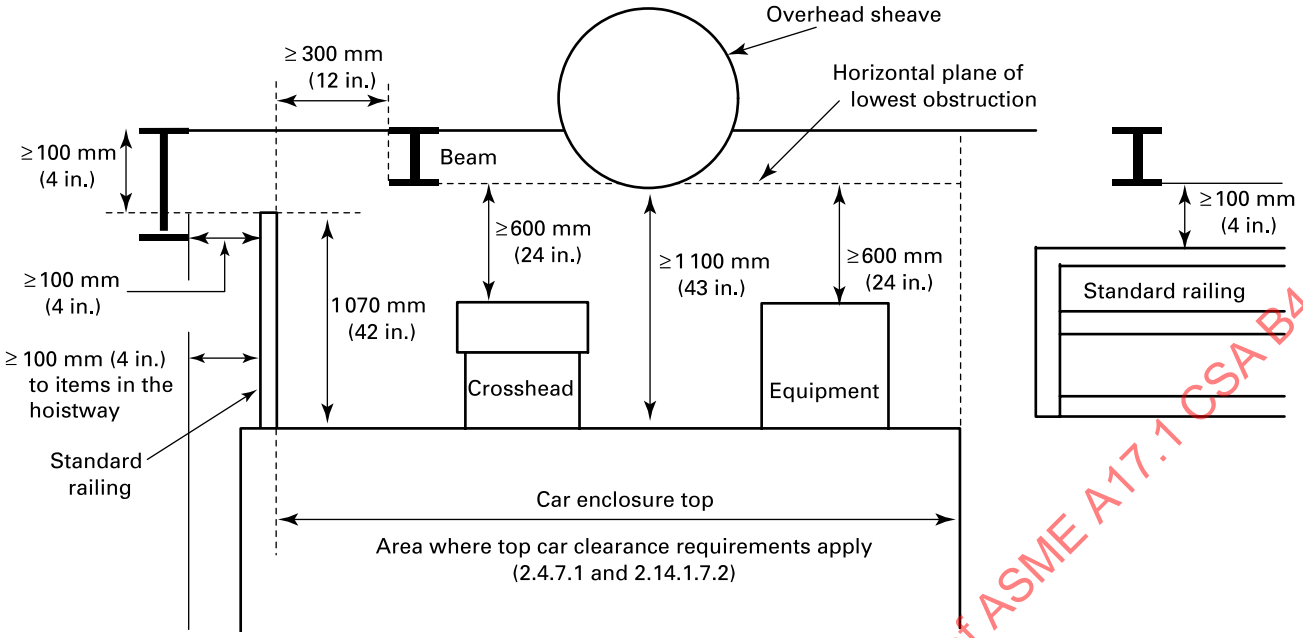
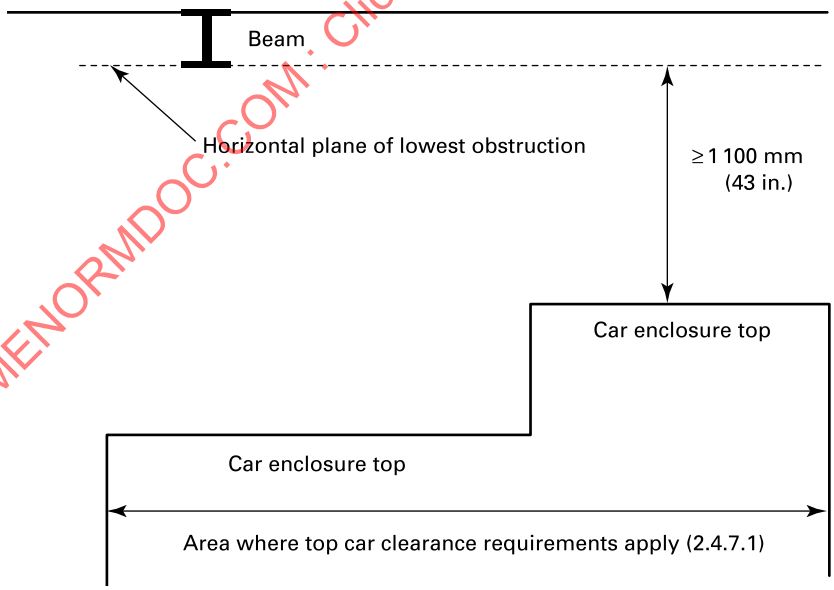
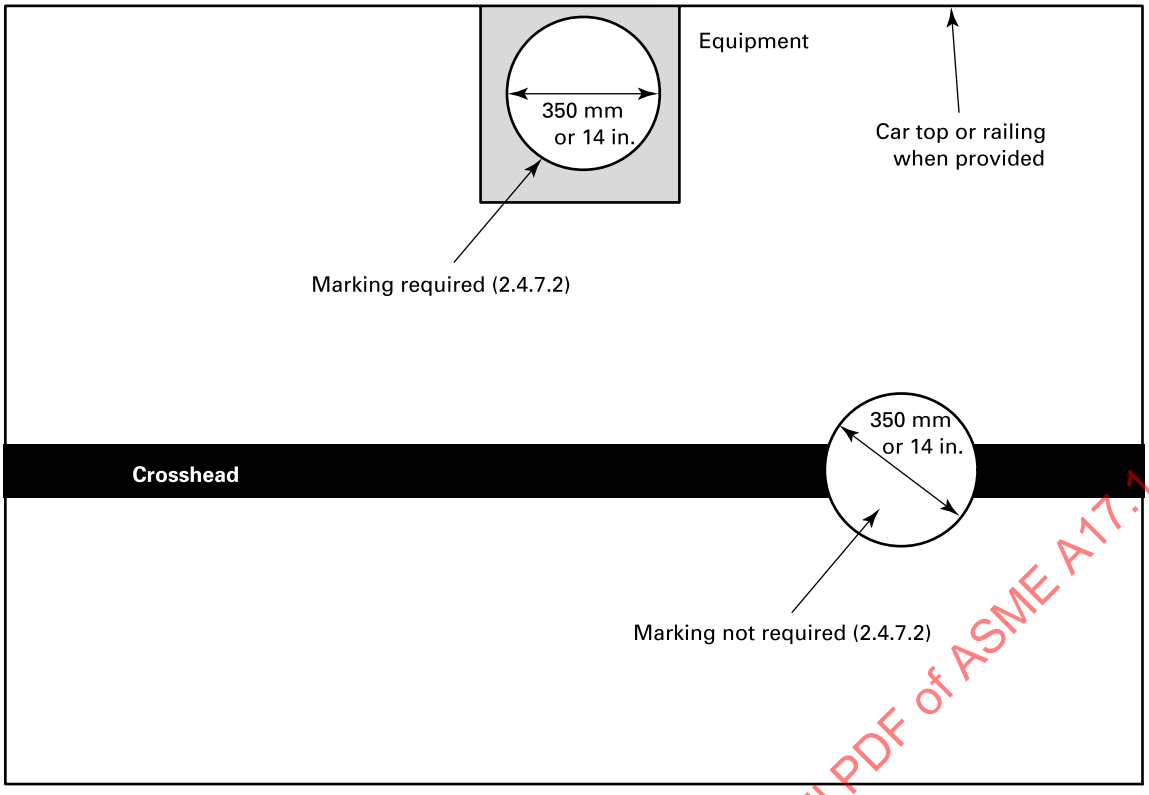


Diagram 2.4.7(b)
Additional Top-of-Car Clearance Requirements (2.4.7.1)



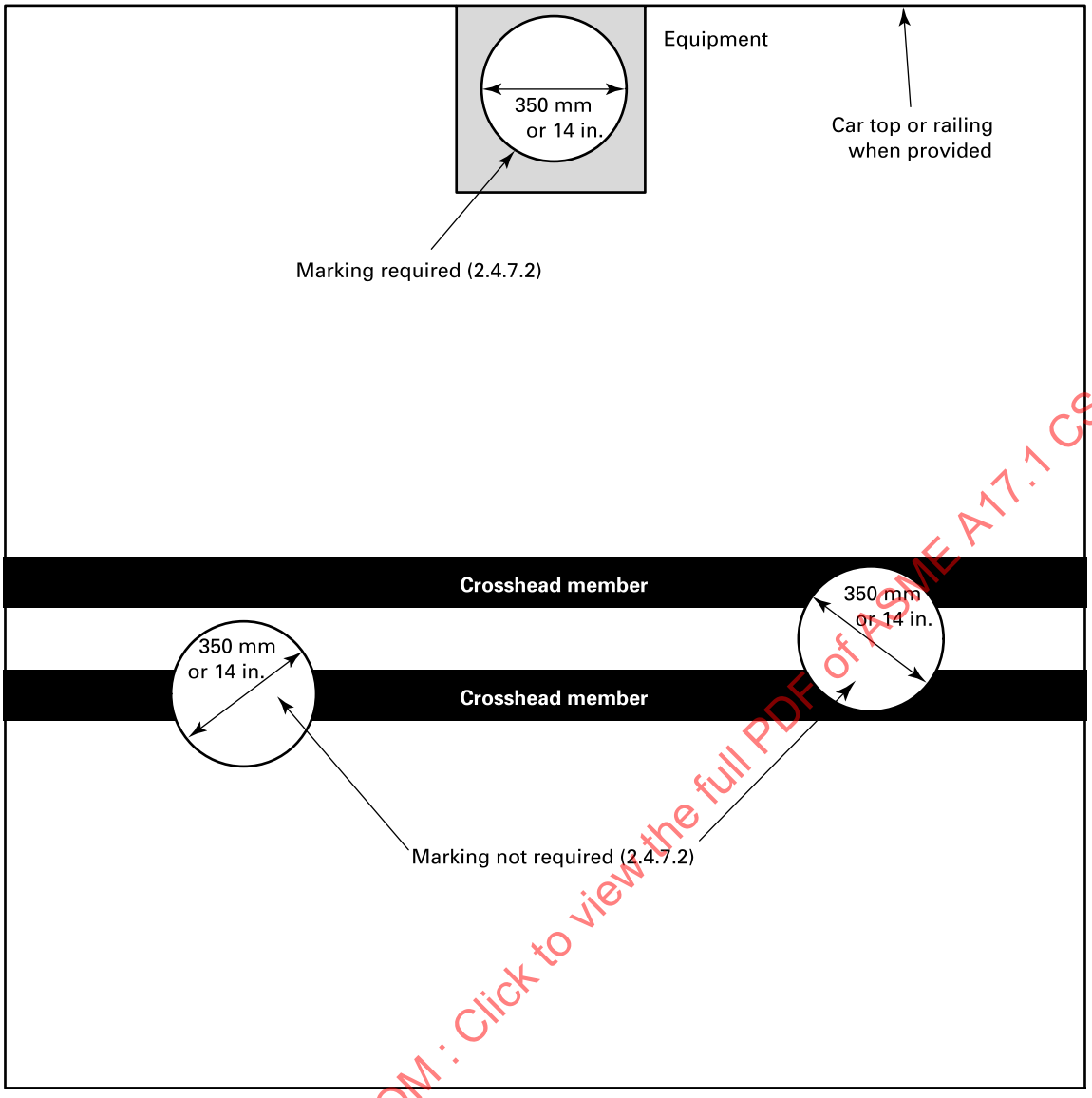
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Diagram 2.4.7(c)
Top-of-Car Marking Requirements (2.4.7.2)



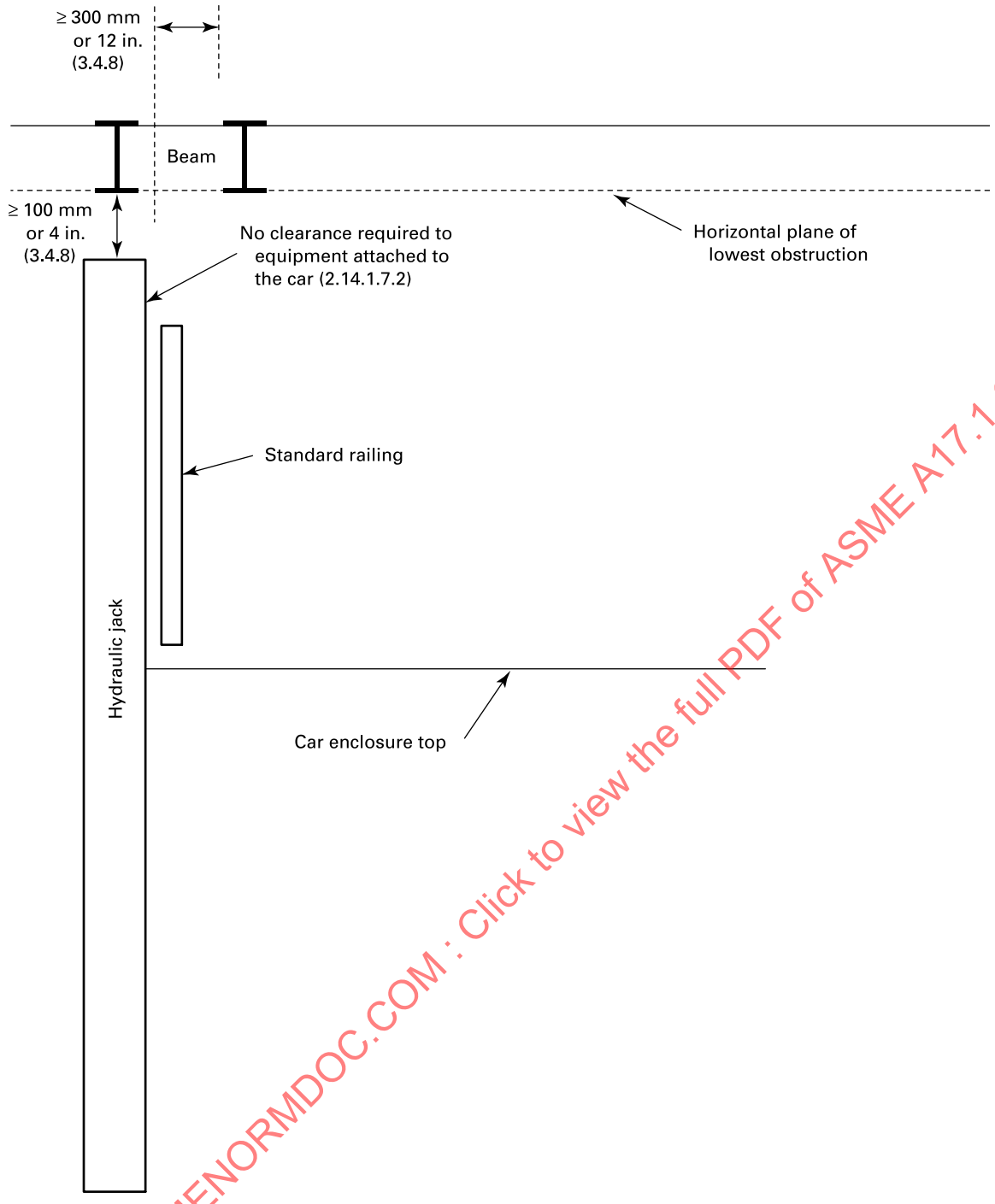
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Diagram 2.4.7(d)
Additional Top-of-Car Marking Requirements (2.4.7.2)



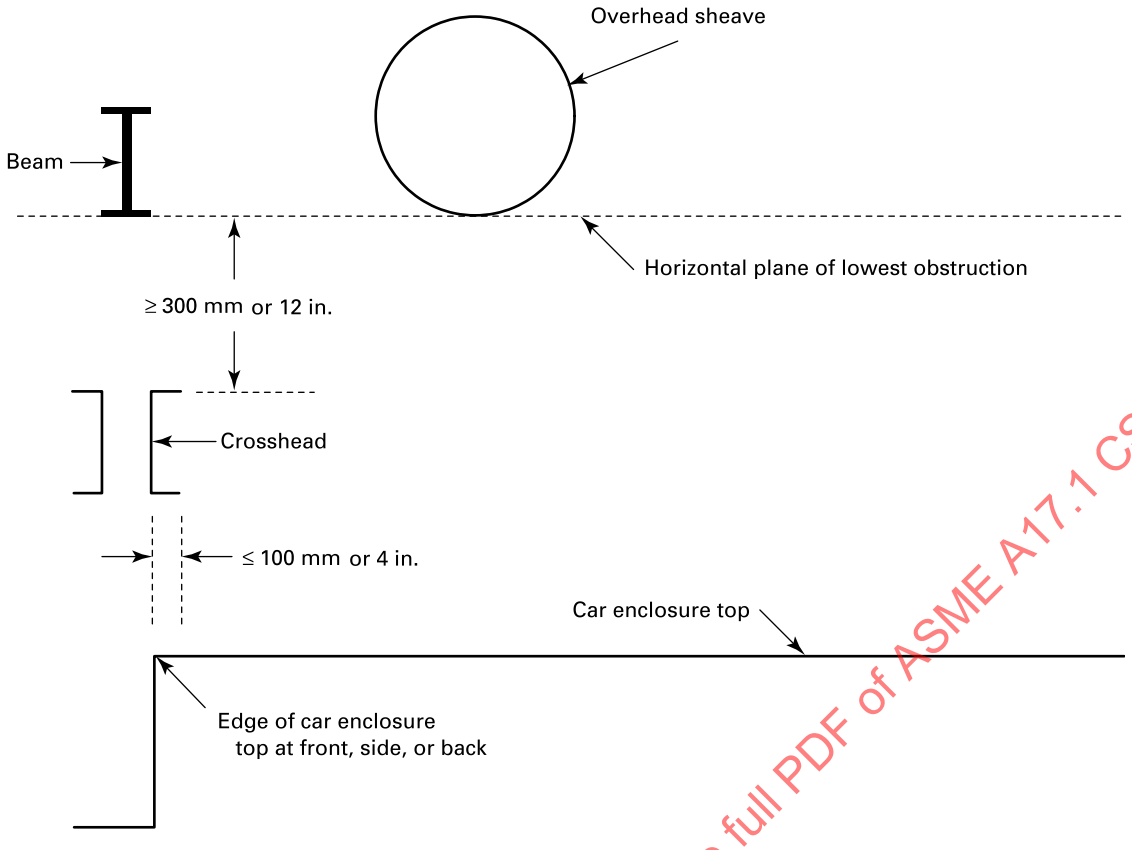
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Diagram 2.4.7(e)
Additional Top-of-Car Clearance Requirements



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Diagram 2.4.7(f)
Additional Top-of-Car Clearance [2.4.7.1(b)]



SECTION 2.5
HORIZONTAL CAR AND COUNTERWEIGHT CLEARANCES

2.5.1 Clearances Between Cars, Counterweights, and Hoistway Enclosures

The clearances specified are measured from the car, excluding attachments such as vanes, conduit, etc., except as stated in 2.5.1.3. Requirement 2.5.1.3 includes attachments to the cars in measuring the clearance between cars in a multiple hoistway. See Diagram 2.5.1.

2.5.1.1 Between Car and Hoistway Enclosures. This requirement refers to the clearance between the car and hoistway enclosure. It does not refer to equipment that is in the hoistway.

2.5.1.5 Clearance Between Loading Side of Car Platforms and Hoistway Enclosures. At the lower end of the hoistway, the specified clearance must be maintained to the location of the car sill when the car is resting on its fully compressed buffer. At the upper end of the hoistway, the clearance must be maintained to the location of the car sill when it has reached its maximum upward rise.

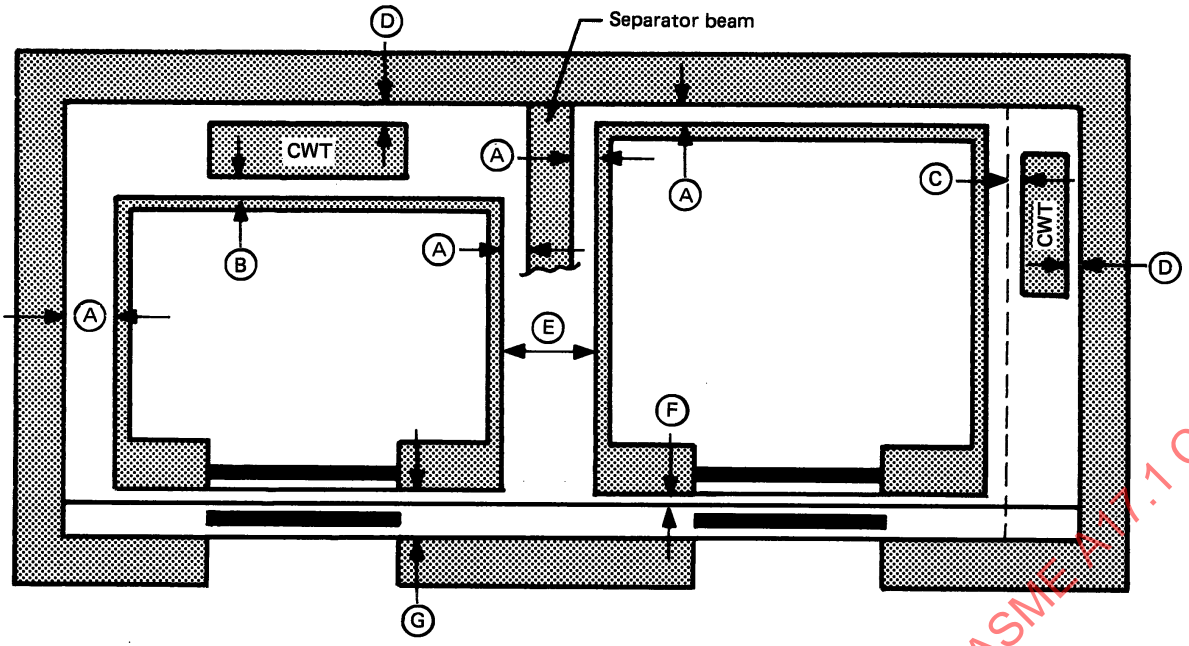
Fascia plates are normally provided to maintain the required clearances, unless the hoistway wall line is located such that the clearance is provided. See Diagram 2.5.1.5.

2.5.1.5.3 If the car door is equipped with a car door interlock (2.14.4.2.3) and meets the structural requirements in 2.5.1.5.3(b), the maximum clearances stated in 2.5.1.5.1 do not apply. A typical example of an application for a car door interlock is an observation elevator with front and rear entrances. The front entrance is utilized at the main floor only and the hoistway enclosure adjacent to the front entrance does not extend above the main floor. As such, a car door interlock would be required on the front entrance.

Requirement 2.5.1.5.3 was revised in ASME A17.1-2016/CSA B44-16 to reference 2.12.1 so users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

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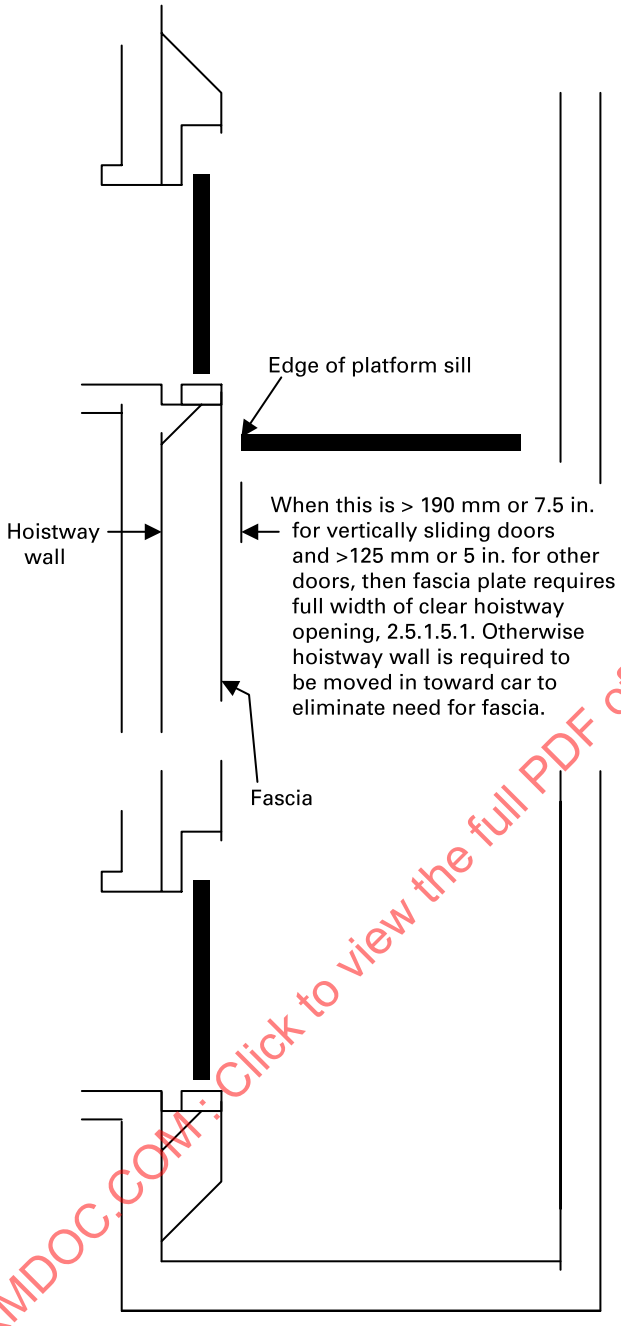
Diagram 2.5.1
Horizontal Car and Counterweight Clearances



	Clearance	Requirement	Min., in./mm	Max., in./mm
A	Between car and hoistway enclosure (see also 2.14.1.3)	2.5.1.1	0.8/20	...
B	Between car and counterweight (see also 2.14.1.3)	2.5.1.2	1/25	...
C	Between counterweight and screen	2.5.1.2	0.8/20	...
D	Between counterweight and hoistway enclosure	2.5.1.2	0.8/20	...
E	Between cars (see also 2.14.1.3)	2.5.1.3	2/50	...
F	Between car sill and landing sill — all entrance types	2.5.1.4	...	1.25/32
	Passenger elevator with car side guides		0.5/13	...
	Passenger elevator with corner car guides		0.8/20	...
	Freight elevator		0.8/20	...
G	Between car sill and hoistway enclosure or fascia	2.5.1.5		
	Vertically sliding hoistway doors		...	7.5/190
	Other doors		...	5/125

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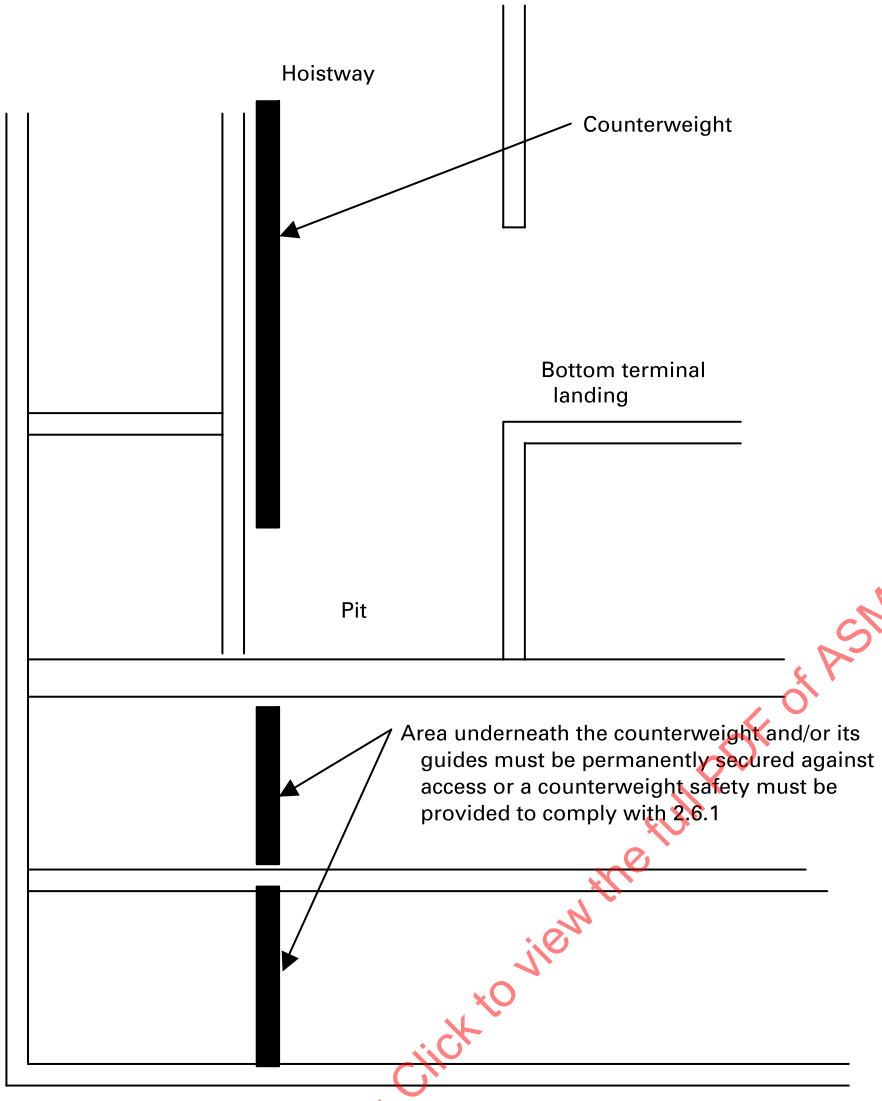
Diagram 2.5.1.5
Clearance Between Loading Side of Car Platform and Hoistway



GENERAL NOTE: Courtesy of Louis M. Capuano, Elevator Engineering Services, LLC.

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Diagram 2.6
Protection of Space Below Hoistway



GENERAL NOTE: Courtesy of Louis M. Capuano, Elevator Engineering Services, LLC.

SECTION 2.6
PROTECTION OF SPACE BELOW HOISTWAYS

This requirement provides protection for people in spaces below an elevator hoistway. Where the hoistway does not extend to the lowest level of a building and the space underneath the counterweight and/or its guides is not permanently secured against access (see Diagram 2.6), the requirements of 2.6.1 apply. Where the space is underneath the car and/or its guides and if spring buffers are used, then the requirements of 2.6.2 apply.

The counterweight, in addition to the car, is required to be equipped with a safety device to stop and hold the counterweight in case of free fall or overspeed. This is intended to prevent building damage, which would endanger people below the hoistway, if the counterweight were to strike its buffer at excessive speed. These requirements are to be met when any of the spaces, on each succeeding floor directly below the hoistway, are not permanently secured against access.

See Handbook commentary on 2.7.6 when a machine room or control room is located below the hoistway.

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SECTION 2.7
MACHINERY SPACES, MACHINE ROOMS, CONTROL SPACES, AND CONTROL ROOMS

The following definitions (see Section 1.3) are paramount in understanding the requirements in Section 2.7:

control room, elevator, dumbwaiter, material lift: an enclosed control space outside the hoistway, intended for full bodily entry, that contains the motor controller. The room could also contain electrical and/or mechanical equipment used directly in connection with the elevator, dumbwaiter, or material lift but not the electric driving machine or the hydraulic machine. See Chart 2.7.1 and Diagram 2.7.1.

control space, elevator, dumbwaiter, material lift: a space inside or outside the hoistway, intended to be accessed with or without full body entry, that contains the motor controller. This space could also contain electrical and/or mechanical equipment used directly in connection with the elevator, dumbwaiter, or material lift but not the electric driving machine or the hydraulic machine. See Chart 2.7.1 and Diagram 2.7.1.

NOTE: See ASME A17.1/CSA B44, 2.7.6.3.2 for an exception regarding the location of a motor controller.

machine room and control room, remote, elevator, dumbwaiter, material lift: a machine room or control room that is not attached to the outside perimeter or surface of the walls, ceiling, or floor of the hoistway. See Chart 2.7.1 and Diagram 2.7.1.

machine room, elevator, dumbwaiter, material lift: an enclosed machinery space outside the hoistway, intended for full bodily entry, that contains the electric driving machine or the hydraulic machine. The room could also contain electrical and/or mechanical equipment used directly in connection with the elevator, dumbwaiter, or material lift. See Chart 2.7.1 and Diagram 2.7.1.

machinery space and control space, remote, elevator, dumbwaiter, material lift: a machinery space or control space that is not within the hoistway, machine room, or control room, and that is not attached to the outside perimeter or surface of the walls, ceiling, or floor of the hoistway. See Chart 2.7.1 and Diagram 2.7.1.

machinery space, elevator, dumbwaiter, material lift: a space inside or outside the hoistway, intended to be accessed with or without full bodily entry, that contains elevator, dumbwaiter, or material lift mechanical equipment, and could also contain electrical equipment used directly in connection with the elevator, dumbwaiter, or material lift. This space could also contain the electric driving machine or the hydraulic machine. See Chart 2.7.1 and Diagram 2.7.1.

2.7.1 Enclosure of Rooms and Spaces

Machine room and control room enclosures and machinery space and control space enclosures outside the hoistway must conform to the building code. If the building code requires fire-resistive construction, follow the requirements in 2.7.1.1; otherwise, you can follow the requirements in 2.7.1.2. See Handbook commentary on 2.1.1.1 for important information on the building codes. The International Building Code (IBC), Section 3005.4; NFPA 5000®, Section 54.5.3; and NBCC, Clause 3.5.3.3 require the machine room enclosure to have the same fire-resistance rating as the elevator hoistway.

2.7.1.1 Fire-Resistive Construction. Enclosures must be fire resistive, as required by the building code. The fire-resistance rating of the machinery space, machine room, control space, or control room is typically required to be equal to that required for the hoistway. Where a 2-h fire-resistive hoistway enclosure is required, the machinery space, machine room, control space, or control room would be enclosed by a 2-h fire-resistive enclosure. Where a 1-h hoistway enclosure is required, a 1-h machinery space, machine room, control space, or control room enclosure is required. Entrances to machinery spaces, machine rooms, control spaces, or control rooms that are enclosed by fire-resistive construction are typically rated at 1½-h when a 2-h fire-resistive hoistway enclosure is provided. See Handbook commentary on 2.1.1.1.

2.7.1.2 Non-Fire-Resistive Construction. These requirements apply only if the building code does not require a fire-resistive enclosure. See Diagram 2.1.1.2(a).

2.7.1.3 Floors

2.7.1.3.1 Difference in Floor Levels. Ideally, floors should be designed and constructed without a difference in floor levels. Where there is a difference of more than 400 mm or 16 in., a railing and stair or fixed ladder is required to reduce the hazard to elevator personnel from falling or tripping. While not required by ASME A17.1/CSA B44 where the difference is less than 400 mm or 16 in., the area where the floor level differs should be clearly marked to identify the potential hazard.

2.7.2 Maintenance Path and Clearance

The maintenance clearance is determined based on component design and the manufacturer's recommendation of where maintenance access is needed.

2.7.3 Access to Machinery Spaces, Machine Rooms, Control Spaces, and Control Rooms

These requirements are intended to prohibit access by unqualified persons but provide safe and convenient access for elevator personnel (see Section 1.3).

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2.7.3.1 General Requirements

2.7.3.1.3 This requirement was added in ASME A17.1-2013/CSA B44-13 to limit access to machine rooms and related spaces by non-elevator personnel to instances when such personnel require access to the elevator-related equipment. This reduces frequency of exposure of non-elevator personnel to hazards related to elevator equipment. Such hazards could include rotating machinery and high voltage.

2.7.3.2 Passage Across Roofs

2.7.3.2.1 This requirement starts at the top floor in a building. Passage over a flat roof is considered safe and convenient and no walkway is required, provided the roof has a parapet or guardrail at least 1 070 mm or 42 in. high. Passage to and from the roof and the machine room must be by means of a stairway conforming to the requirements of 2.7.3.3. This will often prohibit the use of scuttles or other trap-door-like openings to the roof. The building code may also have specific requirements regarding passage across a roof.

2.7.3.2.2 When passage is over a sloping roof or a flat roof with no parapet or guardrail at least 1 070 mm or 42 in. high, a walkway must be provided to ensure safe and convenient passage. Passage to the walkway and from the walkway to the room or space must be by a stairway or ladder conforming to the requirements of 2.7.3.3. This requirement is intended to provide safe passage and minimize safety hazards under all environmental conditions.

2.7.3.3 Means of Access. A permanent vertical ladder is permitted as a means of access to rooms, spaces, or different floor levels in a room or space if the difference in levels is 900 mm or 35 in. or less. However, if a room or space contains only equipment such as overhead sheaves, deflecting sheaves, governors, or auxiliary equipment, 2.7.3.3.2 permits a vertical ladder to be provided for access to this area even though the difference in level exceeds 900 mm or 35 in. Diagrams 2.7.3.3(a) and 2.7.3.3(b) detail the access requirements in multilevel machine rooms. When a ladder is permitted for access from a roof, the roof must still be accessible by stairs. The exposures are different and the ASME A17 Committee is of the opinion that a ladder is safe for one situation but not for the other. Ladders over 3.04 m or 10 ft high will have to be guarded to comply with OSHA requirements.

The requirement for a platform at the top of the stairs ensures that there is a safe place to stand when entering and exiting and when opening and closing the machine room door. Diagrams 2.7.3.3(c) and 2.7.3.3(d) detail the access requirements to machine rooms. The platform requirement does not apply in Canada as it is within the scope of NBCC.

Requirement 2.7.3.3.2 was revised in ASME A17.1-2019/CSA B44:19 to clarify that vertical ladders are not permitted for spaces containing either controllers or motor generators.

2.7.3.3.4 An alternating tread device (defined as a device that has a series of steps between 50 deg and 70 deg from horizontal, usually attached to a center support rail in an alternating manner so that the user does not have both feet on the same level at the same time) at a maximum inclination of 60 deg with railings complying with 2.10.2.1 through 2.10.2.3 is not a stair. It does not comply with this requirement.

2.7.3.3.5 and 2.7.3.3.6 Requirements provide a safe means for entry and exit to machine rooms or machinery spaces. When either a stairway or ladder is used and complete bodily entry to a machine room, control room, machinery space, or control space is not required, a platform is required at the access opening.

2.7.3.4 Access Doors and Openings. In addition to the requirements found in this requirement, access doors in fire-resistive construction must have a fire-resistance rating as specified in the building code. These doors must be self-closing and self-locking to ensure access only by authorized personnel. The key must be kept in the building and available only to authorized personnel. Since non-elevator personnel have access to machine rooms, etc., any access into the hoistway from such space must be additionally protected from access by such non-elevator personnel. Requirement 2.7.3.4.6 ensures that non-elevator personnel would only have supervised access to the elevator hoistway even from an elevator equipment area that they are permitted to enter. See Handbook commentary on 8.1.

The Code does not limit the number of access doors. However, the doors must be for gaining access to the machinery space, machine room, control space, or control room. If the purpose of a door is to allow access such as to a roof or any equipment located adjacent to the machinery space, machine room, control space, or control room by passage through the machinery space, machine room, control space, or control room, then it is not permitted.

2.7.3.5 Stop Switch for Machinery Spaces or Control Spaces. The stop switch(es) or disconnecting means gives elevator personnel control over elevator movement. In those cases where a disconnecting means is provided, a separate stop switch is not required. Where specified stop switches are already required by other provisions of the Code, those suffice and additional switches are not required.

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2.7.4 Headroom in Machinery Spaces, Machine Rooms, Control Spaces, and Control Rooms

The dimensions specified in this requirement are for clear headroom. Clear headroom measurements are taken from the floor to the bottom of the lowest obstruction below the ceiling (e.g., wiring gutters, conduit, beams, lights, etc.). See Diagram 2.7.4.

2.7.4.4 The headroom dimension of 2 000 mm or 78 in. is equivalent to the minimum headroom required by NFPA 70® and CSA C22.1.

2.7.4.5 These requirements address spaces located inside the car, on the car top, or within the pit, and the car is in the blocked position. This allows minimizing the risk of falling by keeping equipment within reach without using ladders, etc. Any reduced height must not be less than 1 350 mm or 53 in. See also NFPA 70®, Sections 110.26(A) and 620.5, and CSA C22.1, Sections 38-005(1) and 38-005(2).

2.7.4.6 The headroom dimension of 2 000 mm or 78 in. is equal to the minimum headroom required by NFPA 70® and CSA C22.1.

2.7.5 Working Areas Inside the Hoistway and in the Pit

This section was added in ASME A17.1S-2005/CSA B44-04 Supplement 1-05 to address the safety concerns related to working areas within the car, on the car top, and within the pit not addressed in previous Code editions, but more common in today's technology.

2.7.5.1 Working Areas in the Car or on the Car Top

2.7.5.1.1 A means to prevent movement is not required provided there is no reason for elevator personnel to access equipment for maintenance or inspection that could cause unexpected car motion.

2.7.5.1.2

2.7.5.1.2(a) It is important that the means to prevent unintended movement be independent of the equipment that could cause such motion.

2.7.5.1.2(b) The requirement prescribes the appropriate factors of safety and load requirements for this means. Values of 3.5 for factor of safety and the 15% for elongation are consistent with values used for safeties for electric elevators (see 2.17.12.1). When working on brakes, there may be as much as 125% rated load in the car.

2.7.5.1.2(c) When the car is mechanically blocked, it is important that the car is not electrically driven to avoid undue stress and load on this means.

2.7.5.1.2(d) Stresses and deflection limits are the same as those required for the car frame, since in this case the load is transmitted to the car frame.

2.7.5.1.2(e) Provides a warning to elevator personnel relative to proper usage of the device. Signage requirements are also prescribed.

Requirement 2.7.5.1.2(e) was revised in ASME A17.1-2019/CSA B44:19 to allow flexibility in the wording required on the sign for applications where the means is not required.

2.7.5.1.2(f) It is important to prevent accidental disengagement of the device.

2.7.5.1.2(g) Loss of electrical power or an electrical circuit should not prevent continued application of the device.

2.7.5.1.4 Equipment access panels in the car are restricted to elevator personnel — Group 1 security. When such panels are open, operation of the machine, i.e., movement of the car, must be prevented.

2.7.5.2 Working Areas in the Pit. These requirements address the safety concerns when particular types of equipment are maintained or inspected from within the pit and have potential for uncontrolled or unexpected car movement.

2.7.5.2.3 Egress from the working area must be provided when the means in 2.7.5.2.1 is in use. The 1 200 mm or 48 in. dimension is based on the requirement in 2.2.4.2. The pit ladder shall extend not less than 1 220 mm or 48 in. above the sill of the access door, or handgrips shall be provided to the same height.

2.7.5.2.4 Where the distance to the equipment is expansive means are required to gain access to it. This is similar to that required for access to the underside of a car (see 2.2.8).

2.7.5.3 Working Platforms

2.7.5.3.1 Operation of the elevator must be prevented when a person is working on a platform that is retractable, and its operating position is in the line of movement of the car or counterweight. To prevent operation, the retractable platform must be equipped with an electrical protective device.

2.7.5.3.2 Strength requirements are based on mechanical loading involved and are consistent with those used for working platforms in the EN81-1 Code, 6.4.5.3.

2.7.5.3.3 Open or exposed sides of the platform are required to have a standard railing to prevent falling. See Handbook commentary on 2.10.2.

This requirement was revised in ASME A17.1-2016/CSA B44-16. Prior to the 2016 edition, this provision required a railing when there was a horizontal clearance of 300 mm or 12 in. between the working platform or car enclosure top and the hoistway enclosure regardless of the overall size of that space. The intent of the requirement is to protect against fall hazards, so the requirement was

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updated to more effectively define the space. Anthropometric data from ASME A17.7/CSA B44.7, Nonmandatory Appendix B show the body thickness to be 342 mm, so a 300-mm or 12-in. circular space in all orientations as defined by a 300-mm or 12-in. sphere is small enough to provide protection from the fall hazard.

2.7.5.3.4 Appropriate protection against shearing hazards is required when working from platforms in the hoistway.

2.7.5.3.5 Operation of the elevator must be prevented when access to the platform requires elevator personnel to enter the hoistway through an access panel or door. The landing door interlock prevents elevator operation when accessing the hoistway.

This requirement was revised in ASME A17.1-2013/CSA B44-13 to specify an electric contact in lieu of an electromechanical device. This was a clarification of the Committee's intent to permit a lock and contact and is consistent with the requirements for pit access doors and access doors to blind hoistways.

2.7.5.3.6 To perform maintenance and inspections, elevator personnel may need to operate the machine from the platform.

2.7.5.4 Working Platforms in the Line of Movement of the Car or Counterweight. When working from a platform that could be struck by the car or counterweight, it is important that the travel of the car be limited to prevent striking the platform. This can be accomplished by a retractable stop that physically stops the car or counterweight before it gets to the platform or by blocking the car with a car-blocking device.

This requirement was revised in ASME A17.1-2016/CSA B44-16 because a separate refuge space is no longer specified in the Code. The clearances necessary for refuge space are now incorporated into the top-of-car clearances for both electric and hydraulic elevators.

2.7.5.5 Retractable Stops

2.7.5.5(a) A stop is required to have an electrical protective device to prevent the car or counterweight from being electrically driven into the stop.

2.7.5.5(b) In some cases it may be necessary to move the car when the working platform is in the operating position, and the stops are fully extended. In such cases the car may be moved only on inspection operations, and additional stopping devices are required to prevent the car from being electrically driven into the stop.

2.7.5.5(d) The car or counterweight must be safety stopped and supported when a brake is released or as needed by other conditions.

2.7.5.5(e) It is important to prevent accidental disengagement of the device.

2.7.6 Location of Machinery Spaces, Machine Rooms, Control Spaces, Control Rooms, and Equipment

Elevator machine rooms and control rooms shall not be located in the hoistway. Machinery spaces and control spaces shall be permitted inside or outside the hoistway. An electric driving machine shall be located in a machinery space or machine room. A motor controller shall be located in a machinery space, machine room, control space, or control room. An elevator without a machine room and with the machine totally within the hoistway is commonly referred to as a machine-room-less (MRL) elevator.

2.7.6.3 Location of Equipment. Requirement 2.7.6.3 was revised in ASME A17.1-2022/CSA B44:22 to add a Note to reference 8.12.1 for additional requirements that may impact the location of equipment based on flood requirements.

2.7.6.3.2 Adequate working clearance is required by NFPA 70® or CSA C22.1. This requirement was revised in ASME A17.1-2016/CSA B44-16 to correlate with changes to CSA-B44.1/ASME-A17.5, which is being updated to include additional requirements for enclosures for motor controllers that can be installed outside a machinery space, machine room, control space, or control room. Requirement 2.7.6.3.2(e) was added to specify that motor controller enclosures meeting the CSA-B44.1/ASME-A17.5 requirements shall be marked with the additional marking "AGP" (Accessible to General Public). Since the actual installation of the equipment is outside the scope of CSA B44.1/ASME A17.5, the requirement for the additional marking "AGP" was included in ASME A17.1/CSA B44. Requirement 2.7.6.3.2(f) was also added in ASME A17.1-2016/CSA B44-16 to require a sign instructing elevator personnel to close and lock the motor controller if they are not going to be present at the controller, in order to prevent unauthorized personnel from accessing it.

2.7.6.3.4 When the governor is located in the hoistway and the elevator does not have a machine room to accommodate the governor, a means of accessing the governor is required from outside the hoistway through an access door (2.7.3.4.6) where full bodily entry is not necessary.

Access doors in the hoistway to the governor are not required if the governor can be inspected, tested, and serviced from the car top and can be tripped for testing from an adjacent car or outside the hoistway. A means must be provided to prevent movement of the car when servicing the governor.

2.7.6.4 Means Necessary for Tests. Devices necessary for tests must be operable from outside the hoistway. In some cases, they are required to be provided in a separate

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enclosure outside the hoistway, when the specified control equipment is located in the hoistway (see 2.7.6.5.1). Dynamic tests of the elevator should not be performed from within the hoistway due to the hazards of moving cars, counterweights, the risks of short or long safety stops, etc., which could put personnel in a hazardous situation. These requirements specify that the means to perform these tests must be provided outside the hoistway to preclude these hazards.

2.7.6.4.1 When direct observation of the machine sheave is not possible, key elements of movement such as direction, car location relative to unlocking zone, and approximate speed must be visible to elevator personnel performing tests.

Requirement 2.7.6.4.1 was revised in ASME A17.1-2022/CSA B44:22 to align with the new definition of "normal building power."

2.7.6.4.3 Requires a safe means for moving the car when there is no normal power.

Requirement 2.7.6.4.3 was revised in ASME A17.1-2022/CSA B44:22 to align with the new definition of "normal building power."

2.7.6.5 Inspection and Test Panel. When control devices are not already provided outside the hoistway, they must be provided in a separate, secure enclosure that has adequate lighting in the work area, and must not open towards the hoistway where doors could be struck by the car or counterweight, etc. Some of the electrical protective devices or circuits may not be available for elevator personnel to temporarily jump to allow movement of the car. It may be necessary to move cars off of terminal limits, move cars up to release the car safety, release the governor, etc. Such provisions require a special inspection operation. The operation is subject to the single failure requirements, etc., in 2.26.9.3(a) and 2.26.9.4. "BYPASS" switches are also required to be located in this enclosure and be accessible to elevator personnel.

2.7.6.5.2 Display devices must be provided outside the hoistway at the control location. Adequate working clearances are required by NFPA 70® or CSA C22.1 as applicable.

2.7.7 Machine Rooms and Control Rooms Underneath the Hoistway

A machine room or control room located directly under the hoistway is not commonly found, but is permitted as long as the requirements of 2.7.7.1 through 2.7.7.5 are met. If the counterweight runway does not extend into the machine room or control room, or if there is occupiable space below the machine room, a counterweight safety is required.

2.7.7.4 The counterweight guard prevents entry through the counterweight runway into the pit of the hoistway above the machine room or control room located underneath the hoistway, as well as provides protection for elevator personnel in those spaces.

2.7.8 Remote Machine Rooms, Control Rooms, and Control Spaces

Remote machine rooms, control rooms, and control spaces are defined as rooms or spaces that do not share a common wall, floor, or ceiling with the hoistway. The requirement addresses the need for access to elevator equipment and communications between the car and machine room for inspection, maintenance, testing, and repair.

Requirement 2.7.8, including subsections, was revised in ASME A17.1-2019/CSA B44:19 to include control spaces and clarify references. It was also revised to clarify that the requirements for stop switches, duplex receptacles light switches, lights, and permanent means of communication between the elevator car and remote control spaces apply to control spaces as well.

2.7.9 Lighting, Temperature, and Humidity in Machinery Spaces, Machine Rooms, Control Spaces, and Control Rooms

2.7.9.2 Temperature and Humidity. Machinery spaces, machine rooms, control spaces, and control rooms must be maintained within a prescribed temperature and humidity range to prevent elevator equipment from overheating. *NEII*®-1, Building Transportation Standards and Guidelines, recommends that the room or space temperature be maintained between 13°C and 32°C, or 55°F and 90°F, and with a relative humidity not to exceed 80%. The specific temperature and humidity ranges required by the elevator equipment manufacturer have to be permanently posted in the machine room, control room, or control space. Temperature and humidity ranges do not have to be posted for machinery spaces. The Code does not specify the means used to control the temperature and humidity. It can be by natural means such as open vents or by mechanical means such as motorized vents, central air-conditioning, or room air conditioners. Elevators in colder climates may require heating in the room or space to maintain a minimum temperature of 13°C or 55°F. Control of the room or space temperatures is critical when solid-state devices are utilized. Building codes recognize the need to control machinery space, machine room, control space, and control room temperatures during a fire to ensure continued firefighters' service elevator operation. The International Building Code (IBC) and NFPA 5000® require the room or space ventilation and air-conditioning to be connected to standby power when the elevator is connected to standby power.

The term "permanent" refers to "legible" for the entire life cycle of the equipment.

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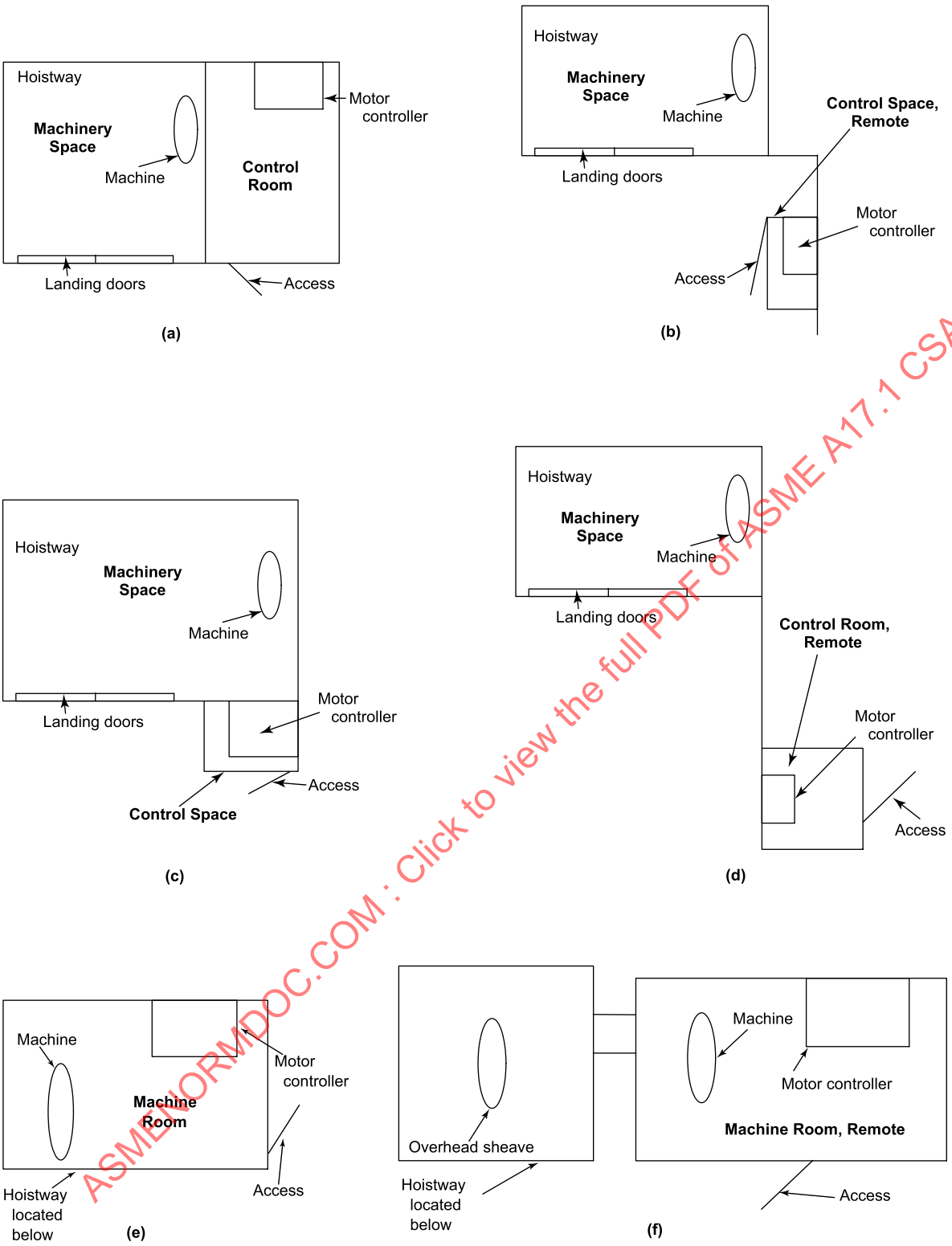
Chart 2.7.1
Machinery Space, Machine Room, Control Space, Control Room, Remote Machine Room, and Remote Control Room

	Location		Entry into the Space, Full or Partial	Equipment Used Directly in Connection With the Elevator, Dumbwaiter, or Material Lift		Equipment Contained Within	
	Inside or Outside the Hoistway	Attached to or Within the Hoistway		Mechanical Other Than Electric Driving Machine or Hydraulic Machine	Electrical Other Than Motor Controller	Electric Driving Machine or Hydraulic Machine	Motor Controller
Machinery Space [Note (1)]	Either	Either	Either	Permitted	Permitted	Permitted	Permitted
Control Space						Not permitted	Required
Machine Room [Note (1)]	Outside the hoistway	Attached to but not within	Full bodily entry required			Required	Permitted
Control Room						Not permitted	Required
Machine Room, Remote		No				Required	Permitted
Control Room, Remote						Not permitted	Required
Machinery Space, Remote			Either			Permitted	Permitted
Control Space, Remote			Either			Not permitted	Required

NOTE: (1) A machinery space outside the hoistway containing an electric driving machine and a motor controller or a hydraulic machine and a motor controller is a machine room.

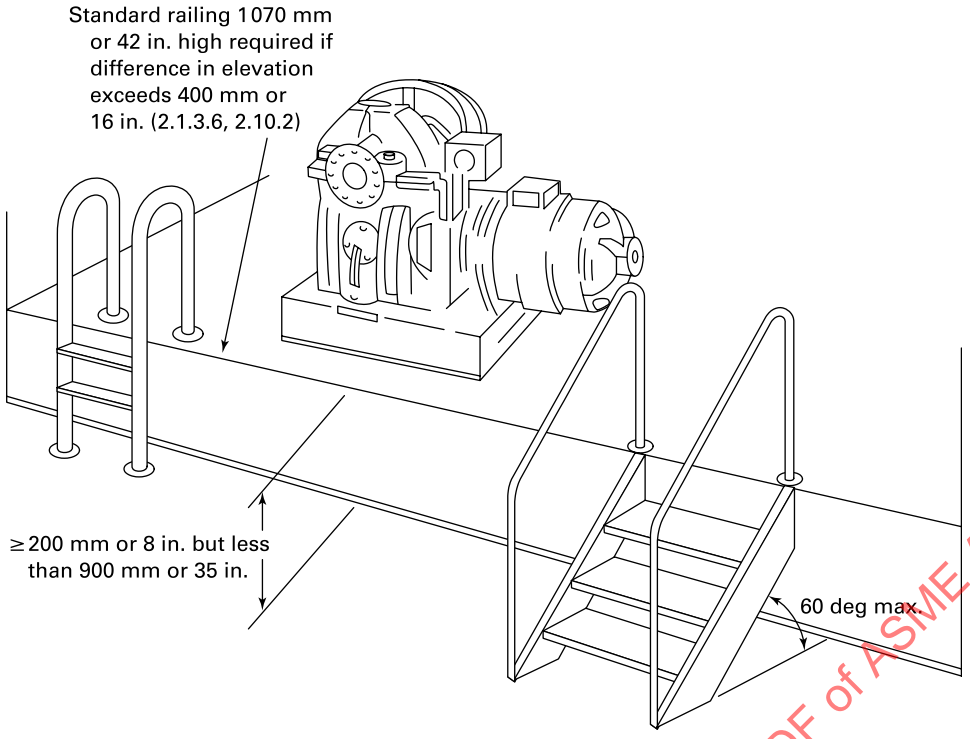
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Diagram 2.7.1
Machinery Space, Machine Room, Control Space, and Control Room Configurations



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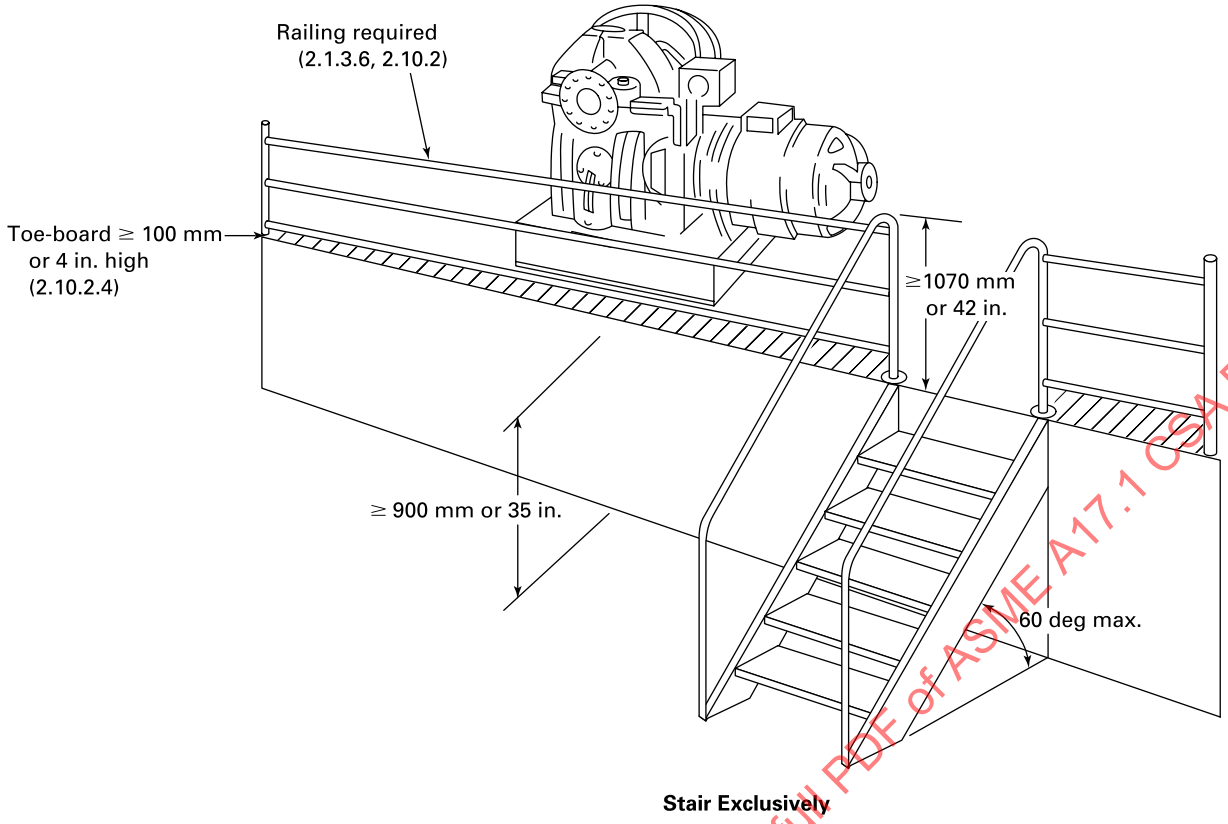
Diagram 2.7.3.3(a)
Multilevel Machine Room Access



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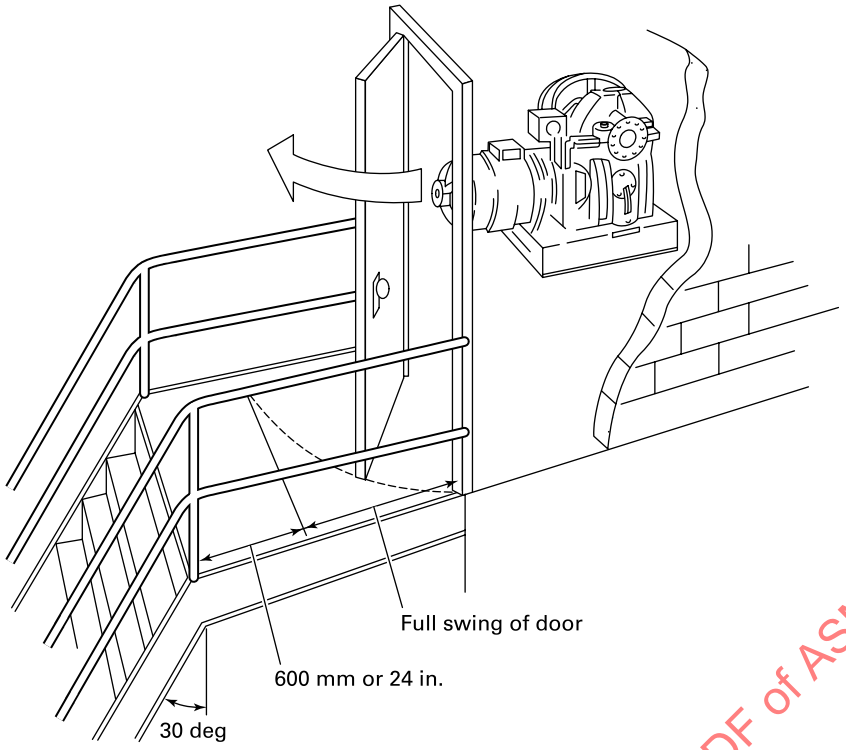
Diagram 2.7.3.3(b)
Multilevel Machine Room Access



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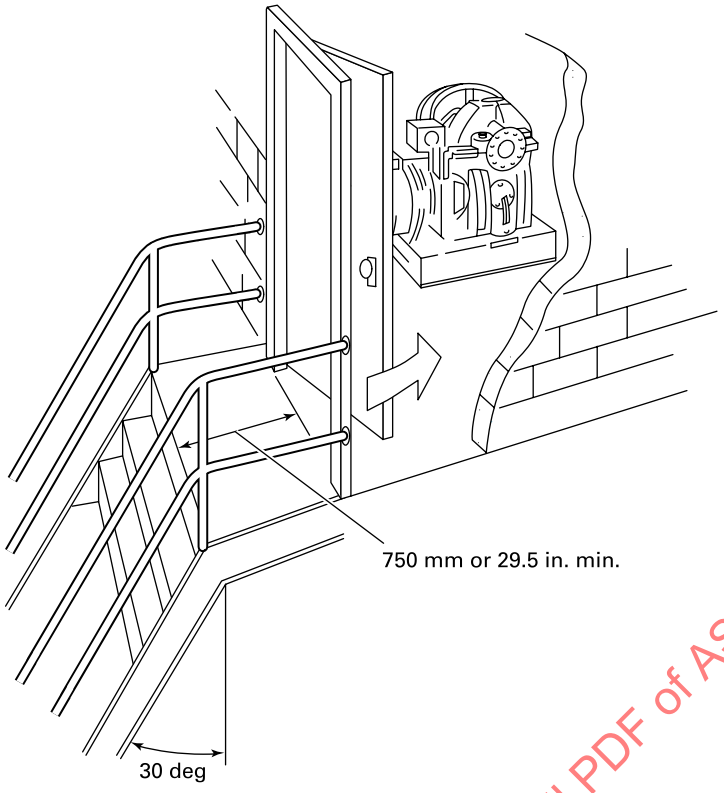
Diagram 2.7.3.3(c)
Machine Room Access



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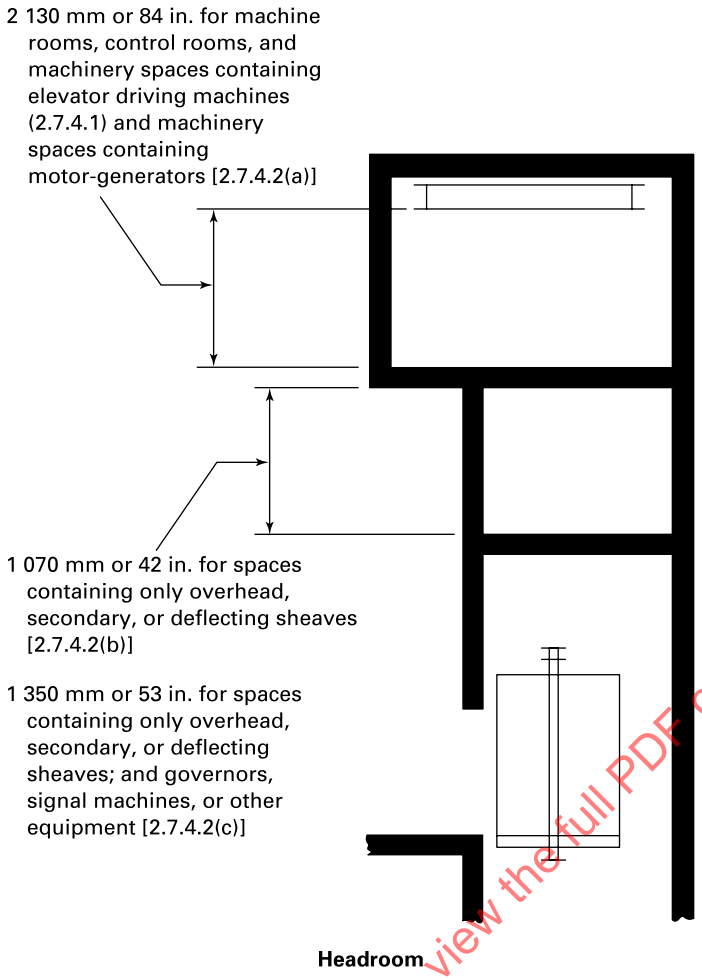
Diagram 2.7.3.3(d)
Machine Room Access



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Diagram 2.7.4
Headroom in Machinery Spaces, Machine Rooms, and Control Rooms



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SECTION 2.8
EQUIPMENT IN HOISTWAYS, MACHINERY SPACES, MACHINE ROOMS, CONTROL SPACES, AND CONTROL ROOMS

2.8.1 Equipment Allowed

Elevator machinery spaces, machine rooms, control spaces, and control rooms should only contain elevator equipment and associated control equipment, unless another requirement in this Code permits other equipment. Other equipment such as TV antenna controls, radio transmission, telephone equipment, etc., traditionally has not been allowed in these rooms or spaces. In the past, electronic and radio transmission equipment located in elevator machinery spaces, machine rooms, control spaces, and control rooms has been found to cause interference with elevator equipment.

Requirement 2.8.1 was revised in ASME A17.1-2022/CSA B44:22 to allow exceptions, including equipment for emergency responder radio coverage (ERRC) per 2.8.7. See Handbook commentary on 2.8.7.

This requirement prevents unauthorized personnel from entering an area that is hazardous to those that are not trained in the safe maintenance or repair of elevator equipment. Unauthorized persons may accidentally cause an elevator shutdown, trapping passengers in a stalled car. They would also be exposed to the moving machinery, potentially causing injury to them.

The prohibition against other equipment in the machinery spaces, machine rooms, control spaces, and control rooms reduces the fire load and the potential of fire and sprinkler activation. Firefighters require elevator service in emergencies, especially in high-rise buildings, thus the need to control the potential ignition sources in an elevator machine room. A fire in a basement machine room also would expose the hoistway to the fire as there is no way to provide fire-resistant construction between the hoistway and machine room.

Elevator machine rooms are not permitted to be used as passageways to other areas inside and outside the building. For example, a scuttle used to check roof condition is not allowed.

2.8.2 Electrical Equipment and Wiring

See Handbook commentary on 2.26.4 for a discussion of the National Electrical Code (NEC®), also known as NFPA 70®, requirements that pertain to elevators. The requirements in 2.8.1.2 eliminate the need for persons other than elevator personnel from having access to the hoistway to install or maintain non-elevator wiring and piping. The hoistway is usually the most convenient location in a building to run wires and pipes from the basement to the roof; thus, a careful inspection should be made of all wiring and piping to ensure that no foreign wiring or piping has been installed. The only wiring permitted in the hoistway and machine room is elevator wiring. The main feeders for the elevator are not allowed (NEC®, Section 620.37) to be run in the hoistway unless by special permission, or unless the driving-machine motor is located in the hoistway. Coaxial wiring and antennas used only for communications in elevators are permitted in the hoistway. No wiring that is to service other equipment in the building is permitted to pass through these spaces. See Diagram 2.8.3.

NEC®, Section 620.71 requires only the "motor controller (power converter)" and not the "auxiliary control equipment" to be located in a room or space set aside for that purpose unless otherwise permitted. This clarifies the need to guard the motor controller as defined in NEC®, Section 620.2, so as not to confuse them with motor control circuits as defined in NEC®, Section 430.71. The disconnect switch is to be located within sight of the motor controller on nongenerator field control systems, and located within sight of the motor controller for the driving motor of the motor generator set on generator field control system. It is in the interest of safety that a means to prevent starting be located near and in direct view of a driving machine. It is appropriate that power circuits for the elevator driving motor be required to remain in the machine room. Requiring that the operation controller or motion controller (except the motor controller) be located in a room or space set aside for that purpose serves no safety purpose and penalizes modern advanced designs. It is common practice today to locate door operator control devices on car tops adjacent to the operating motors. There is no safety reason to require all devices and circuits covered under the "controller" definition to be located in a room or space set aside for that purpose.

The insulation on standard wire would readily melt in a fire, causing an electrical short, which could allow an elevator to operate with the door(s) open. This condition could also place an elevator out of service for emergency personnel. To overcome this problem, NEC®, Section 620.11(A) requires wiring from the hoistway door interlock to the hoistway riser shall be flame retardant and suitable for temperatures not less than 200°C or 392°F. The most commonly used wire insulation meeting this specification is Type SF. See NEC®, Section 620.11(A) and Table 402.3. This requirement does not apply to the factory wiring within the interlock.

Section 620.44 of NEC® (see also 2.26.4) requires that the traveling cable where it leaves the hoistway be enclosed in a raceway such as rigid metal conduit, intermediate metal conduit, electrical metallic tubing, or wireways within a distance not exceeding 1.83 m or 6 ft after it is secured. Traveling cables that are suitably supported and protected from physical damage are permitted to be run without the use of a raceway inside the hoistway, or on the elevator car, hoistway wall, counterweight, or

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controllers and machinery that are located inside the hoistway, provided the cables are in the original sheath.

The building's lightning protection system grounding down conductors are not allowed to be run in the hoistway. Lightning Protection Codes NFPA-780 and CAN/CSA-B72 address bonding of long vertical metal bodies in close proximity to the lightning protection system grounding down conductor in order to prevent side flash during a lightning strike. The results of this side flash (arcing) between the lightning protection system grounding down conductor and the vertical metal body may be personal injury, fire, or destruction of equipment due to the extremely high voltage levels and electromagnetic forces. The use of bonding conductors will equalize the potential differences between the lightning protection system grounding down conductor and the vertical metal bodies and keep the "air gap" voltage between the two to a minimum to prevent an arc strike.

Requirement 2.8.2.4 was added in ASME A17.1-2019/CSA B44:19 to permit a means for testing and maintenance of fire alarm initiating devices without having to enter the hoistway. Elevator hoistways can be extremely dangerous locations, and there are safety concerns when fire alarm technicians, who are not trained as elevator personnel, perform work installing, testing, and maintaining fire alarm initiating devices located inside of the elevator hoistway.

The small size of the access panels in combination with the protective guards (cages) will mitigate injury to fire alarm technicians while performing work on fire alarm initiating devices located inside the elevator hoistway and will mitigate injury to elevator personnel should they be in the hoistway while fire alarm technicians are accessing the FAIDs.

2.8.3 Pipes, Ducts, Tanks, and Sprinklers

If a pipe or duct conveying gases, vapors, or liquids passed through a hoistway, machinery space, machine room, control space, or control room and burst, the operation of the elevator could be affected in such a manner as to make it unsafe. Water could cause the malfunctioning of hoistway door interlocks, allowing an elevator to leave a floor with the hoistway door open. A broken steam pipe could scald a passenger in the elevator. Additionally, the hoistway, machinery space, machine room, control space, or control room are secured against access except to authorized and elevator personnel who are familiar with the precautions necessary when working around moving equipment and the dangers associated with tampering with the equipment. See Diagram 2.8.3 for examples of typical applications that comply and do not comply. Ducts for heating, cooling, ventilating, and venting of the machine rooms and machinery spaces may be in the space, and also continue on to serve other portions of the buildings.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to reference 2.12.1 so users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

Requirement 2.8.3.1.4 was added in ASME A17.1-2019/CSA B44:19 to permit installation of means for testing and maintenance of fire alarm initiating devices to be installed in the hoistway and to provide requirements for the means to ensure clearances and fire resistance ratings are maintained.

2.8.3.3 Sprinklers have been recognized by the ASME A17.1/CSA B44 Code in elevator machine rooms and hoistways since the 1955 edition of the Code, although until the early 1980s they were not normally found in these areas. In the 1980s, building codes began to recognize sprinklers as one of the most effective means of controlling fires in buildings. The building codes at first did not require buildings to be fully sprinklered but encouraged their use by allowing "trade-offs," which reduced the cost of construction by relaxing code requirements in areas such as fire-resistance ratings, distances to exits, and area and height limitations, in exchange for full sprinkler protection. The theory behind this was that the cost of construction would be comparable for a fully sprinklered building versus a nonsprinklered building and the levels of fire protection would be equal or greater in a sprinklered building. The payoff for a fully sprinklered building is a reduced premium for fire insurance throughout the life of the building, thus lowering the operating cost.

In recent years, the building codes have begun to require fully sprinklered buildings for certain types of occupancies, such as high-rise office buildings and multiple family dwellings. This has been successful, and today it is common for new buildings, especially high-rise buildings, to be fully sprinklered.

In the early 1980s, the ASME A17 Committee became aware of this trend and initiated a study of the hazards of water being discharged on elevator equipment. The possible effects of water on brakes, shorting an elevator safety circuit, motors, generators, or transformers, with the resulting hazards to people on the elevator, should not be too difficult to envision. Some of the reported hazardous conditions are cars operating with car and/or hoistway doors open, loss of braking, and loss of traction. The ASME A17 Committee could not blindly prohibit sprinklers in elevator machine rooms and hoistways, for if a building code or fire code required sprinklers in all areas of the building, that code would be enforced, regardless of any contrary requirement that would appear in the elevator code.

The ASME A17 Committee was aware that something must be done to ensure that, when sprinklers are installed in areas with elevator equipment, the safety of the passengers on the car would be addressed. In early 1982, contact

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was made with the National Automatic Sprinkler and Fire Control Association, Inc., the trade association for the sprinkler industry. The potential hazards were discussed in detail, and the following response was sent to the ASME A17 Committee:

Our Committee members and the insurance authorities are unanimous that sprinkler protection should be provided in all building areas, and that there is no record of adverse experience with sprinkler protection of electrical rooms or computer rooms or other rooms of this type, especially as compared to consequences of manual fire-fighting efforts with hose streams. As such, our Committee has recommended that the elevator machine rooms be protected in one of three ways.

(a) standard sprinkler protection in accordance with NFPA 13, with raintype rated electrical equipment specified for all equipment or otherwise shielded with noncombustible hoods;

(b) standard sprinkler protection in accordance with NFPA 13, but with a water flow switch on the branch line to the elevator machinery room, such that flow of sprinklers in the elevator machinery room causes automatic shutdown of elevators; or

(c) protection of the elevator machinery room with non-water automatic fire suppression systems such as carbon dioxide or Halon. In such case, the special system should be provided with a connected reserve.

The ASME A17 Committee reviewed this response and felt that the first recommendation was impractical. Even if complied with at the time of installation, shields and raintype covers would, over a period of time, be removed or become ineffective, thus permitting the equipment to become subject to water from a discharged sprinkler. The third recommendation also was discarded, as its effectiveness was questionable. Automatic fire suppression systems that use a substance other than water, such as carbon dioxide or Halon, normally are effective in areas with only minimal air movement. It was agreed that air movement resulting from the elevator operation and stack effect in the hoistway would make these systems impractical and ineffective in controlling a fire. Recommendation two was acceptable, and was reworded in performance language, balloted, and approved by the ASME A17 Committee. The following commentary applies only in jurisdictions not enforcing NBCC.

If a fire developed in an elevator machine room or hoistway, the sequence of events would typically be as follows: Smoke in the machine room or hoistway during the initial stage of the fire activates the smoke detector required by 2.27.3.2. Activation of the smoke detector causes all elevators to be recalled to the designated level on Phase I Emergency Recall Operation. As the intensity of the fire builds, the sprinkler system is activated and the power to the elevator driving machine is interrupted. Power is removed even if the elevator is operating on Phase I or Phase II firefighters' service.

It should also be pointed out that the Committee gave serious consideration to the possibility of a car stopping with passengers and even firefighters between floors. All types of recommendations were made, such as not removing power until Phase I emergency recall was complete. All elevator controls (electromechanical and static) are limited to some maximum ambient operating temperature above which the performance of the devices is unpredictable, nonrepeatable, and unreliable. This may lead to a failure in the elevator control resulting in unsafe elevator operation. The Committee also recognized that in all probability the elevator system might be on fire. In Committee deliberations, it was concluded that if there was sufficient heat to activate the sprinkler, a fire was in progress and there was no way of assuring control of the elevator except by disconnecting the main line power supply.

After the requirements were published, many questions were raised in the field as to what type of system could be installed that would meet the intent of this requirement. Following are three methods, the first being the most economical:

(a) First Method. Rate-of-rise/fixed-temperature heat detectors, in the elevator machine room and/or hoistway, would be arranged to automatically disconnect the main line power supply. These detectors would be placed near each sprinkler. The sprinkler rating would exceed the heat detector ratings. The detectors could be independent of the sprinkler system. The heat detector would cause a shunt-trip circuit breaker to disconnect the main line power to the affected elevators prior to the application of water.

By using combination rate-of-rise and fixed-temperature detectors, we can assume fast response from the rate-of-rise portion whenever we have a fast fire. However, in slower fires or in larger spaces it is more likely that the rate-of-rise portion will not respond and, eventually, the fixed-temperature portion of the heat detector will actuate. With fixed-temperature detectors (including sprinklers that are heat detectors with water behind them), temperature rating is not the only important factor in determining its response time. It is also important to consider the mass of the element, which must be heated. It is very easy to show that two units with the same temperature rating but different masses will not respond at the same time. It can also be demonstrated that a higher temperature unit may respond faster than a lower temperature unit having greater mass. The factor being considered here is called "thermal lag."

Mechanical and electrical engineers measure thermal lag as a "time constant" at a given hot gas velocity or electrical current level. Higher time constants mean longer response times with all other conditions being equal. In the fire protection community, the latest term used is Response Time Index (RTI), which is related to a unit's time constant. The lower the RTI of a detector

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or sprinkler, the faster its response will be to a given fire. [See Charts 2.8.3.3(a) through 2.8.3.3(c).]

If color of the detector is the same as the color code marking for the detector, it should be marked in a contrasting color with either a ring on the surface or numbers at least 9.38 mm or $^{3}/_{8}$ in. high indicating the temperature rating.

This is not often a problem since most heat detectors have low RTIs compared to sprinkler heads. However, the growing popularity of "fast response sprinklers" means that it is possible to have a 73.8°C or 165°F sprinkler respond before a 57.2°C or 135°F heat detector.

Authorities having jurisdiction should require engineers and designers of such systems to demonstrate that the devices will operate in the correct order. This can be done by using calculation methods contained in NFPA 72®, National Fire Alarm and Signaling Code Handbook. The calculations should be done for both slow and fast fires and should include appropriate factors of safety.

NOTE: NFPA 72® is a registered trademark of the National Fire Protection Association (NFPA), Quincy, MA.

(b) Second Method. The sprinkler system in the elevator machine room and the hoistway would be a preaction system. A preaction sprinkler system employs automatic sprinklers attached to a piping system containing air or nitrogen that may or may not be under pressure, with a supplemental fire detection system installed in the same areas as the sprinklers. Actuation of a heat detector from a fire opens a valve that permits the air or nitrogen to escape and water to flow into the sprinkler piping system and to be discharged from any sprinkler head that may be open. The heat detector or flow valve in the sprinkler piping would cause a shunt-trip circuit breaker to disconnect the main line power to the affected elevators at the time the flow valve opens. The preaction system should not be activated by a smoke detector, as this would shut the elevator down prematurely. Requirement 2.8.2.3.4 prohibits activation by a smoke detector, as this would shut the elevator down without any chance for Phase I recall as described above.

(c) Third Method. The sprinkler system in the machine room or hoistway would be a dry-pipe system. A dry-pipe switch would be installed in the sprinkler piping where it enters the elevator machine room or hoistway. The pipe would contain air or nitrogen under pressure from the sprinkler head to dry-pipe switch and water to the opposite side of the dry-pipe switch. The heat from a fire would open the sprinkler head, allowing the air to escape and water to flow into the system. The dry-pipe switch would trip and cause a shunt-trip circuit breaker to disconnect the main line power to the affected elevators.

One final point: ASME A17.1/CSA B44 requires that the power removal be independent of the elevator control. System designs that require elevators to complete Phase I recall are permitted, provided the elevator control system is not required to send a signal that Phase I has been accomplished. Recently there have been designs where a heat detector in the machine room activates Phase I and starts a timer in the fire alarm system. After a predetermined time, the shunt trip is activated and water is allowed to flow from the sprinklers. The "predetermined time" is calculated based on the maximum time necessary to complete Phase I recall. Passengers may still be trapped if Phase I has not been completed; however, it reduces that possibility. If the elevator controller is relied on to signal that Phase I is completed, it may never come and the sprinklers never activated. The elevator control may in all likelihood be the source of the fire and thus cannot be relied on to respond.

In 1994, the Sprinkler Standard NFPA 13 revised the requirement for sprinkler protection in elevator hoistways. Sprinklers installed at the bottom of the shaft must be positioned so that they do not interfere with the platform guard [see Chart 2.8.3.3(d)]. Sprinklers may be omitted from the top of the noncombustible elevator hoistways of passenger elevators complying with ASME A17.1/CSA B44 [see Chart 2.8.3.3(d)]. The standards will also permit the elimination of sprinklers at the bottom of the shaft when the elevator shaft is enclosed with noncombustible materials and combustible hydraulic fluids are not present in the shaft [see Chart 2.8.3.3(d)]. Clearly this provision applies to hydraulic elevators. A potential problem is the interpretation of this provision on an electric traction installation with oil buffers. As of the 2010 edition of NFPA 13, sprinklers are required at the top and bottom of hoistways where "polyurethane-coated steel belts or other similar combustible belt materials" are provided.

See also Chart 2.8.3.3(e), which contains excerpts from the *National Fire Alarm and Signaling Code Handbook* on this issue. Diagram 2.8.3.3.2 presents a smoke/heat detectors and shunt-trip decision-making flowchart.

NOTE: All excerpts from National Fire Protection Association (NFPA) books are used with the permission of the NFPA. See last page of each excerpt for the full permission statement.

Requirement 2.8.3.3.2(d) was added in ASME A17.1-2019/CSA B44:19 to address elevators that are not provided with Phase I Emergency Recall Operation. If a shunt trip is provided on an elevator without Phase I, there is a potential to trap passengers if there is a fire in the machine room. By eliminating the shunt trip in these applications, the potential for passenger entrapment during sprinkler activation is reduced.

Requirement 2.8.3.3.4 was revised in ASME A17.1-2019/CSA B44:19 to clarify the car sill position relative to the pit floor elevation.

Requirement 2.8.3.3 was revised in ASME A17.1-2022/CSA B44:22 to add a Note to alert users that the building codes and sprinkler codes may prohibit installation of

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sprinklers in spaces associated with Fire Service Access Elevators and occupant evacuation elevators.

Requirements 2.8.3.3.2 and 2.8.3.3.3 were revised in ASME A17.1-2022/CSA B44:22 to align with the new definition for "main line power."

2.8.5 Air-Conditioning

This requirement controls the location and installation of air-conditioning equipment in machinery spaces, machine rooms, control spaces, and control rooms to ensure that they do not adversely affect elevator operation. Since air conditioner maintenance personnel may have to be in the room or space, the equipment should not be located over elevator equipment. Piping is to be routed in such a fashion that any leaks or condensation would not affect elevator operation. Drains connected directly to sewers could allow sewer gases to enter the machine room if the trap dried out. Adequate clearance must be provided to ensure the safety of air-conditioning service personnel. Guards are to be provided on exposed moving parts to protect personnel from entanglement.

2.8.6 Miscellaneous Equipment

Attachment to the elevator car and counterweight must be considered in the structural design and not reduce clearance below that required by the requirements of this Code.

2.8.7 Emergency Responder Radio Coverage (ERRC) Equipment Inside Hoistways

Requirement 2.8.7, including subsections, was added in ASME A17.1-2022/CSA B44:22 to allow the installation of ERRC equipment in the hoistway. The communication equipment technology used by emergency responders has changed. Radio equipment has replaced the plug-in phones used in the past. Ensuring reliable emergency responder communications while inside the elevator car enhances the safety of building occupants. Allowing ERRC equipment, including antennas, to be installed in the hoistway and the elevator car makes improved reliability possible.

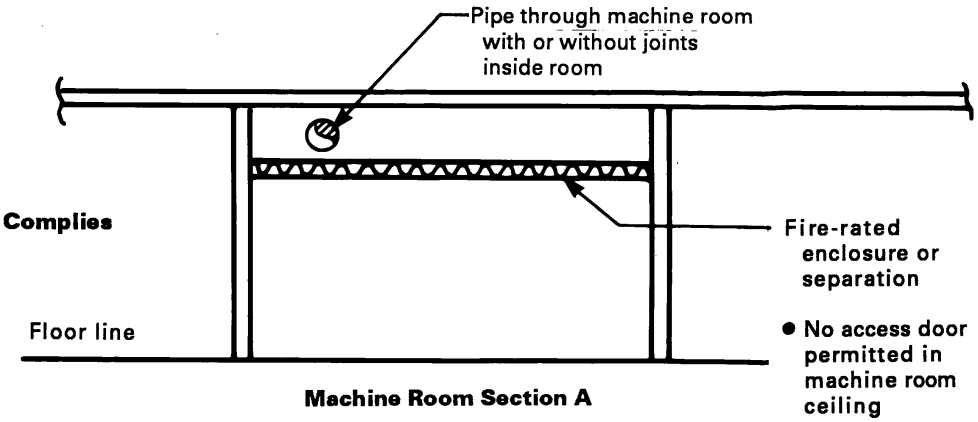
This equipment was not previously addressed by ASME A17.1/CSA B44. Model fire codes and model building codes have been revised to require ERRC in buildings in lieu of the firefighters' phone jack system. There is a published national standard, UL 2524, for this equipment. NFPA 1225 is replacing NFPA 1221 and was published in 2021. NFPA 1225 just added all elevators, in addition to elevator lobbies, as critical areas in the building requiring 99% first responder radio coverage (see NFPA 1225, Section 18.8.3).

Detailed requirements for the installation, use, and access to ERRC equipment in the hoistway and the elevator car enclosure were added. The equipment is for exclusive use by emergency responders. The immunity tests required in EN 12016 and ISO 22200 cover the radio frequencies used in the U.S. EN 12016 covers the frequency range of 80 MHz to 1,960 MHz, and ISO 22200 covers a range of 80 MHz to 2,170 MHz. Typical fire department frequencies are in the VHF high band (150 MHz to 160 MHz) or the UHF ultra-high band (450 MHz to 470 MHz).

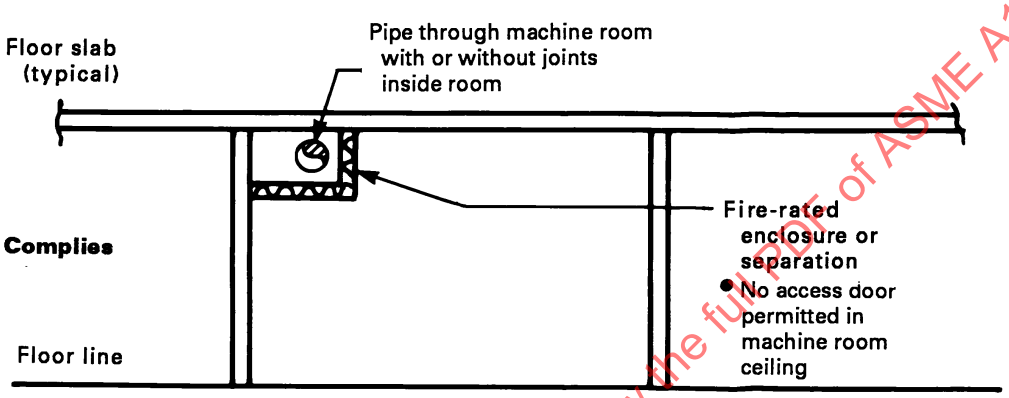
ERRC equipment in the hoistway or on the car cannot interfere with normal elevator operation, inspection of the elevator, repair of the elevator, or maintenance of the elevator, and running clearances must be maintained. Equipment must be designed and installed so that no maintenance is required or so that maintenance can be done without entering the hoistway. The equipment is also required to be guarded to prevent damage and to prevent objects from falling into the hoistway.

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Diagram 2.8.3
Machine Room Pipe, etc., Separation



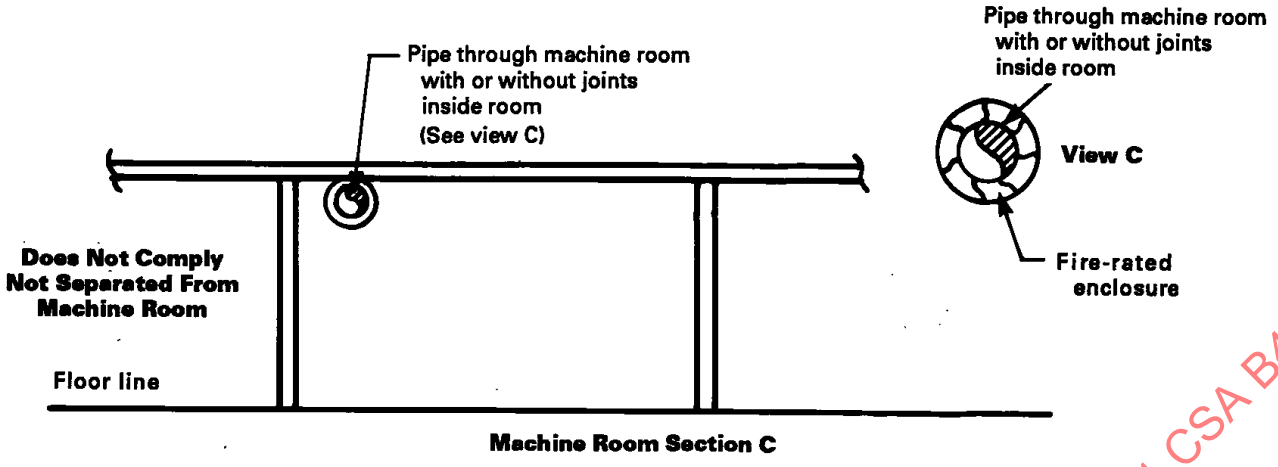
Machine Room Section A



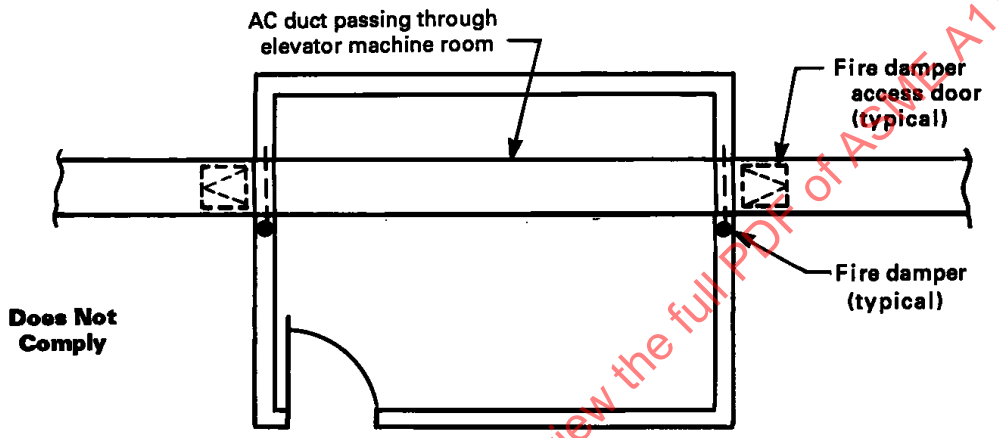
Machine Room Section B

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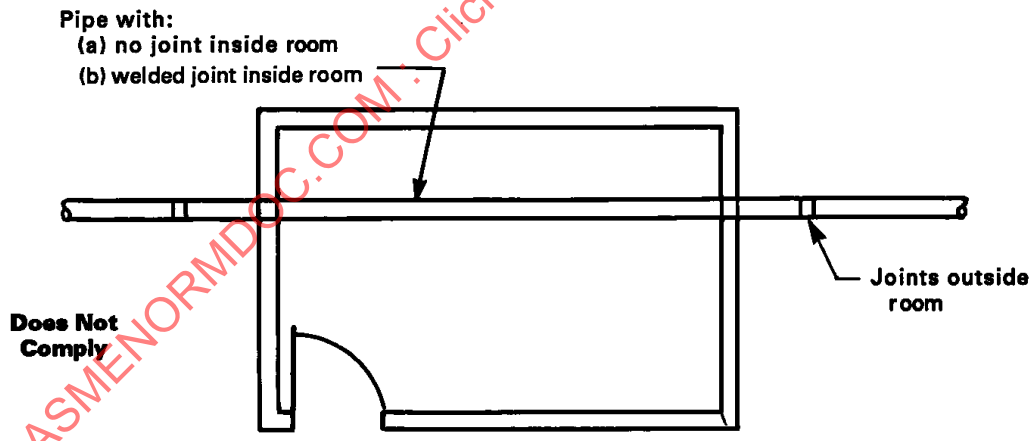
Diagram 2.8.3
Machine Room Pipe, etc., Separation (Cont'd)



Machine Room Section C



Machine Room Section D



Machine Room Section E

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Chart 2.8.3.3(a)
NFPA 13-2022, Table 7.2.4.1(a), Temperature Ratings, Classifications, and Color Codings for Glass Bulbs

Maximum Ceiling Temperature		Temperature Rating			
°F	°C	°F	°C	Temperature Classification	Glass Bulb Colors
100	38	135	57	Ordinary	Orange
120	49	155	68	Ordinary	Red
150	66	175	79	Intermediate	Yellow
150	66	200	93	Intermediate	Green
225	107	250–300	121–149	High	Blue
300	149	325–375	163–191	Extra high	Purple
375	191	400–475	204–246	Very extra high	Black
475	246	500–575	260–302	Ultra high	Black
625	329	650	343	Ultra high	Black

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Chart 2.8.3.3(b)
NFPA 13-2022, Table 7.2.4.1(b), Temperature Ratings, Classifications, and Color Codings for Fusible Links

Maximum Ceiling Temperature		Temperature Rating			
°F	°C	°F	°C	Temperature Classification	Color Code
100	38	135–170	57–77	Ordinary	Uncolored or black
150	66	175–225	79–107	Intermediate	White
225	107	250–300	121–149	High	Blue
300	149	325–375	163–191	Extra high	Red
375	191	400–475	204–246	Very extra high	Green
475	246	500–575	260–302	Ultra high	Orange
625	329	650	343	Ultra high	Orange

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Chart 2.8.3.3(c)
NFPA 72®-2022 Handbook, Table 17.6.2.1, Temperature Classification and Color Code for Heat-Sensing Fire Detectors

Temperature Classification	Temperature Rating Range		Maximum Ceiling Temperature		Color Code
	°F	°C	°F	°C	
Low	100–134	38–56	80	28	Uncolored
Ordinary	135–174	57–79	115	47	Uncolored
Intermediate	175–249	80–121	155	69	White
High	250–324	122–162	230	111	Blue
Extra high	325–399	163–204	305	152	Red
Very extra high	400–499	205–259	380	194	Green
Ultra high	500–575	260–302	480	249	Orange

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Chart 2.8.3.3(d)
Excerpts From NFPA 13-2022: Elevator Hoistways and Machine Rooms

9.3.6 Elevator Machine Rooms, Machinery Spaces, Control Rooms, Control Spaces, and Hoistways.

Elevator machine rooms, machinery spaces, control rooms, control spaces, and hoistways are covered in 9.3.6. Codes that cover elevator design, such as ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators,* do not permit water discharge in elevator shafts until electrical power to the elevator cab has been shut down where elevator equipment is located or if water from sprinklers could create an unsafe environment for elevator operation. This situation necessitates some special arrangement, such as a preaction system, to make sure that water does not flow into the elevator shaft until power shutdown has occurred. The additional cost of a special installation and the benefits returned for the protection must be weighed against the small number of fires in elevator shafts.

N **9.3.6.1*** Sidewall spray sprinklers shall be installed at the bottom of each elevator hoistway not more than 2 ft (600 mm) above the floor of the pit.

Refuse and residual hydraulic fluids tend to collect at the bottom of shafts. A properly located sprinkler, as required by 9.3.6.1, can control a fire of such material. Conventional requirements regarding the placement of the deflector and clear space below the sprinkler cannot always be adhered to in this area. These issues are not critical, however, because the sprinkler would be physically close to any point where a fire could originate, still allowing the sprinkler to control the fire.

Several papers were presented by participants, including the American Society of Mechanical Engineers (ASME), at a symposium in February 1991, in Baltimore, MD (*Proceedings of the Symposium on Elevators and Fires*). Subjects covered at this symposium ranged from general elevator safety to potential problems associated with premature discharge of water onto elevator control elements. Following the symposium, representatives from the building code organizations and ASME worked to resolve the problem of providing proper fire protection without sacrificing any of the inherent safety features of the sprinkler system or the elevator and its associated equipment. The result of that cooperation was the development of 9.3.6 to specifically address the installation of sprinklers in elevator shafts and equipment rooms.

This area is constantly changing, and some changes have been proposed to ASME A17.1 that might result in modification of elevator requirements in the future. Also, in some jurisdictions, there is a movement to eliminate the sprinklers and automatic shutdown so that the fire service can continue to use the elevator as long as possible when fighting fires in a high-rise building. Any modifications to these rules that would permit the omission of sprinklers by local officials need to be carefully considered due to the possibility of uncontrolled fire growth within elevator machine rooms combined with simultaneous fire department dependence on the elevators. Additional concerns surround the fire department's assumption when responding to a fire incident within an elevator machine room that such spaces within the building are fully sprinklered.

FAQ [9.3.6.1]

Where sprinklers are installed at the bottom of the elevator shaft, is water discharge required to be delayed until power shutdown has occurred?

Because the sprinkler at the bottom of the shaft cannot discharge onto the elevator or other operating components of the elevator, ASME A17.1 no longer requires that the sprinkler discharge at the bottom of the shaft be delayed until power shutdown has occurred. The sprinkler at the bottom of the shaft, where installed, is permitted to be part of the normal building sprinkler system and is not required to be part of the special system used to protect the rest of the elevator equipment.

N **A.9.3.6.1** The sprinklers in the pit are intended to protect against fires caused by debris, which can accumulate over time. Ideally, the sprinklers should be located near the side of the pit below the elevator doors, where most debris accumulates. However, care should be taken that the sprinkler location does not interfere with the elevator toe guard, which extends below the face of the door opening.

N **9.3.6.2** The sprinkler required at the bottom of the elevator hoistway by 9.3.6.1 shall not be required for enclosed, noncombustible elevator shafts that do not contain combustible hydraulic fluid.

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Chart 2.8.3.3(d)
Excerpts From NFPA 13-2022: Elevator Hoistways and Machine Rooms (Cont'd)

Δ **9.3.6.3** Automatic fire sprinklers shall not be required in elevator machine rooms, machinery spaces, control rooms, control spaces, or hoistways of traction elevators installed in accordance with the applicable provisions in NFPA *101*, or the applicable building code, where all of the following conditions are met:

(1) The elevator machine room, machinery space, control room, control space, or hoistway of traction elevator is dedicated to elevator equipment only.
(2) The elevator machine room, machinery space, control room, control space, or hoistway of traction elevators are protected by smoke detectors, or other automatic fire detection, installed in accordance with *NFPA 72* or other approved fire alarm code.
(3) The elevator machinery space, control room, control space, or hoistway of traction elevators is separated from the remainder of the building by walls and floor/ceiling or roof/ceiling assemblies having a fire resistance rating of not less than that specified by the applicable building code.
(4) No materials unrelated to elevator equipment are permitted to be stored in elevator machine rooms, machinery spaces, control rooms, control spaces, or hoistways of traction elevators.
(5) The elevator machinery is not of the hydraulic type.

9.3.6.4* Automatic sprinklers in elevator machine rooms, machinery spaces, control rooms, control spaces, or hoistways shall be standard response.

A.9.3.6.4 ASME A17.1, *Safety Code for Elevators and Escalators*, requires the shutdown of power to the elevator upon or prior to the application of water in elevator machine rooms or hoistways. This shutdown can be accomplished by a detection system with sufficient sensitivity that operates prior to the activation of the sprinklers *(see also NFPA 72 or other approved fire alarm code)*. As an alternative, the system can be arranged using devices or sprinklers capable of effecting power shutdown immediately upon sprinkler activation, such as a waterflow switch without a time delay. This alternative arrangement is intended to interrupt power before significant sprinkler discharge.

9.3.6.5 Upright, pendent, or sidewall spray sprinklers shall be installed at the top of elevator hoistways.

Historically, upright or pendent sprinklers were required at the top of an elevator shaft. In many instances, however, upright or pendent sprinklers cannot be centered above the hoistway because of the presence of cables and other equipment. Sidewall sprinklers, which can be installed clear of elevating equipment and which might be easier to install and replace, are now permitted as an alternative.

9.3.6.6* The sprinklers required at the top of the elevator hoistway by 9.3.6.5 shall not be required where the hoistway for passenger elevators is noncombustible or limited-combustible and the car enclosure materials meet the requirements of ASME A17.1, *Safety Code for Elevators and Escalators*.

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Chart 2.8.3.3(e)
Excerpts From NFPA 72®-2019 Handbook: Elevator Power Shutdown

21.4 Elevator Power Shutdown.

FAQ What is the purpose of elevator shutdown?

Power to the elevator must be disconnected automatically (i.e., elevator shutdown) on or before the application of water wherever a sprinkler system is installed in the elevator machine room, machinery space, control space, control room, or hoistway, as specified in the following excerpt from ASME A17.1/CSA B44:

ASME A17.1/CSA B44 (2019)

2.8.3.3 Sprinkler systems conforming to NFPA 13 or the NBCC, whichever is applicable (see Part 9), shall be permitted to be installed in the hoistway, machinery space, machine room, control space, or control room subject to 2.8.3.3.1 through 2.8.3.3.4.

2.8.3.3.1 All risers shall be located outside these spaces. Branch lines in the hoistway shall supply sprinklers at not more than one floor level. When the machinery space, machine room, control space, or control room is located above the roof of the building, risers and branch lines for these sprinklers shall be permitted to be located in the hoistway between the top floor and the machinery space, machine room, control space, or control room.

2.8.3.3.2 In jurisdictions not enforcing the NBCC, where elevator equipment is located or its enclosure is configured such that application of water from sprinklers could cause unsafe elevator operation, means shall be provided to automatically disconnect the main line power supply to the affected elevator and any other power supplies used to move the elevator upon or prior to the application of water.

(a) This means shall be independent of the elevator control and shall not be self-resetting.
(b) Heat detectors and sprinkler flow switches used to initiate main line elevator power shutdown shall comply with the requirements of *NFPA 72*.
(c) The activation of sprinklers outside of such locations shall not disconnect the main line elevator power supply. See also 2.27.3.3.6.

2.8.3.3.3 Smoke detectors shall not be used to activate sprinklers in these spaces or to disconnect the main line power supply.

2.8.3.3.4 In jurisdictions not enforcing the NBCC, when sprinklers are installed not more than 600 mm (24 in.) above the pit floor, (a) and (b) apply to elevator electrical equipment and wiring in the hoistway located less than 1200 mm (48 in.) above the pit floor, except earthquake protective devices conforming to 8.4.10.1.2(e); and on the exterior of the car at the point where the car platform sill is level with the sill at the bottom terminal landing.

(a) Elevator electrical equipment shall be weatherproof (Type 4 as specified in NEMA 250).
(b) Elevator wiring, except traveling cables, shall be identified for use in wet locations in accordance with the requirements in *NFPA 70*.

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The primary purpose of elevator shutdown is to avoid the potential hazards of a wet elevator braking system. If the elevator brakes are wet and cannot hold, the elevator could move uncontrolled to the top or bottom of the hoistway, depending on the load in the car and the type of elevator control system. A secondary concern is that the application of water could short an electrical safety circuit or elevator control circuit, causing the elevator to operate erratically.

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Chart 2.8.3.3(e)
Excerpts From NFPA 72®-2019 Handbook: Elevator Power Shutdown (Cont'd)

As shown in the 2.8.3.3.2 excerpt from ASME A17.1/CSA B44, an automatic means is required to disconnect the main line power supply to the affected elevator in situations "where elevator equipment is located or its enclosure is configured such that application of water from sprinklers could cause unsafe elevator operation." The decision to have sprinklers in the elevator machine room, machinery space, control space, control room, or hoistway comes from the requirements of NFPA 13. Refer to the commentary following A.21.3.8 for a discussion regarding the need for sprinklers in the elevator hoistway and for an excerpt of NFPA 13. The elevator pit is part of the hoistway — sprinklers may be required at the bottom of the hoistway (i.e., the elevator pit) even though they may not be required at the top of the hoistway.

If sprinklers are installed, especially in the hoistway, the fire protection system designer, the elevator equipment service company of record, and the authority having jurisdiction (e.g., fire marshal, elevator inspector, building department) will need to be consulted to determine what sprinkler arrangements are at risk of unsafe elevator operation.

System Design Tip

21.4.1* When heat detector(s) are used to actuate the disconnecting means described in 2.8 of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, to disconnect the main line power supply to the affected elevator and any other power supplies used to move the elevator, upon or prior to the activation of sprinkler(s), the detector(s) shall have both a lower temperature rating and a lower response time index (RTI) as compared to the sprinkler(s).

While elevator shutdown is a separate function from Elevator Phase I Emergency Recall Operation, the implicit relationship between the two functions is important to understand. Ideally, elevator recall should be completed before elevator shutdown occurs. The expected sequence is that the fire alarm initiating device used to initiate Elevator Phase I Emergency Recall Operation, typically a smoke detector, would operate well in advance of the fire alarm initiating device used to initiate elevator shutdown, typically a heat detector or waterflow initiating device. The fire alarm initiating devices permitted for Elevator Phase I Emergency Recall Operation are outlined in 21.3.3. The fire alarm initiation devices permitted for elevator shutdown are not similarly prescribed. However, ASME A17.1/CSA B44 prohibits the use of smoke detectors to initiate elevator shutdown.

In any case, the operation of the device must result in the expected sequence for recall and then shutdown (if needed), regardless of the device used. The requirement that elevator shutdown must occur at or before sprinkler activation adds another layer of complexity. When selecting equipment for these functions, the correct timing of events needs to be considered to the extent possible so that all three conditions — Elevator Phase I Emergency Recall Operation, elevator shutdown, and sprinkler activation — are met.

Subsections 21.4.1 and 21.4.2 for heat detector selection and placement ensure that shutdown occurs at or before sprinkler activation. Smoke detectors used to initiate Elevator Phase I Emergency Recall Operation are assumed to respond in advance of heat detector or sprinkler activation. When selecting and locating another device in place of a smoke detector for Elevator Phase I Emergency Recall Operation as permitted by 21.3.10, it is important to consider the intended sequence of operation. Also see A.21.3.10.

Even with careful design, equipment selection, and placement, the possibility exists that initiation of elevator power shutdown could occur before completion of Elevator Phase I Emergency Recall Operation. This could entrap elevator passengers.

A.21.4.1 When determining desired performance, consideration should be given to the temperature and response time characteristics/index (RTI) of both the sprinkler and the heat detector to ensure that the heat detector will operate prior to the sprinkler, because a lower temperature rating alone might not provide earlier response.

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Chart 2.8.3.3(e)
Excerpts From NFPA 72®-2019 Handbook: Elevator Power Shutdown (Cont'd)

Despite the obvious differences in temperature rating, a 135°F (57.2°C) heat detector may not respond before a 165°F (73°C) sprinkler head. The response time of a heat detector or sprinkler head is based on the response time index (RTI) of each device. The RTI must be known before the design and installation of heat detectors for elevator shutdown. See the commentary following A.17.6.1.5 for a discussion on RTI.

21.4.2* The heat detector(s) specified in 21.4.1 shall be placed within 24 in. (610 mm) of each sprinkler and be installed in accordance with the requirements of Chapter 17.

A.21.4.2 The purpose of spacing heat detectors in close proximity to each sprinkler is to ensure the operation of the disconnecting means upon heat detection prior to the operation of any sprinkler installed in those locations. Spot-type heat detectors or linear heat detectors are acceptable.

System Design Tip

Proper application of heat detectors used to initiate elevator power shutdown (shunt trip) in accordance with Section 21.4 relies on coordination between the fire alarm and sprinkler contractors. This becomes especially important with 21.3.7, which requires the fire alarm initiating devices to be accessible from outside the elevator hoistway. These requirements of *NFPA 72* may dictate sprinkler locations.

21.4.2.1 Engineering methods, such as those specified in Annex B, shall be permitted to be used to select and place heat detectors to ensure response prior to any sprinkler operation under a variety of fire growth rate scenarios.

21.4.3* If pressure or waterflow switches are used to actuate the disconnecting means specified in 21.4.1, the use of devices with time-delay capability shall not be permitted.

A.21.4.3 Care should be taken to ensure that elevator power cannot be interrupted due to water pressure surges in the sprinkler system. The intent of the Code is to ensure that the switch and the system as a whole do not have the capability of introducing a time delay into the sequence. The use of a switch with a time delay mechanism set to zero does not meet the intent of the Code, because it is possible to introduce a time delay after the system has been accepted. This might occur in response to unwanted alarms caused by surges or water movement, rather than addressing the underlying cause of the surges or water movement (often due to air in the piping). Permanently disabling the delay in accordance with the manufacturer's printed instructions should be considered acceptable.

21.4.4* Control circuit(s) of the disconnecting means specified in 21.4.1 shall be monitored for the presence of operating voltage.

A.21.4.4 Figure A.21.4.4 illustrates one method of monitoring elevator shunt trip control power for integrity.

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Chart 2.8.3.3(e)
Excerpts From NFPA 72®-2019 Handbook: Elevator Power Shutdown (Cont'd)

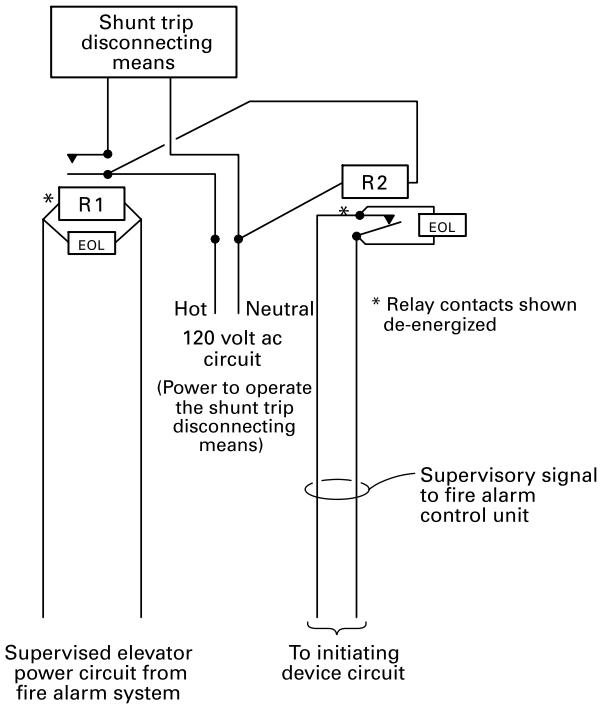


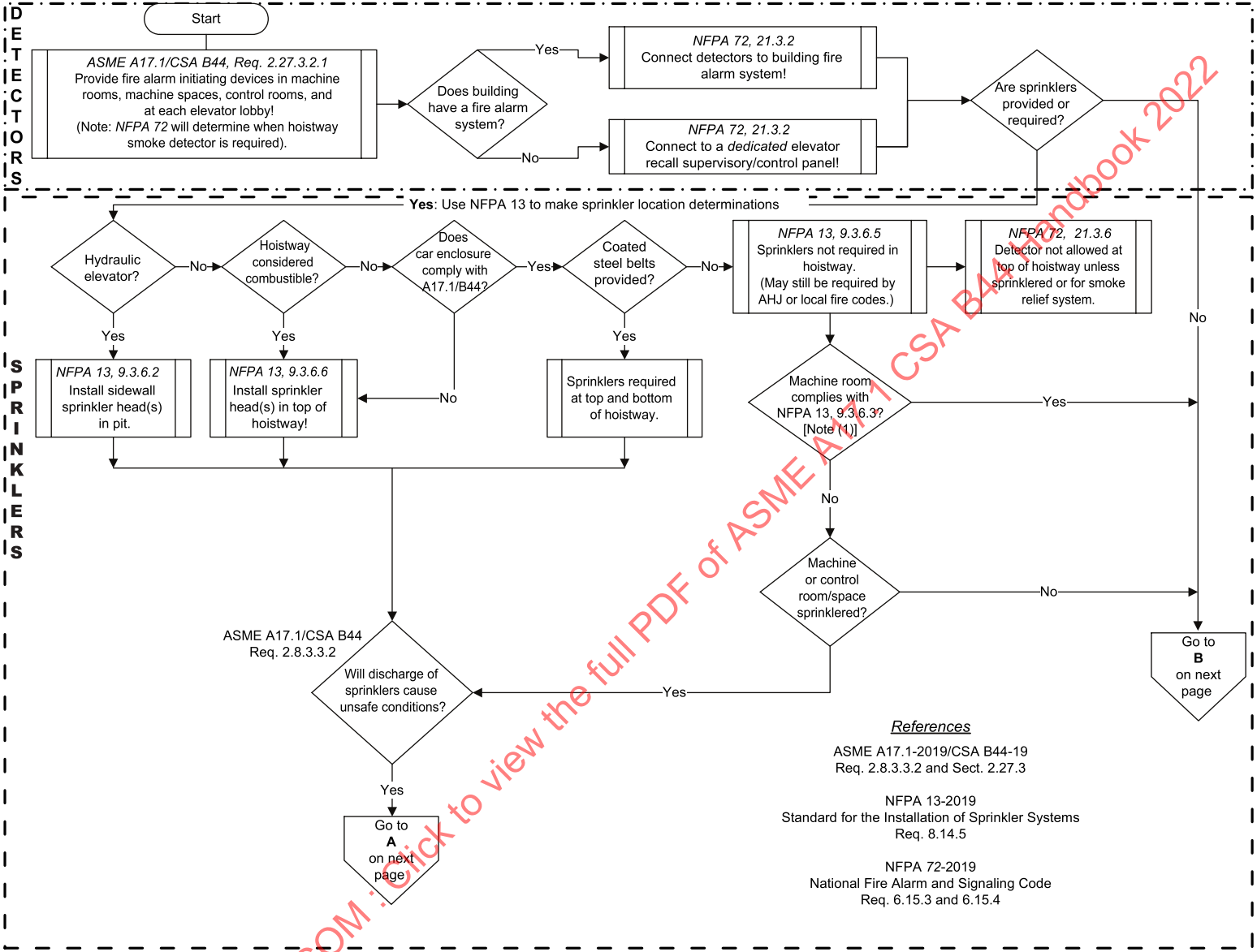
FIGURE A.21.4.4 *Typical Method of Providing Elevator Power Shunt Trip Supervisory Signal.*

This makes clear that fire alarm initiating devices used for elevator shutdown must be connected to a fire alarm and signaling system.

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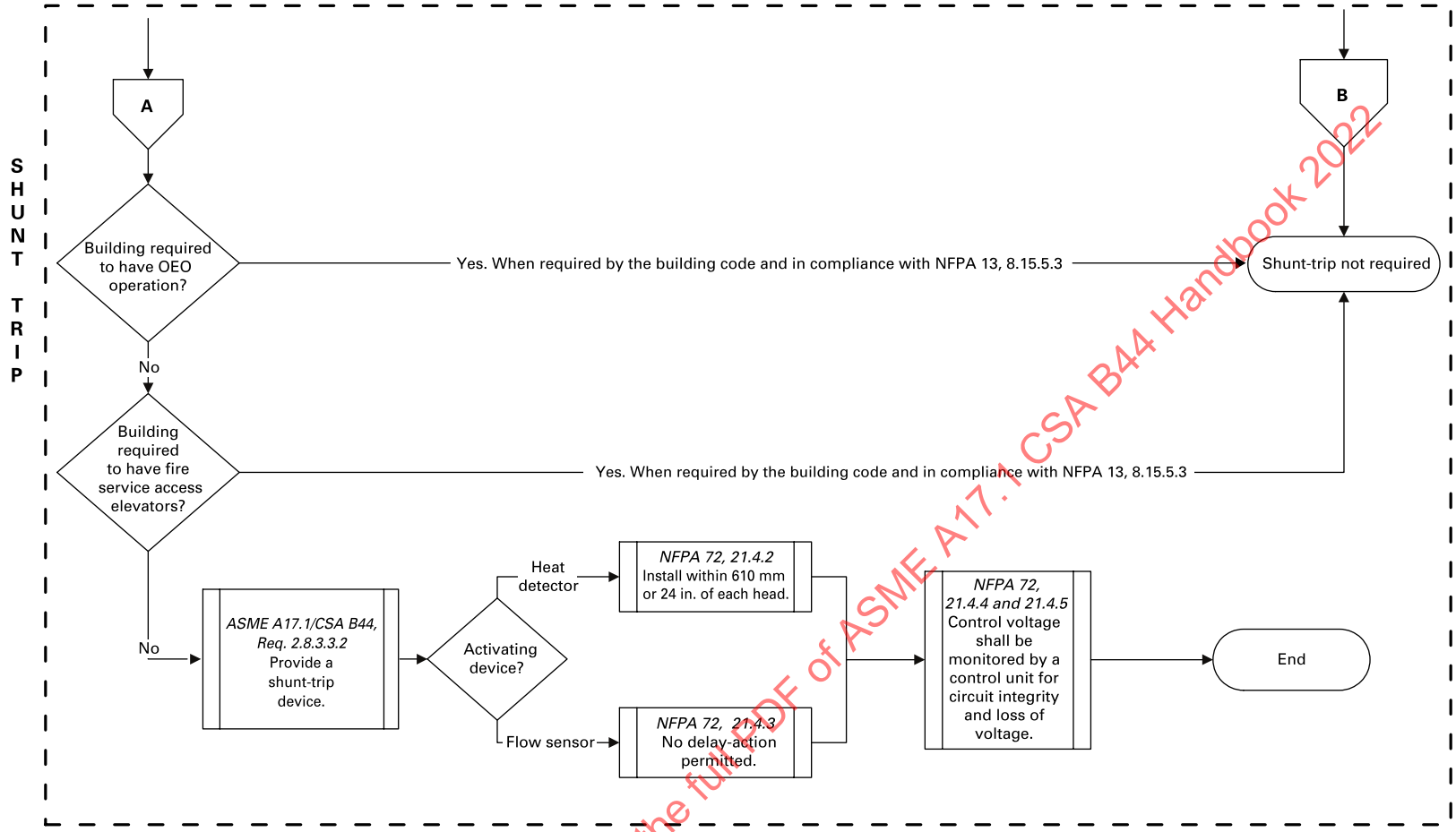
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Diagram 2.8.3.3.2
Smoke/Heat Detector and Shunt-Trip Decision-Making Flowchart



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Diagram 2.8.3.3.2
Smoke/Heat Detector and Shunt-Trip Decision-Making Flowchart (Cont'd)



GENERAL NOTE: Courtesy of Jim Runyan.

NOTE: (1) NFPA 13-2019, 9.3.6.3 provides four conditions that must be met to exempt sprinklers in machine rooms, machine spaces, control rooms, and control spaces for traction elevators. Hydraulic elevators do not qualify for these exemptions.

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SECTION 2.9
MACHINERY AND SHEAVE BEAMS, SUPPORTS, AND FOUNDATIONS

Machine beams, where used, transfer their loads to the building structure. The Code does not limit the design of the machine and its structural support system, if they comply with the applicable requirements. Depending on the specific design configuration, the machine beams may be located directly beneath the machine, bedplate, blocking, or stacking assembly.

2.9.1 Supports Required

It is the intent that machines, machinery, and sheaves be so supported and maintained in place to prevent any part from becoming loose or displaced under the conditions imposed in service. If a structural slab is provided, a machine beam is not required. Additional details on machine beams and structural slabs can be found in the Building Transportation Standards and Guidelines, *NEII*®-1. See Part 9 of this Handbook for procurement information.

2.9.2 Loads on Machinery and Sheave Beams, Floors, or Foundations, and Their Supports

2.9.2.2 Foundations, Beams, and Floors for Machinery and Sheaves Not Located Directly Over the Hoistway. The traction sheave is often located at a considerable distance from the center of gravity of the foundation mass in order to permit a particular roping arrangement. In such cases, the deadweight of the foundation might have to be heavier than two times the vertical components in order to have the capability of withstanding two times the vertical component and the overturning moment.

2.9.3 Securing of Machinery and Equipment to Beams, Foundations, Guide Rails, Structural Walls, or Floors

2.9.3.2 Beams or Foundations Supporting Machinery and Sheaves Not Located Directly Over the Hoistway. The bolt specification referenced, ASTM A307, covers carbon steel threaded fasteners that are not quenched or tempered. The minimum tensile strength allowed by this standard is 414 MPa or 60,000 psi; thus, the load of 82.7 MPa or 12,000 psi allowed by this requirement provides for a factor of safety of 5. The standard requires bolt heads to be marked with the manufacturer's identification. This standard requires the nuts to conform to ASTM A563. Since there is no activity to accredit fastener manufacturers and there have been cases of spuriously marked bolts, the manufacturer's identification and source of bolt supply is worthy of careful attention.

2.9.3.3 Securing of Machines, Sheaves, Equipment, and Hitches to Guide Rails or Structural Walls. Requirements added in ASME A17.1S-2005 and CSA B44-04 Supplement 1-05.

2.9.3.3.2 Sound isolation materials placed in shear or tension must be secured with bolts or fastenings.

2.9.3.5 Bolts Made of Steel. This requirement is applicable to all bolts made of steel as specified in 2.0.3.2.1, 2.9.3.3.3, and 2.9.3.4.2.

2.9.4 Allowable Stresses for Machinery and Sheave Beams or Floors, Their Supports, and Any Support Members That Transmit Load to the Guide Rails or Structural Walls

Specifying allowable deflections and stresses for the equipment establishes a safe level of design consistent with sound structural engineering practice for rigidity and strength.

2.9.4.3 Cast Metals in Tension or Bending. Restricts the use of cast metals with guide rails or structural walls.

2.9.5 Allowable Deflections of Machinery and Sheave Beams, Their Supports, and Any Support Members Loaded in Bending That Transmit Load to Guide Rails or Structural Walls

The term "static load" means the actual weight of all equipment and applicable portions of the flooring supported by the beams as defined by 2.9.2.1(b) in addition to the sum of the tensions in all suspension means supported by the beams with rated load in the car. There is no increase to these static loads to take care of impact, accelerations, etc.

The allowable deflection is intended to apply to machinery and sheave beams and any intermediate supports that comprise the structural interface between these structural elements and the building structure.

The basis for the derivation of the $^{1}/_{1666}$ figure cannot be found in the ASME A17 Committee records. The Committee is of the opinion that the intent was to have a stiff set of machine and sheave beams. A word of caution: $^{1}/_{1666}$ can be difficult to meet if the span of the structural support is long. The practical span limit that can be accommodated while still maintaining the $^{1}/_{1666}$ deflection is about 6 m or 20 ft between supports.

2.9.6 Allowable Stresses Due to Emergency Braking

This requirement provides criteria for the safe design of the respective components/structures subject to forces developed during the retardation phase of the emergency braking and all other loading acting simultaneously, if

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applicable, with factors of safety consistent with the types of equipment/structures involved. As the Code provides for stopping an ascending car, additional forces may need to be considered depending on the type of device used. For example if a rope brake is used, the forces necessary to stop the descending counterweight would be transferred to the point that the rope brake is mounted.

SECTION 2.10
GUARDING OF EQUIPMENT AND STANDARD RAILING

2.10.1 Guarding of Equipment

Guards and railing are required to prevent contact with moving equipment. To allow for visual examination and maintenance, the driving-machine sheave and rope are only required to be guarded where they extend beyond the base of the machine. Guarding of hand-winding wheels, etc., may not be practical, and where they are not guarded, they must be clearly identifiable by yellow markings.

2.10.2 Standard Railing

ASME A17.1-2000 and CSA B44-00 consolidated requirements for standard railing in one place. Other requirements in the Code reference 2.10.2 for standard railing requirements. These requirements ensure that railings are structurally sound and of adequate height to guard against a fall hazard. Strength requirements mandate adequate support for the railing and its support posts without specifying the location of posts or requiring toe-boards to be fastened to the posts. The forces specified meet OSHA requirements.

2.10.2.1 Top Rail. A tolerance was added to the top rail requirement in ASME A17.1-2013/CSA B44-13. Prior to the Code tolerance, some AHJs interpreted the top rail height as an exact dimension. A review of OSHA requirements and of various U.S. and Canadian building codes was conducted to determine a safe value for the tolerance.

SECTION 2.11
PROTECTION OF HOISTWAY OPENINGS

See Diagram 2.11, which illustrates hoistway components typically supplied on the entrance side of the hoistway wall.

2.11.1.1 Hoistway Landing Entrances. The minimum height of the entrance is consistent with the dimensions for egress doorways required by the building codes.

2.11.1.2 Emergency Doors in Blind Hoistways. A single blind hoistway is that portion of a single hoistway that passes floors or other landings at which no normal landing entrances are provided. The requirement for emergency doors is to provide access in order to evacuate passengers from a stalled elevator. The required distance between emergency doors was calculated to ensure that a firefighters' extension ladder placed on top of the disabled car could reach the floor at the access door. The sign [2.11.1.2(d)] warns building personnel that the door does not lead to an office, slop sink, janitor's closet, etc. The requirement for a cylinder-type lock [2.11.1.2(f)] that will not be unlocked by any key that will open any other lock or device in the building ensures that building personnel will not be able to enter this door accidentally.

The electromechanical device [2.11.1.2(e)] will monitor the door to ensure it is closed and locked and prevent elevator operation if it is not. This will check that the door has not been left in the open position. The barrier [2.11.1.2(i)] will guard the opening when the door is in the open position.

2.11.1.2(e) ASME A17.1-2013/CSA B44-13 was revised to specify an electric contact in lieu of an electromechanical device. This was not considered a reduction in safety as the entrance is protected by a Group 1 security key, is self-locking, and has a hinged self-closing barrier independent of the door.

2.11.1.3 Telephone as Alternative to Emergency Doors. In some installations, there are no floors (2.11.1.2) between landings. This requirement applies to those applications. If intermediate floors as specified in 2.11.1.2 are available for emergency access doors, this requirement does not apply.

2.11.1.4 Access Openings for Cleaning of Car and Hoistway Enclosures. The Code Committee concluded it was preferable to have an access panel in the car enclosure for cleaning hoistway glass than doing it from the top of the car. Maintenance requirement 8.6.11.3.2 requires a written procedure for cleaning the glass, for every installation. See Handbook commentary on 8.6.11.3.

2.11.2 Types of Entrances

2.11.2.1 Passenger Elevators. See Diagrams 2.11.2.1(a)(1) through 2.11.2.1(d).

2.11.2.2 Freight Elevators. See Diagrams 2.11.2.1(a)(1) through 2.11.2.1(d) and Diagrams 2.11.2.2(e)(1), 2.11.2.2(e)(2), and 2.11.2.2(f).

2.11.3 Closing of Hoistway Doors

The self-closing feature required for horizontally sliding or swing doors of automatic operation elevators provides an automatic mechanical means of closing the hoistway door opening if for some reason the elevator malfunctions and moves more than 450 mm or 18 in. away from the landing. The requirement for location of the door closer (2.11.3.2) is to ensure that all panels are closed if the normal relating means fails.

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Members of the ASME A17.1 and CSA B44 Code Committees recognized that differences exist between vertically and horizontally sliding doors, and swing doors. If a person were in the path of a closing horizontally sliding door, the door would strike the individual in such a manner that they would be impacted at the side of their body. They probably would retain their balance and likely not be injured.

Vertical sliding doors that slide down to close could strike the individual in the head with the potential for very serious injury. Vertical sliding doors that slide up to close have the potential to trip an individual as they begin to close unexpectedly. Vertical biparting doors again have the same exposure risks. Both scenarios have the potential of trapping an individual in the door opening with the elevator moving away from the landing.

At one time, self-closing vertical sliding doors were used in North America. This was recognized as the source of numerous accidents; they are now prohibited.

When the elevator is on firefighters' service (2.27.3), the following conditions are considered, which changed the requirement to keep the doors closed when the car was parked at the landing starting with ASME A17.1-2000 and CSA B44-00. Under Phase I Emergency Recall Operation, the elevator is returned to the designated level or alternate level and the doors shall open and remain open. This sequence of events assumes that the elevator has been returned to a safe floor and the doors are opened to allow passengers to exit from the elevator and are left open to assist arriving firefighters. Arriving firefighters want to immediately confirm that all elevators have been returned to the designated or alternate level, and that no passengers are caught in stalled elevators. The open door allows them to quickly assess this condition and gives them the opportunity to start immediate rescue operations if necessary.

2.11.4 Location of Horizontally Sliding or Swinging Hoistway Doors

The purpose of this requirement is to reduce the possibility of a person or object being caught between the hoistway door and the car door or gate. The permissible distance is greater for elevators that can only be operated from within the car (2.11.4.1), since the operator has control of the car and would not move the car if a person or object were in this area. The permissible distance (2.11.4.2) is less for swinging doors than for sliding doors since a swinging door can close behind someone, forcing the person into the area between the two doors. This is not the case with sliding doors. The reason for the differences in the points of measurement is also based on reducing the possibility of entrapping a person between doors. With a swinging hoistway door, the largest entrapment area is between the hoistway door and the section of the car door furthest from it. With sliding car and hoistway doors, the leading sections are the ones that could cause entrapment, as these sections are the ones nearest to each other.

Additionally, the specified distance eliminates the possibility of a person standing on the hoistway landing sill when the hoistway door is closed. See Diagram 2.11.4.

2.11.5 Projection of Entrances and Other Equipment Beyond the Landing Sills

Requirement 2.11.5(a) was revised in ASME A17.1-2013/CSA B44-13 to recognize that door-guiding devices and retaining devices can project beyond the line of the landing sill.

2.11.6 Opening of Hoistway Doors

When a passenger elevator car is outside the unlocking zone, the hoistway door or car door must be so arranged that one or the other or both cannot be opened more than 100 mm or 4 in. from inside the car. The unlocking zone is a zone that is determined by the elevator manufacturer in accordance with 2.12.1 and 2.14.5.7. The 100 mm or 4 in. dimension was the maximum permitted opening under which a hoistway door and car door or gate could be considered in the closed position when this requirement was originally developed in the early 1980s. When the passenger elevator car is within the unlocking zone, 75 mm or 3 in. up to 175 mm or 7 in. or less above or below the landing, passengers may be able to open the door by hand from within the car. The passenger must be able to open the door from inside the car within 75 mm or 3 in. above or below the landing. See Diagram 2.14.5.7 (ASME A17.1/CSA B44, Fig. B1).

The requirements pertaining to locking doors out of service (2.11.6.2) applies to both passenger and freight elevators. "Locked out of service" refers to a physical locking of the doors. A keyed car and/or corridor switch does not constitute a locked-out-of-service means since it allows the doors to be opened manually. The hoistway door must not be locked out of service at the top or bottom terminal landing, as a malfunctioning elevator has a tendency to home-in on the terminal landing. Also, if these doors were locked out of service, evacuation of passengers would be severely hampered. The designated and alternate floor landing doors must not be locked out of service when Phase I is effective, as this is the location that elevators return to when operated under firefighters' service (2.27.3.1). If the designated and alternate floor doors were locked, passengers would not be able to exit the car and emergency personnel, firefighters, etc., would not be able to enter the car.

If the elevator is equipped with Phase II Emergency In-Car Operation, no landing is permitted to be locked out of service when Phase II is in effect. Firefighters must be able

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to access all floors served by the elevator during a fire. A locked-out-of-service entrance would not allow access.

2.11.6.1 This requirement was revised in ASME A17.1-2016/CSA B44-16 to reference 2.12.1 so users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

2.11.6.3 This requirement was revised in ASME A17.1-2013/CSA B44-13 to provide requirements, when permitted by the building code, for additional doors and similar devices mounted adjacent to the elevator hoistway opening, the purpose of which is to minimize the migration of smoke into or out of the elevator hoistway. The devices are currently being permitted by the building codes and may affect the operation of the elevator; it is important to address these potential safety and certification issues.

The requirements ensure that firefighters can safely use the elevator on Phase II as intended.

2.11.7 Glass in Hoistway Doors

2.11.7.1 Vision Panels. A manually operated hoistway door is one that is opened and closed by hand. A self-closing hoistway door is one that is opened manually and that closes automatically when released. Vision panels or hall position indicators are required only for manually operated doors or doors equipped with self-closing devices such as swing doors. Neither a vision panel nor position indicator is required for doors that open and close under power even if such doors are equipped with self-closers. The vision panel construction requirements are applicable whenever hoistway door vision panels are provided, whether they are required or not.

Wire glass in a vision panel should never be replaced by, or covered by, any other material such as Plexiglas since this could adversely affect the fire-resistance rating of the door. Other transparent glazing materials are permitted [2.11.7.1.4(b)]; however, if the door is a labeled door, the glazing material must be approved by the certifying agency. See also Handbook commentary on 8.6.3.7. The height of the panel from the floor places it at a location that facilitates its use.

The size of each panel precludes someone from sticking his head through the opening if the glass is missing. Vision panel protective grills (2.11.7.1.7) were first required by New York City and have proven to be effective in reducing injuries and fatalities due to broken vision panels.

2.11.7.2 Glass Doors. The Code makes a clear distinction between vision panels and glass doors. The minimum area requirement for the glass door ensures that these requirements are not used to install oversized vision panels. Laminated glass is required to minimize the possibility of an opening into the hoistway if the glass is broken. The Consumer Product Safety Commission (CPSC) standard 16 CFR Part 120 would apply in the United States as the glazing is classified by the building codes and CPSC regulations as being in a location subject to human impact loads.

Protection is required on glass door edges as door panels tend to be struck by carts, etc. If the glass was not protected, the edges might become hazardous to people passing through the doorway.

In addition to the requirement for glass doors in 2.11.7.2, the requirements in 2.11.11 are also applicable. As an example, any area depressed or raised more than 3.125 mm or $\frac{1}{8}$ in. would require beveling in compliance with the requirements in 2.11.11.5.5.

Requirement 2.11.7.2.2 was revised in ASME A17.1-2022/CSA B44:22 to reduce the minimum glass area from 60% to 50%. This change allows more steel reinforcement to support the glass.

2.11.10 Landing-Sill Guards, Landing-Sill Illumination, Hinged Landing Sills, and Tracks on Landings

2.11.10.1 Landing-Sill Guards. See Diagrams 2.11.10(a) and 2.11.10(b).

2.11.10.1.4 This requirement was added in ASME A17.1-2013/CSA B44-13. The allowable gap between the door and sill [see 2.11.11.5.2(d)] is 10 mm or $\frac{3}{8}$ in. Sight guards are allowed to be 12 mm or $\frac{1}{2}$ in. above the sill. Prohibiting pre-door opening and preventing releveling up before the car sill surface reaches the groove ensure that the door guiding groove is not exposed to users in the car.

2.11.10.2 Illumination at Landing Sills. Just as automatic cameras do not focus on a long myriad of tightly spaced horizontal lines, our eyes are unable to perceive depth or contrast in closely spaced fine lines. The standard elevator door guide is generally 13 mm or $\frac{1}{2}$ in. wide and anywhere from 13 mm or $\frac{1}{2}$ in. to 25 mm or 1 in. deep. There are generally two of these guides at the threshold of an elevator, one in the car sill, and the other in the landing sill. In between these sills is the gap between the elevator car and the elevator hoistway. This running clearance is typically 25 mm or 1 in. to 32 mm or $1\frac{1}{4}$ in. An elevator threshold resembles such a group of lines, which creates a competition for one's vision between the very visible gap between car and hoistway sills and the less visible door guides. The gap between car and hoistway wall is visible because it is sufficiently wide and dark. The door guides are camouflaged because they blend into the threshold pattern, which is generally a profusion of deceptive horizontal lines, thereby creating a lack of conspicuity. Dimly lighted areas render the inconspicuous guides more difficult to see, as do glares, shadows, or heavy reflection.

The required illumination should be measured with the door in the open and closed positions.

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Requirement 2.11.10.2 was revised in ASME A17.1-2019/CSA B44:19 to include more performance-based language to require illumination at the sill anytime the elevator is in service. The previous language did not address elevators installed in locations without a building corridor.

2.11.10.3 Hinged Hoistway Landing Sills. Hinged landing sills were common on old single- or two-speed A/C elevators that did not level to allow easy transport of handcarts from sill to sill. They are seldom if ever found on modern equipment. This requirement reduces the possibility that the elevator can be operated before the hinged landing sill is in the upright position.

2.11.11 Entrances, Horizontal Slide Type

2.11.11.1 Landing Sills

2.11.11.1(b) This requirement reduces a potential tripping hazard at the entrance-landing sill.

2.11.11.1(d) This requirement was added in ASME A17.1-2013/CSA B44-13 to clarify that a sill/sill structure is permitted as a guiding component. When a sill/sill structure is used as a guiding component, it must meet the strength requirement of 2.11.11.5.7.

2.11.11.3 Entrance Frames. The frame return leg must be parallel to the plane of the door panels but need not be in the same plane (flush) with the return wall of the hoistway.

Entrance frames are not designed to carry the weight of the wall above the frame. When inspecting entrance frames, be sure that a lintel is provided with masonry construction and that in other construction, the wall framing is designed to carry the weight of the wall. Entrance frames normally cannot use the wall alone for structural support. They need to be secured to the building structure or to the track supports in addition to the hoistway wall. See Handbook commentary on 2.1.1.5. The wall anchors are provided to ensure fire integrity.

Passenger elevator doors installed in masonry walls would perform the same under fire exposure conditions without a frame, providing the doors overlapped the masonry opening the same distance as an assembly incorporating a frame. Masonry-type walls are generally considered to consist of brick, concrete block, or reinforced concrete construction. All three of these materials have demonstrated their resistance to fire exposure.

Masonry and drywall constructions that have veneers of marble or granite have not been investigated by testing laboratories under fire conditions. Engineering judgment can be applied when comparing granite- or marble-faced drywalls with solid masonry walls. The passenger elevator doors should perform the same under fire conditions in a granite- or marble-faced wall, providing the doors overlapped the masonry wall opening, or the steel-framed opening in a drywall construction, the same distance as an opening without the marble or granite facing. The thickness of the facing should not be considered in determining the correct overlap of door opening. This judgment can only be made by assuming that the application of the marble or granite facing does not adversely affect the structural integrity of the wall under fire conditions. In the case of drywall construction, the interface between the door and steel frame could be affected by the application of the facing material.

The stringent fire test of an entrance that subjects a test assembly to 982°C or 1,800°F necessitates the use of steel for doors and frames. Metals, such as aluminum or bronze, and other materials, such as marble, wood, etc., cannot withstand 982°C or 1,800°F; therefore, a steel subframe is necessary in order to preserve the fire integrity. Diagram 2.11.11.3 illustrates the use of a steel subframe with stone facing. Note that in order to preserve the fire integrity, the door must overlap the steel subframe and not the marble facing.

2.11.11.5 Panels

2.11.11.5.3 A finger or hand caught between the landing edge of the door panels and a strike jamb pocket could cause serious injury. Without a pocket, a person should be able to free a hand or finger that has been trapped.

2.11.11.5.7 It is not intended that this requirement be field tested.

Requirement 2.11.11.5.7 was revised in ASME A17.1-2019/CSA B44:19 to clarify the requirements. The requirements are intended to apply to the assembled panels, hanging hardware, and guiding members, and each panel must meet the requirements. The revisions removed some vague language and aligned the language with other code requirements. The revisions also removed the implication that a test was required. Compliance can be demonstrated via structural analysis.

2.11.11.5.8 This requirement controls the amount the door can be forced open with the door in the closed and locked position. A simple field-test to determine compliance can be performed as follows:

On the landing side, hook a spring scale around the leading edge of the hoistway door at the furthest point from the interlock. Let the door close and the car leave the floor. Exert a pull of 135 N or 30 lbf at the furthest point from the interlock, typically the bottom of the panel, in the opening direction and measure the door movement. For center parting doors, exert the 135 N or 30 lbf pull on each panel measuring the door movement between the panels. Test only one panel at a time. Do not apply the force to both panels at the same time.

2.11.11.6 Bottom Guides. The 6-mm or 0.25-in. engagement of the door guide in the sill is necessary to prevent disengagement of the guide from the sill.

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Disengagement would allow the door panel to swing into the hoistway, an extremely hazardous condition.

2.11.11.7 Multipanel Entrances. An interconnecting means complying with 2.11.11.7.1 or interlocks on each panel complying with 2.11.11.7.2 must be provided. When you comply with 2.11.11.7.1, a door closer on the panel that does not have the interlock is required by 2.11.3.3. This will close the nondriven door if the interconnecting means fails. When an interconnecting means complying with 2.11.11.7.1 is not provided, interlocks are required by 2.11.11.7.2 on each driven panel. This is to ensure that the elevator cannot run with an open hoistway door panel.

On multispeed doors, 2.11.11.7.3 requires a mechanical-interconnecting means between panels moving in the same direction, to ensure the panels will not separate leaving an open hoistway door panel.

2.11.11.8 Hoistway Door Safety Retainers. It is not intended that this requirement be field tested. See also 2.28.1(i).

2.11.11.9 Beams, Walls, Floors, and Supports. This requirement is necessary to ensure that the doors are secure. It is not intended that this requirement be field tested. However, the supports should be visually examined to ensure they are in place and not subject to wear or stress during normal operation.

Requirement 2.11.11.9 was deleted in ASME A17.1-2022/CSA B44:22. The requirements were moved to 2.1.1.5 to make the requirements applicable to vertically sliding and swing-type doors. See also Handbook commentary on 2.1.1.5.

2.11.11.10 Hoistway Door to Sill Clearance. The horizontal distance from the leading edge of the hoistway doors or sight guard to the edge of the hoistway sill is limited by these provisions to reduce the open gap between the hoistway and car doors. The vertical distance between a sight guard and the landing sill is limited to reduce a pinching hazard. A sight guard is defined as a vertical member mounted on the hoistway side, leading edge of the hoistway door. It is used to reduce the opening between the leading edge of the hoistway door and the car door to inhibit placing objects in this space.

2.11.12 Entrances, Vertical Slide Type

See Diagram 2.11.12.

2.11.12.1 Landing Sills. See Diagram 2.11.12.1.

2.11.12.2 Entrance Frames. The walls may not be able to sustain the loads and forces applied to them by the entrance. This is the reason why the entrance frames normally are secured to the building structure in addition to the wall itself. The wall anchor is provided to ensure fire integrity. See Handbook commentary on 2.1.1.5. See Diagram 2.11.12.2 for typical drywall frame arrangement.

2.11.12.3 Rails. The walls themselves may be incapable of withstanding the loads and forces applied on them during the normal use of the entrance. These loads and forces are transmitted to the door guide rails and they in turn must transmit the load to the building structure.

2.11.12.4 Panels. See Diagram 2.11.12.4.

2.11.12.4.3 A rigid astragal is a horizontal molding attached to the meeting edge on a pair of panels for protection against weather conditions and/or to retard the passage of smoke, flame, or gases during a fire. Rigid astragals are prohibited as they were found to be a shearing hazard. A fire-resistive, nonshearing, and noncrushing astragal is to be provided on the upper panel and provides the same protection that the rigid astragal does but in a safe manner. A nonshearing and noncrushing astragal reduces the effects of injury should someone's hand, etc., get caught between door panels during the closing operation of the door. See Diagram 2.11.12.4.3.

2.11.12.4.7 A pass-type entrance is a biparting door having the upper panel offset from the lower panel. It is used when the floor height is not sufficient for the upper panel at one landing to open without interference with the lower panel of the door at the landing immediately above. See Diagram 2.11.12.4.7.

2.11.12.4.8 This requirement controls the amount the door can be forced open with the door in the closed and locked position. A simple field test to determine compliance can be performed as follows:

On the landing side, hook a spring scale around the leading edge of the hoistway door at the furthest point from the interlock. Let the door close and the car leave the floor. Exert a pull of 135 N or 30 lbf at the furthest point from the interlock, typically the bottom of the panel, in the opening direction and measure the door movement.

2.11.13 Entrances, Swinging Type

2.11.13.1 Landing Sills. This requirement reduces a potential tripping hazard at the entrance landing sills.

2.11.13.2 Entrance Frames. Entrance frames are not designed to carry the weight of the wall above the frame. When inspecting entrance frames, be sure a lintel is provided for masonry construction and that in all other construction the wall framing is designed to carry the weight of the wall. Entrance frames normally cannot use the wall alone for their structural support. They need to be secured to the building structure or to track supports in addition to the hoistway walls. See Handbook commentary on 2.1.1.5. The wall anchoring is provided only to ensure fire integrity. When installed

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in other than masonry walls, the interface between the frame and wall construction should be approved for such use.

2.11.13.3 Panels

2.11.13.3.3 Typically a fire-resistive swinging entrance requires a center latch in order to remain in the closed position during a fire test. The fire test report for the swinging entrance should be checked to see if a center latch is required.

2.11.13.3.4 The use of brass, bronze, stainless steel, woven metal, or plastic laminate facings on UL-classified passenger elevator doors is currently covered in each individual manufacturer's follow-up service procedure and is based upon investigation by fire test. The facings are installed at the manufacturer's plant.

The particular type of mechanical fastening and/or adhesive fastening method investigated is specifically described. The fastening methods have been investigated as part of the test specified in 8.3.1.2 for their effect on the structural performance of the door (in the case of mechanically fastened systems) or flaming characteristics (in the case of adhesively fastened systems) while the assembly is under fire exposure conditions.

The addition of architectural facing materials, in the field, to labeled entrances may not be authorized by the certifying organization and could affect the fire performance of the door assembly.

2.11.14 Fire Tests

Most elevator entrances are rated for 1½ h and are tested in the furnace for 1½ h. If a different hourly rating is required, the test time is adjusted accordingly. The landing side of a passenger door or hoistway side of a freight door is exposed to the furnace flame and a temperature rise that peaks at approximately 982°C or 1,800°F at the 1½-h point. During this time, the test assembly must preserve its integrity by complying with limitations on flame spread and with no occurrence of through openings in the test assembly.

On conclusion of the fire test, the test assembly is moved away from the heat source and is subjected to a high-pressure stream of water for a varying length of time that is a function of the total square footage of the test specimen. This is known as the hose stream test. The hose stream test, with its resulting extreme temperature differential, tests for structural integrity simulating an explosion during a fire. As a result of the hose stream test, the space between the door panel and frame cannot exceed 73 mm or 2⅞ in.

As Underwriters Laboratories (UL) is the predominant certifying organization in the United States, it will be referenced in the Handbook commentary. Other certifying organizations are approved in many areas and the information below should also apply.

At the time elevator fire door assemblies were first investigated by UL, they were intended for installation in masonry walls only. UL did not establish listings for the frames because the doors were not attached or supported by the frame and the frame primarily served the purpose of finishing the masonry opening. At the time, it was judged that elevator doors installed in masonry walls would perform the same under fire exposure conditions with or without a frame, provided the doors overlapped the masonry opening the same distance as an assembly incorporating a frame. In later years, passenger and eventually freight elevator door assemblies were evaluated for installation in drywall construction. In the case of drywall construction, it was found that the interface detail of the wall and frame was an important factor in the overall fire performance of the assembly. Accordingly, the frame detail is an important factor in the performance of elevator fire door assemblies installed in drywall construction. As a result, elevator door frames intended for installation in drywall construction are listed under the follow-up service program of UL

If a manufacturer wanted to establish classification, fire tests were conducted on both the single-slide opening and center-opening entrance assemblies incorporating the largest size door panel the manufacturer intended to include under UL's follow-up service program. As the result of a successful investigation, a manufacturer would be in a position to provide elevator fire doors incorporating the classification mark (label) for use on single-slide entrances, multispeed side-slide entrances, center-opening entrances, and multispeed center-opening entrances, provided the door panel sizes do not exceed the maximum size of the panels tested.

At the time UL was requested to establish classification for passenger elevator fire doors installed in drywall construction, they reviewed the past fire performance data of single-slide and center-opening entrances previously tested in masonry walls. From that data, it was determined that, in general, the center-opening doors were more critical with respect to fire performance. Accordingly, passenger elevator fire door manufacturers who had established their classification as the result of tests conducted on single-slide and center-opening entrances in masonry construction could obtain coverage for their doors in a drywall construction based upon a successful fire test of a center-opening entrance. As a result of the performance of the center-opening assembly, UL was in a position to establish coverage for the single-slide and multispeed entrances in drywall construction. Manufacturers submitting their doors for the first time, or existing classified manufacturers submitting a new door design, would still need to fire test a single-slide opening and center-opening entrance assembly.

Based upon a review of past fire performance data of masonry and drywall elevator door entrances, it was determined that, in general, the drywall entrance

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assembly was more critical with respect to fire performance. As a result of the performance of a drywall entrance assembly, UL was in a position to establish coverage for the same assembly in masonry construction.

The UL building materials directory contains a current list of classified passenger and freight elevator fire door manufacturers, listed passenger and freight elevator fire door frame manufacturers, and listed elevator hardware manufacturers.

UL has been classifying sliding passenger elevator entrances and listing passenger elevator door hardware (see Section 1.3) for approximately 50 years. The product categories of passenger elevator type fire doors (GSUX) and passenger elevator door hardware (GZKZ) were established in 1970. The listing of passenger elevator door frames (GVTV) was formally established in 1979.

The classification marking (label) on passenger elevator doors covers the design and construction of the door or door panels only.

Passenger elevator door hardware consists of a header, track hangers, pendent bolts, floor sill with guides, sill support plates, sill brackets, retaining angles, and closer assemblies. Listing marks (labels) are applied to each header, track, hanger, aluminum sill, sill support plate, sill bracket, retaining angle, and closer assembly.

Elevator door frames are intended for use with sliding passenger elevator fire door designs for use in drywall shaft construction. In addition to the "Fire Door Frame" label, each frame bears a supplementary marking indicating "passenger elevator door frame for use with "ABC" company's passenger elevator type fire doors to be installed in drywall shaft construction."

Between the date on which UL conducted the first successful test (1975) for passenger elevator door frames in a drywall and the date on which listing and UL follow-up service was promulgated (1979), manufacturers were providing copies of their UL test reports on drywall shaft construction to code authorities.

When a frame manufacturer wants to obtain the broadest listings of frame design options, based on a single fire test investigation, the certifying agency requires that it produce a frame sample for test having the minimum face and throat dimensions, minimum material gauge, and maximum height and width to be constructed under the follow-up service program.

If the test results are successful, door frames having a greater face and throat dimension, greater material thickness, and a lesser opening height and width — provided the frame profile is similar, the frame construction identical, and the type and number of anchors the same as originally tested — are authorized for listing.

To date, UL has tested passenger elevator door frames for use in drywall construction with face dimensions ranging from 31.8 mm or 1¼ in. to 51 mm or 2 in. Due to the importance of the wall and frame interface, frames with face dimensions less than those originally tested by a particular manufacturer would not be authorized for listing without further test.

Frames with face dimensions greater than 51 mm or 2 in. may be judged acceptable by engineering study. However, UL would need to review detailed drawings illustrating not only the frame/wall interface but also the method of wall construction. Based upon the present shaft wall designs, face dimensions greater than 51 mm or 2 in. may make proper wall installation very difficult.

UL also classifies gasketing materials for use on fire door and frame assemblies. The individual gasketing materials are currently investigated for use on particular frame or door types (i.e., hollow metal, wood composite, passenger elevator, etc.) and for specific fire duration periods (i.e., 1½ h, 2 h, 20 min, etc.).

The basic standard used to investigate gasketing materials applied to fire-resistive entrances is UL 10B or NFPA 252 (fire tests of door assemblies). The gasketing materials are investigated as applied to a door or frame type selected by the gasket material manufacturers and installed in accordance with the gasket manufacturer's instructions. The fire performance of the gasketing is observed during the test with particular attention to flaming characteristics and effect on the door or frame design. The assembly, with gasketing material applied, must comply with the conditions of acceptance specified in 8.3.4. The operation of the door assembly cannot be adversely affected by the installed gasketing material so as to restrict door operation.

Note that test standard UL 10B does not provide for evaluation of the door assembly or gasket material relative to the prevention of smoke or other products of combustion. Also, see the Handbook commentary on 2.1.1.1 and 2.11.19.

2.11.15 Marking

See Handbook commentary on 2.11.14.

Requirement 2.11.15 was revised in ASME A17.1-2022/CSA B44:22 to ensure marking requirements for jurisdictions enforcing the NBCC are aligned with those currently specified in ASME A17.1/CSA B44.

2.11.15.1 Labeling of Tested Entrance Assembly. This requirement provides a mechanism for identifying all entrance components of a labeled or listed entrance assembly.

2.11.15.3 Entrances Larger Than Tested Assemblies. The practice is to limit the assembly size bearing the labels to the maximum size the furnace can accommodate for a fire test. In some fire door categories (e.g., large freight doors, etc.), some certifying agencies have made available an oversize labeling program. In this case, an oversize door (i.e., one larger than the maximum size that can be fire tested) is provided with an "oversize label." The "oversize label" does not indicate that such doors are capable of

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furnishing standard fire protection, but only that they conform to the construction details of the doors successfully fire tested except for size.

In order to be eligible for an "oversize label" program, the door manufacturer must have tested the largest door the testing laboratory's furnace would accept. It must then demonstrate that the oversize design and corresponding increase in hardware size and mounting technique are satisfactory for use through operational tests, structural calculations, drawings, or a combination of such data.

2.11.16 Factory Inspections

Recognized testing laboratories are required to have a follow-up inspection service to ensure that their label is being placed on assemblies that comply with the test reports.

Requirement 2.11.16 was revised in ASME A17.1-2022/CSA B44:22 to ensure marking requirements for jurisdictions enforcing the NBCC are aligned with those currently specified in ASME A17.1/CSA B44.

2.11.17 Transoms and Fixed Side Panels

As UL is the predominant certifying organization, it will be referenced in the Handbook commentary. Other certifying organizations are approved in many areas and the information below should also apply.

This requirement states in part that the opening closed by the transom and fixed side panels must not exceed in width or height the dimensions of the entrance above which it is installed.

This means if there is an entrance 1.06 m or 42 in. wide by 2.13 m or 84 in. high, the transom cannot exceed 1.06 m or 42 in. in width or 2.13 m or 84 in. in height. There are two types of transoms: flush and offset. The flush transom, as illustrated in Diagram 2.11.17, sketches (a) and (e), requires a 69.9 mm or 2¾ in. hoistway door panel. Offset transom panels, as shown in Diagram 2.11.17, sketches (b), (c), and (d) can be of two types: offset pan transom and offset fire test transom. The offset fire test transom has a construction comparable to a door panel. The pan transom must be backed up with a fire-resistive wall.

It has been determined that the interface detail of the gypsum drywall design and the entrance frame are an important factor in the overall fire performance of the door assembly. Passenger elevator entrance frames and transoms are covered under UL's follow-up service program. A manufacturer can obtain UL listings for transom panels by having an engineering study conducted or by fire test. In the case of an engineering study, the manufacturer's request and drawings would be reviewed with regard to the following guidelines:

(a) The opening closed by the transom assembly cannot exceed the maximum width or height dimensions of the entrance above which it is installed.

(b) The transom panels must be constructed in a manner equivalent to the door construction eligible for labeling.

(c) The transom panel must be securely anchored.

(d) The passenger elevator door overlaps the transom panel by the same dimension as it overlaps the frame head when a transom panel is not installed.

Transom panel and door constructions incorporating a flush design requiring rabbeted edges or other unique design combinations would need to be investigated by fire test in order to determine their acceptability.

Requirement 2.11.15.1.2(c) requires transom panels to be labeled as passenger elevator frame transom panels by fire test or engineering study. When covered under the UL follow-up service program, the transom panel bears its own listing mark (label) reading "transom panel" along with any applicable supplementary markings.

Requirement 2.11.17 was revised in ASME A17.1-2022/CSA B44:22 to ensure marking requirements for jurisdictions enforcing the NBCC are aligned with those currently specified in ASME A17.1/CSA B44.

2.11.18 Installation Instructions

This has been a condition for UL labeling for many years and is a means of ensuring construction of the entrance assembly in accordance with the labeling procedure. Inspectors should check for conformance with the installation instructions.

Requirement 2.11.18 was revised in ASME A17.1-2022/CSA B44:22 to ensure marking requirements for jurisdictions enforcing the NBCC are aligned with those currently specified in ASME A17.1/CSA B44.

2.11.19 Gasketing of Hoistway Entrances

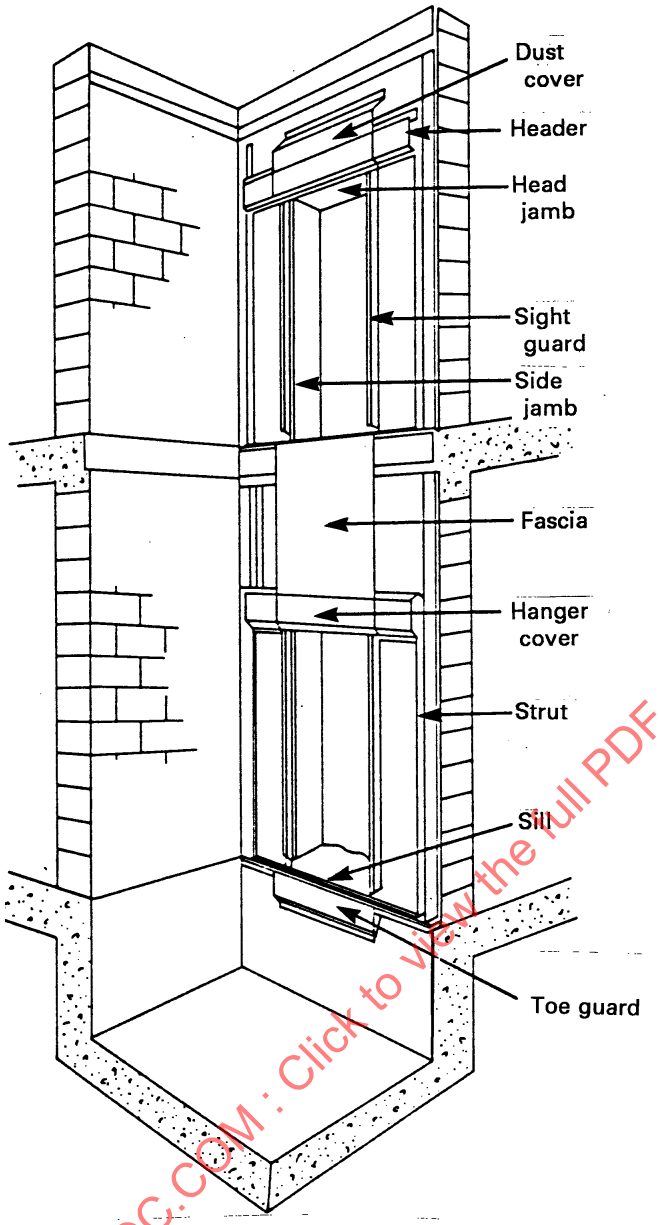
The application of gasketing to hoistway entrances may affect the performance of the entrance. The reference to the tests in 2.11.19.1 is to evaluate the material's performance when subjected to a fire door test. Requirement 2.11.19.2 specifies a maximum temperature in accordance with a recognized national standard. Note (1) to 2.11.19 is for information and provides a list of Code requirements that may be affected when gasketing is applied to an elevator entrance.

Note (2) to 2.11.19 points out that these requirements do not attest to the performance of gasketing material in terms of air and/or smoke leakage performance. Gasketing quite often is specified for smoke and draft control purposes. Where gasketing has been installed for this purpose, it may not prove to be effective. Due to the limits placed on kinetic energy and door closing forces, a positive sealing may not be possible under field conditions.

2.11.19.3 This requirement was revised in ASME A17.1-2013/CSA B44-13 to require that the certifying agency identification be included on the required label.

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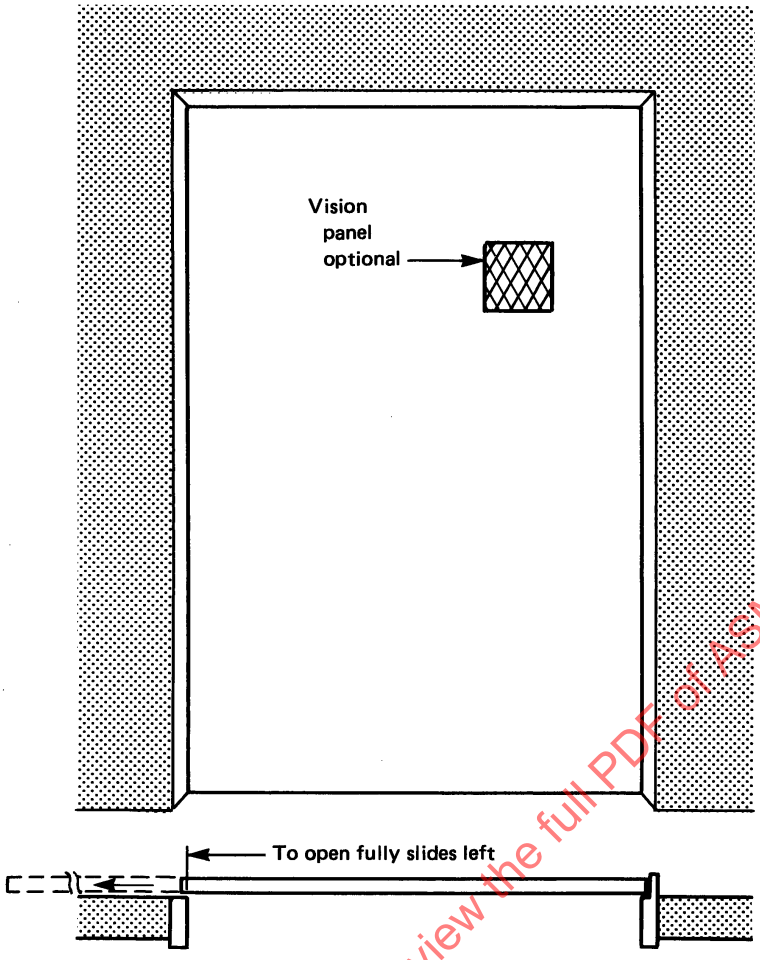
Diagram 2.11
Typical Hoistway Elevation



Typical Hoistway Elevation

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Diagram 2.11.2.1(a)(1)
Single-Slide, Horizontal

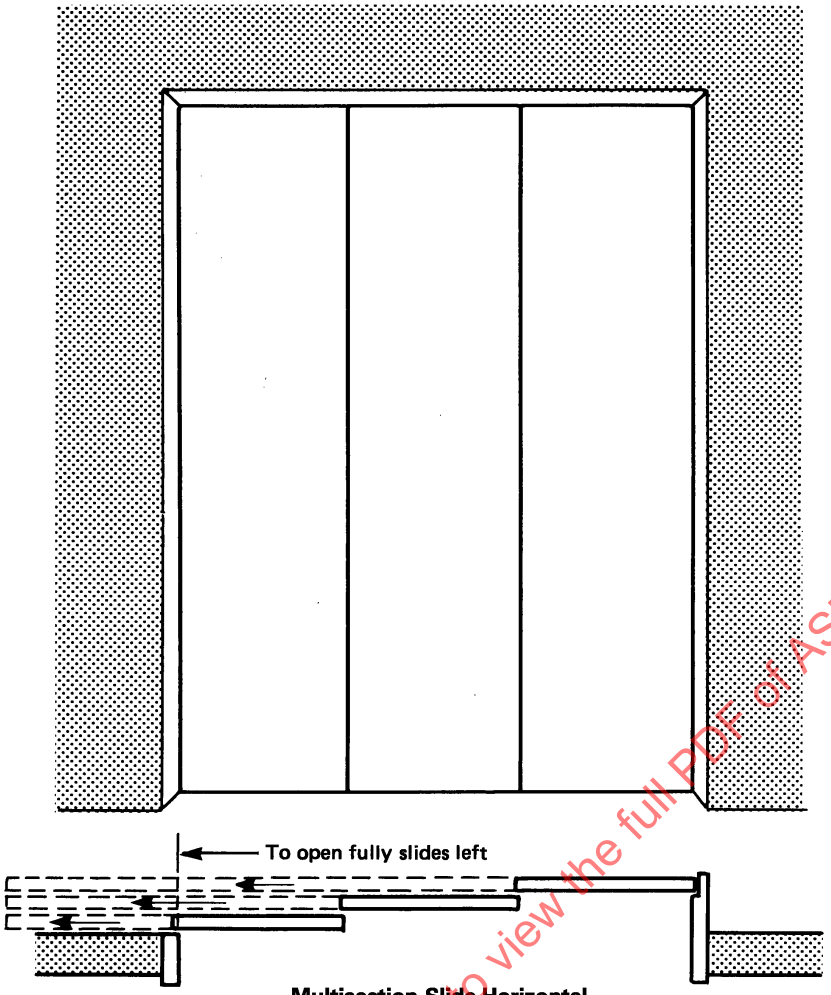


Single-Slide Horizontal
Right-hand slide is shown.
Left-hand slide is available.

GENERAL NOTE: Courtesy of Charles Culp.

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Diagram 2.11.2.1(a)(2)
Multisection-Slide, Horizontal

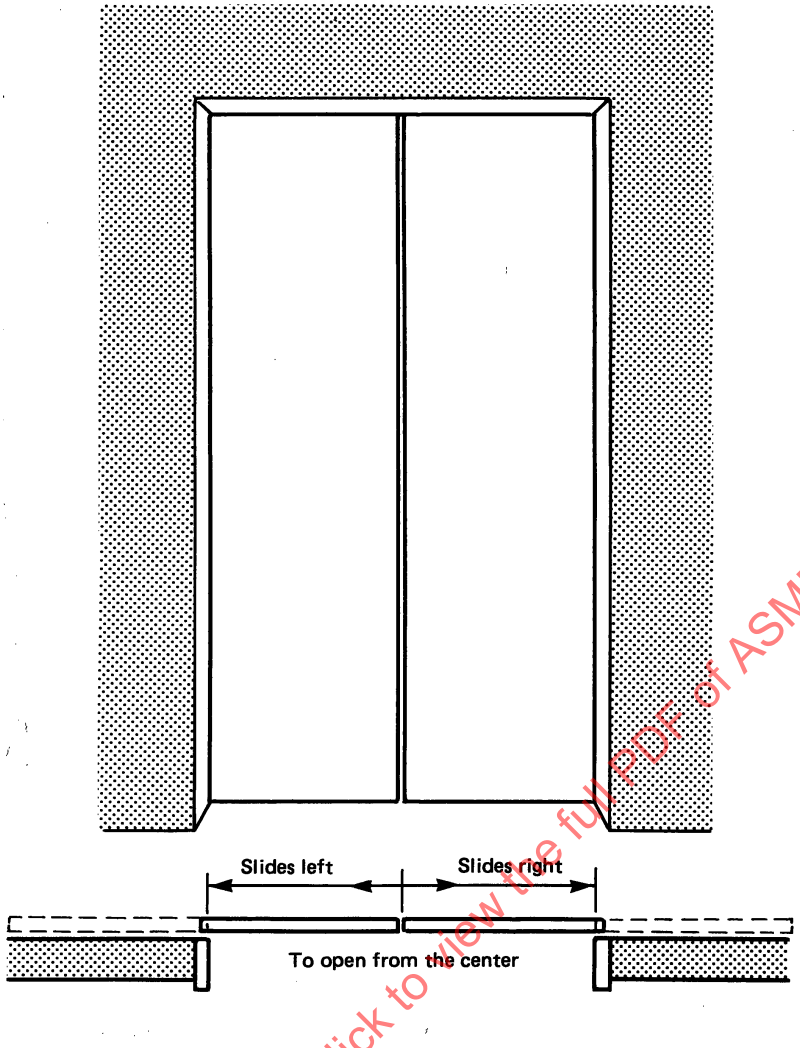


Multisection-Slide Horizontal
Right-hand slide is shown.
Left-hand slide is available.

GENERAL NOTE: Courtesy of Charles Culp.

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Diagram 2.11.2.1(a)(3)
Center-Opening Horizontal Slide Doors, Two Section, Single Speed

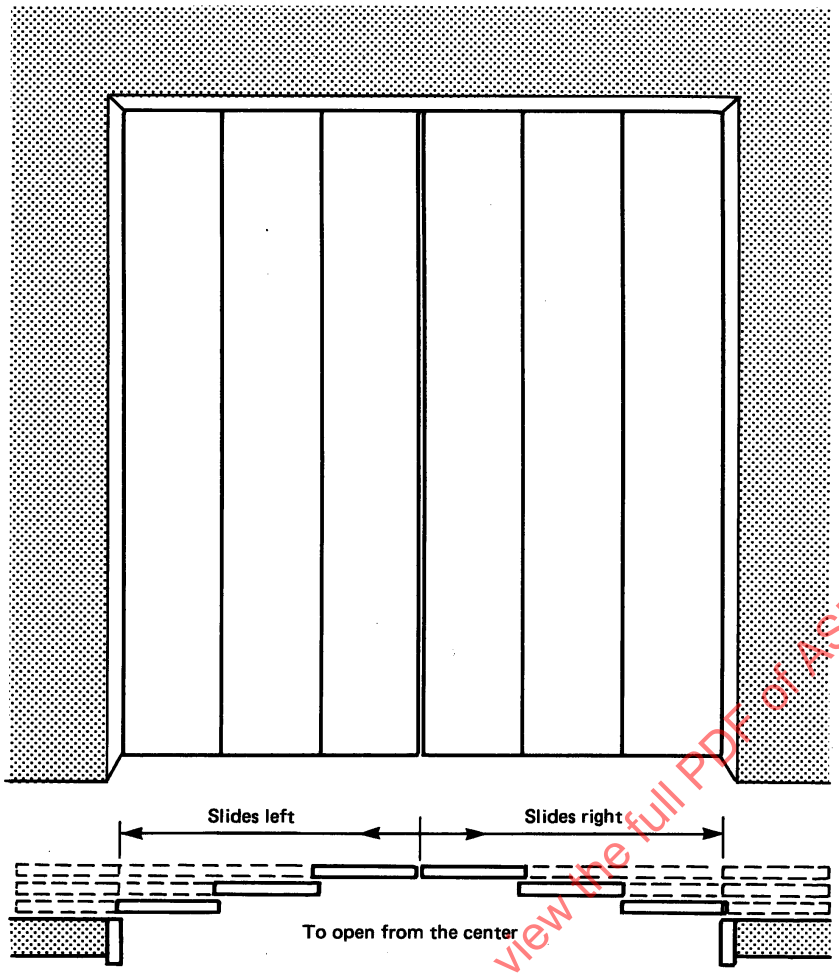


Center-Opening Horizontal Slide Doors, Two Section, Single Speed

GENERAL NOTE: Courtesy of Charles Culp.

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Diagram 2.11.2.1(a)(4)
Center-Opening Horizontal Slide Doors, Multiple Section, Multiple Speed

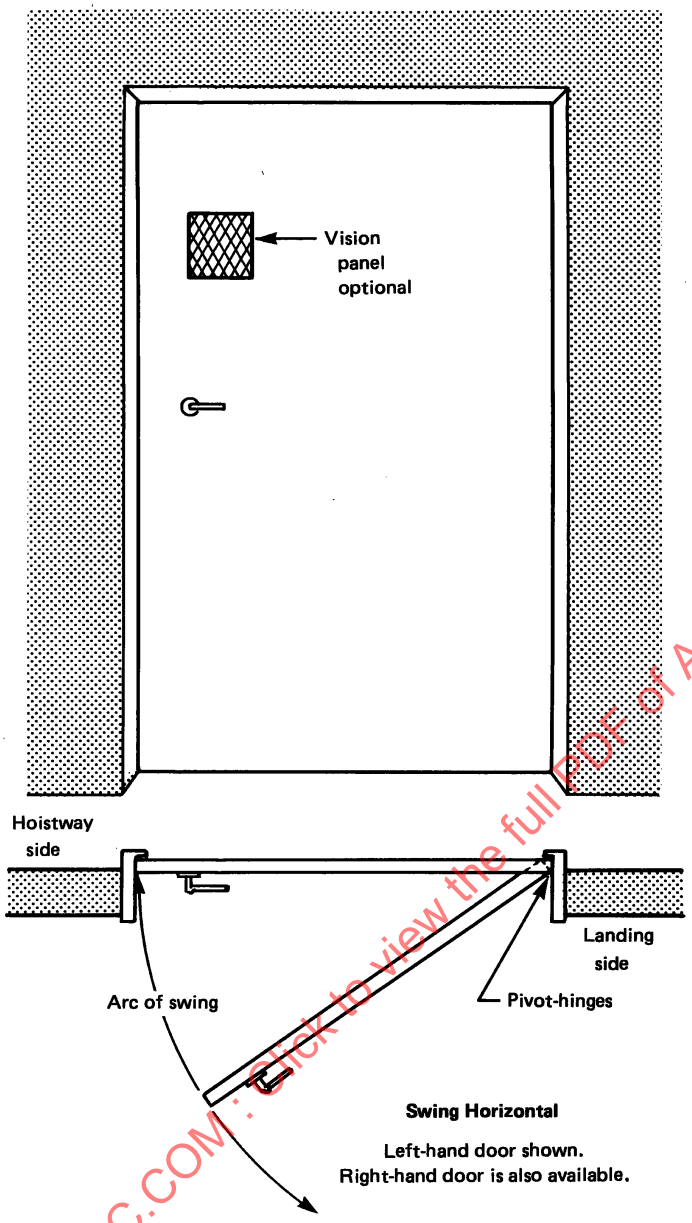


Center-Opening Horizontal Slide Doors, Multiple Section, Multiple Speed

GENERAL NOTE: Courtesy of Charles Culp.

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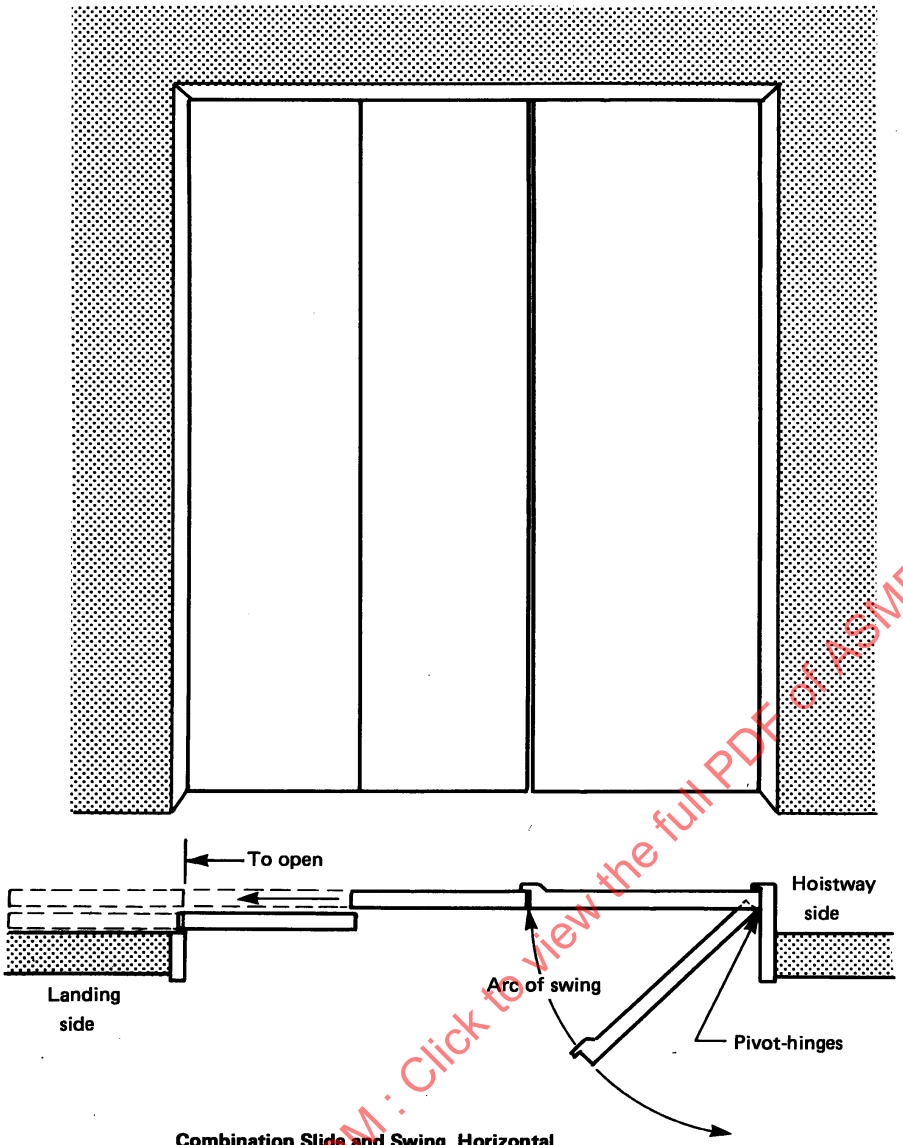
Diagram 2.11.2.1(b)
Swinging, Horizontal



GENERAL NOTE: Courtesy of Charles Culp.

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Diagram 2.11.2.1(c)
Combination Slide and Swing, Horizontal



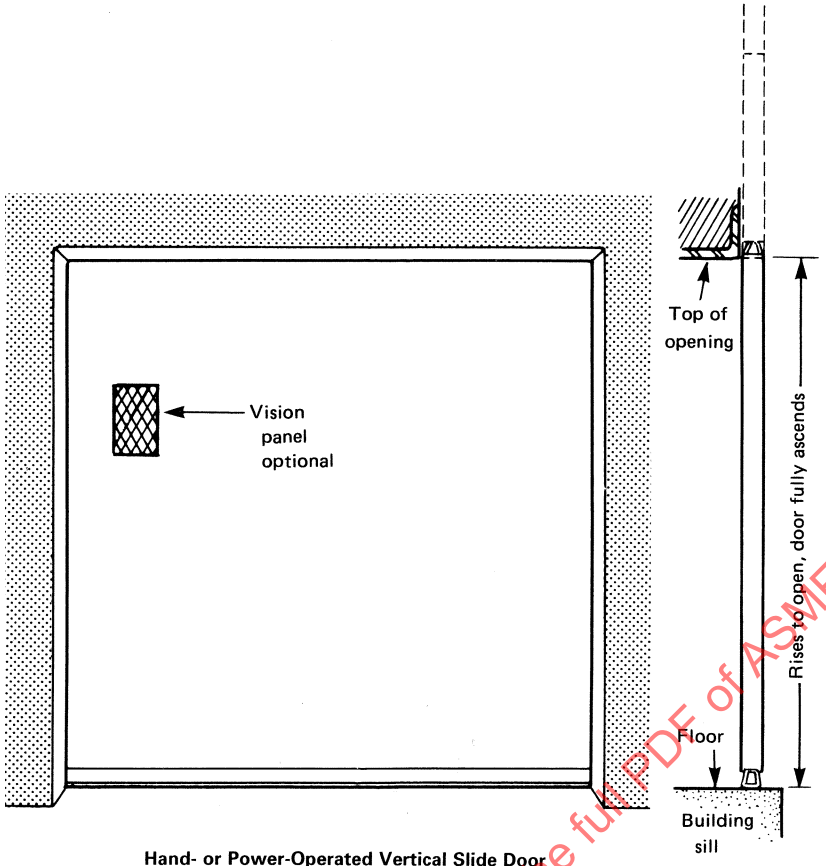
Combination Slide and Swing, Horizontal

The swing door may hang on the right jamb as an option to the above arrangement, and the slide doors move toward the left jamb to fully open.

GENERAL NOTE: Courtesy of Charles Culp.

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Diagram 2.11.2.1(d)
Hand- or Power-Operated Vertical Slide Door

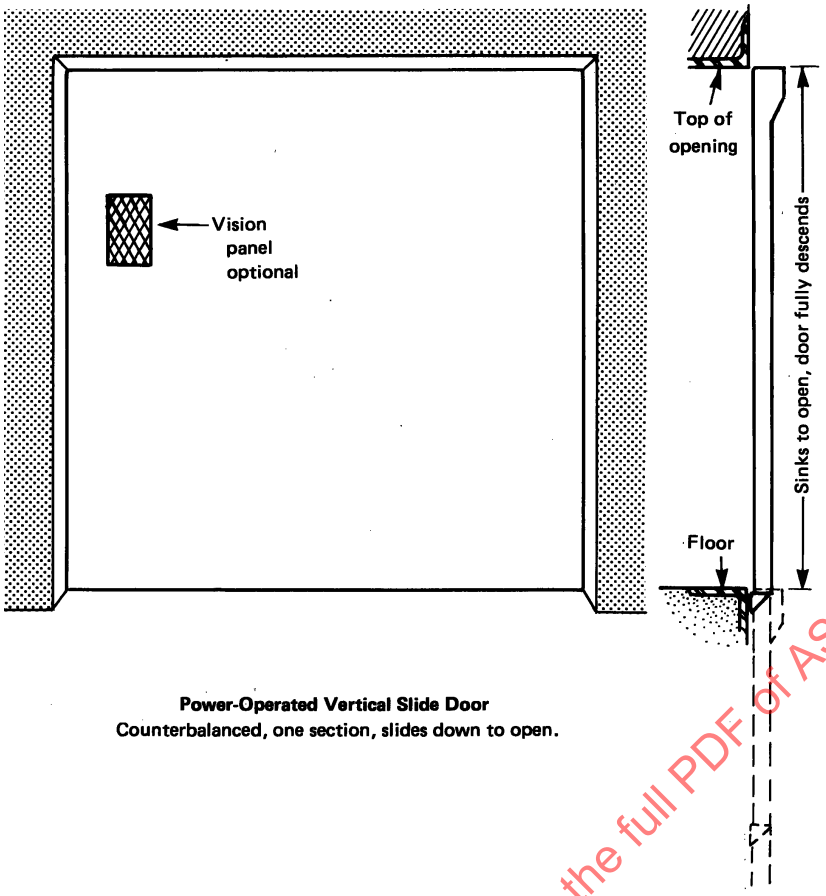


Hand- or Power-Operated Vertical Slide Door
Counterweighted, one section, slides up to open.
Counterweighted, multisection arrangement also available.

GENERAL NOTE: Courtesy of Charles Culp.

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Diagram 2.11.2.2(e)(1)
Power-Operated Vertical Slide Door

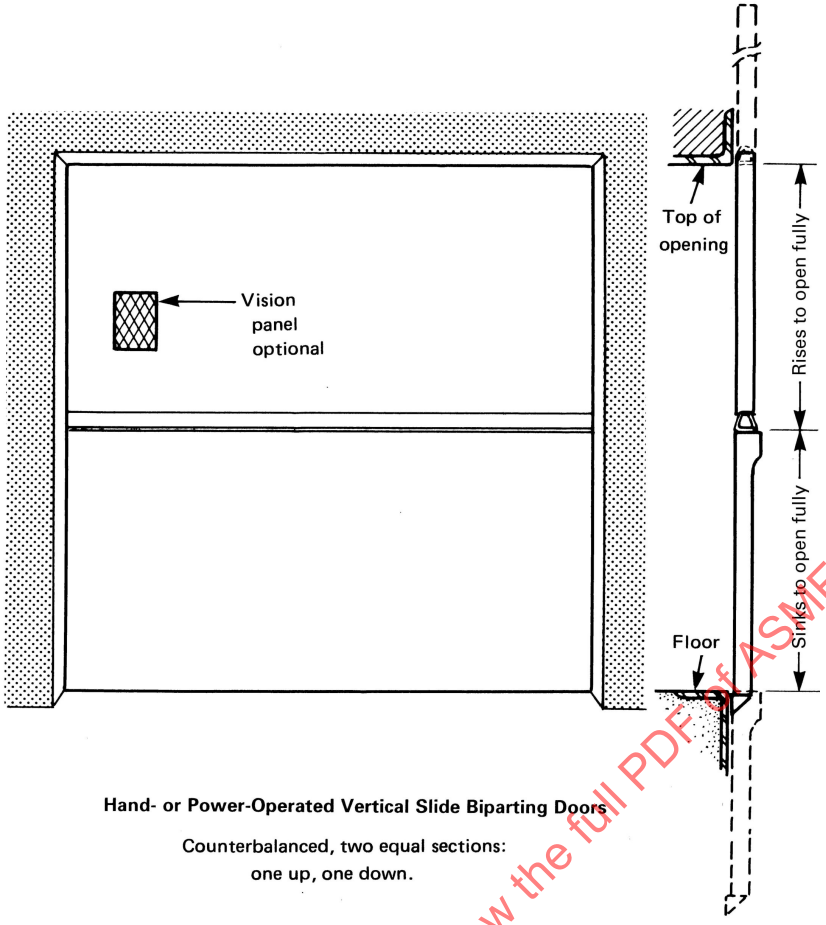


Power-Operated Vertical Slide Door
Counterbalanced, one section, slides down to open.

GENERAL NOTE: Courtesy of Charles Culp.

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Diagram 2.11.2.2(e)(2)
Hand- or Power-Operated Vertical Slide Biparting Doors



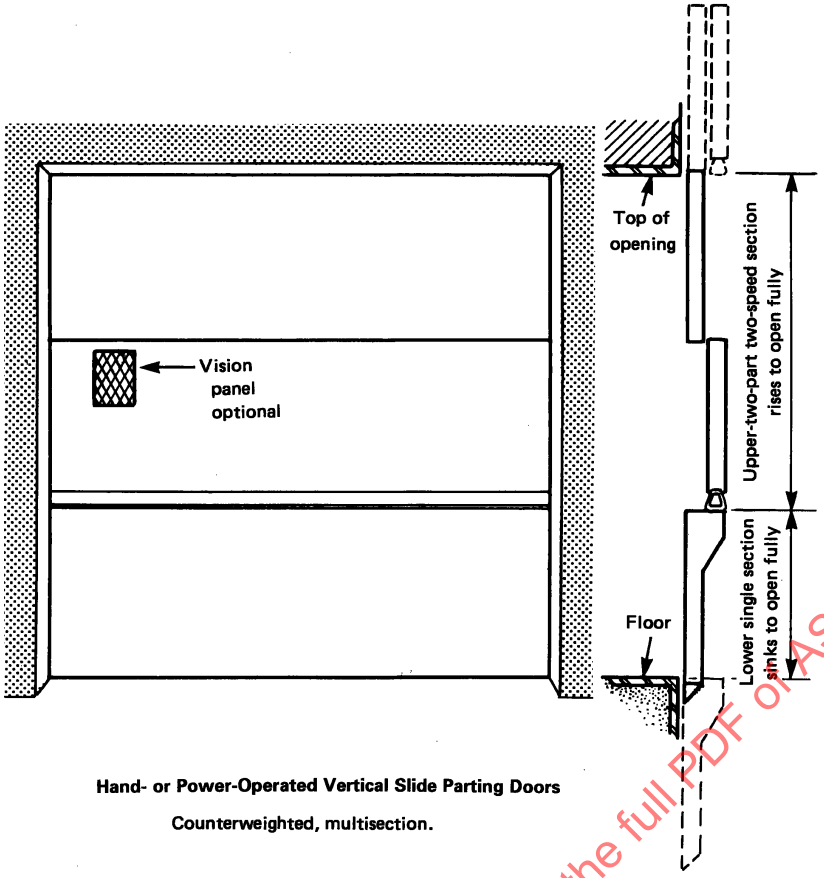
Hand- or Power-Operated Vertical Slide Biparting Doors

Counterbalanced, two equal sections:
one up, one down.

GENERAL NOTE: Courtesy of Charles Culp.

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Diagram 2.11.2.2(f)
Hand- or Power-Operated Vertical Slide Parting Doors



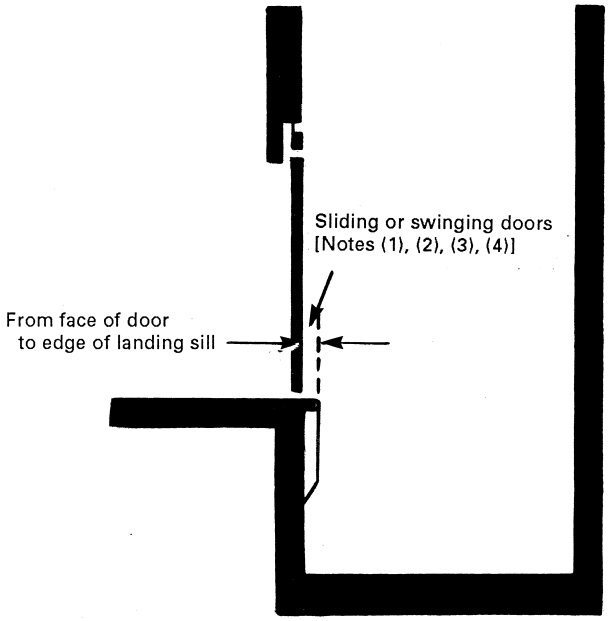
Hand- or Power-Operated Vertical Slide Parting Doors

Counterweighted, multisection.

GENERAL NOTE: Courtesy of Charles Culp.

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Diagram 2.11.4
Door Face to Edge of Landing Sill

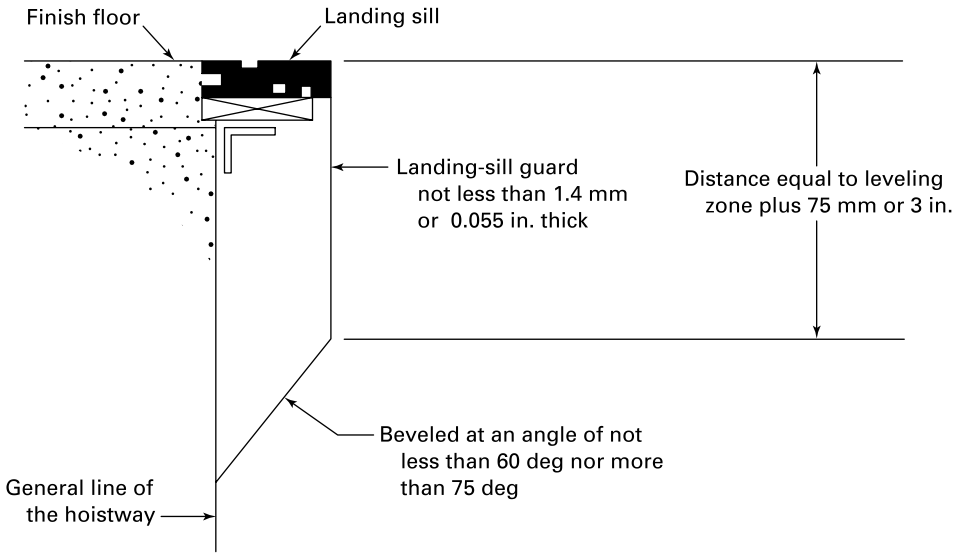


GENERAL NOTES:
(a) Courtesy of Zack McCain, Jr., P.E.
(b) For multispeed doors, the distance is measured from the face of the door section nearest the car.
(c) See Code for exceptions related to new elevators installed in existing multiple hoistways or replacement doors.

NOTES:
(1) 100 mm or 4 in. where the elevator can be operated only from inside the car.
(2) 57 mm or $2\frac{1}{4}$ in. for sliding doors.
(3) 19 mm or $\frac{3}{4}$ in. for swinging doors.
(4) 57 mm or $2\frac{1}{4}$ in. for swinging emergency doors complying with 2.11.4.2(b).

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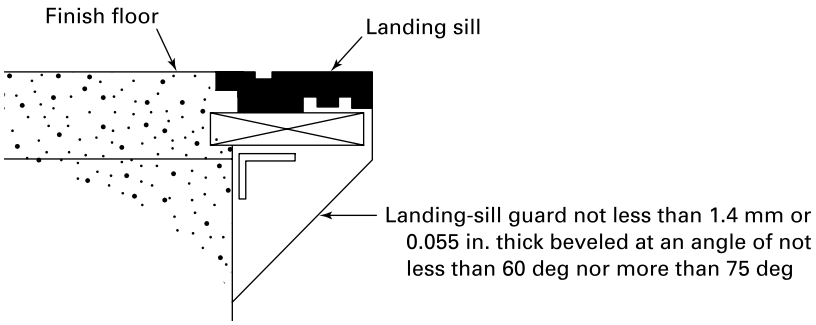
Diagram 2.11.10(a)
Typical Landing-Sill Guard Where a Car-Leveling Device Is Provided



GENERAL NOTE: Beveled bottom edge may be eliminated if landing-sill guard extends to the top of door hanger pocket of the entrance immediately below.

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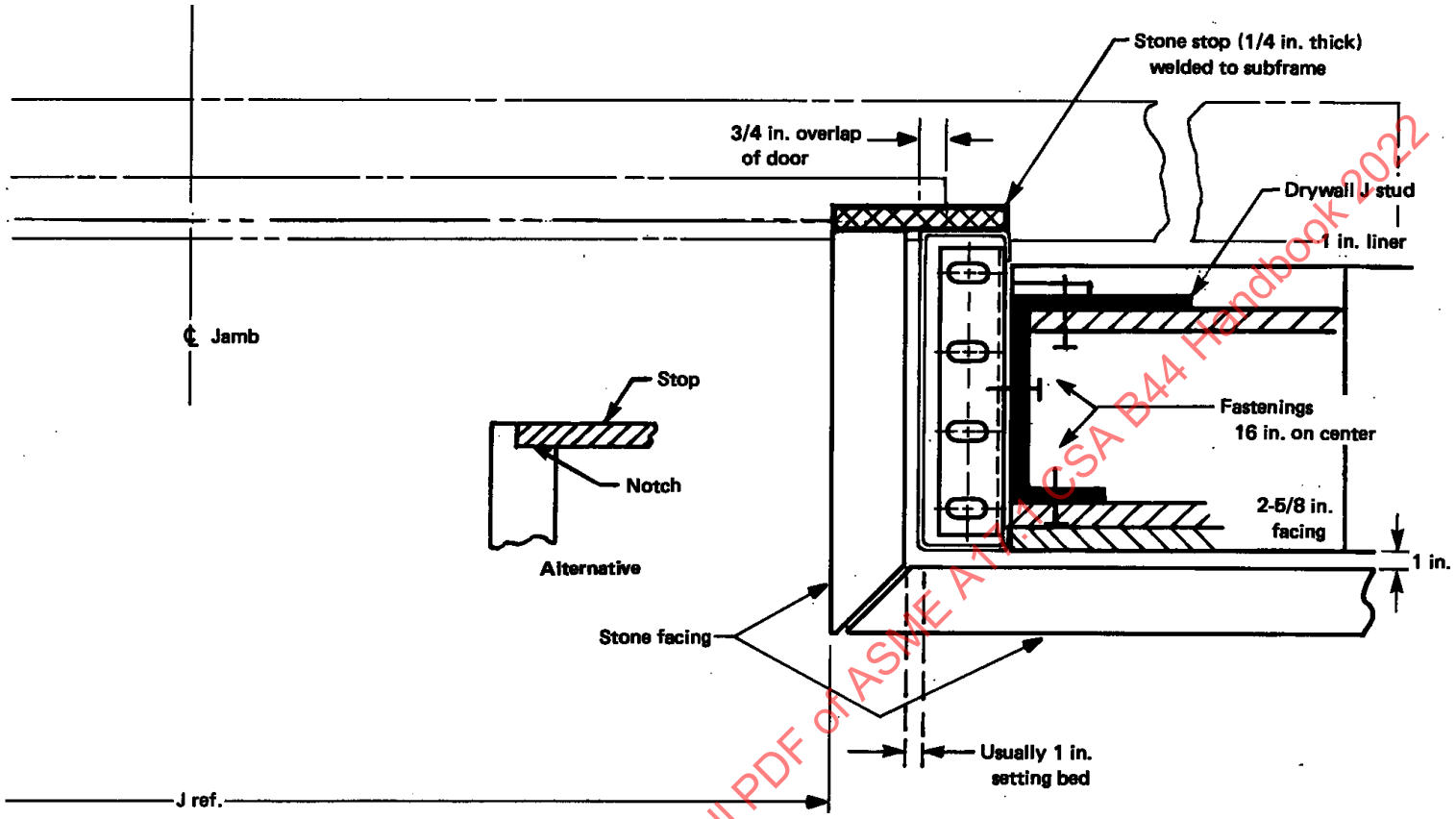
Diagram 2.11.10(b)
Typical Landing-Sill Guard Where No Car-Leveling Device Is Provided



GENERAL NOTE: Beveled edge may be eliminated if landing-sill guard extends to the top of door hanger pocket of the entrance immediately below.

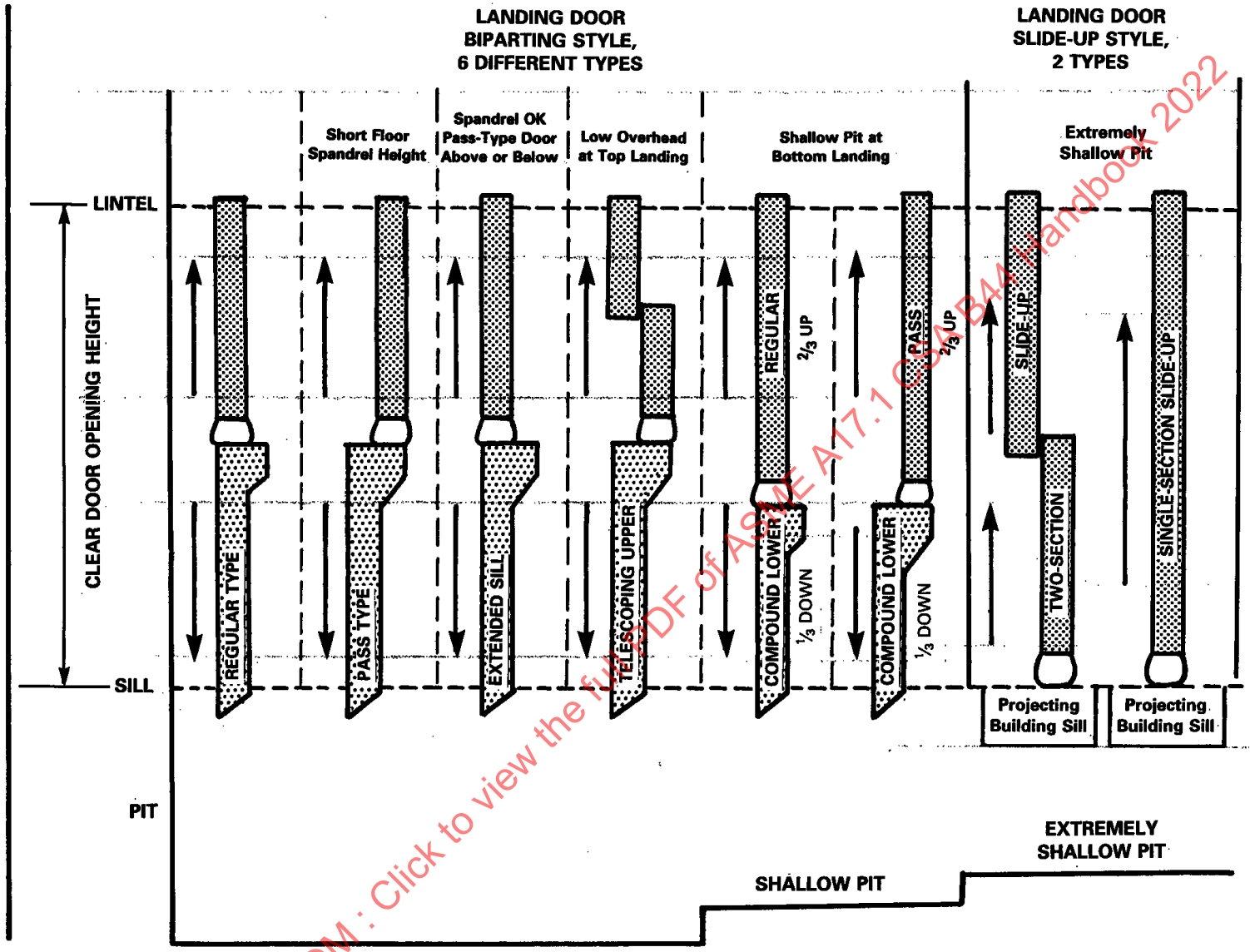
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Diagram 2.11.11.3
Door Frame With Stone Facing



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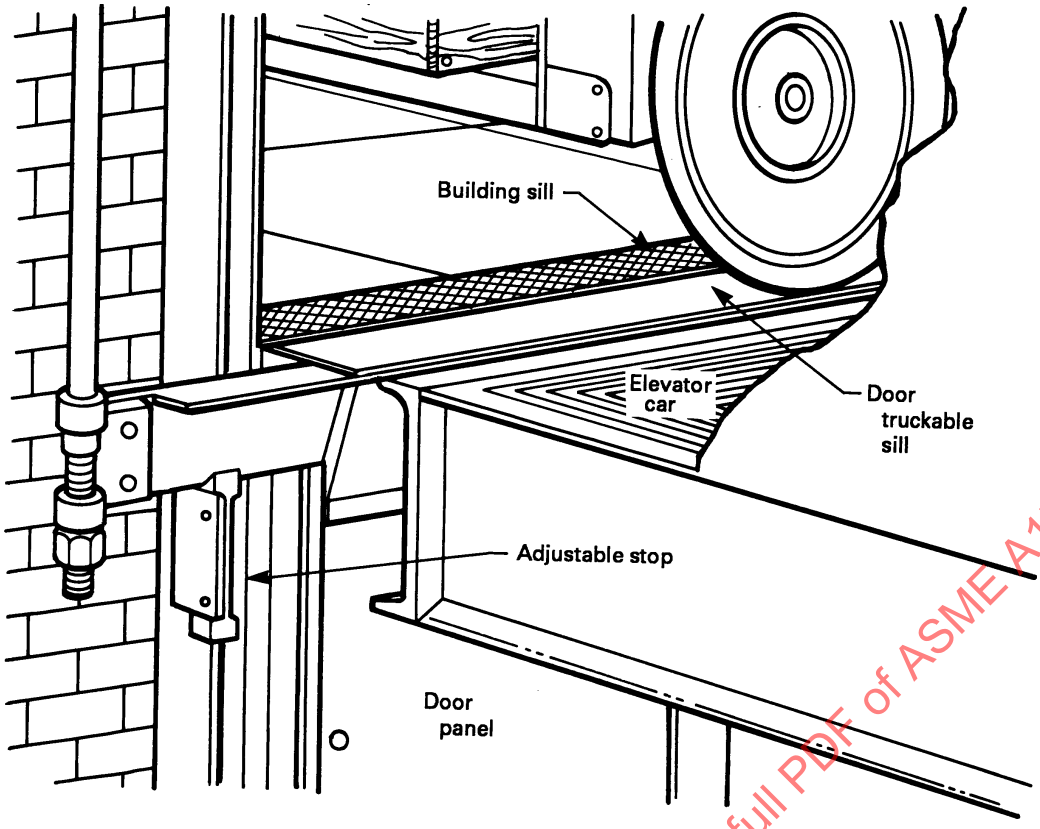
Diagram 2.11.12
Vertical Slide-Type Entrances



GENERAL NOTE: Courtesy of The Peelle Co.

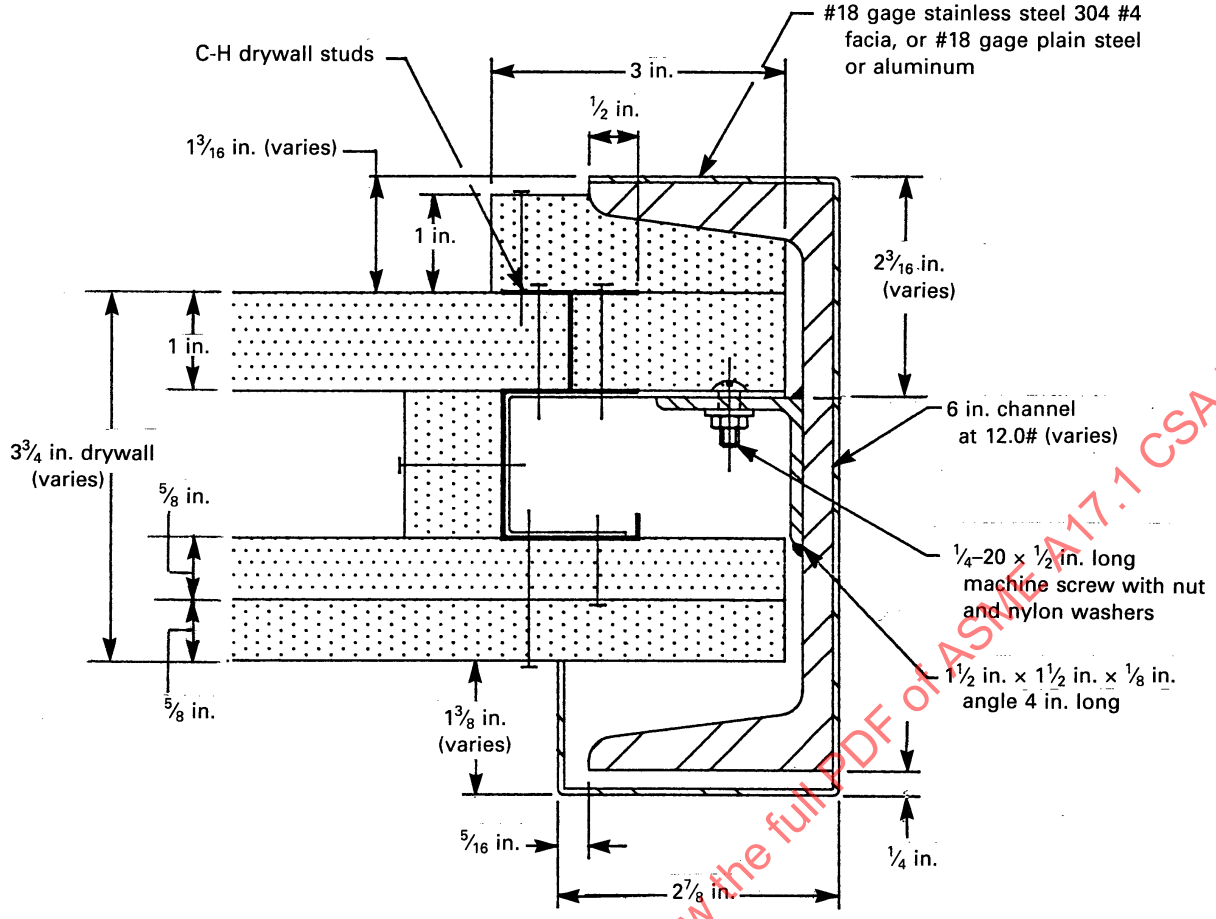
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Diagram 2.11.12.1
Typical Trucking Sill Arrangement



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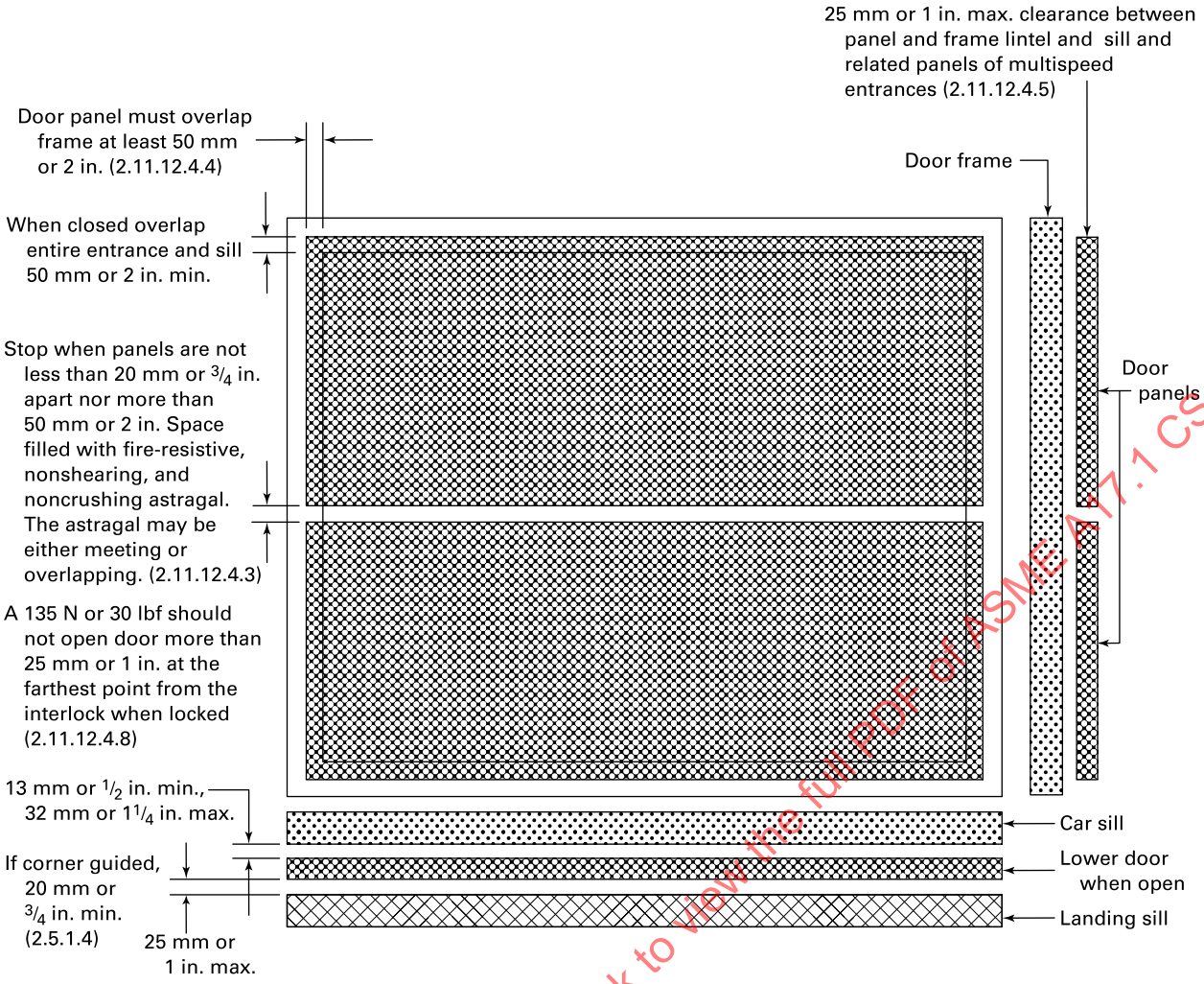
Diagram 2.11.12.2
Vertical Slide-Type Entrance Typical Section Through Frame Showing Connection to Drywall



GENERAL NOTE: Courtesy of The Peelle Co.

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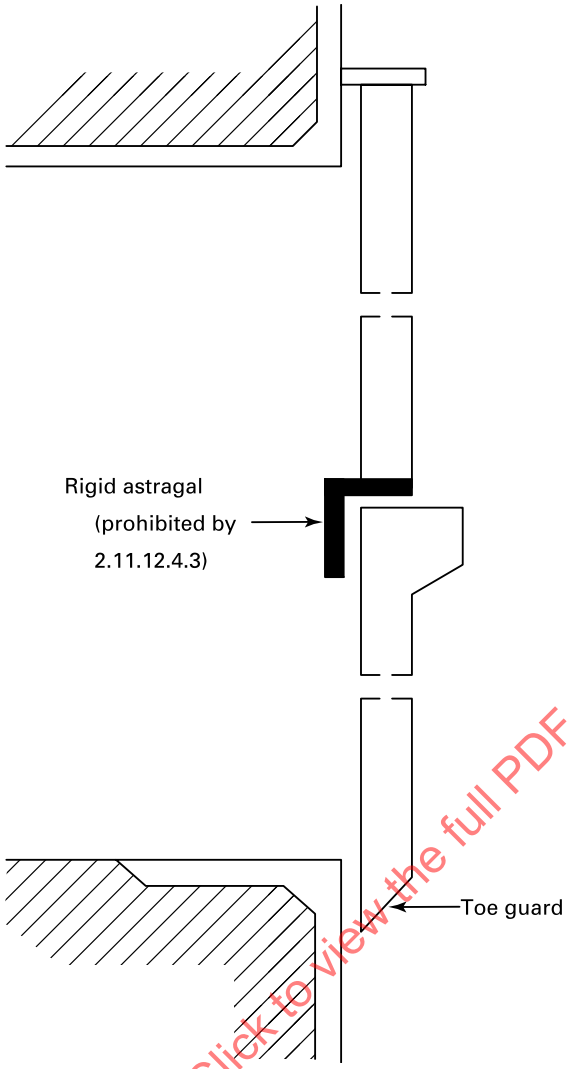
Diagram 2.11.12.4
Vertical Slide-Type Entrance Panels



GENERAL NOTE: Courtesy of Zack McCain, Jr., P.E.

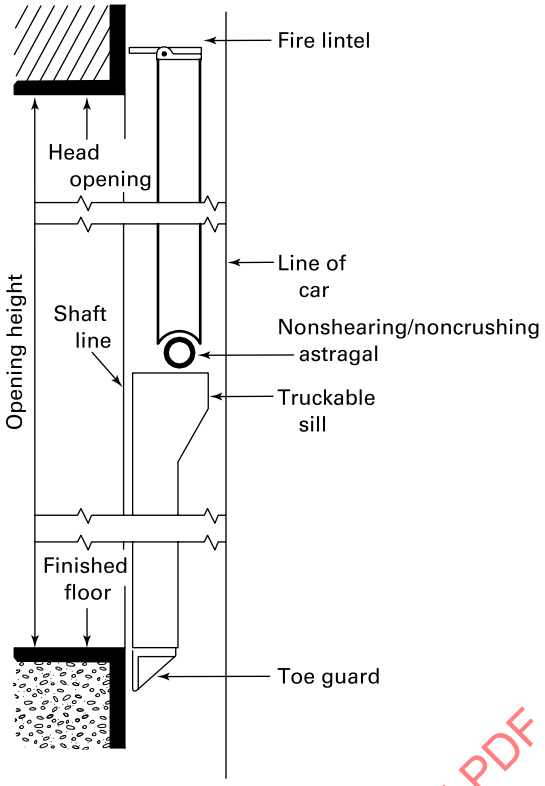
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Diagram 2.11.12.4.3
Vertical Biparting Entrance With Rigid Astragal

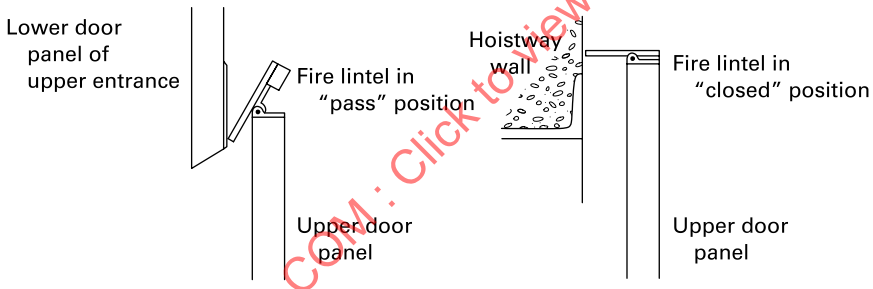


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Diagram 2.11.12.4.7
Typical Pass-Type Entrance



Vertical Section Pass Type Doors

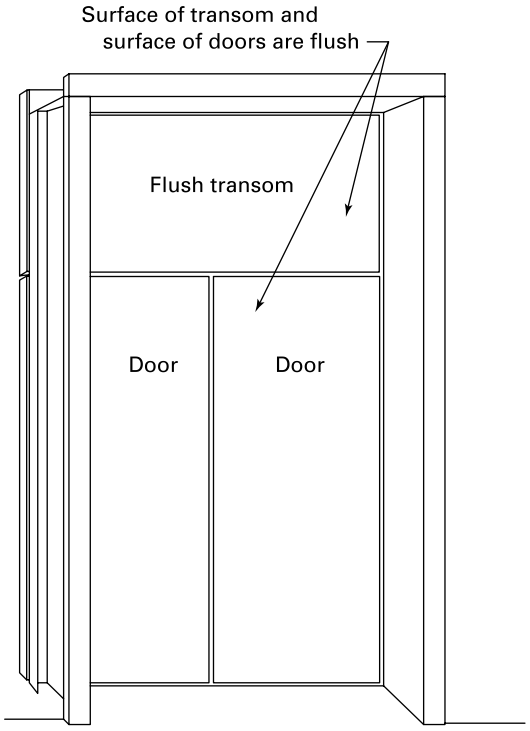


Operation of the Fire Lintel

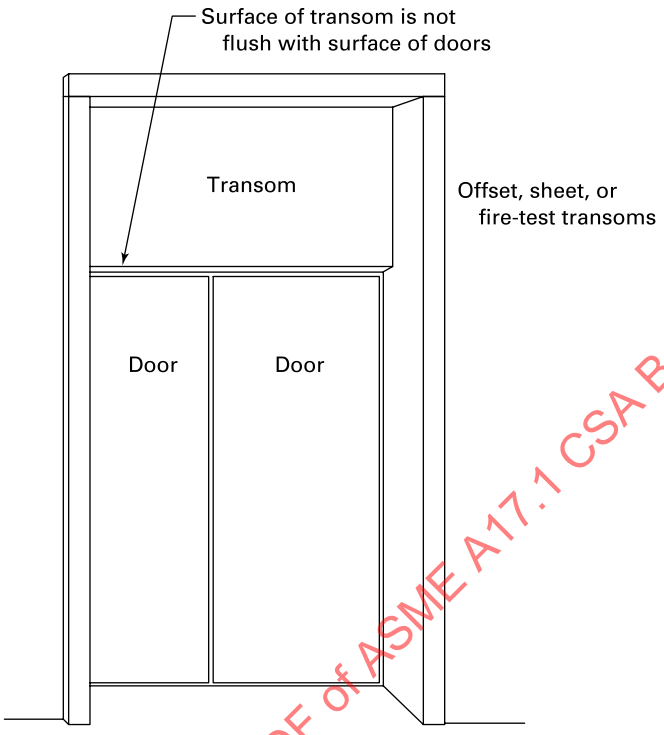
GENERAL NOTES:
(a) Courtesy of National Elevator Industry Educational Program.
(b) The upper half of the pass-type entrance is offset into the hoistway so that when it opens it will pass the lower closed panel of the entrance on the floor immediately above.

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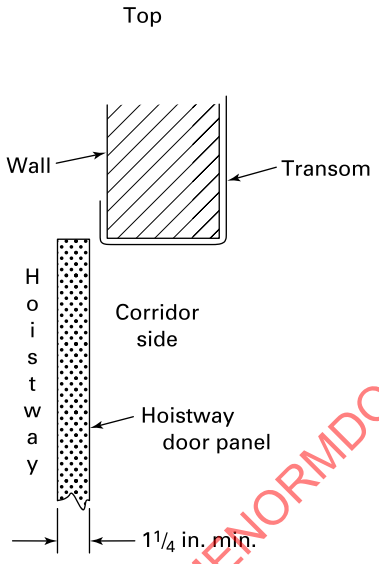
Diagram 2.11.17
Transoms



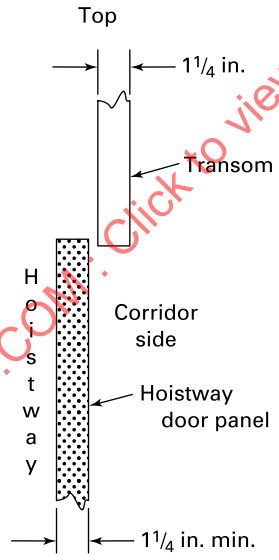
(a) Flush Transom Jambs



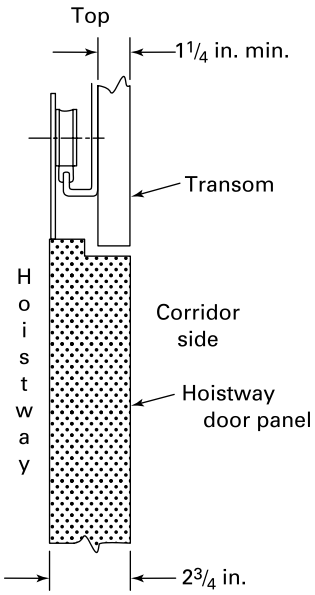
(b) Offset Transom Jambs



(c) Offset Pan Transom



(d) Offset Fire-Test Transom



(e) Flush Transom

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SECTION 2.12
HOISTWAY DOOR LOCKING DEVICES AND CLOSED DETECTION MEANS, AND HOISTWAY ACCESS SWITCHES

The title of Section 2.12 was revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means." Several revisions were also made to Section 2.12 to clearly define a hoistway door interlock as an electrical protective device in 2.26.2 that may have a traditional contact or be an SIL rated device according to 2.26.4. If it is an SIL rated device, it still needs to meet the interlock requirements.

2.12.1 General

In ASME A17.1-2016/CSA B44-16, the dimensional requirements for "unlocking zone" were deleted from the definition in Section 1.3 and moved to 2.12.1; Section 2.12 is the appropriate place in the Code for these dimensions. The unlocking zone for passenger elevators is 75 mm or 3 in. up to but not more than 175 mm or 7 in. above or below the landing. The unlocking zone for freight elevators is 75 mm or 3 in. up to but not more than 450 mm or 18 in. above or below the landing.

Requirement 2.12.1.1 prohibits the condition where there is a locked hoistway door with the car at the landing such as found with a straight arm closer. When this requirement was first introduced in the Code (ASME A17.1-1997 and CSA B44-00), it eliminated the need for parking device requirements on new elevators. As parking devices may still be needed on existing elevators, those requirements can be found in 8.7.2.11.3.

Requirement 2.12.1.5 was revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means."

2.12.2 Interlocks

2.12.2.1 General. The hoistway door interlock is a device having two related and independent functions, which are

(a) to prevent the operation of the driving machine by the normal operating device unless the hoistway door is locked in the closed position.

(b) to prevent the opening of the hoistway door from the landing side, unless the car is within the landing zone and is either stopped or being stopped. See Diagram 2.12.2.1.

2.12.2.2 Closed Position of Hoistway Doors. This requirement defines what is meant by the closed position of the hoistway doors. When the hoistway doors are in the closed position (see Diagram 2.12.2.2), the car may run normally. Operation of the driving machine when the hoistway door is unlocked and not in the closed position is also permitted by a car-leveling or truck-zoning device (2.26.1.6), when a hoistway access switch is operated (2.12.7), or when a bypass switch is operated (2.26.1.5).

2.12.2.3 Operation of the Driving Machine With a Hoistway Door Unlocked or Not in the Closed Position. This requirement allows controlled and restricted movement of the elevator when the hoistway door interlock is in the open position.

2.12.2.4 General Design Requirements

2.12.2.4.1 A new Requirement 2.12.2.4.1 was added in ASME A17.1-2019/CSA B44:19 to clarify the types of devices, including SIL rated devices, that can be used to detect the locked position and to clearly define the closed and locked position as well as the open and unlocked position of the door. The remaining requirements under 2.12.2.4 were editorially renumbered.

2.12.2.4.2 Switches that depend solely on "snap action" to open their contacts do not meet the requirements.

Requirement 2.12.2.4.2, formerly 2.12.2.4.1, was revised in ASME A17.1-2019/CSA B44:19 to clarify that this requirement only applies to traditional contacts.

2.12.2.4.3 Requirement 2.12.2.4.3 was added in ASME A17.1-2019/CSA B44:19 to provide new requirements for interlocks utilizing SIL rated devices for the detection means. The requirements are similar to those used for traditional detection means.

2.12.2.4.5 Requirement 2.12.2.4.5, formerly 2.12.2.4.3, was revised in ASME A17.1-2019/CSA B44:19 to address the application of SIL rated devices to detect the door closed and locked position.

2.12.2.4.6 Requirement 2.12.2.4.6, formerly 2.12.2.4.4, was revised in ASME A17.1-2019/CSA B44:19 to apply the new term "closed detection means" to the requirement and to include referenced rules for SIL rated devices

2.12.2.4.7 This requirement prohibits the use of an interlock system that employs the mechanical locking portion of an interlock at each hoistway door and a single electric contact for a group of hoistway doors, which is actuated by a series of rods and/or cables attached to the mechanical portion of the interlock on each door.

Requirement 2.12.2.4.7, formerly 2.12.2.4.5, was editorially renumbered in ASME A17.1-2019/CSA B44:19.

2.12.2.4.8 Misuse of mercury tube switches can be hazardous. They were permitted by ASME A17.1 prior to the 1987 edition; at that time it was believed that they had not been used for years.

Requirement 2.12.2.4.8, formerly 2.12.2.4.6, was editorially renumbered in ASME A17.1-2019/CSA B44:19.

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2.12.2.5 Interlock Retiring Cam Device. A hoistway door interlock retiring cam device is a device that consists of a retractable cam with its actuating mechanism and is entirely independent of the car door or hoistway door power operator. See Diagram 2.12.2.5.

2.12.3 Hoistway Door Combination Mechanical Locks and Closed Detection Means

The title of Section 2.12.3 was revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means."

2.12.3.1 Where Permitted. Hoistway door combination mechanical locks and closed detection means are permitted on manually opened, vertically sliding counterweighted doors or vertically sliding biparting counterbalanced doors on freight elevators only under the following conditions: if the pit depth is 1 525 mm or 60 in. or less, the lower door may have a mechanical lock and electrical contact. The upper hoistway door must be equipped with hoistway unit system hoistway door interlocks described in 2.12.2. However, if the elevator has a rise of 4 570 mm or 15 ft or less, the top landing door and any door whose sill is located not more than 1 225 mm or 48 in. below the sill of the top landing door may be equipped with combination mechanical locks and electrical contacts. See Diagrams 2.12.3.1(a) and 2.12.3.1(b).

A hoistway combination mechanical lock and closed detection means is a mechanical and electrical device with two related but entirely independent functions, which are

(a) to prevent operation of the driving machine by the normal operating device unless the hoistway door is in the closed position.

(b) to lock the hoistway door in the closed position and to prevent it from being opened from the landing side unless the car is within the landing zone. See Diagram 2.12.3.1(a).

As there is no positive mechanical connection between the electric contact and the door locking mechanism, this device only indicates that the door is closed but not necessarily locked when the car leaves the landing. Should the lock mechanism fail to operate as intended, when released by a stationary or retiring cam device, the door can be opened from the landing side even though the car is not at the landing. If operated by a stationary cam device, it does not prevent opening the door from the landing side as the car passes the floor.

Requirement 2.12.3.1 was revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means."

2.12.3.2 Closed Position of Hoistway Doors. See Handbook commentary on 2.12.2.2 and Diagram 2.12.2.2.

2.12.3.3 Operation of the Driving Machine With a Hoistway Door Not in the Closed Position. This requirement allows controlled and restricted movement of an elevator when the hoistway combination mechanical lock and electrical contact is in the open position.

2.12.3.4 General Design Requirements. Requirement 2.12.3.4, including sub-requirements 2.12.3.4.1 and 2.12.3.4.2, was revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means" and to editorially correct the referenced rules.

2.12.3.4.4 Requirement 2.12.3.4.4 was revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means" and update the requirement based on SIL rated devices.

2.12.3.4.5 See Handbook commentary on 2.12.2.4.6.

2.12.3.5 Location. Requirement 2.12.3.5 was revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means."

2.12.4 Listing/Certification Door Locking Devices and Door or Gate Closed Detection Means

The title of Section 2.12.4 was revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means."

2.12.4.1 Type Tests. Type tests consist of an endurance test, current interruption test, test in moist atmospheres, test without lubricant, misalignment test, insulation test, and force and movement tests. See 8.3.3 for the test requirements for devices tested August 1, 1996, and later. Devices tested prior to August 1, 1996, are required to be tested to the requirements in ASME A17.1a-1994, Section 1101 in jurisdictions enforcing ASME A17.1. In jurisdictions enforcing NBCC, devices tested prior to March 23, 2002, are required to be tested to CSA B44 Supplement 1-97, Clause 11.4. The previous reference to CSA B44 Supplement 1-97, Clause 11.5 was corrected to Clause 11.4 in ASME A17.1-2013/CSA B44-13. Devices tested to these requirements have a strong safety record; thus, the ASME A17 and CSA B44 Committees concluded there was no justifiable reason to require retesting. With computer-aided design, new products can be built that passed the former requirements but would not perform adequately in the field. The current 8.3.3 addresses that concern. The label required by 2.12.4.3 requires a test date identifying the appropriate test.

Requirement 2.12.4.1 was revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means" and to include car door interlocks in the list of devices that require type tests.

2.12.4.2 Listing/Certification. Requirement 2.12.4.2 was revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means" and to include car door

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interlocks in the list of devices that require listing/certification.

2.12.4.3 Identification Marking. At the time of installation, it should be verified that the hoistway door interlock, hoistway combination mechanical lock and closed detection means, and door or gate closed detection means have not only been tested as specified in 2.12.4.1 but have also been installed in accordance with all the requirements found in Section 2.12.

A testing laboratory can make a determination that an interlock is the same basic type as previously tested, based upon their technical evaluation, and testing might not necessarily be required for a modified interlock.

Approved devices must be labeled. The label will identify the manufacturer, certifying agency, and date of test. The test date on the label will assist in identifying which test requirements are applicable. If the device has been tested for use only on a private residence elevator, the label will indicate the restricted use. See also Handbook commentary on 8.6.3.7, replacement of listed devices and or their component parts.

Requirement 2.12.4.3 was revised in ASME A17.1-2019/CSA B44:19 to direct the reader to additional marking requirements when SIL rated devices are used.

2.12.6 Hoistway Door Unlocking Devices

2.12.6.1 General. A hoistway door unlocking device is a device that permits the unlocking and opening of the hoistway door from an access landing, irrespective of the position of the car. The operating means for the hoistway door unlocking devices shall be Group 1 security and made available only to elevator personnel and emergency personnel. See Handbook commentary on Section 8.1. Hoistway door unlocking devices are required on all floors for emergency access. These requirements vary in numerous jurisdictions and it would be advisable to check the local requirements. Unlocking devices are necessary for the evacuation of passengers from stalled cars and allow emergency personnel access to the hoistway without unnecessary damage to hoistway entrances.

There are some inherent dangers associated with use of a hoistway door unlocking device; therefore, these dangers must be taken into account when access to an open hoistway is required. The *Elevator Industry Field Employees' Safety Handbook* procedures should be followed when hoistway door unlocking devices are used.

Some jurisdictions prohibit hoistway door unlocking devices or restrict their application to a limited number of entrances and/or to specific floors.

2.12.6.2 Location and Design. The device is to be designed to prevent unlocking the door with common tools (2.12.6.2.1). A screwdriver is a common tool and cannot be considered an acceptable means for opening hoistway doors. A lunar- or T-shaped key was often used since it is not easily duplicated. When used, the escutcheon plate, if provided, should be of hardened steel to prevent the tab from being distorted. If the tab is distorted, the escutcheon plate should be replaced.

Earlier editions of the Code required the operating means for unlocking the device to be kept in a break-glass covered box, which would be accessible to the general public. This requirement was removed from the Code as it was found that vandals were misusing the key. The key should be in a location readily accessible to elevator and emergency personnel but not where it is accessible to the general public.

The keyway or locked panel (see 2.12.6.2.3) is required to be at a height of 2 100 mm or 83 in. or less so that the inspector or mechanic can conveniently reach it while standing on the lobby floor (2.12.6.2.5). Keyways at greater heights might require the use of a stepladder, which could be dangerous if an individual were to lose balance after the doors had opened.

2.12.7 Hoistway Access Switches

The hoistway access switch is defined as "a switch, located at a landing, the function of which is to permit operation of the car with the hoistway door at this landing and the car door or gate open, in order to permit elevator personnel access to the top of the car or to the pit."

Hoistway switches are required for all cars with speeds greater than 0.75 m/s or 150 ft/min at the lowest landing for access to the pit when a separate pit access door is not provided and at the top landing for top-of-car access. When car speeds are 0.75 m/s or 150 ft/min or less, hoistway access switches are required only at the top landings where the distance from the top-of-car to the access landing sill is greater than 900 mm or 35 in., with the car level at the landing below.

It was generally agreed that hoistway access switch operation provided the best control for safely gaining access to the car top for top-of-car inspection operation. See Diagram 2.12.7. Procedures in the *Elevator Industry Field Employees' Safety Handbook* should be followed when accessing the hoistway.

2.12.7.1 General. The requirement specifies where hoistway access switches, provided in addition to required access switches, must be located, and establishes when additional access switches are permitted. By ensuring required switches remain in a consistent location, elevator personnel unfamiliar with a job site can safely access the pit or top of the car.

2.12.7.1.2 It is extremely difficult to position a car to allow safe access to the top-of-car when an access switch is not provided.

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2.12.7.2 Location and Design. It is not the intent of this requirement to prohibit the use of a single key for the hoistway access switch and for other key switches in the car that perform functions as required by 2.12.7.3.3. Requirement 2.12.7.2.3 requires the key to be Group 1 security and therefore prohibits a lock that can be operated by a key that is intended for other building uses. See also Handbook commentary on Section 8.1.

Requirement 2.12.7.2 was revised in ASME A17.1-2016/CSA B44-16 to specify that the hoistway access switch be located where it is readily visible to and safely accessible by elevator personnel when the door is open. The new requirements limit locations for hoistway access switches and therefore make it safer for elevator personnel to access and egress the hoistway. The changes ensure that in installations where a hoistway access switch is located on the sight guard, the support for the switch will be adequate, and the car cannot move if a ground or short circuit occurs in the flexible wiring.

Requirement 2.12.7.2.1 was revised in ASME A17.1-2019/CSA B44:19 to reinstate requirements from the 2013 edition that were inadvertently omitted in the 2016 edition.

2.12.7.3 Hoistway Access Operation. These requirements ensure that elevator personnel operating the hoistway access switch have complete control over the car. However, it still ensures that the hoistway door interlocks or electric contacts and mechanical locks at other landings are still operational.

The hoistway access switch located at a landing with multiple entrances is permitted to operate only in conjunction with the hoistway door located adjacent to the access switch, and only with the car door or gate associated with this hoistway door.

This requirement was revised in ASME A17.1-2013/CSA B44-13. The control and operation circuit requirements and the appropriate marking of the associated switches and their function have been clearly specified, and it is clarified that it is automatic power operation of doors that is disabled while on hoistway access operation. Additionally, it is now made clear as to when the elevator is on hoistway access operation.

The operation of the access switch permits movement of the car within the zones specified in 2.12.7.3.3(c) or 2.12.7.3.3(d). Prior to the revisions to this requirement in ASME A17.1b-2009/CSA B44b-09, movement of the car with door closed using the access switch was not prohibited or addressed.

2.12.7.3.2 This requirement was revised in ASME A17.1-2013/CSA B44-13 to clarify that the independence is limited to the speed-limiting means as compared to the normal speed control. The provisions and requirements in 2.12.7.3.2(a) and 2.12.7.3.2(b) reflect acceptable industry practices with appropriate monitoring.

2.12.7.3.3

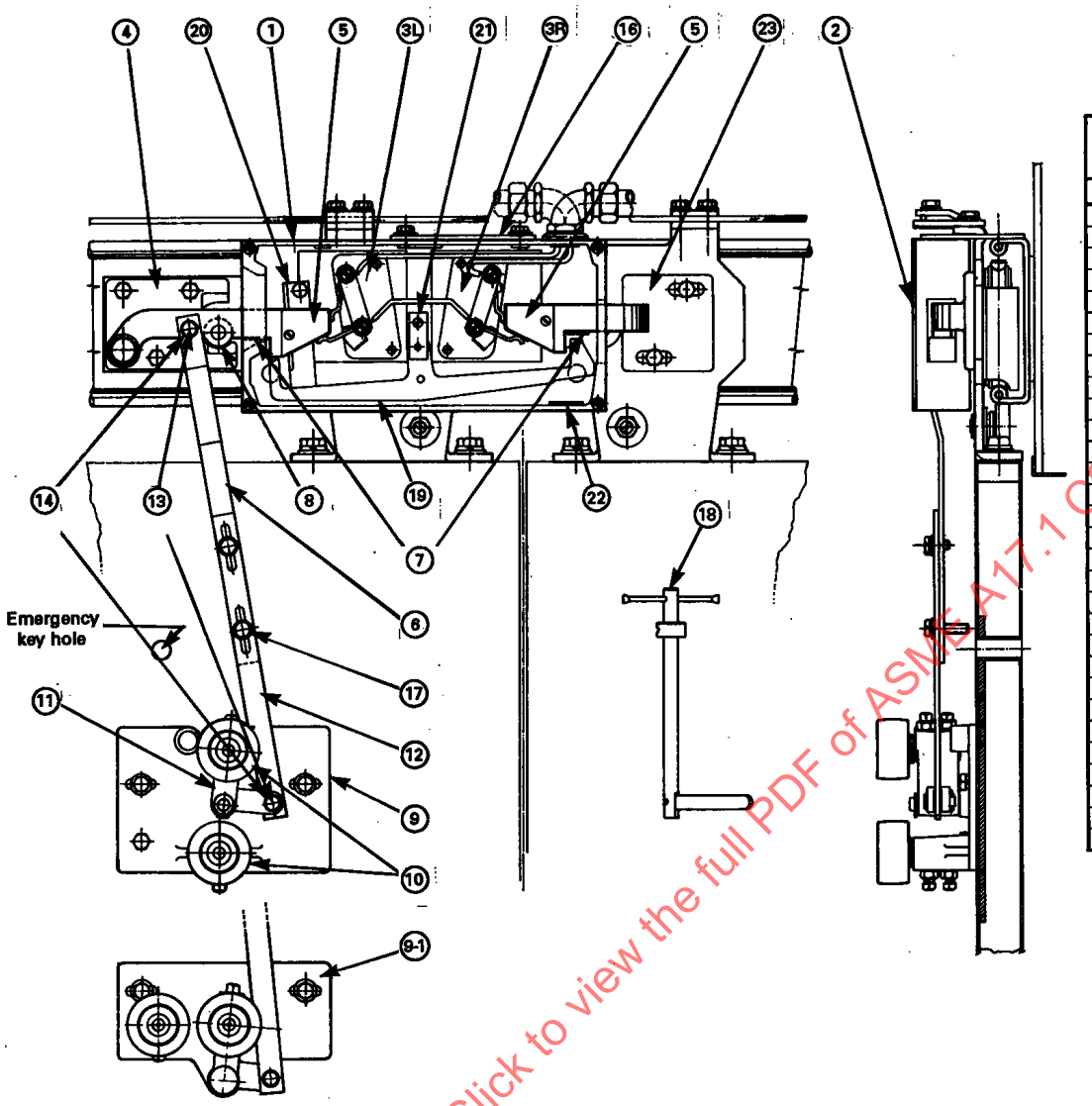
2.12.7.3.3(c) This requirement was revised in ASME A17.1-2016/CSA B44-16 to clarify that the hoistway access switch must be able to raise the car high enough for elevator personnel to safely access and egress the pit unless the car is incapable of traveling to such an elevation (e.g., as would be the case in a very short hoistway). A 300-mm or 12-in. window was included to provide a tolerance. See also Diagram 2.12.7.3.3(c).

2.12.7.3.3(d) See Diagram 2.12.7.3.3(d).

2.12.7.3.4 The requirement was added in ASME A17.1-2013/CSA B44-13 to permit a controlled method for stopping the elevator level with the floor at the conclusion of hoistway access operation.

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Diagram 2.12.2.1
Typical Hoistway Door Interlock

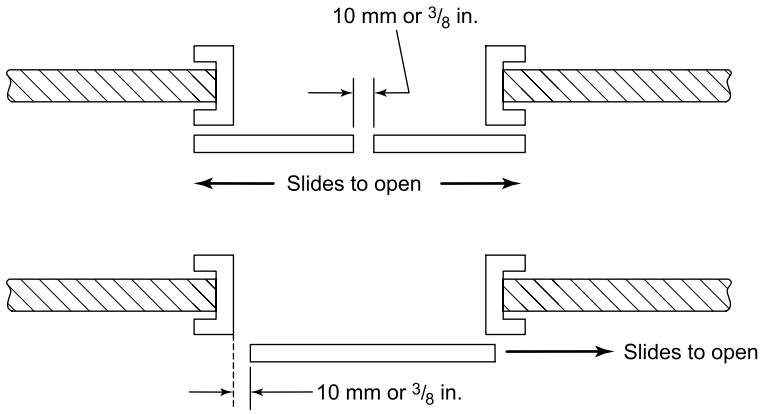


G. A. L. TYPE MOCP INTERLOCK (PARTS LIST)	
ITEM NO.	DESCRIPTION
1	MOCP SWITCH (INCLUDES ITEM 2,3L,3R,19,20,21,&22)
2	COVER & SCREWS WITH INSULATOR
3L	MO CONTACT BASE & INSULATOR (L. HAND)
3R	MO CONTACT BASE & INSULATOR (R. HAND)
4	MO KEEPER (INCLUDES ITEM 5 TO 8)
5	MO KEEPER BRIDGING BLOCK
6	MO UPPER LINK (INCLUDES ITEM 13 AND 14)
7	KEEPER STEM BUMPER
8	KEEPER BUMPER
9	MOM RELEASE (INCLUDES ITEM 10 TO 12)
10	MOM ROLLER & SHAFT (2 REQ'D)
11	MOM RELEASE ROCKER
12	MOM LOWER LINK (INCLUDES ITEM 13 AND 14)
13	MOM LINK SNAP PIN
14	MOM LINK NYLINER BUSHING (6 4L-2FF)
15	MOCPKT CONTACT KIT (INCLUDES 3L or 3R & 5)
16	MO LOCK MOUNTING PLATE
17	EMERGENCY RELEASE BOLT
18	KMO KEY
19	MOCP ROCKER ARM ASS'Y
20	MOCP ROCKER ARM LIFT UP CAM
21	MOCP ROCKER ARM SUPPORT PLATE
22	SELF-ADHESIVE CORK PAD
23	MOCP STATIONARY KEEPER ASS'Y
9-1	MOH RELEASE (INCLUDES ITEM 10 TO 12)

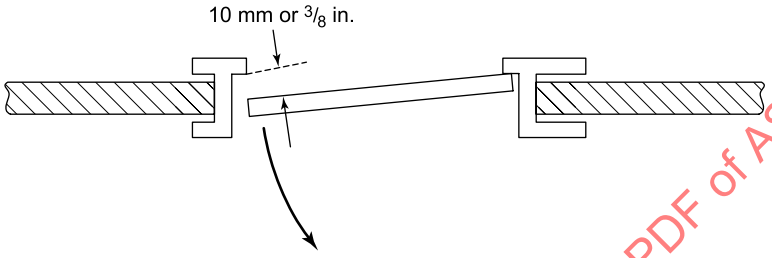
GENERAL NOTE: Courtesy of G.A.L. Manufacturing Corp.

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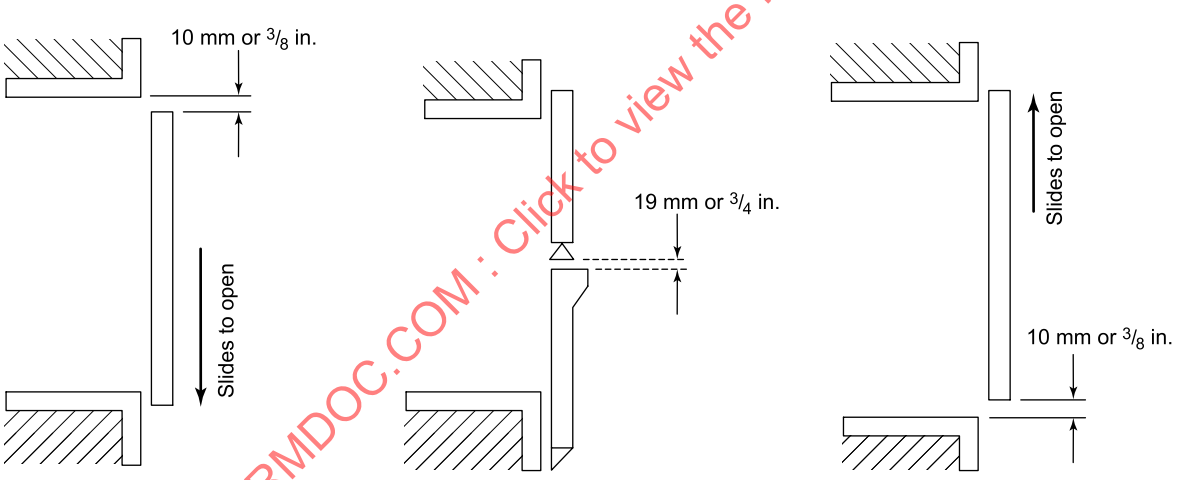
Diagram 2.12.2.2
Closed Position of Hoistway Doors



(a) Closed Position Horizontally Sliding Doors



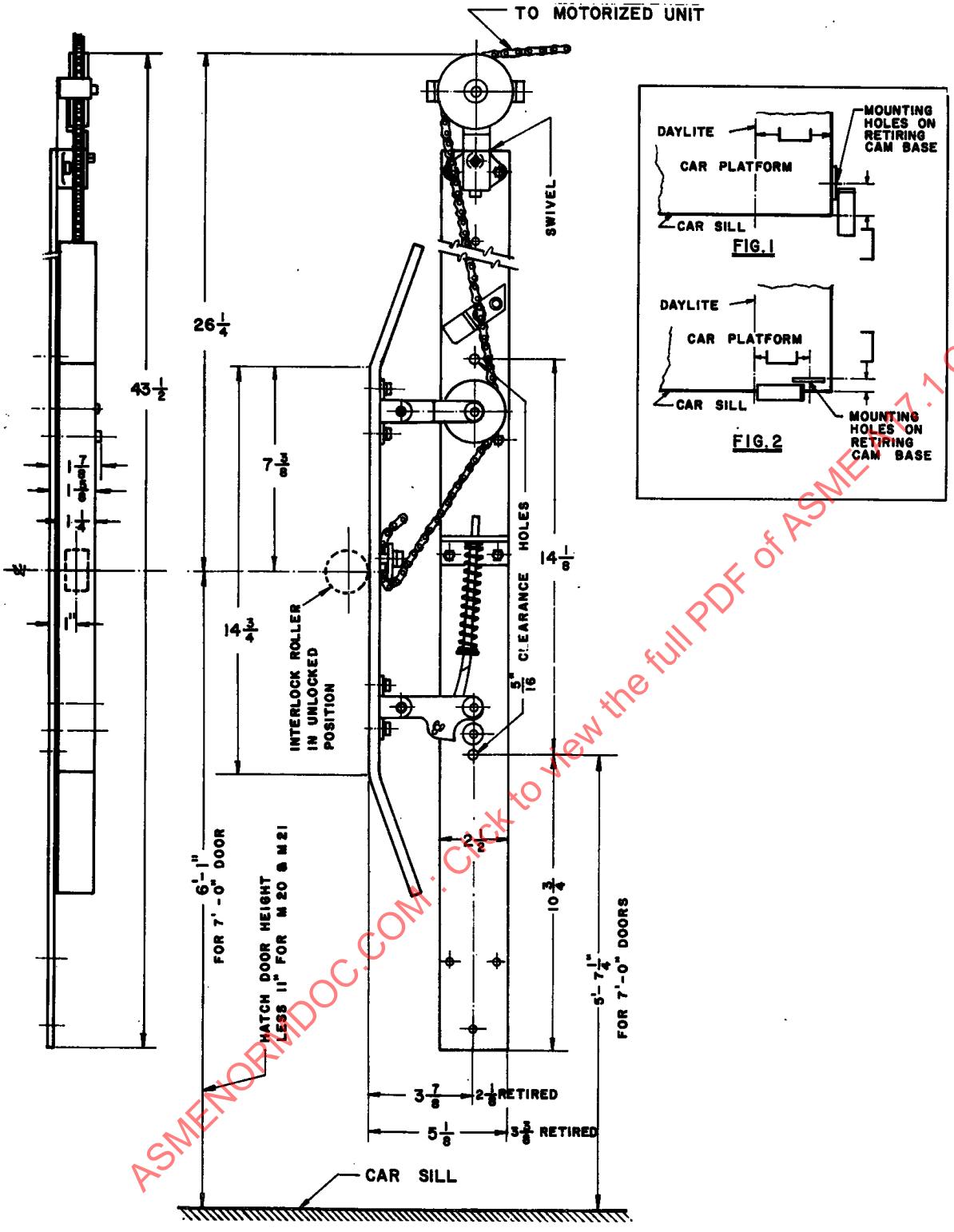
(b) Closed Position Swing Doors



(c) Closed Position Vertically Sliding Doors

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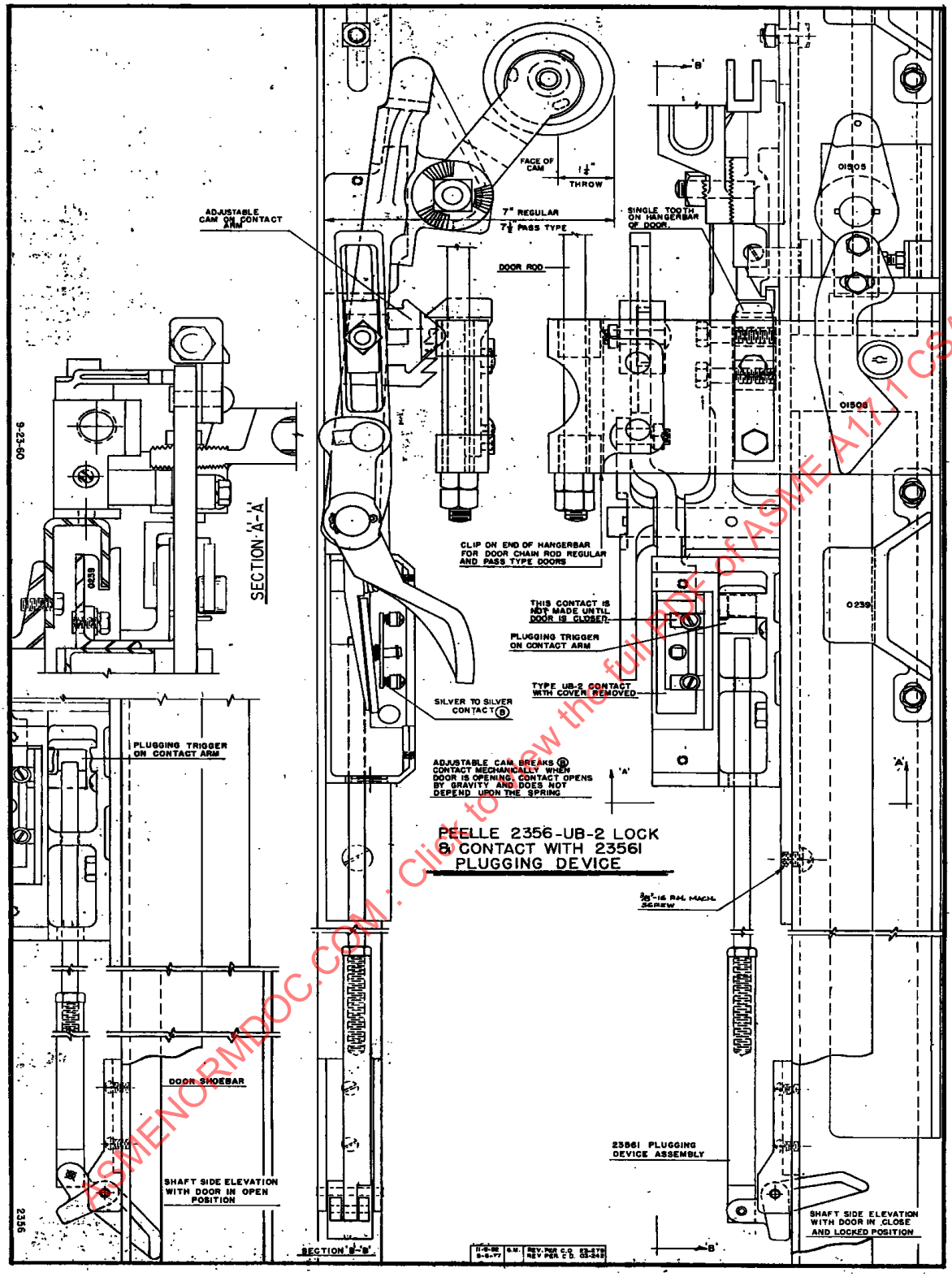
Diagram 2.12.2.5
Typical Retiring Cam



GENERAL NOTES:
(a) Courtesy of G.A.L. Manufacturing Corp.
(b) Right hand retiring cam shown — left hand symmetrically opposite.

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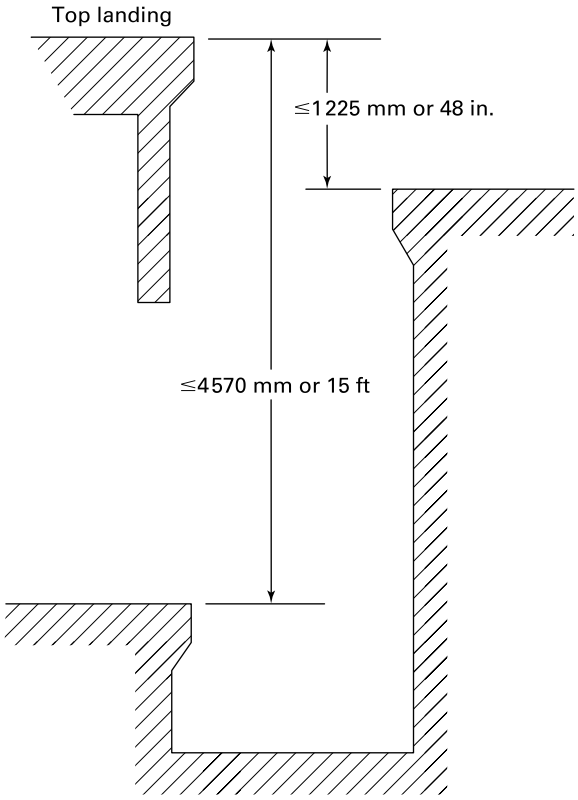
Diagram 2.12.3.1(a)
Typical Hoistway Door Combination Mechanical Lock and Electric Contacts



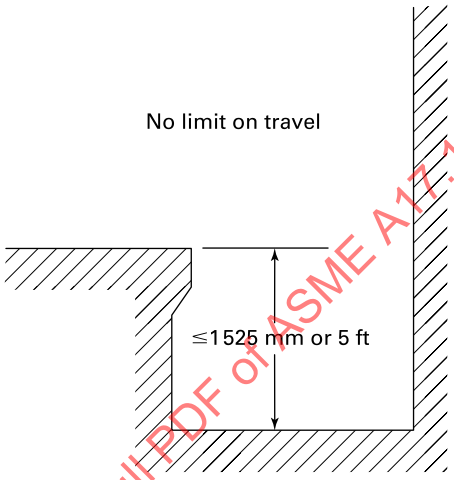
GENERAL NOTE: Courtesy of The Peelle Co.

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Diagram 2.12.3.1(b)
Permitted Use of Hoistway Door Combination Mechanical Lock and Electric Contacts



Exception (1)

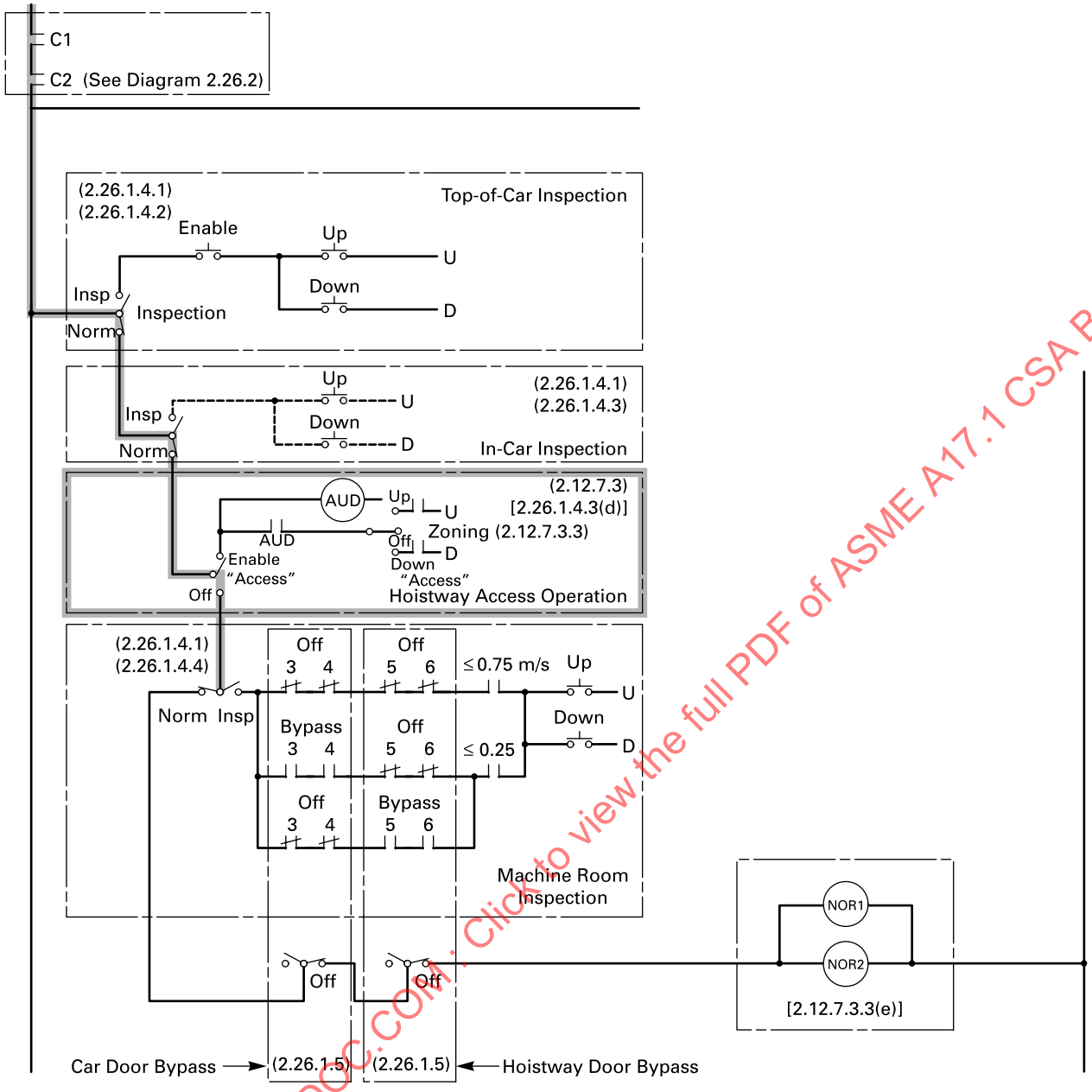


Exception (2)

GENERAL NOTE: Hoistway door interlocks are not required for the conditions shown above on freight elevators with manually operated vertically sliding doors.

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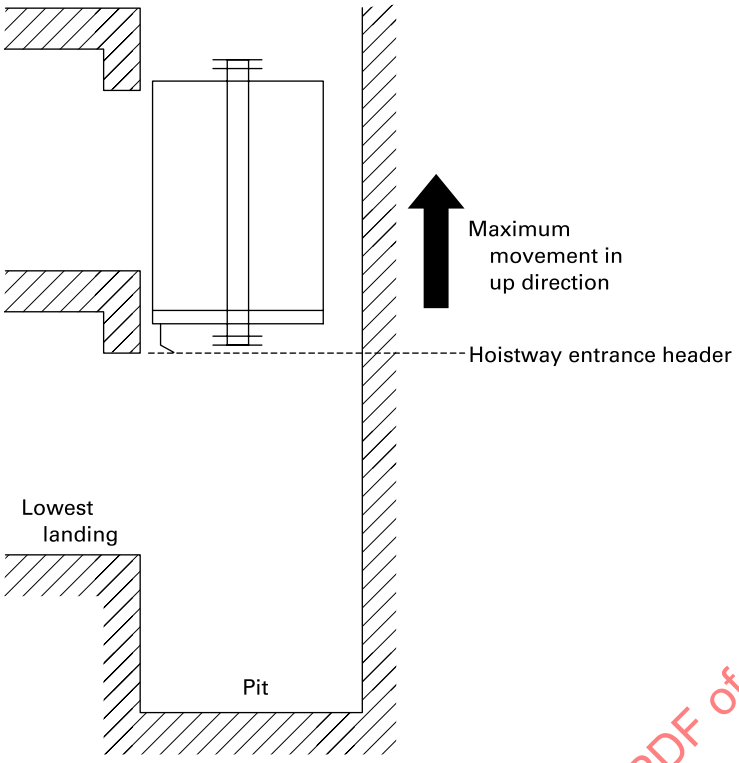
Diagram 2.12.7
Hoistway Access Operation



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Section 2.25 for Diagram legends.

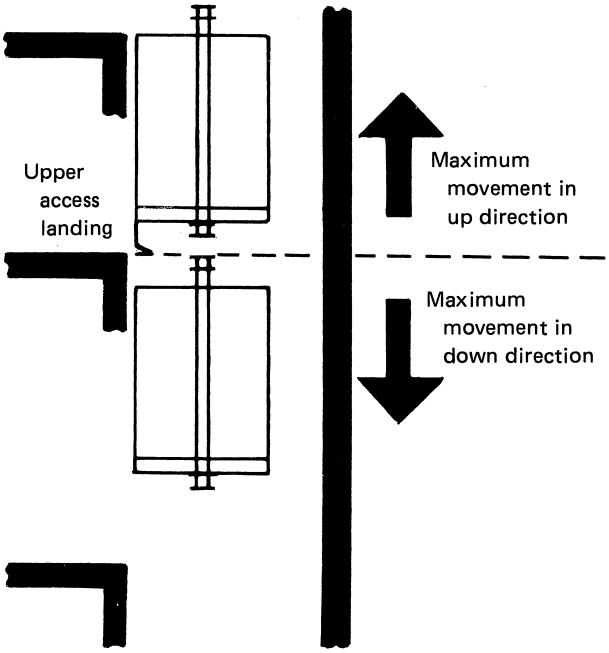
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Diagram 2.12.7.3.3(c)
Hoistway Access Switch Operating Zone — Lowest Landing



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Diagram 2.12.7.3.3(d)
Hoistway Access Switch Operating Zone — Upper Landing



SECTION 2.13
POWER OPERATION OF HOISTWAY DOORS AND CAR DOORS

2.13.1 Types of Doors and Gates Permitted

This requirement reduces the potential of passengers being struck by closing doors or trapped between closing hoistway doors and the facing car door or gate.

2.13.2 Power Opening

2.13.2.1 Power Opening of Car Doors or Gates

2.13.2.1.1 The first requirements governing solid state devices were published in ASME A17.1e-1975. Strong arguments were made for and against allowing advance door opening before the elevator was level at a landing. Most committee members agreed that the point where the hoistway doors physically start to open was more relevant to safety than the point where door opening is initiated. Since high-performance, fast-response elevator static control systems can cause the car to move very rapidly in a short interval of time, the initial application of power to the door operator was restricted to the following:

(a) The car must be leveling into a landing.

(b) The car must be within 300 mm or 12 in. of the landing.

(c) The car speed must not exceed 0.75 m/s or 150 ft/min.

The 300 mm or 12 in. dimension was a compromise between those who wanted no advance door opening and those who wanted no change to the Code requirement. This requirement provides the necessary safety protections and, at the same time, does not severely hamper present-day performance standards of elevators.

This requirement was revised in ASME A17.1-2013/CSA B44-13 to reconcile a conflict between power opening and restricted opening. It was further revised in ASME A17.1-2016/CSA B44-16 to reference 2.12.1 so users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

2.13.2.1.2 The restriction on the distance that a collapsible car gate can be power-opened is to reduce the possibility of a hand or finger being pinched between the openings in the car gate.

2.13.2.2 Power Opening of Hoistway Doors. This requirement does not prohibit power opening of the hoistway door at a landing if the car is stopped within the unlocking zone by other means such as a malfunctioning of a device or the operation of an emergency stop switch.

2.13.2.2.1 This requirement was revised in ASME A17.1-2013/CSA B44-13 to reconcile a conflict between power opening and restricted opening. It was further revised in ASME A17.1-2016/CSA B44-16 to reference 2.12.1 so users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

2.13.2.2.2 The phrase "when stopping under normal operating conditions" describes the condition required to be met only when the power opening is initiated automatically through control circuits.

2.13.3 Power Closing

2.13.3.1 Power Closing or Automatic Self-Closing of Car Doors or Gates Where Used With Manually Operated or Self-Closing Hoistway Doors

(a) This requirement is applicable only to passenger elevators with automatic or continuous-pressure operation when

(1) the car door or gate is of the automatically released, self-closing type

(2) the hoistway door is

(-a) a door or gate that is opened and closed by hand, or

(-b) a door or gate that is manually opened and, when released, closes automatically

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(b) This requirement is also applicable to freight elevators, which are permitted to carry passengers (see 2.16.4) when door or gate closing is

(1) controlled only by a constant pressure switch, or

(2) by means of the car operating device

Release of the door-close switch or operating device must stop, or stop and reopen, the car door or gate.

There is no requirement for a reopening device (2.13.5) on an automatic car door opposite a manual hoistway door because the car door is not permitted to close until the hoistway door is closed.

2.13.3.2 Power Closing of Horizontally Sliding Hoistway Doors and Horizontally Sliding Car Doors or Gates by Continuous-Pressure Means. Whenever continuous-pressure means for power closing of either or both the car door or hoistway gate is provided, this requirement applies. Release of the door or gate-closing switch must stop or stop and reopen the door or gate. A switch must be provided at each landing and control the hoistway and car door or gate at that landing only. For example, one cannot close the second-floor hoistway door from the first or third floor, only from the second floor. When two openings are provided at a landing, a closing switch must be provided at each opening. The switch can control only that hoistway and car door or gate adjacent to the switch. A separate switch should be provided for each car door or gate and its corresponding hoistway door.

2.13.3.3 Power Closing of Horizontally Sliding Hoistway Doors and Horizontally Sliding Car Doors or Gates by Momentary Pressure or by Automatic Means

2.13.3.3.2 The momentary-pressure door-open switch allows a person to stop or stop and reopen the door if additional time is needed to enter or exit the elevator. The switch can only be of the momentary-pressure type and cannot be a toggle switch, which would not conform to the requirements of 2.11.3. A door reopening device cannot be considered an appropriate substitute for the required door-open or door-stop button.

2.13.3.4 Power Closing of Vertically Sliding Hoistway Doors and Vertically Sliding Car Doors or Gates. The following is the rationale for the different size objects referenced in this requirement. Requirement 2.13.3.4.5(a) addresses detection means located immediately adjacent to the landing side of the hoistway door and the car side of the car door, capable of detecting a target equivalent to the head of a small-size adult located from the car/landing floor to 1 880 mm or 74 in. above the car/landing floor. See Diagrams 2.13.3.4.5(a)(1) and 2.13.3.4.5(a)(2).

Requirement 2.13.3.4.5(b) addresses the detection of a target of torso size located wholly within the confines bounded by the vertical planes established by the landing side of the doors and the car side of the doors. See Diagram 2.13.3.4.5(b).

For clarification: If the horizontal distance between the sensors of the detectors placed at landing side of the hoistway door and the car side of the car door is less than 140 mm or 5.5 in., then no additional detectors are required, since those detectors would sense a torso-size object located wholly within the path of the hoistway/car door, thus satisfying 2.13.3.4.5(b).

If a person were entering or exiting the car just prior to or during door closing, the person would encounter the detection means located immediately adjacent to the landing side of the hoistway door and/or the car side of the car door as required in 2.13.3.4.5(a). Thus, the detection means stipulated in 2.13.3.4.5(b) comes into play only if the person is standing wholly within the path of the closing doors prior to closing. To get to that position, the person must have passed through the detection means stipulated in 2.13.3.4.5(a), thus preventing closure or initiating reopen until the head and torso had passed through the 2.13.3.4.4(a) detection zones.

For the head to be wholly within the path of the door, without the torso, the torso would be detected by the devices in 2.13.3.4.5(a). Requirement 2.13.3.4.5(b) provides protection when the horizontal distance between detectors 2.13.3.4.5(a)(1) and 2.13.3.4.5(a)(2) will no longer detect a head. Since the head is attached to the balance of the body and the body must also be located wholly within the confines bounded by the vertical planes established by the landing side of the doors and the car side of the doors [i.e., not sensed by the 2.13.3.4.5(a) detectors], then detection of the body (i.e., torso) will ensure that the head is also detected.

Passage into the zone located wholly within the confines bounded by the vertical planes established by the landing side of the doors and the car side of the doors would have prevented closure or initiated reopen per 2.13.3.4.5(a). Thus, 2.13.3.4.5(a) prevents door closure unless the torso is fully within the confines bounded by the detectors located along vertical planes of the landing side of the hoistway door and the car side of the car door. Since the torso must be fully within this zone prior to door close, detection of the torso will also protect the head.

Detection of the object as described is necessary to demonstrate the efficacy of the protection means. There is no prohibition against detecting larger or smaller objects, just as long as the system can detect the object as described.

There are a large number of hypothetical nonhuman objects that could enter into the path of any closing door and be located such that they are not detected. Scenarios involving the consequential effects on humans were extensively analyzed, and the safety issues were addressed.

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2.13.3.4.1 The requirements for a warning bell were deleted from this requirement as of ASME A17.1a-2008/CSA B44a-08 as hazards addressed by the warning devices are mitigated by new requirements for object detection and reopening.

Warning bells do not mitigate the risks sufficiently to eliminate the need for protective devices. As such, since protective devices were necessary and mitigated the risks, there was no need to retain the warning bell, except for vertical slide-up to open hoistway and car doors with sequence operation [2.13.3.4.6(f)].

Continuous pressure close, momentary pressure close, or closing initiated by automatic means are permissible methods of closing the doors. Regardless of the type of closing means, detection devices are required by requirements 2.13.3.4.5, 2.13.3.4.6, or 2.13.3.4.7.

Requirements for continuous pressure close were selected to conform to industry norms.

Operation by a designated attendant is permitted. Since an inattentive operator might not be aware that a person is entering or leaving the elevator, operation by a designated attendant did not mitigate the risks sufficiently to eliminate the need for protective devices. As such, since protective devices were necessary, there was no need to differentiate between automatic operation and operation by a designated attendant.

2.13.3.4.2 The inclusion of detectors eliminated the need to assume that the person in control of the doors would react in time to initiate reopening. Also see 2.13.3.4.

2.13.3.4.3 Requirements provide users at the landing or in the car with a means to reopen a closing hoistway door or car door or gate. An immediate initiation to reopen is to occur. A minimum distance the doors need to reopen is required. The intention is to open the doors sufficiently to remove the object. Requirements for labeling the door open button were added by ASME A17.1a-2008/CSA B44a-08.

Since the inertia present within the system does not allow any moving mass to instantly stop, there is no scenario where a person situated adjacent to the leading edge of a closing door cannot be struck by the door. The best possible alternative is to lower the probability. In this requirement, the arrangement of the detection means and the requirement that the doors not close or, if closing, reopen when an obstruction is detected, suggests that once the person has entered the path of the door, regardless of location of the doors, the doors will react.

Immediate initiation of reversal is required, which suggests that the control system and motor are attempting to initiate a reversal. However, due to inertia, there is a time delay before the doors physically reverse direction. That time delay varies with numerous factors including door mass, speed, electro-motor force, friction, etc.

Prior to ASME A17.1a-2008/CSA B44a-08, reversal was not initiated until there was physical contact with the obstruction. As of ASME A17.1a-2008/CSA B44a-08, contact resulting from closing door inertia results only if a person places a body part in a position at or just in front of the leading edge of the moving panel — a low probability occurrence for body parts such as the head. Also see 2.13.3.4.

2.13.3.4.5 There are different requirements and different object detection zones for doors with and without sequence operation. The required object detection zones and reopening requirements incorporated in 2.13.3.4.5 eliminated the need for sequence operation.

2.13.3.4.5(a)(1) This requirement is for detecting an object equivalent to a small-size adult head located anywhere from the floor to the height of a large-size adult standing tall located adjacent to the path of the landing side door. This also ensures that larger size body parts are also protected. The prism dimensions were taken from ISO 3411-1995(E). See also the Handbook commentary for different object sizes located in 2.13.3.4.

2.13.3.4.5(a)(2) This requirement is for detecting an object equivalent to a small-size adult head located anywhere from the floor to the height of a large-size adult standing tall located adjacent to the path of the car side door or gate. This also ensures that larger size body parts are also protected. The prism dimensions were taken from ISO 3411-1995(E). See also the Handbook commentary for different object sizes located in 2.13.3.4.

According to SAE J833, the standing height from floor to the top of the head of a tall adult male in the 95th percentile with shoes was 1 880 mm or 74 in.

2.13.3.4.5(b) This requirement is for detecting an object equivalent to a small-size standing adult torso located within the defined zone (480 mm to 1 500 mm, or 19 in. to 61 in.) of the landing door and car side door or gate that may not be addressed by 2.13.4.5(a). This also ensures that larger size body parts are also protected. Anthropometric data shows that the torso will fall within the defined zone. The prism dimensions were taken from ISO 3411-1995(E) and SAE J833-R1989. See also the Handbook commentary for different object sizes located at 2.13.3.4.

2.13.3.4.5(c) This requirement is for detecting an object equal to the size of the front of shoe for a small-size adult located on the floor of the car and in the path of the car side of the car door or gate. The object thickness was estimated, the object width was from ISO 3411-1995(E), and the object depth was calculated as half the shoe length dimension from ISO 3411-1995(E).

Detection devices are not required when the design inherently mitigates the effects of foot entrapment between the leading edge of the car door or gate and the car platform.

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See Diagrams 2.13.3.4.5(a)(1), 2.13.3.4.5(a)(2), 2.13.3.4.5(b), and 2.13.3.4.5(c). Also see 2.13.3.4.

2.13.3.4.6 There are different requirements and different object detection zones for doors with and without sequence operation.

2.13.3.4.6(c)(1) This requirement is for detecting an object equivalent to a small-size adult head located anywhere from the floor to the height of a large-size adult standing tall located adjacent to the path of the landing side car door or gate. This also ensures that larger size body parts are also protected. The prism dimensions were taken from ISO 3411-1995(E).

According to SAE J833, the standing height from floor to the top of the head of a tall adult male in the 95th percentile with shoes was 1880 mm or 74 in.

2.13.3.4.6(c)(2) This requirement is for detecting an object equivalent to a small-size adult head located anywhere from the floor to the height of a large-size adult standing tall located adjacent to the path of the car side of the car door or gate. This also ensures that larger size body parts are also protected. The prism dimensions were taken from ISO 3411-1995(E). See also the Handbook commentary for different object sizes located at 2.13.3.4.

2.13.3.4.6(d) This requirement is for detecting an object equivalent to a small adult torso size located anywhere from the floor to the shoulder height of a seated, squatting, or large-size adult standing tall located within the path of the car door or gate. This also ensures that larger size body parts are also protected. The prism dimensions were taken from ISO 3411-1995(E) and SAE J833-R1989. See also the Handbook commentary for different object sizes located at 2.13.3.4.

2.13.3.4.6(e) This requirement is for detecting an object equal to the size of the front of shoe for a small-size adult located on the floor of the car and in the path of the car side of the car door or gate. The object thickness was estimated, the object width was from ISO 3411-1995(E), and the object depth was calculated as half the shoe-length dimension from ISO 3411-1995(E).

Detection devices are not required when the design inherently mitigates the effects of foot entrapment between the leading edge of the car door or gate and the car platform.

2.13.3.4.6(f) and 2.13.3.4.6(g) This requirement is for providing additional warning, beyond the closing car door or gate, that a slide-up to open hoistway door is closing.

Note that the rising lower panel of a biparting door, in addition to the closing car door or gate, warns users that biparting doors are closing, as such an audible/visual warning was not necessary.

See Diagrams 2.13.3.4.5(a)(2), 2.13.3.4.6(c)(1), 2.13.3.4.6(d), and 2.13.3.4.6(e). Also see 2.13.3.4.

2.13.3.4.7 Sequence closing is required for both continuous and momentary pressure closing to reduce the potential impact if a person has a body part between closing door panels, although contact may occur. Slow closing and the specified dimension were intended to give users additional time to react and remove a body part that might be located between closing biparting door panels. For example, a user with a head size of 170 mm or 6.7 in. would have 0.5 s (corresponding to 75 mm at 0.15 m/s, or 3 in. at 0.5 ft/sec) to remove the head prior to contact.

Biparting panels do not have detection devices. In combination with other safety means the warning strip is intended to remind users not to insert body parts between closing door panels.

2.13.3.4.7(d)(1) This requirement is for detecting an object equivalent to a small-size adult head located anywhere from the floor to the height of a large-size adult standing tall located adjacent to the path of the landing side car door or gate. This also ensures that larger size body parts are also protected. The prism dimensions were taken from ISO 3411-1995(E). See also the Handbook commentary for different object sizes located in 2.13.3.4.

According to SAE J833, the standing height from the floor to the top of the head of a tall adult male in the 95th percentile with shoes was 1880 mm or 74 in.

2.13.3.4.7(d)(2) This requirement is for detecting an object equivalent to a small-size adult head located anywhere from the floor to the height of a large-size adult standing tall located adjacent to the path of the car side of the car door or gate. This also ensures that larger size body parts are also protected. The prism dimensions were taken from ISO 3411-1995(E). See also the Handbook commentary for different object sizes located in 2.13.3.4.

2.13.3.4.7(e) This requirement is for detecting an object equal to a small-size adult torso located anywhere from the floor to the shoulder height of a seated, squatting, or fully standing large-size adult located within the path of the car door or gate. This also ensures that larger size body parts are also protected. The prism dimensions were taken from ISO 3411-1995(E) and SAE J833-R1989. See also the Handbook commentary for different object sizes located in 2.13.3.4.

2.13.3.4.7(f) This requirement is for detecting an object equal to the size of the front of the shoe for a small-size adult located on the floor of the car and in the path of the car side of the car door or gate. The object thickness was estimated, the object width was from ISO 3411-1995(E), and the object depth was calculated as half the shoe length dimension from ISO 3411-1995(E).

2.13.3.4.7(g) If the distance between the closed car door and the car side sill of the open hoistway door is large enough for a person's foot to be entrapped, then an object of shoe size is to be detected.

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See Diagrams 2.13.3.4.7(d)(1), 2.13.3.4.7(d)(2), 2.13.3.4.7(e), 2.13.3.4.7(f), and 2.13.3.4.7(g). Also see 2.13.3.4.

2.13.3.4.8 This requirement is for reducing the probability of contact; two provisions were added in ASME A17.1a-2008/CSA B44a-08. The first was to prohibit closing if the object is present in the detection zones. The second was that a closing door must stop and reopen when an object enters the detection zone. Physical contact is not required to initiate reopening, although contact may occur before the door reverses.

Clarification was added that an immediate initiation to reopen is to occur. A minimum distance the doors need to reopen has been established. Requirement also clarifies the zone and conditions when reopening is no longer required.

Since the system inertia does not allow the moving mass to stop instantly, there is no scenario where a person situated adjacent to the leading edge of a closing door cannot be struck by the door. The best possible alternative is to lower the probability. In this requirement, the arrangement of the detection means and the requirement that the doors not close or, if closing, reopen when an obstruction is detected, suggests that once the person has entered the path of the door, regardless of location of the doors, the doors will react. Also see 2.13.3.4.

In the past requirements, reversal was not initiated until physical contact with the obstruction occurred. As of ASME A17.1a-2008/CSA B44a-08, contact resulting from closing door inertia results only if a person places a body part in a position at or just in front of the leading edge of the moving panel — a low probability occurrence for body parts such as the head.

2.13.3.4.9 This requirement was revised in ASME A17.1-2013/CSA B44-13 to clarify the signal is to be sent to the control that initiates the starting, stopping, and direction of motion of the door(s). This control may or may not be included in the operation control portion of the control system. This requirement provides design flexibility while ensuring that the device is functional. This requirement does not require redundant designs or sensing failure of a particular component, but it requires verification that the detection devices are functional and disables door closing if they are not. Also see 2.13.3.4.

2.13.3.4.10 This requirement recognizes where environmental or other job conditions make the use of detection devices impractical. It also clarifies that elevator usage is specifically limited to “authorized” users.

Clear guidelines to designers and the AHJ are provided when situations arise where conditions prohibit the use of detection devices. Also see 2.13.3.4.

Requirement 2.13.3.4.10 was revised in ASME A17.1-2019/CSA B44:19 to change the reference for signage requirements to a new Section 8.13. See Handbook commentary on Section 8.13.

2.13.4 Closing Limitations for Power-Operated Horizontally Sliding Hoistway Doors and Horizontally Sliding Car Doors or Gates

NOTE: The author expresses his appreciation to George W. Gibson for his extensive contributions to 2.13.4.

Since passenger elevator power door systems consist of moving masses, it is necessary to regulate the effects of the door system on passengers who may come into contact with moving or stationary doors. These effects relate to impact and/or direct forces and are expressed in terms of conventional physical parameters of kinetic energy and force, respectively. Kinetic energy, expressed in 2.13.4.2.1, quantifies the dynamic state of the door system by relating all the rigidly connected moving masses in the door system and their speeds. The direct force, expressed in 2.13.4.2.3, quantifies the static state of the stalled door condition. These two parameters, i.e., kinetic energy and force, are design requirements.

2.13.4.2 Closing Mechanism

2.13.4.2.1 Kinetic Energy. The kinetic energy of completed door systems includes the applicable translational effects of the doors, linkages, hangers, vanes, interlocks, etc., as well as the rotational effects of the door operator motor and transmission.

Requirement 2.13.4 discusses two functions of door closing: kinetic energy (2.13.4.2.1) and force limitation (2.13.4.2.3) for power door operators on horizontally sliding hoistway doors and horizontally sliding car doors or gates. The kinetic energy of the hoistway and car doors and all parts rigidly connected thereto, computed for the average closing speed, within the Code zone distance (2.13.4.2.2) must not exceed 10 J or 7.37 ft-lbf where a reopening device for the power-operated car door or gate is used, and must not exceed 3.5 J or 2.5 ft-lbf where a reopening device is not used.

It should be noted that prior to ASME A17.1-2000 and CSA B44-00, the limiting value for the kinetic energy was 7.0 ft-lbf, whose direct conversion to SI units was 9.49 J. However, recognizing that this historic value had been rounded up to 10 J in the major worldwide codes using the SI system of units, the ASME A17 and CSA B44 Committees agreed that worldwide harmonization would further benefit by the rounding up of the legacy ASME A17 and CSA B44 value of 9.49 J to 10 J.

When hoistway pressurization is utilized in a building during a fire, it may be necessary to increase the forces only as much as required to overcome the forces caused by pressurization.

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Kinetic energy is determined by using the standard formula

$$\text{Kinetic energy} = {}^{1}/_{2}mv^{2}$$

where m is the mass of the door system and v is the average door closing speed as specified in 2.13.4.2.2(a) or (b). The historic limiting value of 7.0 ft-lbf for kinetic energy based on the average closing speed was based on determining the kinetic energy developed by a typical door system with an average closing speed of 0.305 m/s or 1.0 ft/sec. The door system used in this analysis was 2.13 m or 7 ft high with a panel width of 1.07 m or 42 in. plus a small overlap at the jamb side yielding an area of approximately 2.32 m^2 or 25 ft^2. It is further assumed that the hoistway door weighs 34.2 kg/m^2 or 7 lb/ft^2, the car door weighs 23.6 kg/m^2 or 5 lb/ft^2, and that there are two hangers weighing 11.3 kg or 25 lb each. The weight of the door system can then be computed as follows:

	Imperial, lb	SI, kg
Hoistway door	175	79.4
Car door	175	56.7
Hangers	50	22.7
Vanes and hardware	10	4.5
Total	360	163.3

The general equation for the kinetic energy of translating masses is

$$\text{Kinetic energy} = {}^{1}/_{2}mv^{2}$$

Inserting the numerical values into this simplified formula yields the following:

(Imperial Units)

$$\text{Kinetic energy} = \frac{1}{2}\frac{W}{g}v^{2} = \frac{1}{2}\left[\frac{360\text{ lb}}{32.2\left(\frac{\text{ft}}{\text{sec}^2}\right)}\right]\left[1.0\left(\frac{\text{ft}}{\text{sec}}\right)\right]^{2}$$
$$= 5.6\text{ ft-lbf}$$

(*SI Units*)

$$\text{Kinetic energy} = \frac{1}{2}mv^{2} = \frac{1}{2}(163.3\text{ kg})\left[(0.305)\left[\frac{\text{m}}{\text{s}}\right]\right]^{2}$$
$$= 7.6\text{ J}$$

The rotating kinetic energy of the door operator (motor, pulley, etc.) was not included in this analysis, and 25% seems to have been added to round the value up to 9.49 J or 7.0 ft-lbf.

Kinetic energy as it has been codified in 2.13.4.2.1 is based on an average closing speed, unless stated otherwise. Field measurement of kinetic energy by any mechanical device will normally result in an instantaneous reading. Instantaneous kinetic energy was introduced in ASME A17.1-2000 and CSA B44-00, requirement 2.13.4.2.1(b)(1). Its numerical value is derived from sinusoidal velocity dictation where the maximum value of the door panel speed is equal to 1.57^2 times the average, where the average results in a kinetic energy equal to the historical value of 7 ft-lbf or 9.49 J. Therefore, the instantaneous value is equal to 7.0 $(1.57)^2$ = 17.25 ft-lbf × 1.356 = 23.4 J, rounded to 23 J. The same rationale is used to quantify the maximum instantaneous value of the reduced kinetic energy.

Attempting to improve floor-to-floor time and its influence on elevator capacity may lead to the temptation to decrease door time resulting in increase in kinetic energy, which may create an unsafe condition for elevator users. The reason is that every second used for the door closing usually means decrease in elevator capacity of 5% or more. This might be an incentive for compromising safety. Door operators that comply with requirements in present standards (based on average speed) could still create extremely high kinetic energy peaks as a result of poor adjustment.

It should be noted that calculated kinetic energy often gives considerably greater values than measured kinetic energy, because of the elasticity of door hangers and couplers. Therefore, reliance on calculated rather than physically analyzed values of kinetic energy often provides conservative results.

"High-quality" doors require as rigid as possible links between the door operator and the car and landing doors; that means as little elasticity as possible, which in turn will cause the increase in the door force.

Requirement 2.13.4.2.1 was revised in ASME A17.1-2022/CSA B44:22 to require the kinetic energy to be reduced if the detection of objects in the door path has been disabled, but not when the approaching object detection is disabled.

2.13.4.2.2 Door Travel in the Code Zone Distance. The code zone when taken in conjunction with 2.13.4.2.4 provides the means of field verification of compliance with the kinetic energy requirement in 2.13.4.2.1(b)(1).

2.13.4.2.3 Door Force. Any spring gauge readings taken when stopping an already moving door system will result in higher forces due to the dynamics of the system.

A reasonably accurate reading on the spring gauge is accomplished when the forward thrust of the door, i.e., door force, is balanced by the restoring force of the spring gauge. This is accomplished by pushing the spring gauge against the stopped door, removing the stop so that the door is held stationary by the spring gauge, and then slowly backing off on the spring gauge until the point the door just starts to move forward. At this point of impending motion, the door and spring

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forces are in equilibrium and the spring force can be read. Any motion will result in an incorrect reading.

The 135-N or 30-lbf closing force had historically been attributed to a survey of the car doors on the New York City subway system, wherein the subway car doors allegedly had a closing force of 178 N or 40 lbf. This historic basis cannot be verified, and no New York City subway system records have been located that can substantiate the story. Nevertheless, it adds to elevator industry folklore. Notwithstanding, a 135 N or 30 lbf value was adopted for elevator door applications by the ASME A17 Committee in the early 1950s.

The 135 N or 30 lbf force applies only to a door at rest between one-third and two-thirds of its travel, as described in this requirement and Item 1.8.1 of ASME A17.2, Guide for Inspection of Elevators, Escalators, and Moving Walks. There are no force requirements for the doors in other positions.

2.13.4.2.4 Door Marking Plate. Requirement 2.13.4.2.4 was revised in ASME A17.1-2019/CSA B44:19 to change the reference for signage requirements to a new Section 8.13. See Handbook commentary on Section 8.13.

2.13.5 Reopening Device(s) for Power-Operated Horizontally Sliding Car Doors or Gates

NOTE: The author expresses his appreciation to Louis Bialy for his extensive contributions to Section 2.13.5.

Requirement 2.13.5 was substantially revised in ASME A17.1-2019/CSA B44:19 to provide a holistic approach to horizontal door system safety.

Based on a comprehensive hazard assessment and detailed study of exposure of passengers approaching, entering, and exiting elevators equipped with horizontal doors, it was deemed necessary to develop new requirements for door reopening devices. The hazard assessment validated the need for more extensive requirements to address passenger safety in order to further enhance public safety. It became evident that the avoidance of door impacts on passengers required the detection of approaching passengers in addition to the detection of passengers in the door path. The typical speed and paths of motion of approaching passengers were used as input to the development of Code requirements.

In the development of requirements, it was important to evaluate the state of the art in detection means technology to ensure that any requirements advocated were practical and achievable. To this end, it was necessary to review the suitability and reliability of various technologies currently available in the marketplace. Technologies such as infrared detection are well established for sensing passengers directly in the path of motion of the doors. Infrared detection is also used for the detection of approaching passengers. The application of radar technology has also emerged as a viable means for the detection of approaching passengers and objects. The Code requirements are not meant to exclude any viable technology.

In order to assist elevator designers in verifying the effectiveness of any chosen detection means, specific targets were described in the Code. Such targets are only applicable to the elevator design process and are not intended for use in field inspection.

The revised Code requirements also recognize that the availability of elevators is imperative for the vertical transportation of occupants and visitors in buildings. It was recognized that the approaching objects detection means could be unintentionally actuated by people walking past the elevators or congregating close to a given elevator without intending to board. This could indefinitely delay the elevator and disrupt the traffic handling capability of the building transportation system. In order to address this situation, a provision for rendering the approaching object detection means inoperative after a suitable dwell time was included in the Code.

The reasoning behind specific requirements is summarized below.

Requirement 2.13.5 was revised in ASME A17.1-2022/CSA B44:22 to include appropriate reference standards for the detection means addressed by the Code.

2.13.5.1 Specifies where reopening devices are required and defines their function.

(a) Establishes the conditions under which reversal of door motion is to occur and the minimum reopening distance at which this is to take effect. This requirement pertains to the detection means of approaching objects, which is generally a three-dimensional (3D) protection means, as well as the detection means of objects in the door path, which is generally a two-dimensional (2D) car door/gate mounted protection means.

(b) This requirement provides a practical and measurable time limitation to sense and respond to a door close malfunction.

2.13.5.2 Pertains to the conditions under which the approaching object door detection system and the door path detection means are permitted to be rendered inoperative. (See Diagram 2.13.5.2.)

(a) Rendering the door detection means inoperative applies to specific conditions, as follows:

(1) when the door kinetic energy (KE) has been reduced. This allows the doors to be moved at reduced speed if impeded for more than 20 s, which constitutes a dwell time consistent with ADAAG and ANSI/ICC A117.1 requirements.

(2) for approaching objects when the doors approach a particular position, to prevent excessive delay of elevator service.

(3) when the approaching objects detection means has delayed the elevator for at least 20 s without anyone entering or exiting the elevator, the detection means is permitted to be rendered inoperative. The 20 s delay

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is consistent with ADAAG and ANSI/ICC A117.1 requirements.

(4) when doors are within 20 mm of door jamb or opposing door edge the detection means is permitted to be rendered inoperative in order to allow door closure without actuating the detector. The 20 mm gap is sufficiently small so as to avoid accidental hand entrapment.

(b) This requirement allows the door detection means to be rendered inoperative after 20 s if Phase I recall is not provided and the detection means can be affected by smoke or flames. The 20 s delay is consistent with ADAAG and ANSI/ICC A117.1 requirements. This establishes priority of building fire operations to ensure that fire integrity remains intact.

(c) Requires and specifies an audible alarm if the detection means is rendered inoperative to warn passengers of impending door closure when kinetic energy is reduced, and detection means are non-functional.

Requirement 2.13.5 was revised in ASME A17.1-2022/CSA B44:22 to reduce the time interval for detecting persons in the approaching object detection zone to reduce undue delays. The rationale in 2.13.5.2(a) of ASME A17.1-2019/CSA B44:19 was "to provide a method for not unduly delaying the elevator when objects inadvertently transverse the approaching object detection zone." However, in a crowded elevator lobby, building occupants can inadvertently transverse the door approaching detection zone while moving through the lobby without any intention to enter the elevator, resulting in undue delay. This change uses the door path detection means to validate the travel direction of an object detected in the door approaching detection zone. Any time an object is sensed in the door path detection zone, including once the doors begin to close, the doors will reopen and the door approaching protection is made operative. The new value of 3 s corresponds to a slow walking pace from the initial edge of the approach zone [500 mm (20 in.)] to the door path detection zone. If the door path detection means fails to sense the object after a minimum of 3 s, then the doors can begin to close at normal speed because the door path detection means is still operative as protection for passengers.

2.13.5.3 Detection of Approaching Objects. This requirement provides the geometry and dimensions as well as surface finish of targets to be used by designers for the verification of approaching object detection means. It also specifies the location and speed of the targets that must be detected, when moving towards the doors. (See Diagrams 2.13.5.2 and 2.13.5.3.)

The detection means is intended to sense a person or object approaching an elevator from the landing and reduce the likelihood of their being struck by the doors. The locations of the points of verification were chosen based on the results of analysis and hazard assessment. It is understood that advanced detection prior to the leading edge in the plane of the hoistway door may occur, but after the leading edge has passed, the hazard is eliminated

Traditional detection means, mounted on the car door, remain in operation. It is recognized that incidental contact may still occur; however, the incidence of these events will be significantly reduced.

Requirement 2.13.5.3 was revised in ASME A17.1-2022/CSA B44:22 to use performance language so as not to restrict any applicable technologies. The previous requirements primarily applied to photoelectric devices. Other devices may require different detection properties of the target to validate their operation. Based on the application of these devices, the target should simulate what they need to detect (i.e., properties of a human being).

Requirement 2.13.5.3.1 was revised in ASME A17.1-2022/CSA B44:22 to clarify that the target is moving at a minimum speed. The moving target must be detected at some point in the defined area, but the target is not required to be detected at every point of the defined area. The detection must occur prior to the target moving to within 225 mm (9 in.) of the closing door.

2.13.5.4 Detection of Objects in the Door Path. This requirement provides the geometry and dimensions as well as surface finish of targets to be used by designers for the verification of the effectiveness of the detection means for objects in the door path. It also defines the location of the target. (See Diagrams 2.13.5.2, 2.13.5.4(a) , and 2.13.5.4(b).)

These are design requirements, (not on-site test requirements) intended to reduce the likelihood of a body part being struck by or entrapped by the elevator doors. Targets are based on the following:

(a) ANSI A156.10-2005, SDO: BHMA, Section 8.1.2, Motion Sensors

(b) average walking speed for adult, per "Establishing Pedestrian Walking Speeds," authored by Nick Carey at Portland State University, submitted on May 31, 2005

(c) anthropometric data for adults and children contained in ASME A17.7/B44.7 and "The Measure of Man and Woman, Human Factors in Design," by Alvin R. Tilley, Henry Dreyfuss Associates, copyright 2002 by John Wiley & Sons, New York

(d) people approaching elevator, clothed in attire ranging from black nonreflective to white reflective material as approximated by colors defined in FED-STD-595C

Requirement 2.13.5.4 was revised in ASME A17.1-2022/CSA B44:22 to use performance language so as not to restrict any applicable technologies. The previous requirements primarily applied to photoelectric devices. Other devices may require different detection properties of the target to validate their operation. Based on the application of these devices, the target should simulate what they need to detect (i.e., properties of a human being).

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2.13.5.5 Self-Monitoring of Detection Means. The detection means functionality is required to be self-monitoring. If it is nonoperational, the door system is required to operate at reduced kinetic energy.

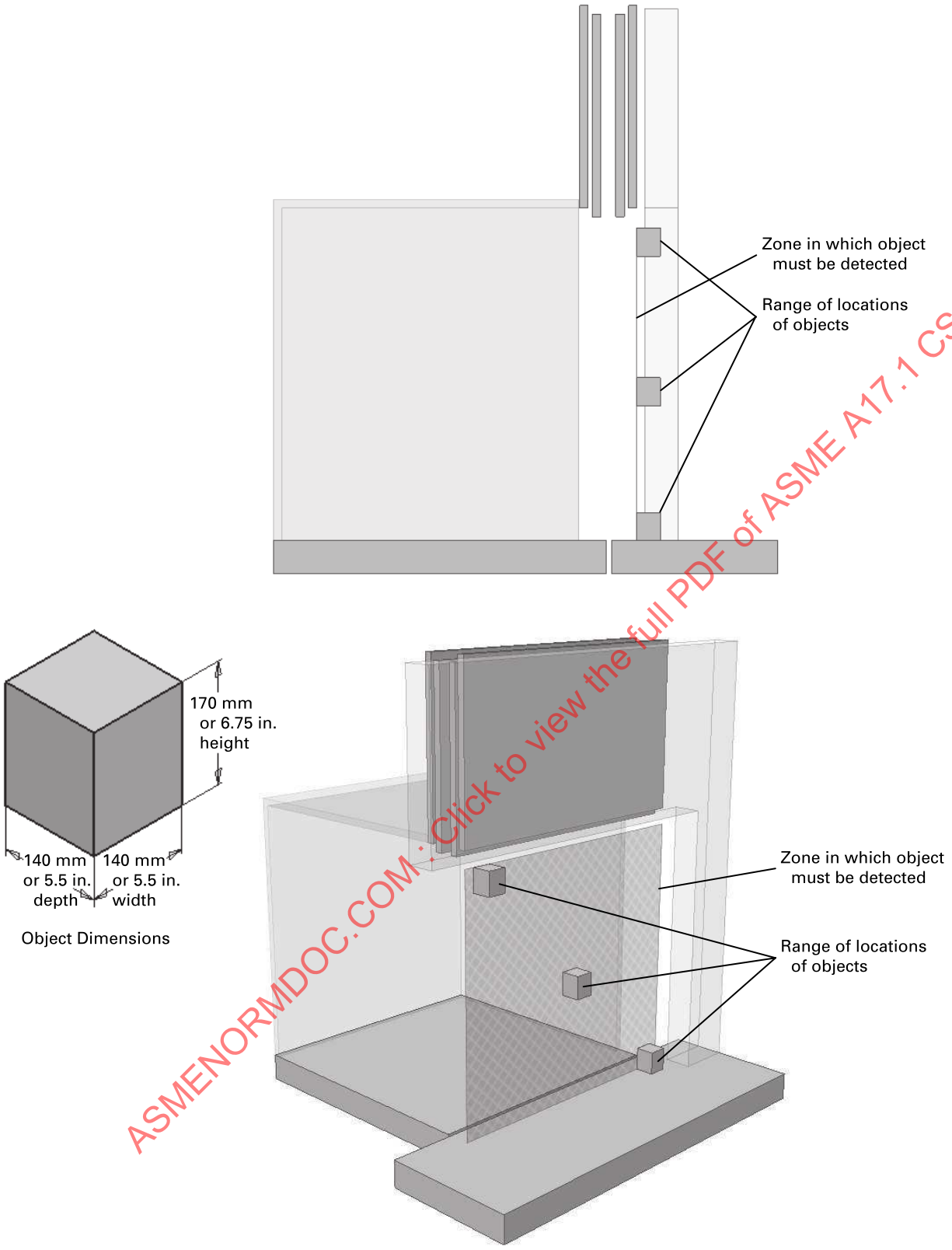
These are design requirements (not on-site test requirements) intended to determine whether the detection means is operational prior to the start of the next 'door close' command, regardless of whether single or multiple devices are utilized. This is a positive way of ensuring that both door path detection and approaching object detection means remain operational.

Requirement 2.13.5.5 was revised in ASME A17.1-2022/CSA B44:22 to provide consistency with the language in requirement 2.13.3.4.9. The self-monitoring feature for the means to detect objects in the door path (2.13.5.4) and approaching objects (2.13.5.3) is required to determine when the means is no longer capable of detecting objects and send a signal to the controller to reduce the kinetic energy of the doors. Reducing the kinetic energy of the doors will minimize the impact of door strikes. The reduced door speed will also be noticeable and should alert maintenance and management personnel.

2.13.5.6 Maintenance and On-Site Testing of Detection Means. The maintenance and testing methods for the detection means are required to be included in the Maintenance Control Program (MCP) in order to ensure ongoing functionality of the detection means.

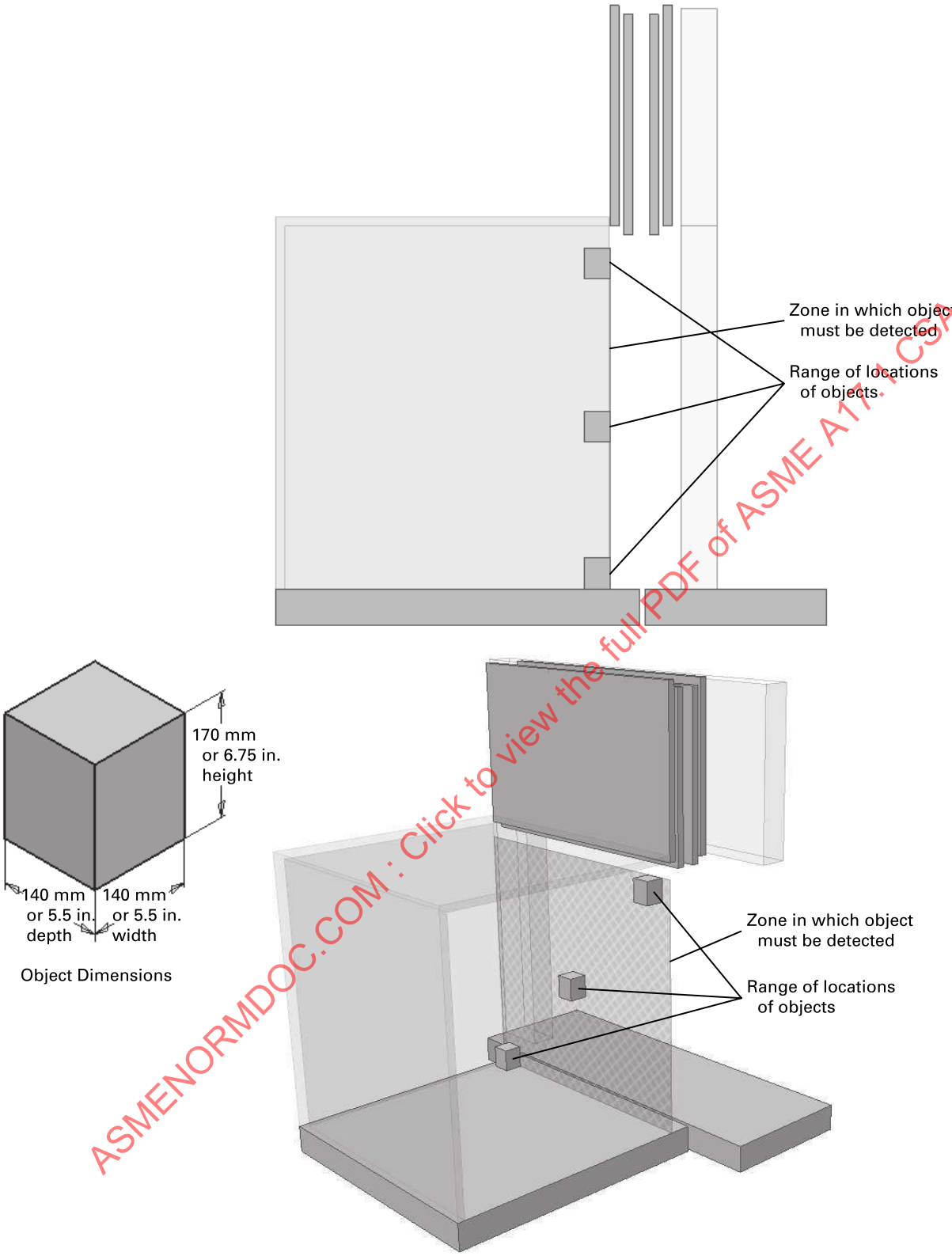
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Diagram 2.13.3.4.5(a)(1)
Detection Zones



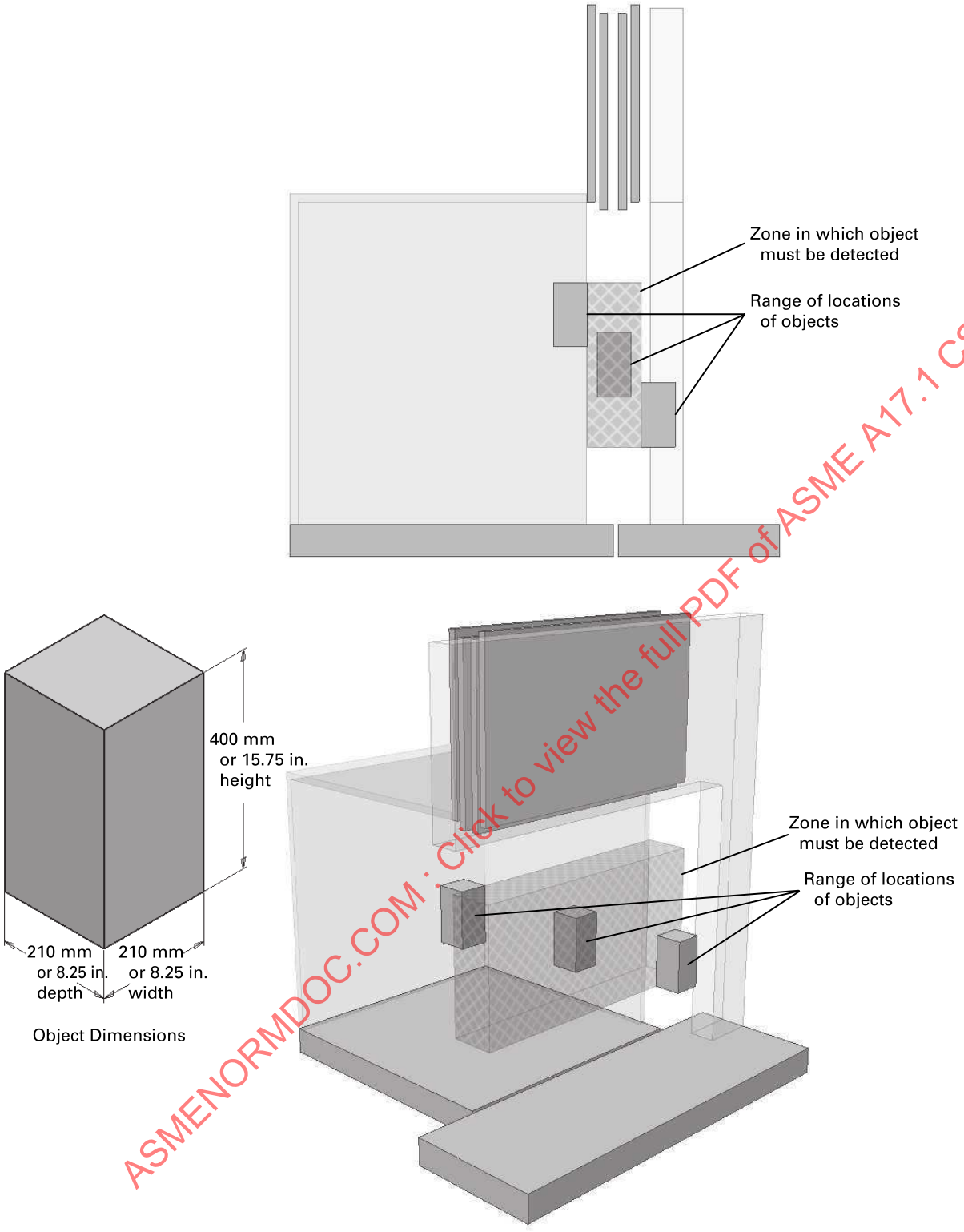
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Diagram 2.13.3.4.5(a)(2)
Detection Zones



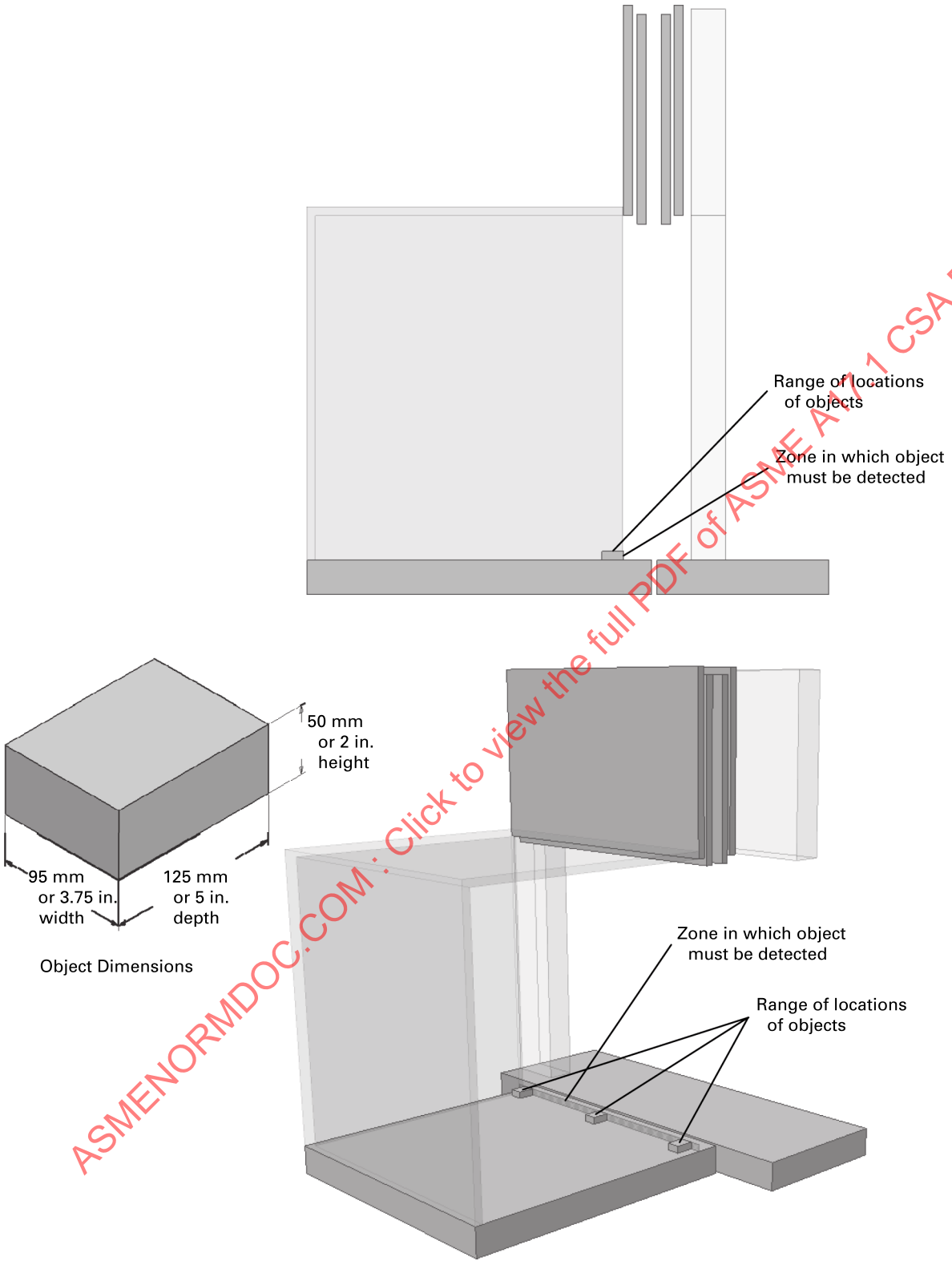
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Diagram 2.13.3.4.5(b)
Detection Zones



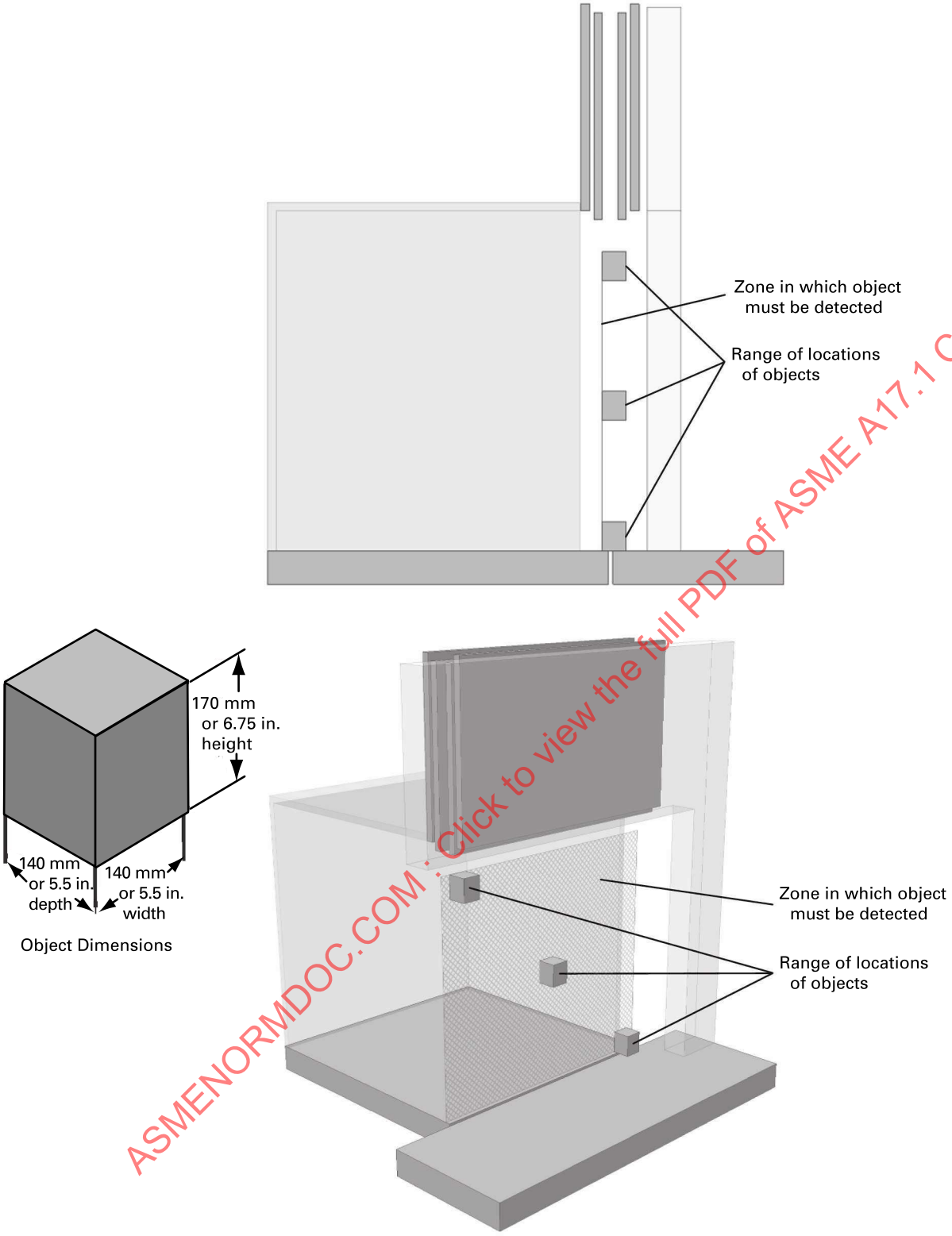
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Diagram 2.13.3.4.5(c)
Detection Zones



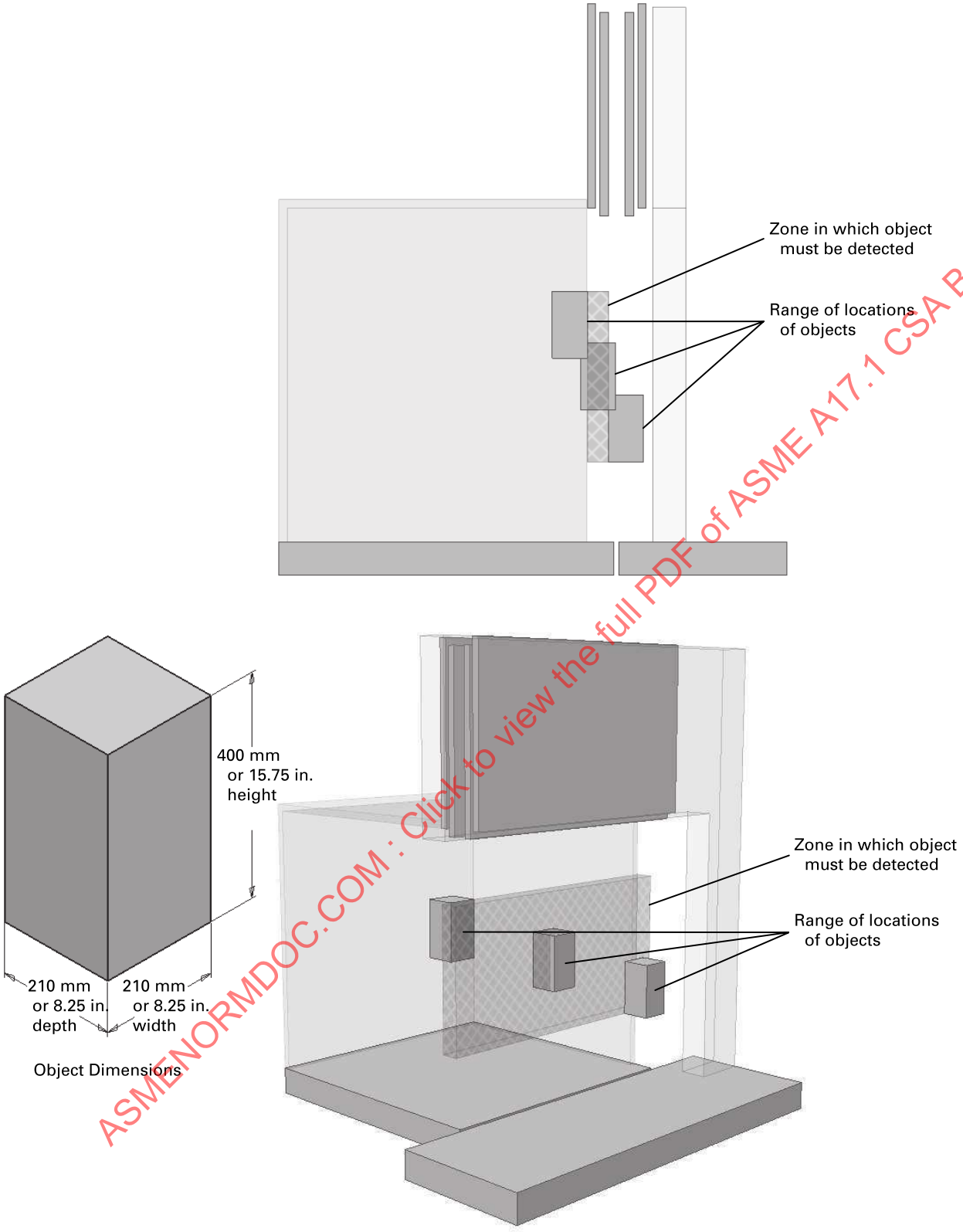
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Diagram 2.13.3.4.6(c)(1)
Detection Zones



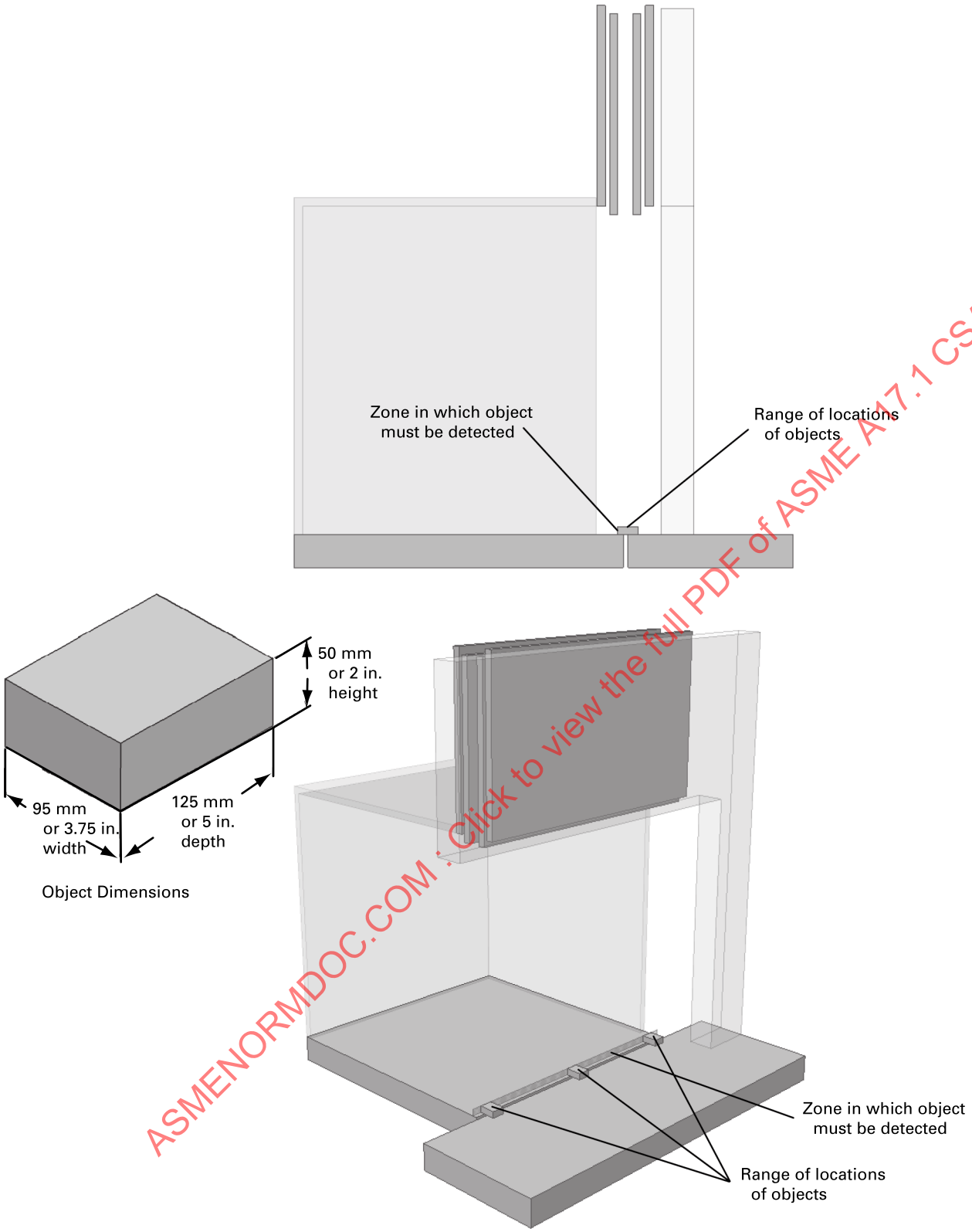
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Diagram 2.13.3.4.6(d)
Detection Zones



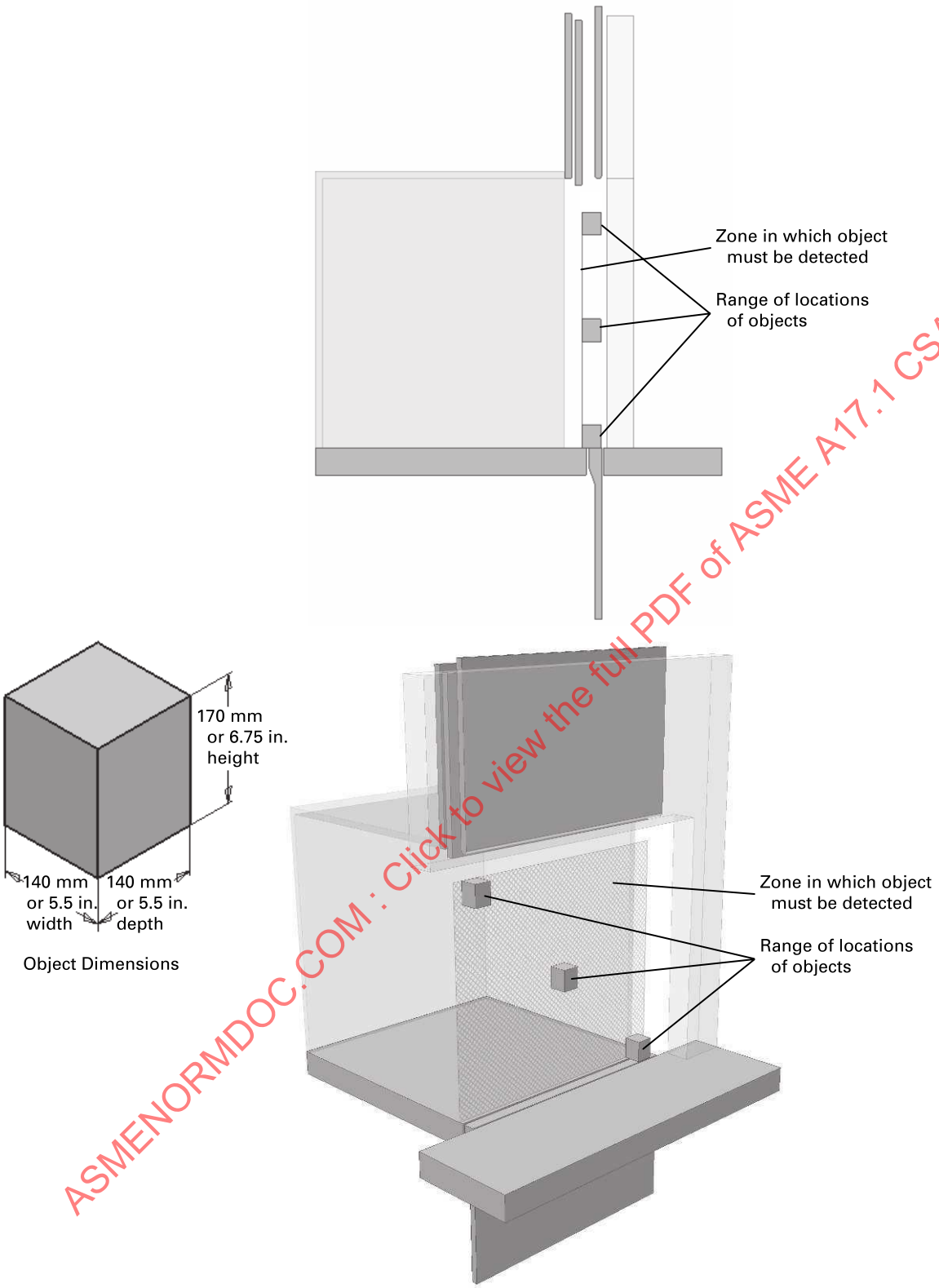
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Diagram 2.13.3.4.6(e)
Detection Zones



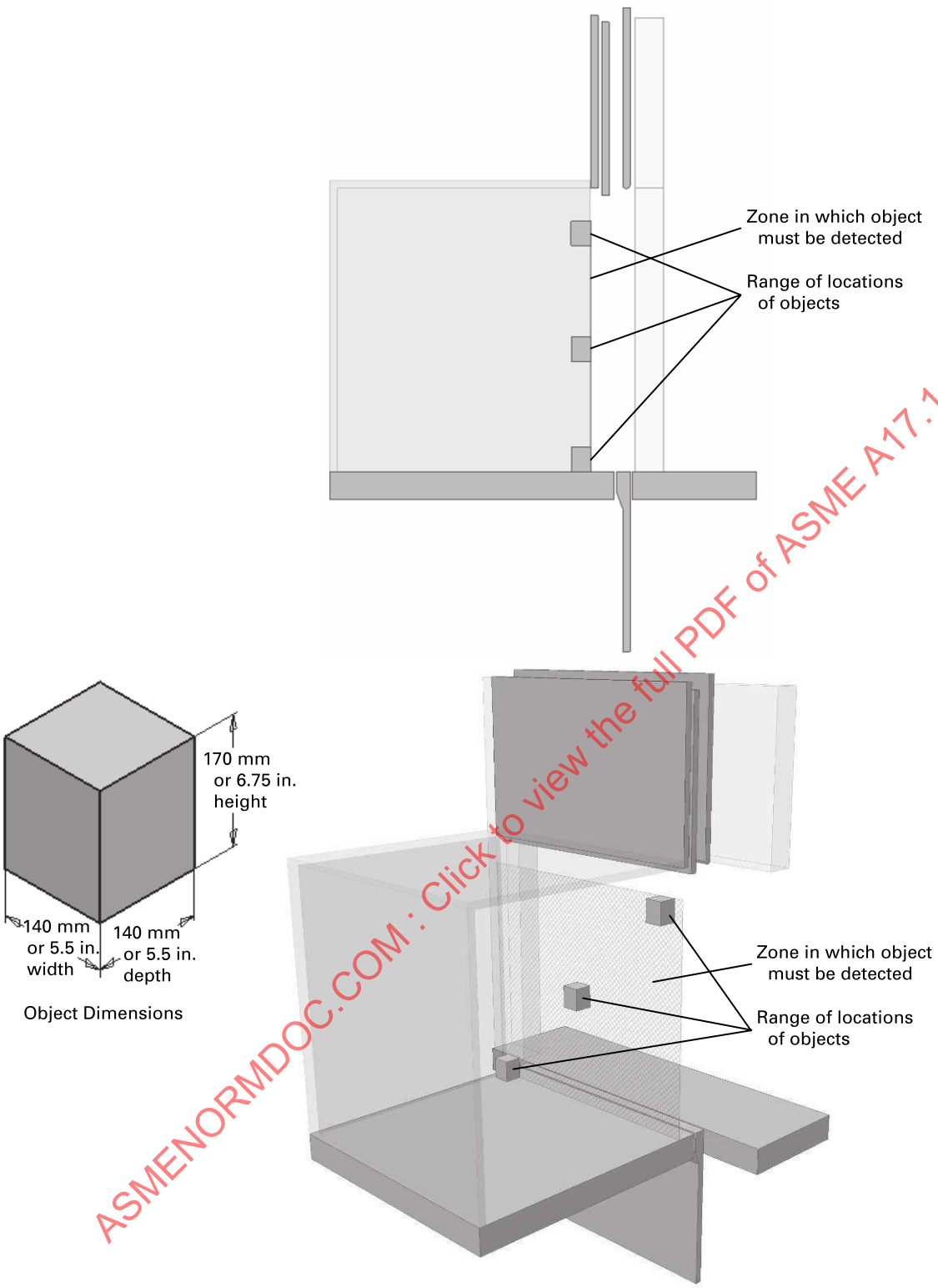
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Diagram 2.13.3.4.7(d)(1)
Detection Zones



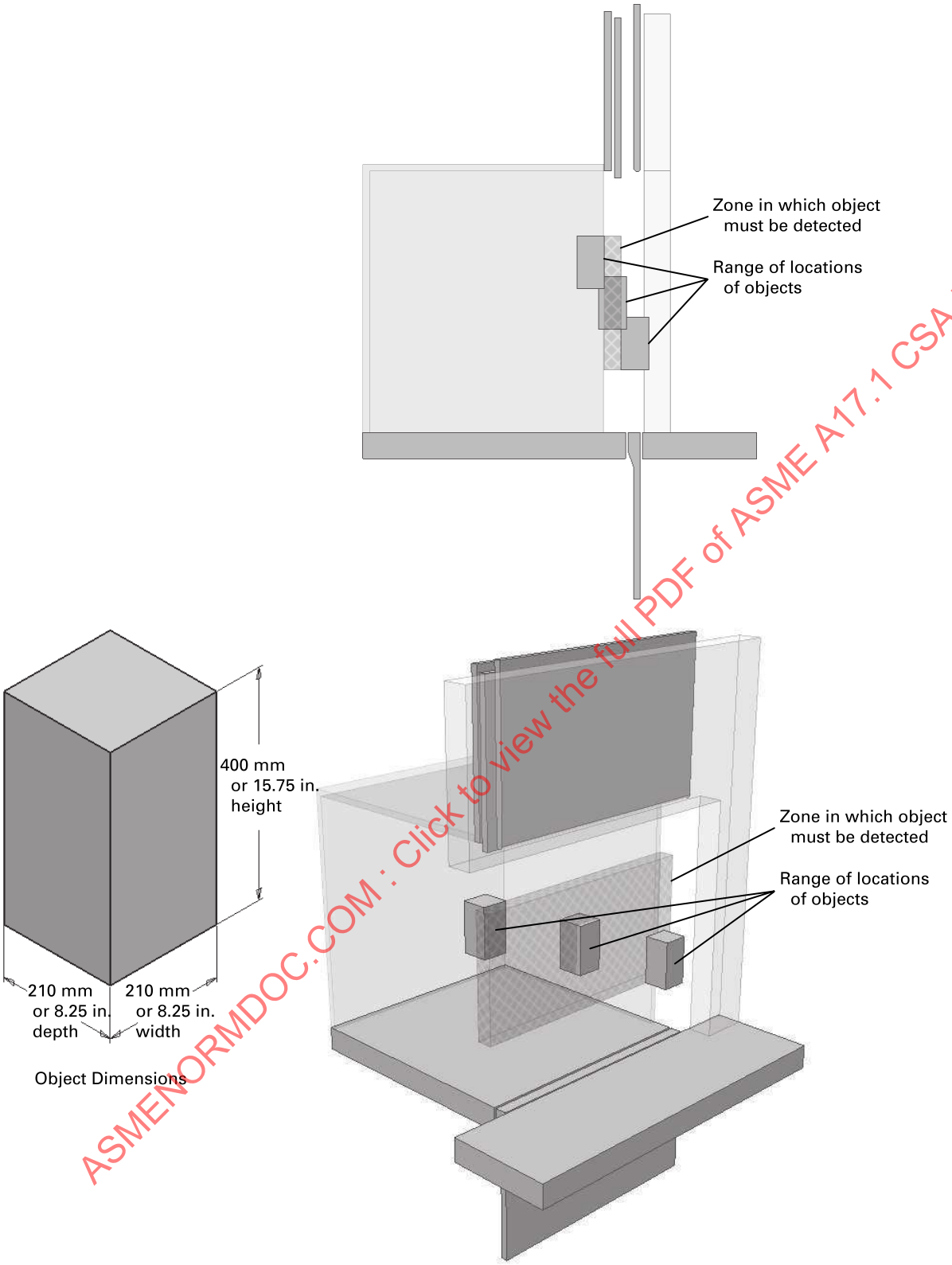
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Diagram 2.13.3.4.7(d)(2)
Detection Zones



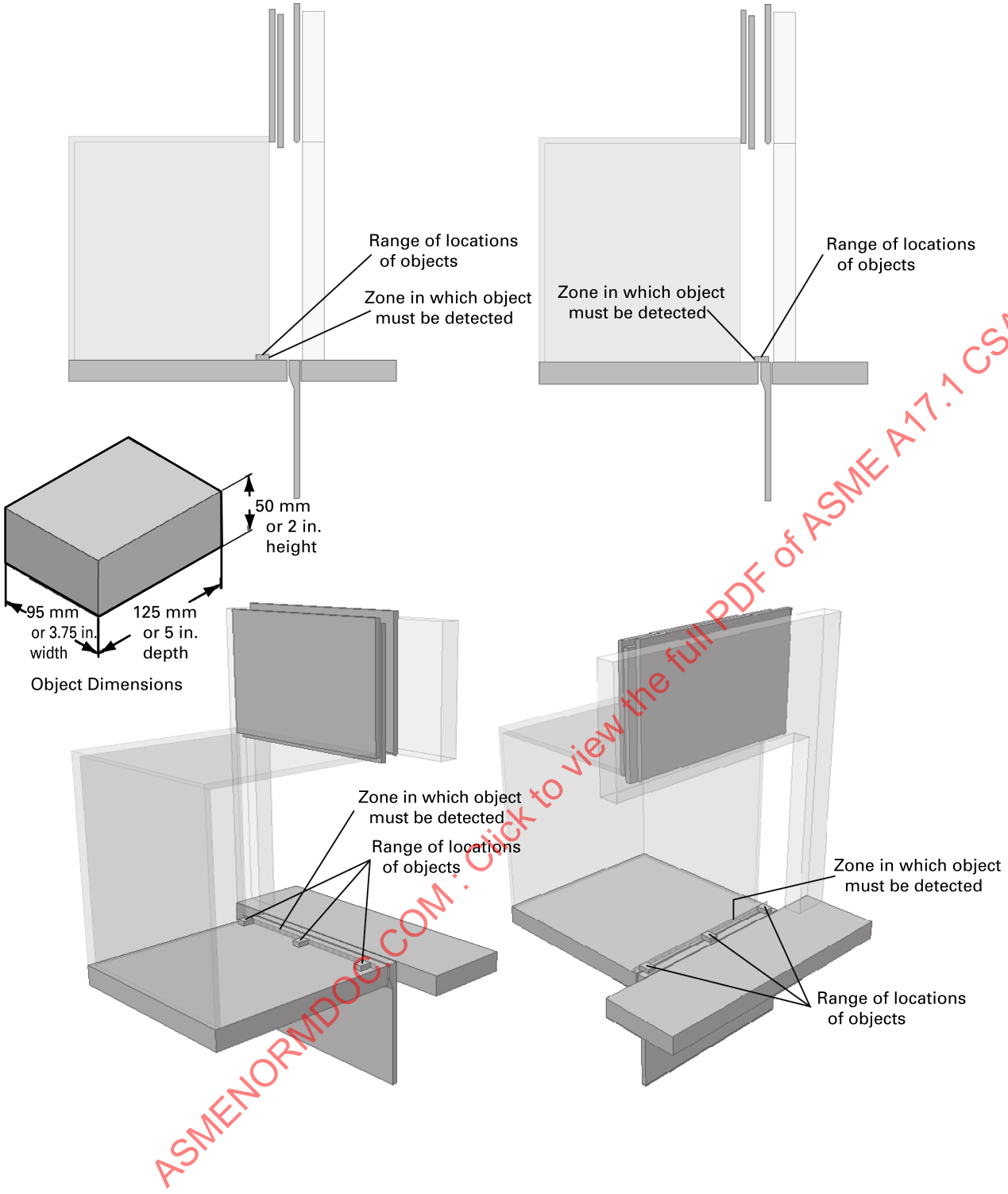
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Diagram 2.13.3.4.7(e)
Detection Zones



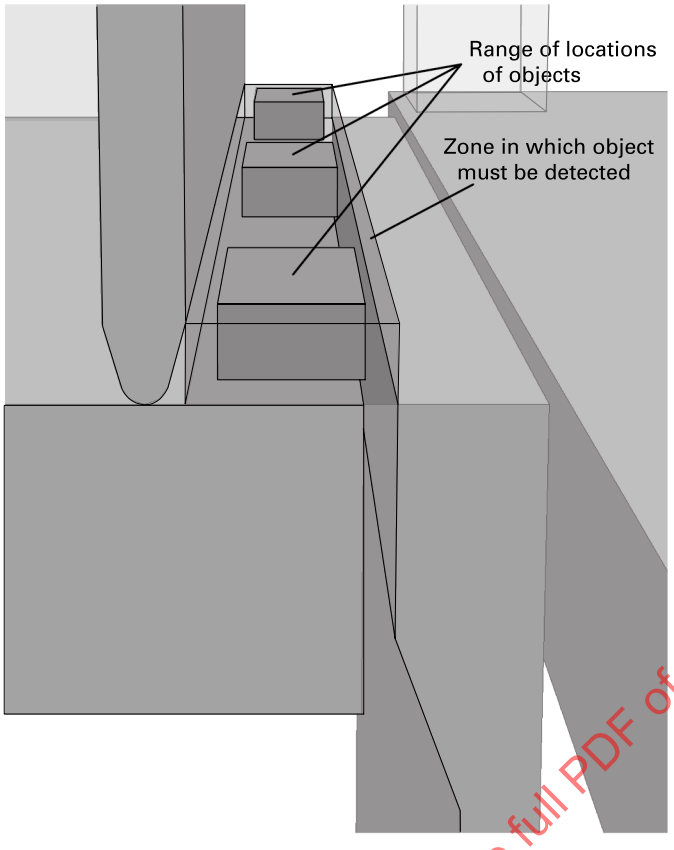
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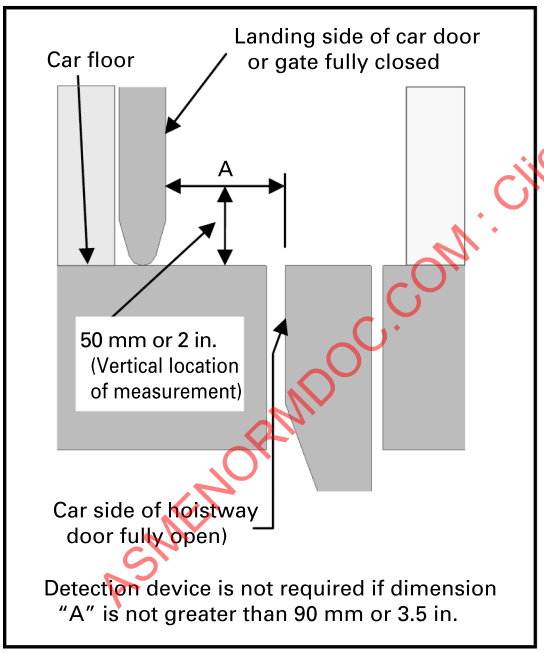
Diagram 2.13.3.4.7(f)
Detection Zones

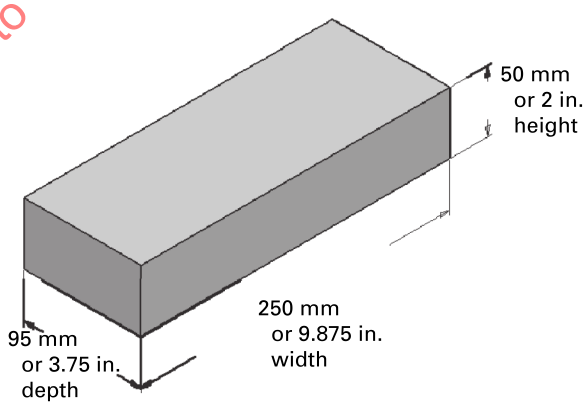


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Diagram 2.13.3.4.7(g)
Detection Zones



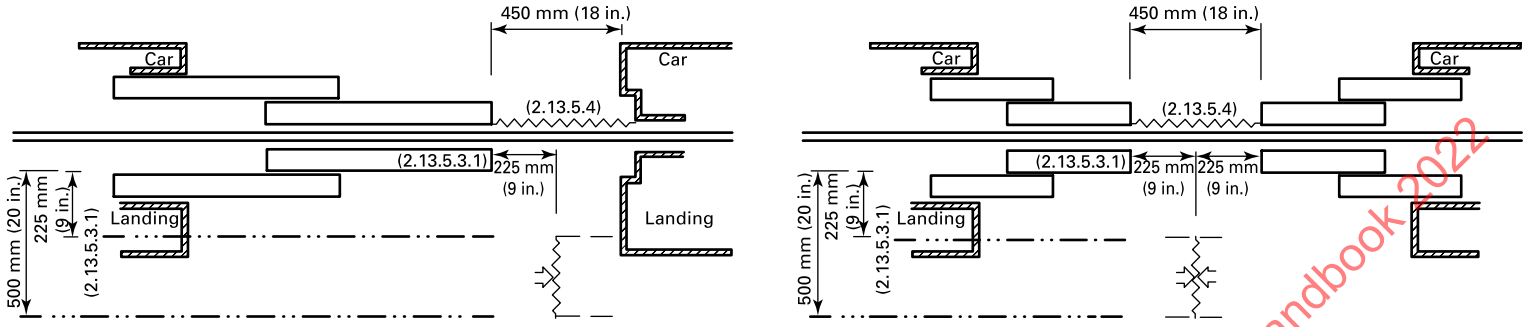




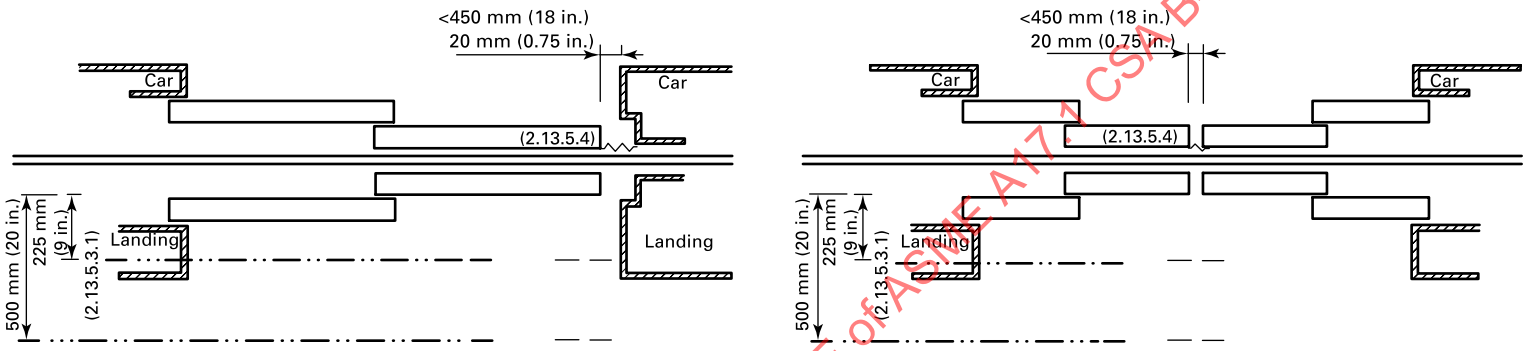
Object Dimensions

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Diagram. 2.13.5.2
Detection Areas Relative to Door Position (Figure S-16)



(c) While closing is in progress with the remaining opening at 450 mm (18 in.) or less from fully closed, the detection means of approaching objects is permitted to be rendered inoperative, however the detection means of objects in the door path remains active.



(d) While closing is in progress with the remaining opening at 20 mm (0.75 in.) or less from fully closed, the detection means of objects in the door path is permitted to be rendered inoperative.

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Diagram. 2.13.5.3
Cylindrical Targets (Figure S-13)

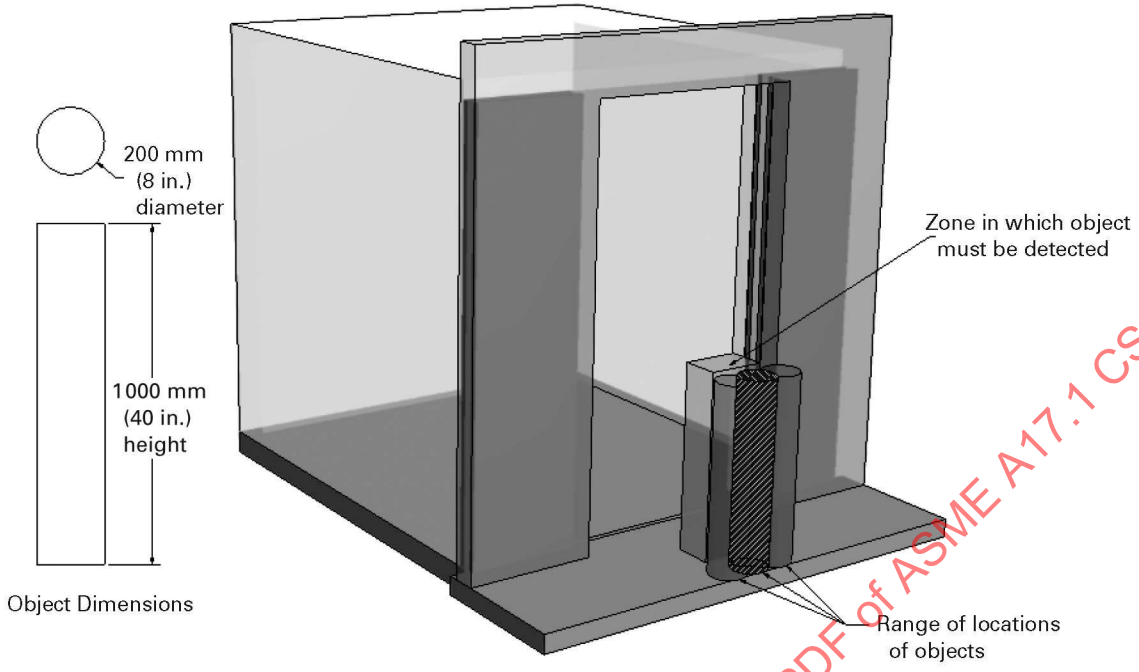
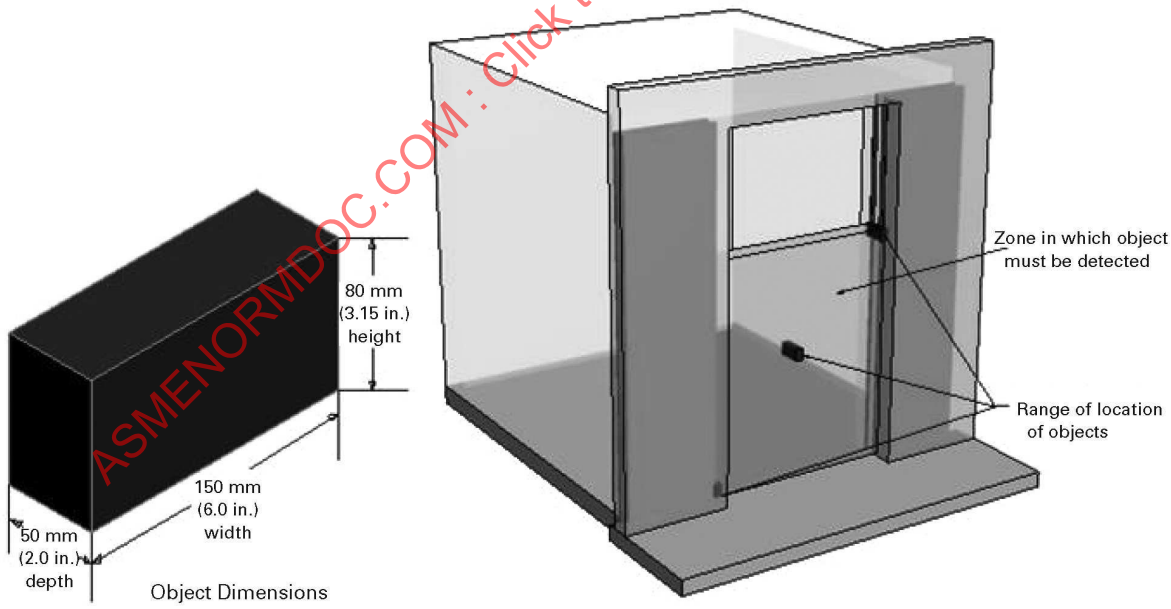
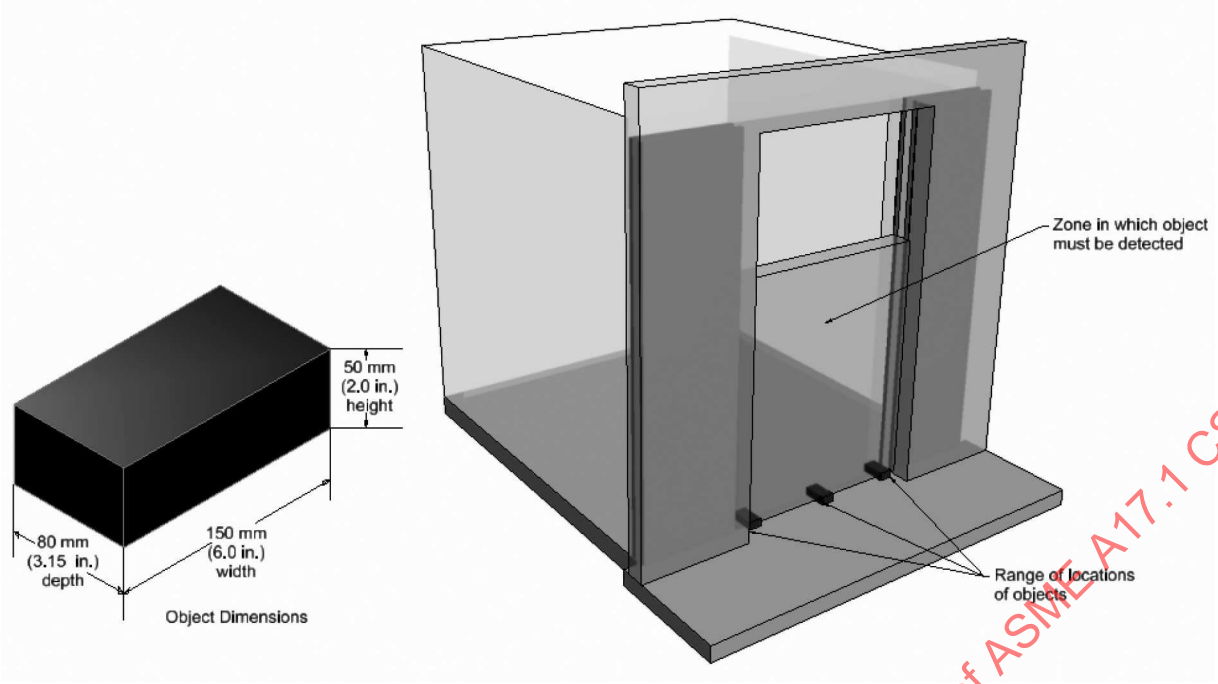


Diagram 2.13.5.4(a)
Prismatic Targets (Figure S-14)



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Diagram 2.13.5.4(b)
Prismatic Targets (Figure S-15)



SECTION 2.14
CAR ENCLOSURES, CAR DOORS AND GATES, AND CAR ILLUMINATION

2.14.1 Passenger and Freight Enclosures, General

2.14.1.1 Enclosure Required. The car enclosure includes the walls as well as the car top. It would be unthinkable today to allow an elevator to operate without a car enclosure, but elevators that did not have complete car enclosures were installed before the first edition of ASME A17.1/CSA B44. The car enclosure is intended to protect passengers from becoming entangled with hoistway equipment when the car is moving, falling out of the car, and being injured by falling objects.

2.14.1.2 Securing of Enclosures. The car enclosure must be constructed in such a manner that it cannot be dismantled from within the car. Decorative wall panels that are removable from inside the car must be backed up by a car enclosure meeting the requirements of 2.14.1.2.2. Holes in the car enclosure for attachment of removable panels that can be removed from inside the car are acceptable as long as the holes conform to the requirements of 2.14.1.2.4. The requirements provide occupants of elevators the protection of not having to ride an elevator exposed to an open hoistway, counterweights, rail brackets, etc., when the decorative panels of a chassis-type car are removed for repair or refinishing. They further prevent passengers from interfering with the movement of elevators by projecting objects through apertures where hanging decorative panels were attached and removed for repair or refinishing. Lighting deflectors and suspended ceiling should remain in place when the tests required by 8.10 and 8.11 are performed. If they remain in place during the test, it can be assumed that they conform to this requirement.

2.14.1.3 Strength and Deflection of Enclosure Walls. The strength requirements are based on limiting the allowable stress to the yield point of the material. See Diagram 2.14.1.3.

2.14.1.4 Number of Compartments in Passenger and Freight Elevator Cars. A multideck elevator is an elevator having two separate platforms and compartments, one above the other and supported within the same car frame. A multideck elevator is commercially referred to as a double-deck elevator. Both upper and lower decks may be loaded and unloaded at the same time. Cars can be arranged to serve either odd or even floors or all floors, whichever operation is desired.

2.14.1.5 Top Emergency Exits. The top emergency exit is used to evacuate passengers from a stalled elevator when exit through the car door or gates and hoistway door is not possible. As such, the exit must be clear of all obstructions, i.e., fixed elevator equipment. See

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Diagram 2.14.1.5.1(b)(2). Many manufacturers locate the top emergency exit within the refuge space on top of the car enclosure (2.4.12). This is not required by the Code but is the typical arrangement due to the limited space availability. The exit cover latch must be openable from the top of the car only, unless required to comply with the seismic provisions in 8.4.4.1.1 or where permitted for access to equipment located in the overhead and equipped with a Group 1 key. On many older installations, the exit cover was installed so that it opened from within the car only. A passenger in a stalled elevator should not be given the opportunity to exit the elevator without the assistance of trained elevator personnel. The exit cover should be latched in such a manner that it can be easily unlatched from the top of the car without the use of tools. Window sash latches and bolt latches are commonly used.

Requirement 2.14.1.5 was revised in ASME A17.1-2019/CSA B44:19 to permit the exit hatch cover to be opened from inside the car with the use of a key meeting Group 1 security requirements. Under certain conditions, equipment may need to be accessed from the car top but the car is unable to move below the top landing. In those cases, access to the equipment could only be done through the top emergency exit from inside the car. The revised language allows the top emergency exit to be used from inside the car provided the exit hatch cover meets the locking requirements previously approved in 8.4.4.1 for seismic situations.

The exit cover is required to be attached by chain or hinges to the car top at all times. It is required to open outward so that it will not infringe on the passenger space. The purpose is to ensure that the exit cover is not removed and cannot fall from the top of the car.

ASME A17.1/CSA B44 requires a car top emergency exit electrical protective device (2.26.2.18). The device will monitor the position of the top emergency exit and not allow operation of the elevator when the top emergency exit is in the open position, except as permitted by 8.4.4.1.2. The top-emergency-exit electrical protective device must be manually reset from the top of the car before normal operation can resume once the open exit cover has been closed. Closing the exit alone is not an acceptable means of "manually resetting" the electrical protective device. This requirement should help prevent use of the top emergency exit for carrying long objects in elevator cars.

For additional information, refer to ASME A17.4, Guide for Emergency Personnel.

2.14.1.5.1 Requirements 2.14.1.5.1(e) and 2.14.1.5.1(f) were revised in ASME A17.1-2016/CSA B44-16 because a separate refuge space is no longer specified in the Code. The clearances necessary for refuge space are now incorporated into the top-of-car clearance for both electric and hydraulic elevators.

2.14.1.5.2 Evacuation of passengers through the top emergency exit is not considered safe from elevators in partially enclosed hoistways. A top emergency exit is allowed but not required. It cannot be the means employed to evacuate passengers. A written evacuation plan is required by 8.6.10.4 for all elevators.

2.14.1.6 Car Enclosure Tops. This requirement ensures that the car top will be able to carry the weight of elevator personnel, emergency personnel, and others who might be on top of the car evacuating people from a stalled elevator. It also limits the deflection to ensure no equipment is damaged due to ceiling deflection.

Two unobstructed areas are required on top-of-car enclosure as it is common to find an inspector and mechanic on top of the car. ISO 15534-3-2000 anthropometric data was used to establish the unobstructed area dimensions.

2.14.1.7 Railing and Equipment on Car Enclosure Top. A standard railing (2.10.2) is required for protection of personnel working on top of completed cars whenever the specified horizontal clearance is exceeded. The vertical clearance above the top rail is 150 mm or 6 in. when the car has reached its maximum upward movement [2.4.6.2(c)]. See Handbook commentary on 2.10.2.

2.14.1.7.1 A person should not stand on the car top area between the standard railing and the edge of the car top perimeter. This requirement was revised in ASME A17.1-2016/CSA B44-16. Prior to the 2016 edition, this provision required a railing when there was a horizontal clearance of 300 mm or 12 in. between the working platform or car enclosure top and the hoistway enclosure regardless of the overall size of that space. The intent of the requirement is to protect against fall hazards, so the requirement was updated to more effectively define the space. Anthropometric data from ASME A17.7/CSA B44.7, Nonmandatory Appendix B show the body thickness to be 342 mm, so a 300-mm or 12-in. circular space in all orientations as defined by a 300-mm or 12-in. sphere is small enough to provide protection from the fall hazard.

2.14.1.7.2 This requirement provides adequate clearances against shearing and crushing hazards if elevator personnel have a hand on the top rail of the standard railing when the car reaches maximum upward movement. ISO 15534-3-2000 anthropometric data was used to establish dimensions. The requirement was revised in ASME A17.1-2016/CSA B44-16 to ensure protection of elevator personnel against shearing hazards throughout the hoistway between the top rail and intermediate rail of the standard railing and fixed equipment passed or approached by the standard railing as the car moves throughout the hoistway.

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2.14.1.7.4 This requirement was added in ASME A17.1a-2002 and CSA B44 Update No. 1-02 to address devices detecting unauthorized access to the top-of-car. When provided, requirements were needed to prohibit interference with the safe access and control of the elevator by elevator personnel. Such devices, when provided, are permitted to only initiate an audible alarm, which shall not exceed 90 dBA measured 1 m from the source. There is no need to include an imperial conversion for the 1 m dimension, as that dimension is standard industry practice for sound measurement.

2.14.1.8 Glass in Elevator Cars. Laminated glass when shattered will normally remain in place, thus assuring the safety of the passengers in the elevator. In an observation elevator, if shattered glass will not stay in place, a railing or framing is required that will guard the opening.

2.14.1.8.2 Requires all glass to meet the requirements for laminated glass in ANSI Z97.1-1984 or 16 CFR Part 1201, Sections 1201.1 and 1202.2 or CAN/CGSB-12.1. The Consumer Product Safety Commission Standard 16 CFR, Part 1201 is more stringent than ANSI Z97.1. See Handbook commentary on 2.11.7.2. Laminated glass is defined by 16 CFR as "glazing material composed of two or more pieces of glass, each piece being either tempered glass, heat strengthened glass, annealed glass, or wired glass, bonded to an intervening layer or layers of resilient plastic material." The ANSI Z97.1 definition is similar.

Bonded glass, which is equivalent to laminated glass, is permitted by 2.14.1.8.2(c) and prohibits the use of film coatings (organic-coated glass, etc.), which are easily damaged, rendering them ineffective. It provides performance language requirements to bond glass fragments and retain broken glass.

Glass is required to be tested in accordance with the applicable standards. Testing requirement for laminated glass applies to both laminated and bonded glass. It recognizes alternative technology for glass products that are equivalent to laminated glass but do not meet the definition for laminated glass.

All glass used in the elevator must be installed in such a manner that it does not become dislodged during the test specified in Sections 8.6 and 8.10.

2.14.1.8.4 Field marking identifies glass that complies with these requirements. This marking is to be on each separate piece of glass and remain visible. Certain specific types of glazing material have additional marking requirements.

2.14.1.9 Equipment Inside Cars. An ashtray is one type of equipment or apparatus that is prohibited by this requirement from being installed inside elevator cars. A fixed bench is permitted. The only equipment or apparatus permitted to be installed in the car, which is not used in conjunction with the use of the elevator, is that equipment that is listed, such as conveyor, tracks, lift hooks, and suspension support beams. Lighting, heating, ventilation, and air-conditioning equipment are also permitted.

Depending on the design and construction of the equipment installed in the car, it may be necessary to evaluate the total construction of the item and part of the car wall to which it is fastened, in accordance with the requirements of 2.14.2.1.1. Consultation with the testing laboratory will be necessary to determine the specified testing criteria.

Picture frames, graphic display boards, etc., are subject to the fire test requirements in 2.14.2.1. In their end use configuration, they must have a flame spread rating of 0 to 75 and smoke contribution of 0 to 450. The projection from the wall is limited to reduce the possibility of injury to the occupants of the car.

Requirement 2.14.1.9.1 was revised in ASME A17.1-2022/CSA B44:22 to allow the installation of ERRC equipment in the elevator car. The communication equipment technology used by emergency responders has changed. Radio equipment has replaced the plug-in phones used in the past. Ensuring reliable emergency responder communications while inside the elevator car enhances the safety of building occupants. Allowing ERRC equipment, including antennas, to be installed in the hoistway and the elevator car make improved reliability possible.

This equipment was not previously addressed by ASME A17.1/CSA B44. Model fire codes and model building codes have been revised to require ERRC in buildings in lieu of the firefighters' phone jack system. There is a published national standard, UL 2524, for this equipment. NFPA 1225 is replacing NFPA 1221 and was published in 2021. NFPA 1225 just added all elevators, in addition to elevator lobbies, as critical areas in the building requiring 99% first responder radio coverage (see NFPA 1225, Section 18.8.3).

Detailed requirements for the installation, use, and access to ERRC equipment in the hoistway and the elevator car enclosure were added in 2.27.12. The equipment is for exclusive use by emergency responders. The immunity tests required in EN 12016 and ISO 22200 cover the radio frequencies used in the U.S. EN 12016 covers the frequency range of 80 MHz to 1,960 MHz and ISO 22200 covers a range of 80 MHz to 2,170 MHz. Typical fire department frequencies are in the VHF high band (150 MHz to 160 MHz) or the UHF ultra-high band (450 MHz to 470 MHz).

ERRC equipment in the hoistway, or on the car, cannot interfere with normal elevator operation, inspection of the elevator, repair of the elevator, or maintenance of the elevator, and running clearances must be maintained. Equipment must be designed and installed so that no maintenance is required or so that maintenance can be done without entering the hoistway. The equipment is also required to be guarded to prevent damage and to prevent objects from falling into the hoistway. See also Handbook commentary on 2.27.12.

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2.14.1.10 Side Emergency Exits. The safest means for evacuating passengers is through the hoistway entrance, and if that is not possible, then through the top emergency exit. ASME A17.1a-2002 and CSA B44 Update No. 1-02 prohibited the installation of side emergency exits. Side emergency exits have not been required since ASME A17.1-1991.

The safest practice to remove passengers from a stalled elevator is to move the elevator car to a landing level. The top emergency exit allows the best alternate means to rescue passengers and to allow emergency personnel access to the car interior.

Side emergency exits require trained elevator personnel in order to line up the elevators properly to use the side emergency exit safely. If these individuals are present, they should be able to get the elevator safely to a floor instead of using the side emergency exit. There have been known incidents of injuries from the use of side emergency exits by individuals who are not properly trained in evacuation procedures. In most cases, it is not possible to level the rescue car with the stalled car by other than the top-of-car operating device. This requires elevator personnel who can usually move the car to a landing and allow persons to safely exit the car.

Another difference between side emergency exit and top emergency exit is that with side emergency exit there is no control over the occupants of the elevator when the door is initially opened. With the top emergency exit, there is control. When using a side emergency exit, passengers could panic and fall through the door upon it being opened. Such is not the case with a top emergency exit. It is also noted that top-of-car guard rails have been required since ASME A17.1-2000 and CSA B44-00, thus minimizing the fall hazard.

The top emergency exit is also more tamper-resistant than a side emergency exit.

For detailed information on the evacuation of passengers from a stalled elevator, refer to ASME A17.4.

2.14.2 Passenger-Car Enclosures

2.14.2.1 Material for Car Enclosures, Enclosure Linings, and Floor Coverings. The requirements for the materials used in the 1984 and earlier editions of ASME A17.1 left a lot to the imagination. Those requirements were intended to protect a car from a fire to which only the exterior of a car was exposed. Requirements were developed for the 1955 edition of A17.1 and were correct for the construction and conditions that were prevalent at that time. They covered conditions that included oiled rails for car guide shoes and leaking geared machines, the oil from which could go down the hoistway landing on the top of the car, which could lead to a fire in the hoistway.

Construction of elevators has changed over the years, resulting in a decreased fire exposure to the exterior of the car. With the introduction of new materials in the late 1970s, some argued that there was a fire exposure to the interior. Regardless, fire protection to the interior of passenger car enclosures was not addressed in the earlier editions of ASME A17.1 and CSA B44. A study of this subject was begun in the early 1980s when it became apparent that the building codes were poised to act. The results of that study were revisions that first appeared in ASME A17.1a-1985.

There is no requirement for labeling of any of the material used in passenger car enclosures, in keeping with standard construction practice. If an enforcing authority, building owner, etc., questions the material used, all they need to do is request a copy of the test report from the supplier. The test report required by all of the test procedures discussed below will give sufficient information to evaluate the material supplied to ensure that it complies with the requirements of the Code.

2.14.2.1.1

2.14.2.1.1(a) This requirement addresses the materials used for car construction in the United States. It requires all material in its end use configuration, except metal or glass, to be subjected to a Steiner tunnel test specified in ASTM E84, ANSI/UL 723, or CAN/ULC S102. In the test, a specimen 508 mm by 7.6 m or 20 in. by 25 ft is placed on a ledge in the top of the Steiner tunnel furnace in a facedown position, leaving an exposed area 0.45 m by 7.6 m or 17.5 in. by 25 ft. A double-jet gas burner located 305 mm or 1 ft from the air intake of the tunnel is adjusted to provide approximately 5,000 Btu/min for a test period of 10 min. This pulls the gas flame downstream for approximately 1.4 m or 4.5 ft at the beginning of the test, leaving approximately 5.9 m or 19.5 ft of specimen for the flame to advance during the test. Flame travel is observed through sealed windows, and forms the basis for the flame spread rating. Furnace temperature and smoke density are also recorded, and these figures are the basis for calculating fuel contribution and smoke development. Ratings are based on an arbitrarily assigned 0 rating for asbestos-cement board and 100 rating for red oak flooring. It should be noted that there is not necessarily a relationship between flame spread, smoke development, and fuel contribution. ASME A17.1/CSA B44 specifies that acceptable passenger car enclosure materials have a flame spread rating of 0 to 75 and smoke development of 0 to 450. Fuel contribution is not specified and is normally not a requirement in any modern code. In general, material is classified by the building codes based on a flame spread rating as

(a) 0 to 25 Class A or 1
(b) 26 to 75 Class B or 2
(c) 76 to 200 Class C or 3

You will find codes that mandate Class A or 1 material in certain occupancies.

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It is the intent of 2.14.2.1 that metal and its painted or lacquered finish does not have to meet the requirements of 2.14.2.1.1 through 2.14.2.1.5. The application of a paint or lacquer finish to metal does not significantly add to the fire exposure of the car enclosure material.

A key requirement is that the material must be tested in its end use configuration. That statement requires car enclosure walls of sandwich construction to be tested as one complete sample. It is not permitted to take the individual component of the sandwich construction and test them individually and average all the results to get the flame spread and smoke development rating. When these products are combined and tested as one, the results will most likely be entirely different. The materials are also required to be tested on both the side exposed to the car interior and the side exposed to the hoistway.

In reviewing the requirement for testing of the enclosure material in its end use configuration with manufacturers who have tested walls, it has been shown that wall veneers, their finishes, and adhesives have a direct bearing on the results of the test. Testing has shown that minor changes of any one component, even when that component was acceptable when tested individually, have resulted in unacceptable flame spread and smoke development ratings for the car enclosure in their end use configuration.

2.14.2.1.1(b) In the past, napped, tufted, woven, looped (i.e., carpet), and similar material used on car enclosure walls was prohibited. This material is now permitted as long as it passes the vertical burn test as called for in 8.3.7 or in Canada the NBCC or National Fire Code of Canada. The vertical burn test (8.3.7) is based on the applicable portions of a Federal Aviation Administration (FAA) test. A specimen is placed in a draft-free cabinet 19 mm or 0.75 in. above a Bunsen burner with a flame length of 38 mm or 1.5 in. applied for 12 s, then removed. After the burner is removed, flame time, burn length and flaming, and time of the drippings are recorded. The material is acceptable if

(a) average burn length does not exceed 203 mm or 8 in.

(b) average flame time after the removal of the burner does not exceed 15 s

(c) the drippings do not flame for more than 5 s

The fabric or carpeting must meet the requirements of 2.14.2.1.3. The substrate must meet the requirements of 2.24.2.1.1.

Padded protective lining must be subjected to the Steiner tunnel test or vertical burn test and conform to the acceptable criteria for said test. Lining must also clear the floor by a minimum of 100 mm or 4 in., so they do not obstruct car vents.

2.14.2.1.1(c) The last subject covered is floor covering, underlayment, and its adhesive. This material is subjected to the critical radiant flux test using a radiant heat energy source, ASTM E648 or NFPA 253. The test chamber consists of an air-gas fueled radiant heat energy panel inclined at 30 deg and directed at a horizontally mounted floor covering system specimen approximately 203 mm by 1 016 mm or 8 in. by 40 in. The floor-covering specimen should duplicate insofar as possible an actual field installation. Thermal energy is supplied by the radiant heat panel. A pilot light at one end provides the ignition source. Flame travel is then observed through a window in one side of the test chamber. The distance burned to flame-out is converted to watts per square centimeter from a flux profile graph and recorded as critical radiant flux w/cm^2. Unlike the other test addressed above, the higher the w/cm^2, the more resistant the floor covering is to the propagation of flame.

2.14.2.1.2 This requirement applies only in Canada and was revised in ASME A17.1-2013/CSA B44-13 to coordinate with changes in the 2010 edition of NBCC. See Handbook commentary on 2.14.2.1.1(a).

2.14.2.2 Openings Prohibited. This requirement prohibits openings in the sides of car enclosures to prevent a hazardous exposure to the passengers riding in the car. Panels that are designed to form an integral part of the enclosure and that are secured in place by means that are not accessible from inside the car are permitted.

Requirement 2.14.2.2 was revised in ASME A17.1-2019/CSA B44:19 to include the new term “closed detection means” and to renumber references.

2.14.2.3 Ventilation. Natural ventilation by means of vent openings is required on all passenger elevator cars. The openings are required to be equally divided between the top and bottom to facilitate natural airflow by convection. The requirement further stipulates that vent openings shall not be located in that portion of the side enclosure between a height of 300 mm or 12 in. and 1 825 mm or 72 in. above the car floor. It does not exclude the top of the car as a location for vent openings. The clearance between the car door panel and frame qualifies as a vent opening.

2.14.2.3.2 Fans are not required but where provided they must be installed to comply with this requirement to prevent infringing on passenger space. The direction of airflow is not addressed by the Code, however, most fans exhaust air from the car interior.

2.14.2.3.3 Observation elevators exposed to direct sunlight must be provided with forced (mechanical) ventilation. In observation elevators with glass walls exposed to direct sunlight, if a passenger were trapped in a stalled elevator and forced ventilation was not provided, the passenger could be endangered. The CFM rating of the fan as installed must equal the volume inside the car. The auxiliary power to operate this ventilation for 1 h is deemed adequate to provide sufficient time for rescue during a power outage. The Note provides guidance

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to the designer to consider environmental conditions such as the need for heat in extreme cold climates.

Requirement 2.14.2.3.3 was revised in ASME A17.1-2019/CSA B44:19 to be consistent with the new definitions for auxiliary power supply and emergency or standby power.

2.14.2.5 Vision Panels. The restriction of the size of the vision panel is to reduce the hazard if the glass is broken. The term "total area" refers to the sum total of all vision panels. On older installations where larger vision panels were provided, there is a history of decapitations and amputations where panels were broken. Laminated glass panels and wire glass panels when broken will normally stay in one piece. On power-operated car doors, the glass must be located substantially flush with the inside surface of the door in order to reduce a pinching hazard when the door is opening or closing.

2.14.2.6 Access Panels. This requirement was introduced in ASME A17.1-2000 and CSA B44-00 and is intended to provide safe access for cleaning glass in the hoistway. It had appeared in earlier editions of the CSA B44 Code. Stringent requirements for panel design and installation are specified to prevent misuse. A written glass cleaning procedure including training of persons assigned to clean glass outside the car and inside the hoistway is required by 8.6.11.3.

2.14.3 Freight-Car Enclosure

2.14.3.1 Enclosure Material. Freight cars must be enclosed on all sides except the sides used for entrance and exit. The car enclosure must be so constructed that removable portions cannot be dismantled from within the car. Walls of freight cars must be solid to a height of 1 825 mm or 72 in. above the floor. Above that point, the enclosure may be perforated as long as it rejects a ball 25 mm or 1 in. in diameter. The top of the car enclosure may also be perforated as long as it also rejects a ball of 25 mm or 1 in. in diameter. The car enclosure wall, in front of and to a point 150 mm or 6 in. on each side of the counterweight, must be solid. See Diagram 2.14.3.1.

If a freight elevator is permitted to carry passengers, perforations in the enclosure are not permitted.

2.14.3.2 Openings in Car Tops. Common freight car construction incorporates a top emergency exit opening that extends the full width of the car with a minimum depth of 400 mm or 16 in. Usually an emergency exit of this construction is located at the front of the car top enclosure.

2.14.4 Passenger and Freight Car Doors and Gates, General Requirements

2.14.4.1 Where Required. Car door or gate electric contacts must be so located that they are not readily accessible from inside the car. They must be opened positively by a lever or other device attached to and operated by the door or gate. They must be maintained in the open position by the action of gravity or by a restrained compression spring, or by both, or by positive mechanical means.

2.14.4.2 Car Door and Gate Closed Detection Means and Car Door Interlocks. The title of Requirement 2.14.4.2 was revised in ASME A17.1-2019/CSA B44:19 to include the new term "closed detection means" and to be specific about car doors.

2.14.4.2.1 Requirement 2.14.4.2.1 was revised in ASME A17.1-2019/CSA B44:19 to include the new term "closed detection means" and to editorially renumber the reference requirements.

2.14.4.2.2 A car door interlock is the same as a hoistway door interlock. It is required to be provided on car doors when the clearances in 2.5.1.5 are exceeded. A typical application is an observation elevator in a partially enclosed hoistway with front and rear entrances.

2.14.4.2.3 The car door or gate electric contact can be located within the power door operator enclosure. The contacts within the enclosure of the power door operator must be connected by a lever or other means to the door to be positively opened in order to conform this requirement.

Switches that depend solely on "snap action" to open their contacts do not meet the requirements of this requirement. See Diagram 2.14.4.2.3.

Requirement 2.14.4.2.3 was revised in ASME A17.1-2019/CSA B44:19 because the requirements for the detection means that use contacts to detect the closed position were moved to new Requirement 2.14.4.2.4.

2.14.4.2.4 Requirement 2.14.4.2.4 was added in ASME A17.1-2019/CSA B44:19 to include the new term "closed detection means" and to move the requirements for the detection means that use contacts to detect the closed position to this new requirement.

2.14.4.2.5 Requirement 2.14.4.2.5 was added in ASME A17.1-2019/CSA B44:19 to include requirements for detection means that use SIL rated devices to detect the closed position.

2.14.4.2.6 This requirement was revised in ASME A17.1-2016/CSA B44-16 to reference 2.12.1 so users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

Requirement 2.14.4.2.6, formerly 2.14.4.2.4, was editorially renumbered in ASME A17.1-2019/CSA B44:19.

2.14.4.2.7 See Handbook commentary on 2.12.4.

Requirement 2.14.4.2.7, formerly 2.14.4.2.5, was editorially renumbered in ASME A17.1-2019/CSA B44:19 and revised to include the new term "closed detection means."

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2.14.4.2.8 The function, description, testing, listing, and marking requirements for a hoistway door interlock are the same as for a car door interlock. There should be no need to resubmit an approved hoistway door interlock so that it also can be used as a car door interlock.

Requirement 2.14.4.2.8, formerly 2.14.4.2.6, was editorially renumbered in ASME A17.1-2019/CSA B44:19.

2.14.4.3 Type and Material for Doors. See Handbook commentary on 2.11 for description and diagrams of horizontally and vertically sliding type doors. See also Handbook commentary on 2.14.2.1 and 2.14.3.1 for door material requirements.

2.14.4.4 Type of Gates. Horizontally sliding collapsible-type gates are permitted only on freight elevators designed for Type A loading (2.14.6.1).

2.14.4.5 Location. The distance between the hoistway doors and the car doors, or gates on automatic or continuous-pressure elevators, is restricted to eliminate the possibility of a person being caught between the car and the hoistway doors or gates. See Diagrams 2.14.4.5(a) and 2.14.4.5(b).

On many older elevators installed before these requirements were incorporated into the Code, the bottom of the hoistway door is fitted on the hoistway side with a filler that is beveled so a person cannot stand on the hoistway sill when the door is closed. See ASME A17.3, Figure A3 for door filler construction details.

2.14.4.6 Strength of Doors, Gates and Their Guides, Guide Shoes, Tracks, and Hangers. This requirement added in ASME A17.1-2010/CSA B44-10 reduces the allowable deflection for all types of sliding doors from the line of the car sill to a maximum of 12 mm or 0.5 in. It also extends the force and deflection requirements applicable to single and multisection horizontal slide and vertical slide car doors when the force is applied on the car side of the car door to folding doors and gates.

When combining swing landing doors with folding car doors or collapsible gates, excessive deflection of the gate or folding car door away from the landing door can create a space whereby a person might become entrapped. This requirement incorporates a limit on how far the car door or gate can deflect away from the landing door.

The requirement also clarifies that the applicable forces and deflection limitations apply to each individual panel of a folding door or gate and addresses loading criteria should the width of the panel be less than 300 mm or 12 in. Language also reduces the risk of entrapment at any point in the lower part of the door, gate, or folding door.

ASME A17.1-2010/CSA B44-10 added a requirement prohibiting folding doors on new passenger elevators (2.14.5.2). Folding doors are allowed on existing passenger elevators to replace collapsible car gates.

2.14.4.7 Vertically Sliding Doors and Gates. Passenger elevators must have doors, not gates (2.15.5.2).

2.14.4.8 Weights for Closing or Balancing Doors or Gates. If the weights are not guided or restrained from coming out of their runway, they could snag in the hoistway as the car is moving. If the weights were exposed inside the car enclosure, there could be a hazard to the occupants of the elevator. The weights must be restrained if the suspension member fails to stop them from a free fall within the hoistway.

2.14.4.10 Power-Operated and Power-Opened or Power-Closed Doors or Gates. See Handbook commentary on Section 2.13 and the requirements within that Section.

2.14.4.11 Closed Position of Car Doors or Gates. See Diagram 2.14.4.11.

Requirement 2.14.4.11 was revised in ASME A17.1-2019/CSA B44:19 to revise the conditions for the car door to be considered closed when the car door is provided with an interlock. The committee concluded that a car door interlock that could open 30 mm prior to disconnecting power when used without a fascia provided equivalent safety to a gate switch that could be opened 50 mm when used with a fascia. The committee based this conclusion on the fact that using the 30-mm allowance would disconnect power in the same amount of time as the opening allowed for a gate switch and the 30-mm dimension would not allow an adult forearm to extend through the opening enough to defeat the interlock without special knowledge and tools. Since passengers would be unable to defeat the interlock with an opening dimension of 30 mm, the committee concluded that retaining the previous 10 mm dimension did not provide any additional safety.

2.14.5 Passenger Car Doors

2.14.5.1 Number of Entrances Permitted. The more entrances, the greater the risk, as passengers do not know which door will open next. If they lean against a door, it might open, resulting in passenger injury.

2.14.5.2 Type Required. As a door is solid and a gate is perforated, a door reduces the passengers' risk of exposure to unsafe conditions.

2.14.5.3 Vertically Sliding Doors or Gates. When a slide-up-to-open door or gate faces other types of hoistway doors, even horizontally sliding doors, it is not necessary to have the car door or gate be power operated.

2.14.5.6 Door Panels. See Diagrams 2.14.5.6(a) through 2.14.5.6(c).

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2.14.5.6.2 Indentations and moldings have the potential to snag on clothing and could pinch a finger or hand during door operation.

2.14.5.7 Restricted Opening of Car Doors. The requirement was relocated from 2.12.5 and revised in ASME A17.1-2013/CSA B44-13 as the revised requirement pertains to car doors and no longer pertains to hoistway doors.

When a passenger elevator is outside the unlocking zone, it is unsafe for a passenger to try to exit through the elevator entrance unassisted. When a car is above the unlocking zone, the platform guard (apron) may not be long enough to close off the hoistway opening below the car. If this condition exists, a person exiting the elevator is exposed to the open hoistway. In fact, there have been many reports of fatalities due to this condition. A person inside the car should not be able to accomplish their own emergency evacuation through a hoistway door when the car is located outside of the unlocking zone. See Handbook commentary on 2.11.6 and Diagram 2.14.5.7.

The Code permits a door restrictor that releases the car door in the unlocking zone and that relies on primary power. However, a secondary power source that relies on periodic maintenance, such as a battery or generator, must also be provided to release the car door when the primary power is lost.

Requirement 2.14.5.7 was revised in ASME A17.1-2019/CSA B44:19 to clarify that the reference to 2.14.5.7 applies to car door restrictors, not car door interlocks, and to update the references to include new requirement 2.14.5.7.6. The means to restrict the door opening can be either a door restrictor or an interlock.

2.14.5.7.1 and 2.14.5.7.3 These requirements were revised in ASME A17.1-2016/CSA B44-16 to reference 2.12.1 so users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

2.14.5.7.4 This requirement was introduced in ASME A17.1-2013/CSA B44-13 to add and clarify requirements for means to restrict door opening as a result of the use of new technology that requires electrical power. Additional incentive came from requests for interpretation.

The portion of the means dependent on power would include the circuitry incorporated in the means, and a solenoid coil and plunger, where used, but not the mechanical portion of the means.

The specification of 1 h is sufficient time for the restricting means to initiate unrestricting in the unlocking zone. It is also sufficient in the case where power is required to initiate restriction, including when power is lost and the car is moving from inside the unlocking zone to outside the unlocking zone.

The use of power to initiate but not maintain a function is permitted in the Code. See also 2.7.5.2.1(b)(6).

Requirement 2.14.5.7.4 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definitions for "auxiliary power supply" and "normal building power."

2.14.5.7.5 Strength. This requirement was added in ASME A17.1-2013/CSA B44-13 and specifies similar forces for means used to restrict car doors as those required for door interlocks in 8.3.3.4.8.

Requirement 2.14.5.7.5 was revised in ASME A17.1-2019/CSA B44:19 because the committee recognized that the new requirement should have been the same as the existing requirements for not only interlocks in 8.3.3.4.8, but also hoistway landing doors, as per 2.11.11.5.8. When the force is exerted at the bottom of the door panels, particularly tall doors (8 ft to 9 ft.), the door panels could pivot, allowing a gap greater than the required 4 in.

2.14.5.7.6 Requirement 2.14.5.7.6 was added in ASME A17.1-2019/CSA B44:19 to include requirements for engineering tests and a static test of car door restrictors with moving parts similar to applicable requirements for car and hoistway door interlocks. These requirements were added to increase their robustness and reliability because of reports that some restrictors malfunction and do not lock properly.

2.14.5.8 Manual Opening of Car Doors. When a passenger elevator is within the unlocking zone (see Diagram 2.14.5.7) up to 175 mm or 7 in. above or below the landing, a person may be able to open the car door or gate and its related hoistway door from within the car. This requirement may be modified by a locked-out-of-service entrance. See 2.11.6 for where a locked-out-of-service entrance is permitted.

When the elevator is outside the unlocking zone, it is unsafe for a passenger to try to exit through the elevator entrance unassisted. When a car is above the unlocking zone, the platform guard (apron) may not be long enough to close off the hoistway opening below the car. If this condition exists, a person exiting the elevator is exposed to the open hoistway. There have been many reported fatalities due to this condition.

Requirement 2.14.5.8 was revised in ASME A17.1-2016/CSA B44-16 to reference 2.12.1 so users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

2.14.5.9 Glass in Car Doors. This requirement makes a distinction between vision panels and glass doors. Laminated glass is required to maintain the integrity of the opening protection if the glass is broken. The minimum area requirement for the glass door ensures that these requirements are not used to install oversized

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vision panels. However, sufficient nonglass area may be needed for the mounting of interlocks, safety edges, etc. The Consumer Product Safety Commission (CPSC) standard would apply, as the glazing would be classified by the building codes and the CPSC as being in a location subject to human impact loads.

Protection is required on glass door edges as door panels tend to be struck by carts, etc., and if glass was not protected, the edges might chip and become hazardous to people passing through the doorway. The thickness of the glass will be dictated by the structural requirements (2.14.4.6).

Requirement 2.14.5.9.2 was revised in ASME A17.1-2022/CSA B44:22 to provide the ability to design glass doors with additional steel reinforcement if desired. The current glass area of 60% minimum limits the area that supports the glass to 40%. By reducing the minimum glass area to 50% the area that is available to support the glass is increased.

2.14.6 Freight Elevator Car Doors and Gates

2.14.6.1 Type of Gates. This requirement specifies what type gate is permitted based on the class of freight loading. The requirements do not apply to doors.

2.14.6.2 Vertically Sliding Doors and Gates

2.14.6.2.1 Object detection and reversal of power-operated vertical freight doors require that car doors and gates be power operated and of a type that slide up to open. Clarification that power-opened-only doors are permitted and that power closed doors must also be power-openable.

2.14.6.2.3 If a reopening device is provided, and someone deliberately pushes their toe or foot against the reopening device and manages to bend it, they would have to extend the toe several inches beyond the car door before contacting the hoistway wall. See Diagram 2.14.6.2.3 for illustrations of typical car door/gate arrangements.

2.14.6.3 Collapsible-Type Gates. See Diagram 2.14.6.3 for illustrations of collapsible-type gates.

2.14.6.3.3 This ensures that the gate in the extended position cannot be forced towards the hoistway and thus interfere with the running clearances of the car.

2.14.6.3.4 A restriction on the distance that a collapsible car gate can be power-opened (2.13.2.1.2) is specified to ensure that a hand or finger will not be pinched in the opening of the car gate.

2.14.6.4 Folding Car Doors. Applicable design requirements for folding doors were added in ASME A17.1-2010/CSA B44-10. See Handbook commentary on reference requirements.

This requirement, formerly 2.14.5.10, was redesignated in ASME A17.1-2016/CSA B44-16 because folding doors are prohibited for passenger elevators (see 2.14.5.2) for new installations. Folding car doors are permitted for freight elevators (see 2.14.6). The Committee's original intent in adding folding car door criteria to 2.14.5 was to provide requirements for the replacement of existing folding car doors. However, replacement criteria belong in Section 8.6, not in Part 2.

2.14.7 Illumination of Cars and Lighting Fixtures

2.14.7.1 Illumination and Outlets Required. Two lamps are required for both normal and auxiliary lighting such that if one burns out, passengers in the car will not be in total darkness. The same two lamps may be used for both normal and auxiliary lighting. Two fluorescent lamps powered from a single ballast or two incandescent lamps or other types (e.g., LEDs) connected in series do not conform to this requirement. Minimum illumination levels provide adequate lighting for safe ingress to and egress from the car. An auxiliary lighting power source ensures that the passengers in an elevator will not be in total darkness if power to the normal lighting system fails. The auxiliary lights must turn on automatically when "normal car lighting power fails," such as failure of the car lighting circuit, traveling cable, etc.

New technology allows the possibility of a system where when one lamp burns out or is not functional, the other lamp will illuminate. In addition, the new requirement also addresses systems with a primary and redundant set of lights, in which the redundant lamps illuminate upon failure of the primary set of lamps. This requirement ensures that when any one lamp or set of lamps becomes nonfunctional, it does not leave the car without normal illumination.

2.14.7.1.1

2.14.7.1.1(a) If a system with a single lamp is provided to illuminate the car, that single lamp must provide sufficient illumination. In multi-lamp systems where all lamps are illuminated simultaneously, the combination of the lamps must provide sufficient illumination.

2.14.7.1.1(b) Adds a requirement for systems relying on a single lamp or set of lamps to illuminate the car. The unlit lamp or set of lamps is required to immediately illuminate should the current lamp illuminating the car malfunction and no longer be able to illuminate the car. These provisions ensure continuous illumination in the car.

2.14.7.1.1(c) In systems employing simultaneously lit multiple lamps of approximately equal illumination, it should be noticeable when one is burned out or not functional. In contrast, in a system that relies on a single lamp or set of lamps to illuminate the car combined with a backup lamp or set of lamps that only illuminates should the first lamp or set of lamps malfunction, it will not be so noticeable that the first lamp or set of

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lamps is no longer functional. It is important that authorized personnel are notified so that the nonfunctioning lamps or set of lamps gets replaced before the second one burns out or becomes nonfunctional. Visual signals might include an indicator on the car panel or light fixture.

2.14.7.1.3 An auxiliary lighting power source is required to be placed on each elevator car. The building standby power generator is not a recognized alternative to this requirement. The building standby power generator would normally not be activated unless the main building power was lost and would not respond to just the loss of an elevator lighting circuit. Additionally, the building standby power source would rely on the elevator traveling cable to maintain elevator lighting and would not activate the auxiliary lighting if the traveling cable was the source of the lighting problem. Elevator occupants must be provided with a source of reliable lighting.

2.14.7.1.3(a)(6) There was confusion in the industry about whether the push button should be called "HELP" or "PHONE," particularly with the Braille marking. The "PHONE" symbol is universally understood, and eliminating "HELP" will eliminate confusion without any loss of meaning for the button.

2.14.7.1.3(g)(4) Requirement 2.14.7.1.3(g)(4) was revised in ASME A17.1-2019/CSA B44:19 to update the references to include all of the emergency signaling devices in Section 2.27.

Per ICC/ANSI A117.1 and ASME A17.1/CSA B44 Appendix E, emergency control buttons are required to be located a minimum of 890 mm or 35 in. above the car floor. In most cases, floor buttons are permitted to be 1 220 mm or 48 in. above the car floor. Auxiliary lighting is required to illuminate the car operating panel with the minimum illumination over the entire area.

Requirement 2.14.7.1.3 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definition for "main line power."

2.14.7.1.4 Each elevator must be provided with lighting on the car top that provides an illumination level of not less than 100 lx or 10 fc measured at the point where maintenance or inspection is to be performed. Lighting must be permanently connected, fixed or portable (nonremovable) as on a pendant. All lighting shall be equipped with guards. The light switch shall be accessible from the landing when accessing the car top. A duplex receptacle with a GFCI protection is required per NFPA 70® and CSA C22.1.

2.14.7.2 Light Control Switches

2.14.7.2.1 Interior car lighting may be controlled by a switch to facilitate maintenance of the lighting equipment. The switch must be either key operated or in a fixture with a locked cover to ensure that the lights can be turned off only by authorized personnel.

2.14.7.2.2 This requirement permits car lights to be automatically shut off. These requirements are intended to ensure that before turning the lights off no one is in the car.

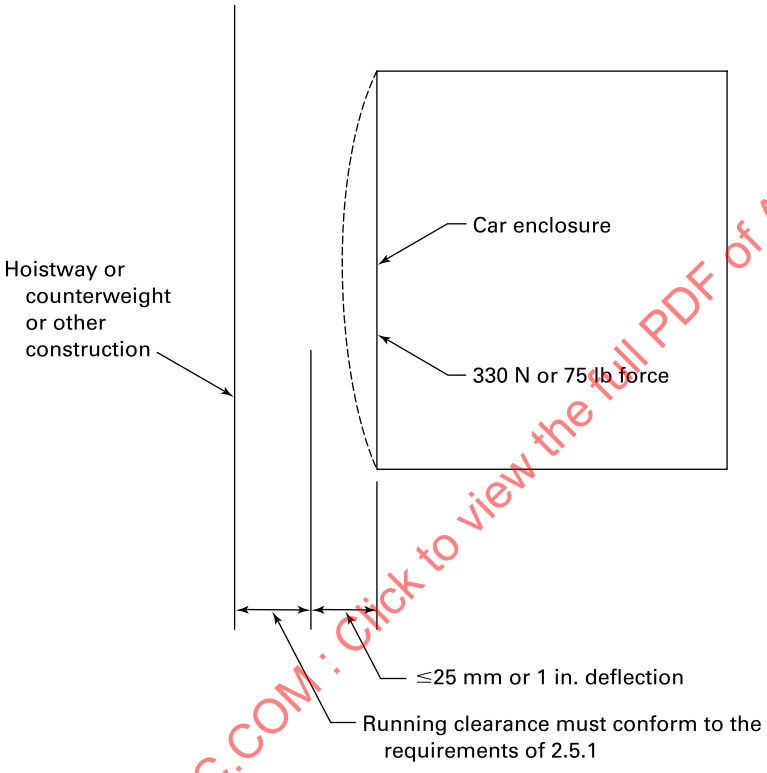
2.14.7.3 Car Lighting Devices. Glass used for lighting fixtures must be laminated glass meeting the requirements of 2.14.1.8. Glass shall be installed and guarded so as to provide adequate protection of passengers in case the glass panel breaks or is dislodged. The glass and the structure the glass is mounted in must withstand without damage the required elevator test in Sections 8.10 and 8.11.

If the light diffuser is other than metal or glass, it must be subjected to the test specified in 2.14.2.1.

2.14.7.4 Protection of Light Bulbs and Tubes. Light bulbs and tubes within the elevator car must be guarded to protect them from accidentally breaking. An exposed bulb or tube could be struck by an elevator passenger carrying an umbrella or similar object. If the bulb or tube were shattered, it could injure the elevator passenger. There are bulbs and tubes manufactured with an outside coating that resists breakage. This coating ensures that the bulb or lamp, if broken, will not shatter. The second part of this requirement addresses the structural soundness of the light fixture, its deflectors (egg crate, etc.), and its bulbs and tubes. There have been incidents of light bulbs or tubes, light fixtures, and their deflectors becoming dislodged during elevator car or counterweight safety application. This condition could cause serious injury to elevator passengers. The bulbs or tubes, fixtures, and deflectors should be in place during the periodic and acceptance safety and buffer tests. If they stay in place during the test, it can be assumed that the requirements have been satisfied.

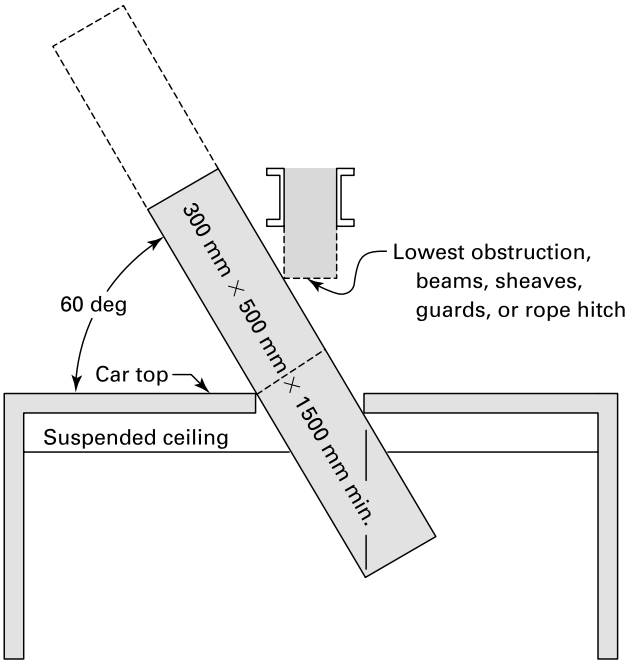
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Diagram 2.14.1.3
Enclosure Wall Deflection Requirements



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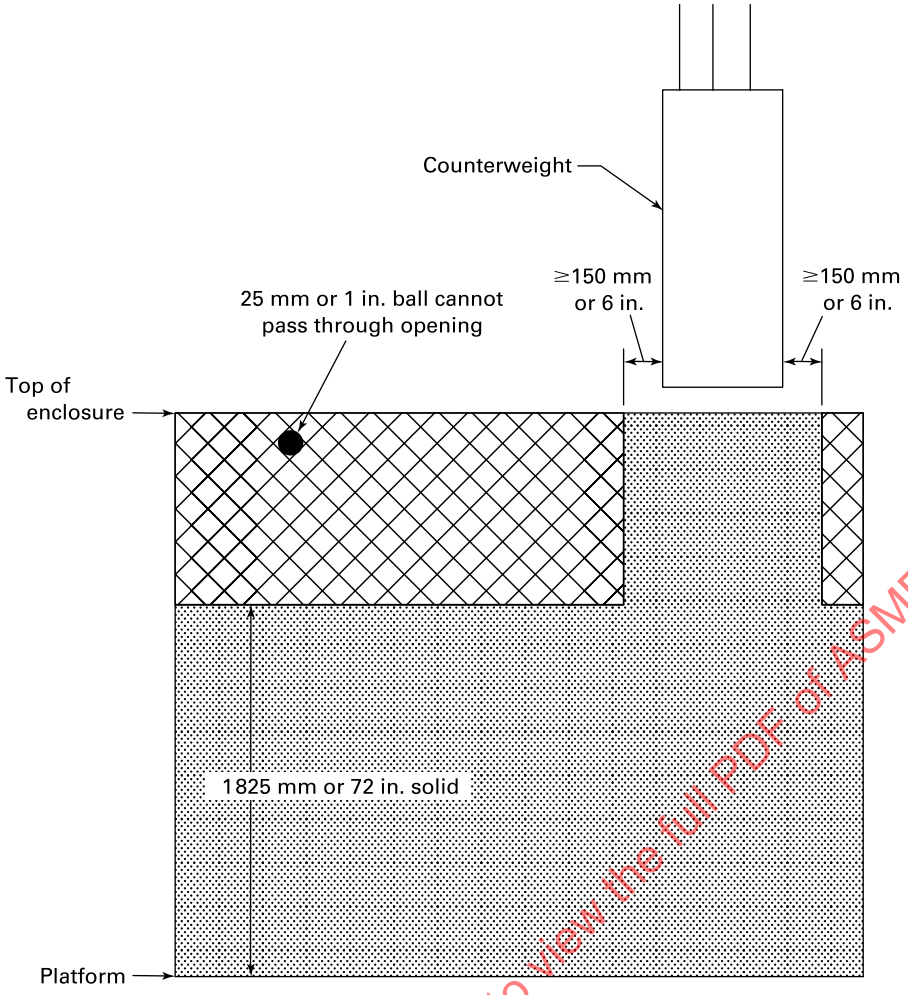
Diagram 2.14.1.5.1(b)(2)
Location of Top Emergency Exit



Parallelepiped Volume Orientations [2.14.1.5.1(b)(2)]

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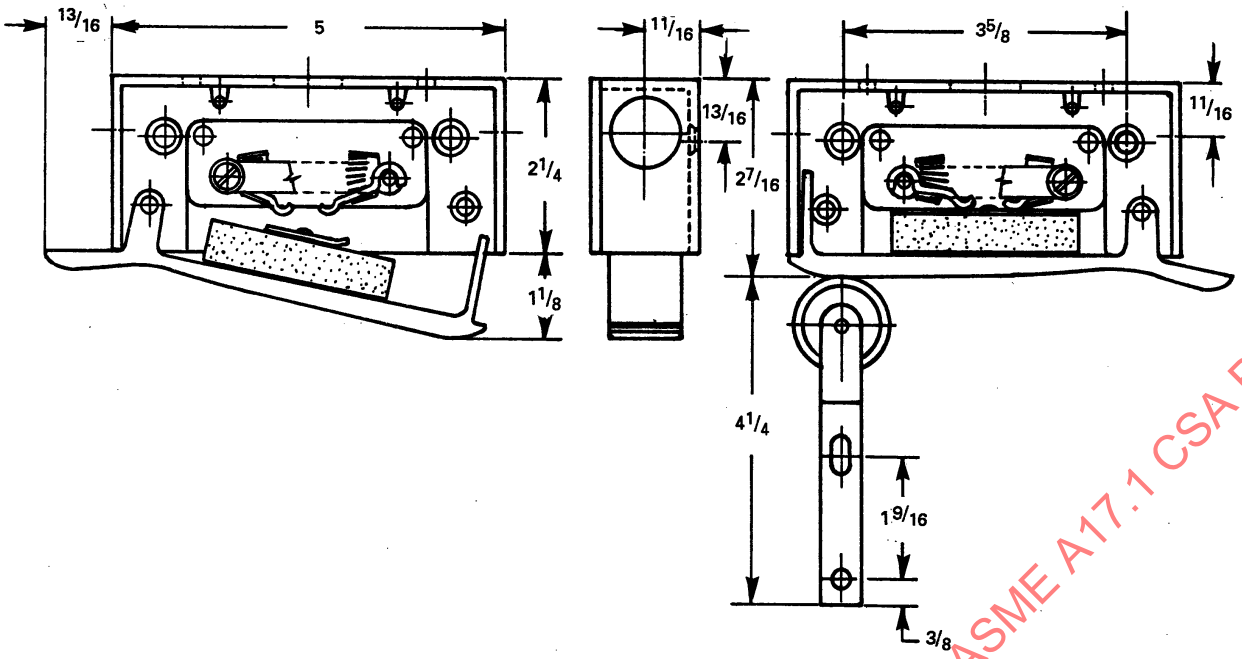
Diagram 2.14.3.1
Freight Car Enclosure Requirements



GENERAL NOTE: Does not apply to freight elevators permitted to carry passengers.

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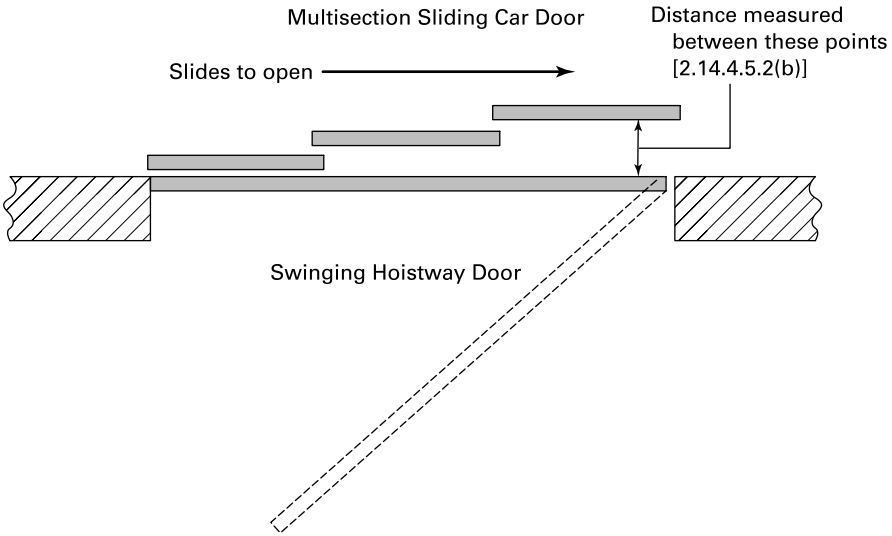
Diagram 2.14.4.2.3
Typical Car Door or Gate Electric Contact

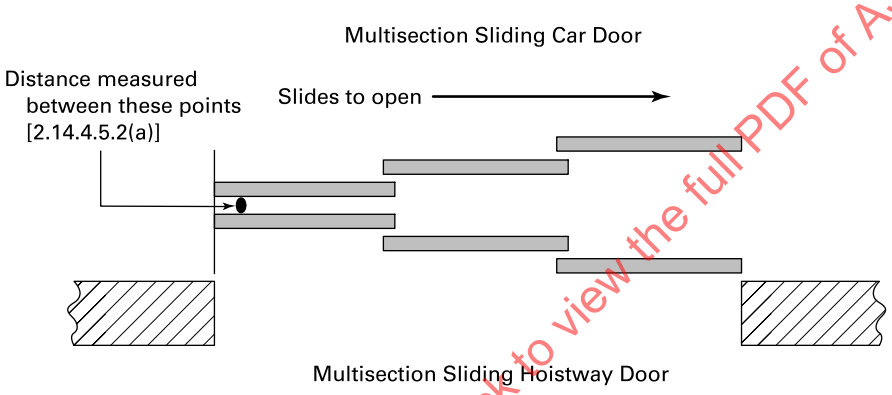


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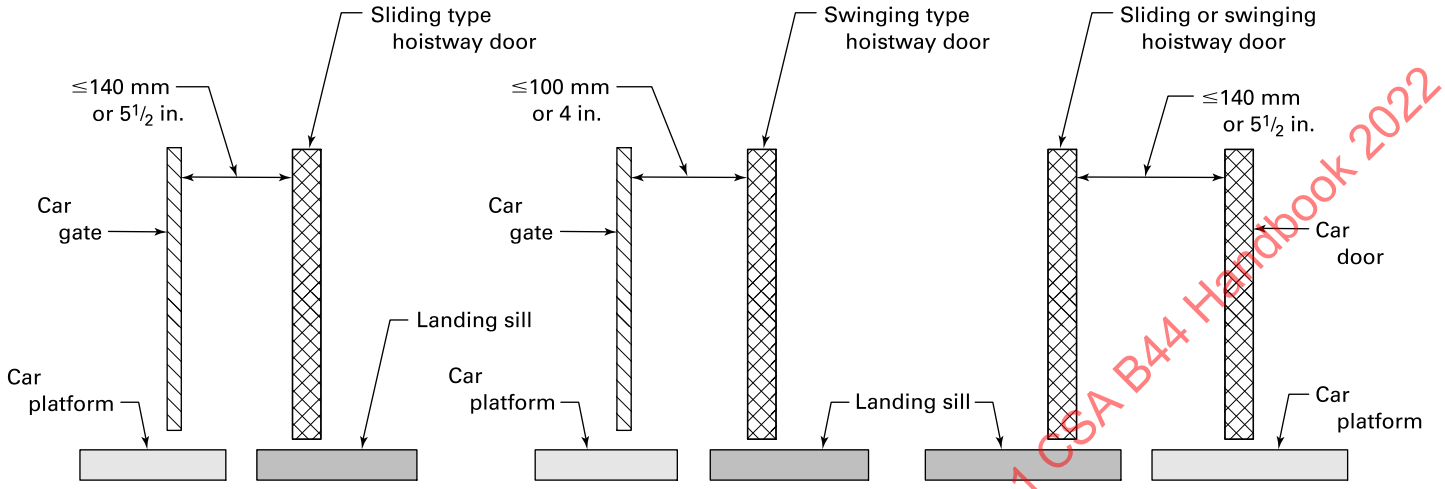
Diagram 2.14.4.5(a)
Measurement of Distance Between Car and Hoistway Doors





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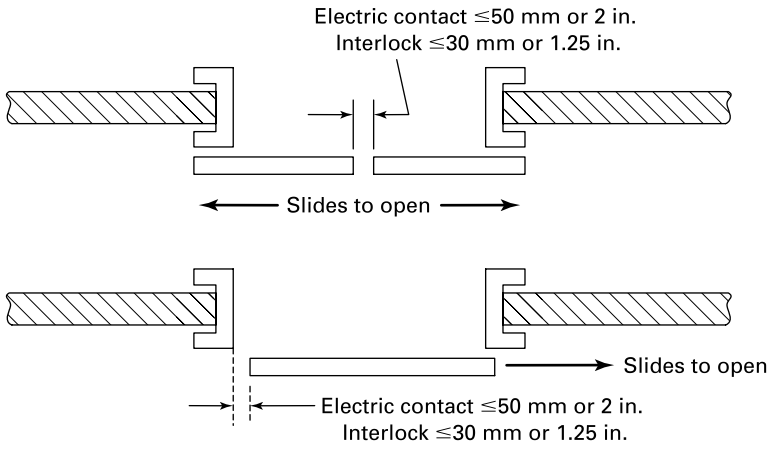
Diagram 2.14.4.5(b)
Distance Between Hoistway Doors and Car Doors and/or Gates



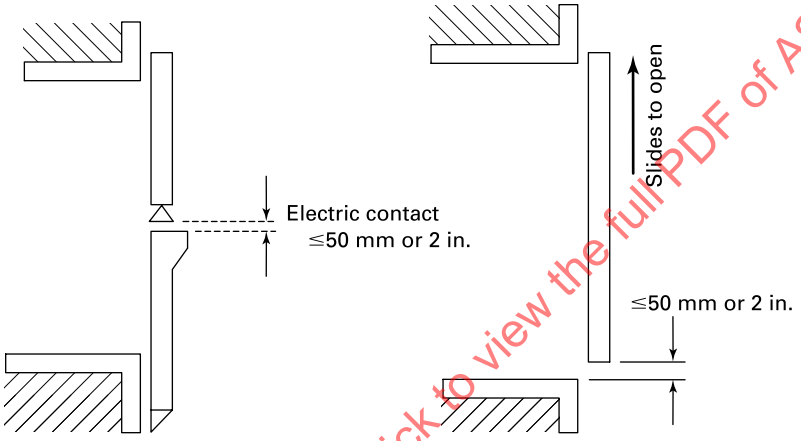
GENERAL NOTE: Courtesy of Zack McCain, Jr., P.E.

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Diagram 2.14.4.11
Closed Position of Car Doors or Gates



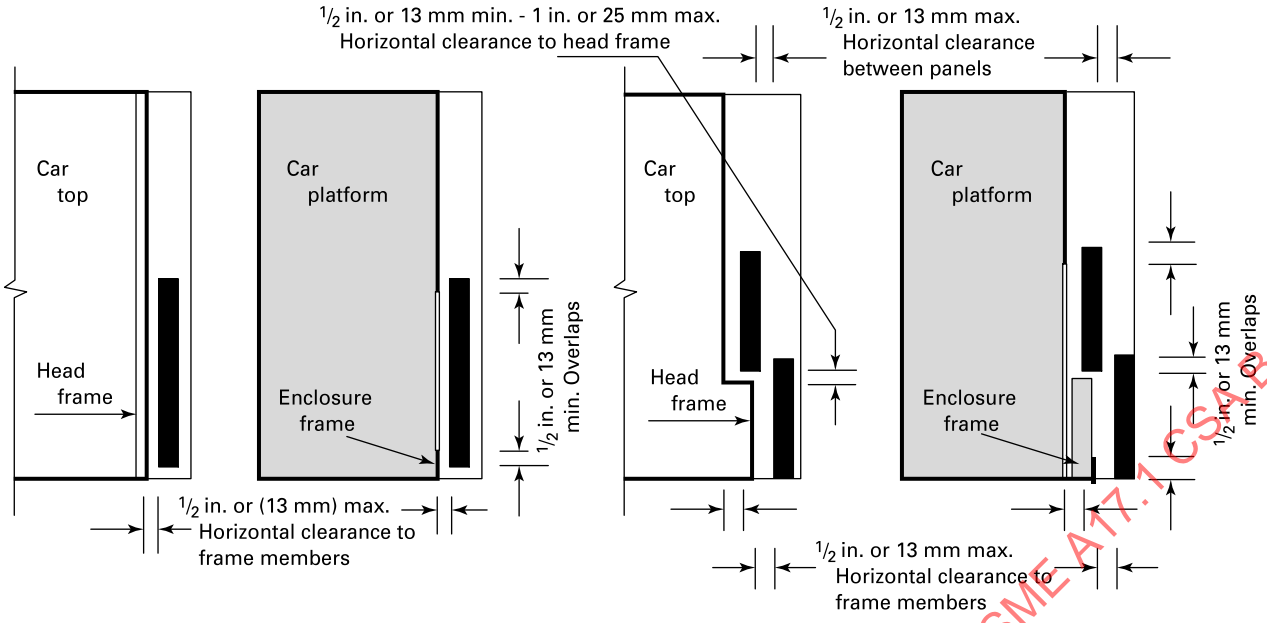
(a) Closed Position Horizontally Sliding Doors

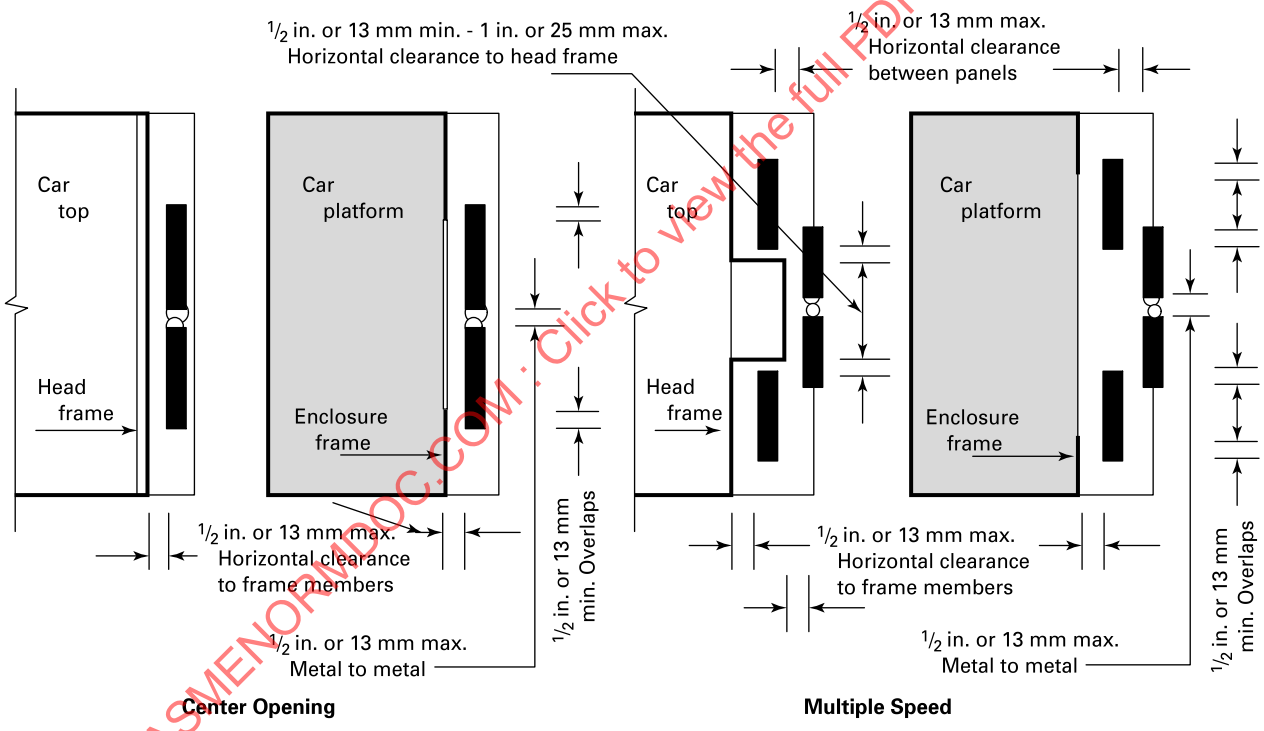


(b) Closed Position Vertically Sliding Doors

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Diagram 2.14.5.6(a)
Horizontal Sliding Car Door Clearances (Part 1)





Car Top Plan View and Sectional Plan View of Enclosure and Doors

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Diagram 2.14.5.6(b)
Horizontal Sliding Car Door Clearances (Part 2)

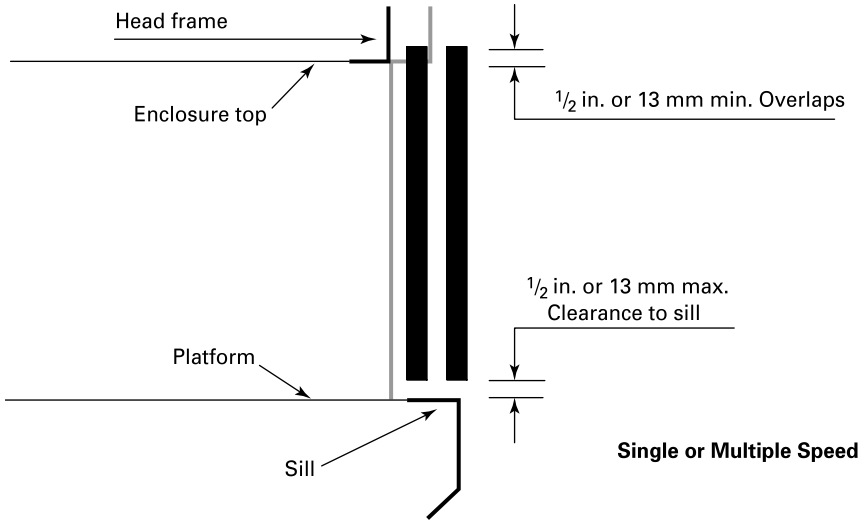
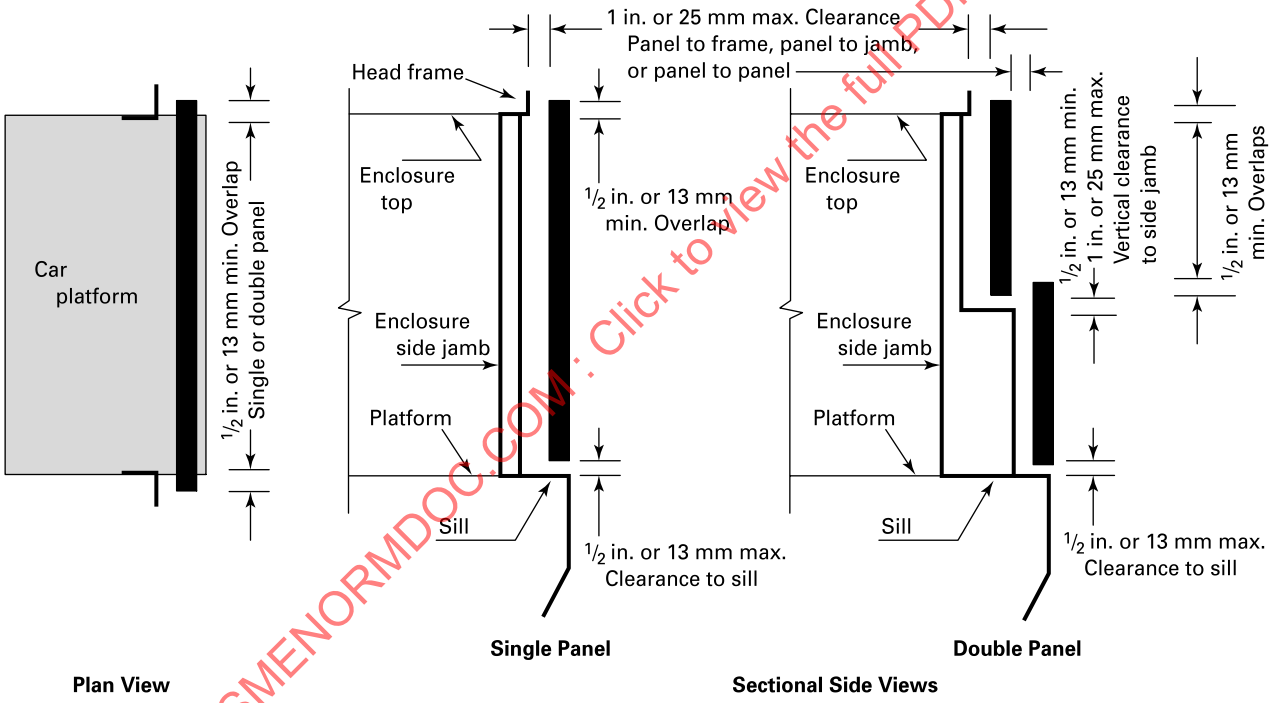
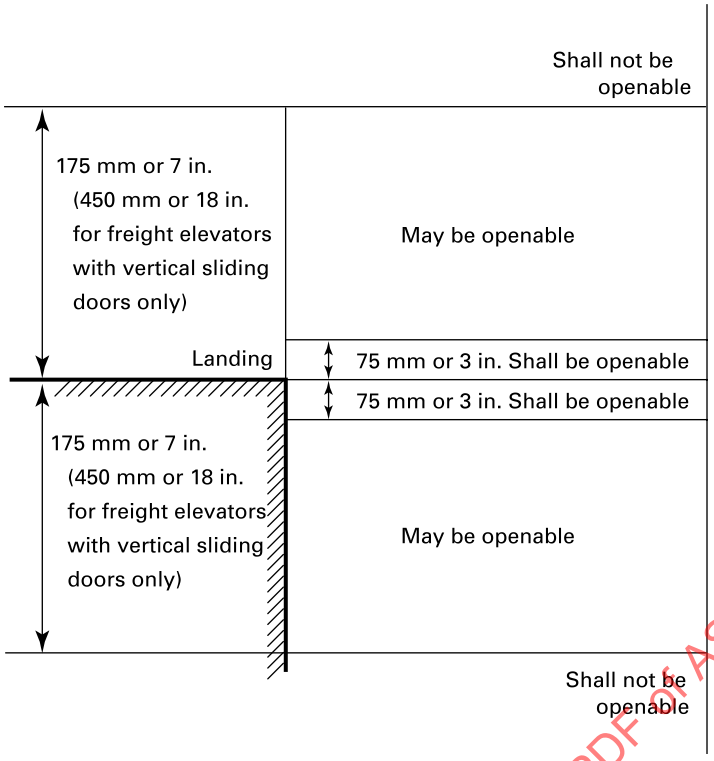


Diagram 2.14.5.6(c)
Vertically Sliding Car Door Clearances



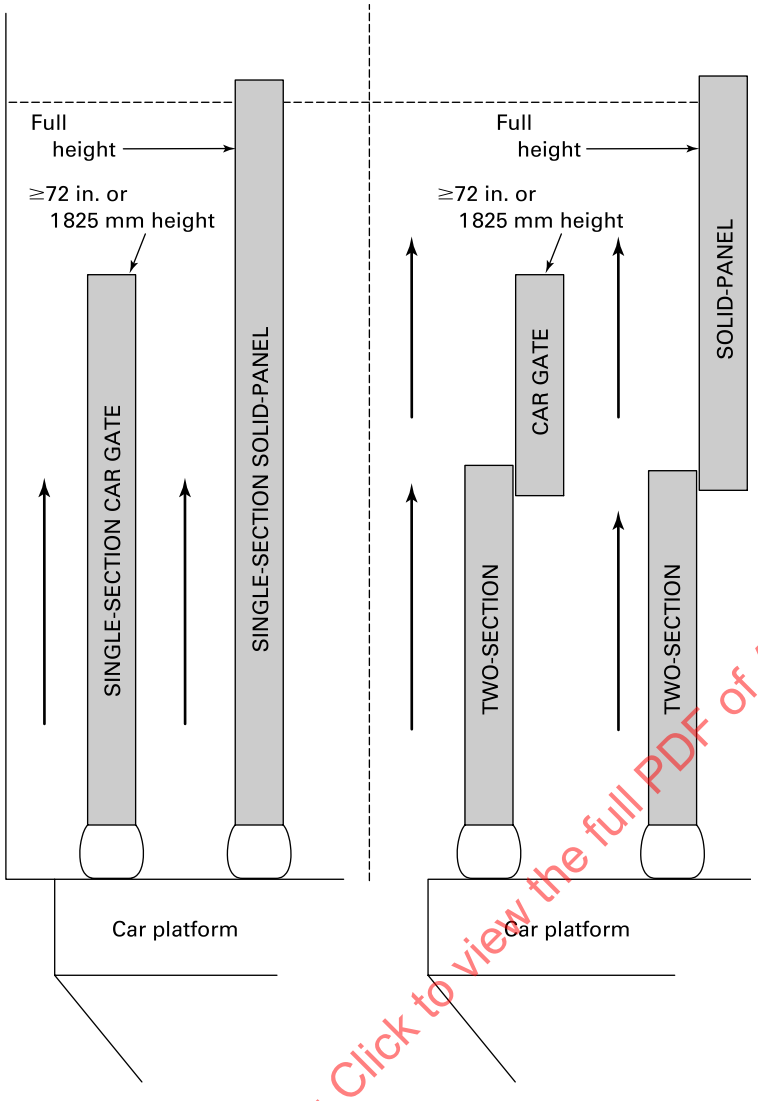
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Diagram 2.14.5.7
Unlocking Zone



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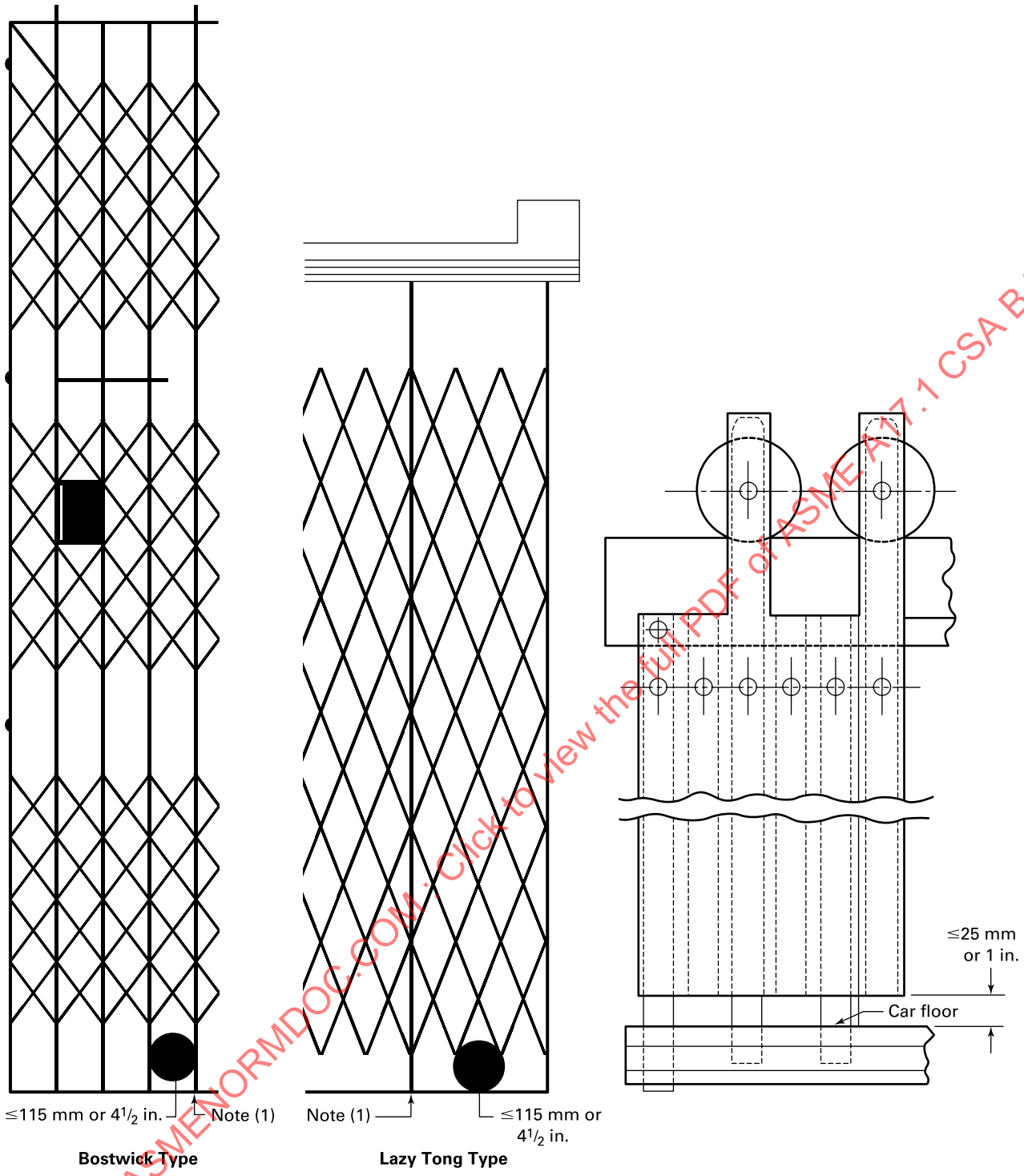
Diagram 2.14.6.2.3
Typical Vertically Sliding Car Door/Gate Arrangements



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Diagram 2.14.6.3
Collapsible-Type Gates



NOTE: (1) Every vertical member must be guided top and bottom.

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SECTION 2.15
CAR FRAMES AND PLATFORMS

NOTE: The author expresses his appreciation to George W. Gibson for his extensive contributions to Section 2.15.

2.15.1 Car Frames Required

A car frame (sling) is the supporting frame to which the car platform, upper and lower sets of guide shoes, car safety, and hoisting ropes or hoisting rope sheaves, or the hydraulic elevator plunger or cylinder are attached. Two common designs of car frames that are used are the side post and the corner post. The side-post construction has the guide rails located on the two opposite sides and allows entrances on opposite sides of the car. When corner-post construction is used, the guide rails are located at opposite corners of the platform. This type of construction allows for adjacent entrances.

Both side- and corner-post car frames can be either overslung or underslung. An overslung car frame is one to which the hoistway rope fastenings or hoisting rope sheaves are attached to the crosshead or top member of the car frame. An underslung car frame is one to which the hoistway rope fastenings or hoisting rope sheaves are attached at or below the car platform.

Another type of car frame that has been used is the sub-post, a car frame where all of the members are located below the car frame. See Diagrams 2.15.1(a) and 2.15.1(b).

A more comprehensive discussion of the forces, bending moments, and their effects on the car frame design is given in the Handbook commentary on 8.2.2.

2.15.2 Guiding Means

This requirement was revised in ASME A17.1-2013/CSA B44-13 to improve the safety of the guiding means by requiring a minimum factor of safety while eliminating language that is overly prescriptive, and to prevent displacements greater than 13 mm or 0.5 in. that could occur on sliding members when gibs are lost or on roller guides when a roller fails.

Guiding members are provided to enable the elevator to move in a fixed path, and to provide a stable ride while transferring lateral forces induced by the car loading to the guide rails and their supporting structure.

Elevator and counterweight guide shoes are either the sliding or roller type. Before the advent of the roller type, the swivel-type sliding shoe was used almost exclusively for passenger service elevators. In this type, the shoe is held in a bracket and arranged to swivel so that it may adjust itself to bear evenly on the sides of the rail. In the direction against the face of the rail, the shoe is backed by a spring and held in the bracket, and adjustment is provided to obtain the desired clearance or float in this direction.

For freight elevators, the guide shoes are generally of the sliding type without provisions for swiveling or aligning themselves automatically to the sides of the rails; therefore, any misalignment due to inequalities of the car frame members must be corrected by means of shims. Guide shoes are provided with removable cast iron gibs, usually in one piece.

The roller guide shoe now supplants the swivel-type shoe on most passenger elevators. This guide allows the elevator car to ride smoothly even though the rails are not smooth and straight. The float is limited by the closeness of the safety jaws to each side of the rails. Each roller is generally mounted to a spring-loaded lever, which pivots about the roller guide stand.

Some of the principal advantages of the roller guide shoes are as follows:

(a) Oil and grease are eliminated from the hoistway, which cuts down the amount of maintenance, particularly in cleaning hoistway walls and pits, and also eliminates a serious fire hazard.

(b) Most of the knocking and scraping noises are eliminated.

(c) Riding quality is improved, especially on some high-speed elevators.

(d) Power consumption of the elevator motor is considerably decreased.

The typical roller guide shoe assembly consists of three rubber-tired wheels resiliently mounted through springs or other means. The elevator, therefore, is riding on 12 wheels in contact with the guide rails. A design that has emerged in recent years for use on some high-speed elevators embodies six rubber-tired wheels resiliently mounted through springs or other means at each corner of the car frame, resulting in 24 rollers for the guiding system.

It is important that the cars be reasonably well balanced when setting a job up in the design stage as well as during installation so that guide shoe pressures due to dead load will be as close to zero as practical. A retention means provides protection against possible collision between the car and equipment in the hoistway. This secondary means can be a part of the base of the guiding means. This has been a common practice of many suppliers.

To ensure the integrity of the guiding means, the Code requires a minimum factor of safety of 5 on all components of the means that serve to limit displacement.

2.15.5 Car Platforms

The Code defines the elevator car platform as the structure that forms the floor of the car and directly supports the load. The basic function of an elevator platform is to directly support the duty load and the car that contains the load.

Passenger platforms are generally of three types: combination wood-steel design consisting of a steel frame on top of which is mounted a wooden flooring;

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the all-steel version, which might embody a welded structural frame to which a steel floor plate is welded forming a unitized construction; or the design might be composed of several sections welded together wherein the stringers and floor plates are modules.

The Code defines the requirements for the design and construction of platforms based on the minimum rated load specified in Section 2.16. The general definitions of components in a platform assembly are

(a) end channels: the front and rear structural members of the platform that support the front and rear of the car, door threshold, toe guards, and the stringers.

(b) stringers: structural members usually running in a front-to-rear direction. They are supported by the end channels and near their center by an intermediate support.

(c) floor plate: a structural plate, either monolithic with the stringers, or welded to them. The finished flooring is laid on top of this plate.

A typical all-steel welded platform is shown in Diagram 2.15.5. The passenger platform rests on rubber blocks located at six points as shown. These blocks are supported by a subframe called the sound isolation support frame, which, in turn, is supported by the car frame plank channels at its approximate center and by the side braces near its four corners.

As live load distributes on the platform, deflection of these rubber blocks occurs, thus causing measurable relative displacement between the platform and support frame. As the load increases in the car, the platform compresses the rubber. When a predetermined compression of the rubber is reached, load-weighing switches are activated and electrical circuits made or broken in order to render the car inoperative or bypass calls. More sophisticated systems now on the market use strain gauge technology for load measurement. A more comprehensive discussion of the loadings and their effects on the platform design is given in the Handbook commentary on 8.2.2.

Sound isolation and vibration damping are important features of passenger elevators. Through the use of rubber, all metal-to-metal contact between the elevator car and its supporting frame is eliminated. The car is permitted to "float" on blocks of rubber that cushion car movement, dampen vibration, and prevent the transmission of sound. Also, see the Handbook commentary on 8.2.2.6.

2.15.5.4 Originally all platforms, whether passenger or freight, used a wood flooring supported by a steel frame. The modern elevator platform utilizes an all-steel construction, which is more efficient and lighter than its steel and wood predecessor. In the early 1970s, ASME A17.1 responded to a changing technology and introduced provisions for laminated platforms, which consisted of steel-faced plywood. A laminated car platform is a self-supporting structure, which forms the floor of the car. It directly supports the load and is constructed of plywood with a bonded steel sheet facing on both the top and bottom surfaces. See Diagram 2.15.5.4.

2.15.5.5 See Handbook commentary on 2.15.5.4.

2.15.6 Materials for Car Frames and Platform Frames

2.15.6.2 Requirements for Steel. A detailed review of ASTM specifications A27, A36, A283, A307, A502, and A668 was performed with respect to mechanical properties. Chart 2.15.6.2 shows the tensile, yield, and elongation requirements for each specification.

The elongation range for materials cited in 2.15.6.2.1 is 21% to 24% in a 51-mm or 2-in. specimen. A 20% minimum elongation requirement would make sense.

The elongation for materials cited in 2.15.6.2.2 is 18% in a 51-mm or 2-in. specimen. A 20% minimum elongation requirement for materials for greater tensile strengths does not make sense.

2.15.6.3 This requirement was revised in ASME A17.1-2016/CSA B44-16 to replace "good engineering practice" with "sound engineering practice." "Sound engineering practice" is a term commonly used in the design of components and systems and is appropriate for use in writing performance-based requirements.

2.15.6.4 Requirement 2.15.6.4 was revised in ASME A17.1-2022/CSA B44:22 to address the outdated wood platform requirements within PS 1-74. The changes removed Exterior type and updated the reference to the latest edition. PS 1-09 removed the PS 1-74 Interior type bonded plywood with interior glue and Interior type bonded plywood with intermediate bonded glue classifications; therefore, there is no need to add an additional requirement for specifying the bonding classification type. Both are required to be exposed to dry and wet weather, but Exposure 1 is designed for short-term exposure to moisture, such as during construction, and Exterior is designed for long-term moisture exposure. The PS 1-09 bonding classifications Exposure 1 and Exterior are both exterior bonding and have the same test requirements. The only difference is that Exposure 1 is allowed to have a slightly higher failure rate. Also, the CSA O151 bonding tests and failure requirements are similar with PS 1-09 Exposure 1 testing requirements. Therefore, both Exposure 1 and Exterior bonding classifications are suitable for elevator use.

2.15.7 Car Frame and Platform Connections

The intent of this requirement is to specify the type of mechanical fastener or attachment used in the platform-to-car frame connection. It is not the intent to limit the attachment to rivets, bolts, or welding. Any mechanical connection that develops the required strength to safely transmit the forces between the platform and car frame in accordance with 2.15.10 is acceptable. A

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clip, similar to a rail clip, is commonly used for this connection.

Car platforms are often supported by an additional frame beneath the platform where rubber isolation or other elastic pads are used in between the platform and supporting frame. ASME A17.1/CSA B44 requires attachment of the platform to the car frame to be done in accordance with good engineering practice. The platform, supporting frame, and their connections are required to meet the static requirements for the type of loading to which they will be subjected.

2.15.7.2 This requirement was revised in ASME A17.1-2016/CSA B44-16; see Handbook commentary on 2.15.6.3.

2.15.8 Protection of Platforms Against Fire

Most hoistway fires that develop today occur in the pit due to the accumulation of trash. At lower landings, the underside of the platform would be exposed to a pit fire and thus must be protected against such fires. The requirement is stated in performance language and is the same as required for car enclosures (2.14.2.1) with one exception. Only the platform surface exposed to the hoistway must be tested.

2.15.9 Platform Guards (Aprons)

Platform guards (aprons) are required on all elevators. ASME A17.1-2000/CSA B44-00 and later editions require that the minimum length of the platform guard be longer than required in previous editions of the Code. The 1 200 mm or 48 in. protect passengers from accessing the hoistway in case of unintended movement [2.19.2.2(b)]. Elevators equipped with leveling devices or truck-zoning devices are allowed controlled movement when both the car door and gate and hoistway door are open. The purpose of the guard is to reduce the shearing action at the edge of the car sill and, when the car is positioned above a floor sill, to seal off the opening under the car from the landing, thereby reducing the possibility of someone falling into the hoistway. See Diagram 2.15.9. A horizontal door guiding groove running across the width of the guard with a maximum width of 10 mm or 0.375 in. is permitted provided that the groove is not exposed by preopening of the doors, or leveling or releveling of the elevator.

This requirement was revised in ASME A17.1-2013/CSA B44-13 to make the requirement consistent with the requirements for landing-sill guards (2.16.10.1.2).

2.15.10 Maximum Allowable Stresses in Car Frame and Platform Members and Connections

The permissible fiber stresses in the car frame and platform members and their connections are specified in 2.15.10. The allowable deflections are covered in 2.15.11.

2.15.10.1 The Code does not fix the amount that the platform edge may sink below the landing sill at the time the load is applied. This amount depends to some degree on the stiffness of the car frame, platform, and rails. Absolute rigidity can never be obtained; therefore, the allowable amount is controlled by the purpose for which the elevator is used.

Car frames for hydraulic elevators are constructed basically the same as those used for traction elevators, except that since the lifting is accomplished by a plunger fastened to the planks, the planks will usually be larger than the crosshead. Also, safeties are not required.

The uprights will be subjected to the same bending moments that were described for traction elevators, but in addition, they will have a compressive load in them due to the platform loads coming up through the side braces. Since this compressive load is quite appreciable, the slenderness ratio of the upright must be kept low enough to ensure that the member will not buckle. When long side braces are used, the slenderness ratio, L/r, is limited to 120; however, when short side braces are used for passenger application, an L/r of 160 is allowed since the compressive load from the braces acts over a shorter length of upright. L is the vertical distance from the lowest bolt hole in the crosshead to the uppermost bolt hole in the plank-to-upright connection, and r is the radius of gyration of the member.

2.15.10.2 The requirement provides criteria for the safe design of the respective components/structures subject to forces developed during the retardation phase of the emergency braking and all other loading acting simultaneously, if applicable, with factors of safety consistent with the types of equipment/structures involved.

2.15.11 Maximum Allowable Deflections of Car Frame and Platform Members

See Handbook commentary on 2.15.10.

2.15.13 Suspension-Rope Hitch Plates or Shapes

The arrangement pictured in Diagram 2.15.13 shows that the vertical load acting on the hitch plate is distributed to all the lug plates, which, in turn, transmit their loads to the car frame through their fastenings to the webs of the crosshead channels. This design transmits the loads to the fasteners in shear, not in tension.

2.15.15 Platform Side Braces

The function of the side braces is to support the corners of the platform. One end of the brace is fastened to a bracket mounted on the underside of the platform and the other end to the car frame. Where short side braces are used, as on passenger elevators, the upper ends of the braces are fastened to the car frame upright.

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The load in the side braces varies with the position of the live load in the car; the deadweight of the platform, enclosure, and doors; and the angle it makes with the vertical. The effect of the side brace load basically takes three forms: it induces a direct axial load along the longitudinal axis of the upright; it produces bending, a corresponding deflection of the upright about its strong axis; and it causes the upright to twist due to the horizontal component of the brace load.

When side braces are designed so that the centerlines of the braces intersect the guide rail at the center of the upper guide shoes, there will be no bending in the uprights caused by the force acting on the braces at this point. Since the brace load in this case is much higher than those associated with passenger loading, long side braces are usually used on freight elevators.

The lower end of each brace is fastened directly to the platform. At this point a bending of the upright is caused, because the thrust from the side brace through the platform is at a point above the lower guide shoes, which are mounted below the safety plank. However, this bending, acting in the strong axis of the upright and in close proximity to the lower guide shoes, is generally of small magnitude and in most cases not serious.

The basic design of the corner-post truss embodies two structural members, usually bent channels, carrying a tension rod at each end for supporting the corners of the platform. Occasionally when the brace rod loads are very high and the crosshead channels have insufficient stiffness, an additional truss is placed beneath the plank channels and the amount of load carried by each truss depends on the relative stiffness of the crosshead and planks.

For rectangular-shaped platforms, the differences in length of the legs of the truss becomes so great that one channel will carry practically all of the load, in which case a different type of truss might be advisable. Since corner-post conditions vary so widely, no fixed set of rules can be set up; therefore, each case must be treated individually. It is important to stress the point again that the use to which the elevator will be put is of extreme importance when designing corner-post structures.

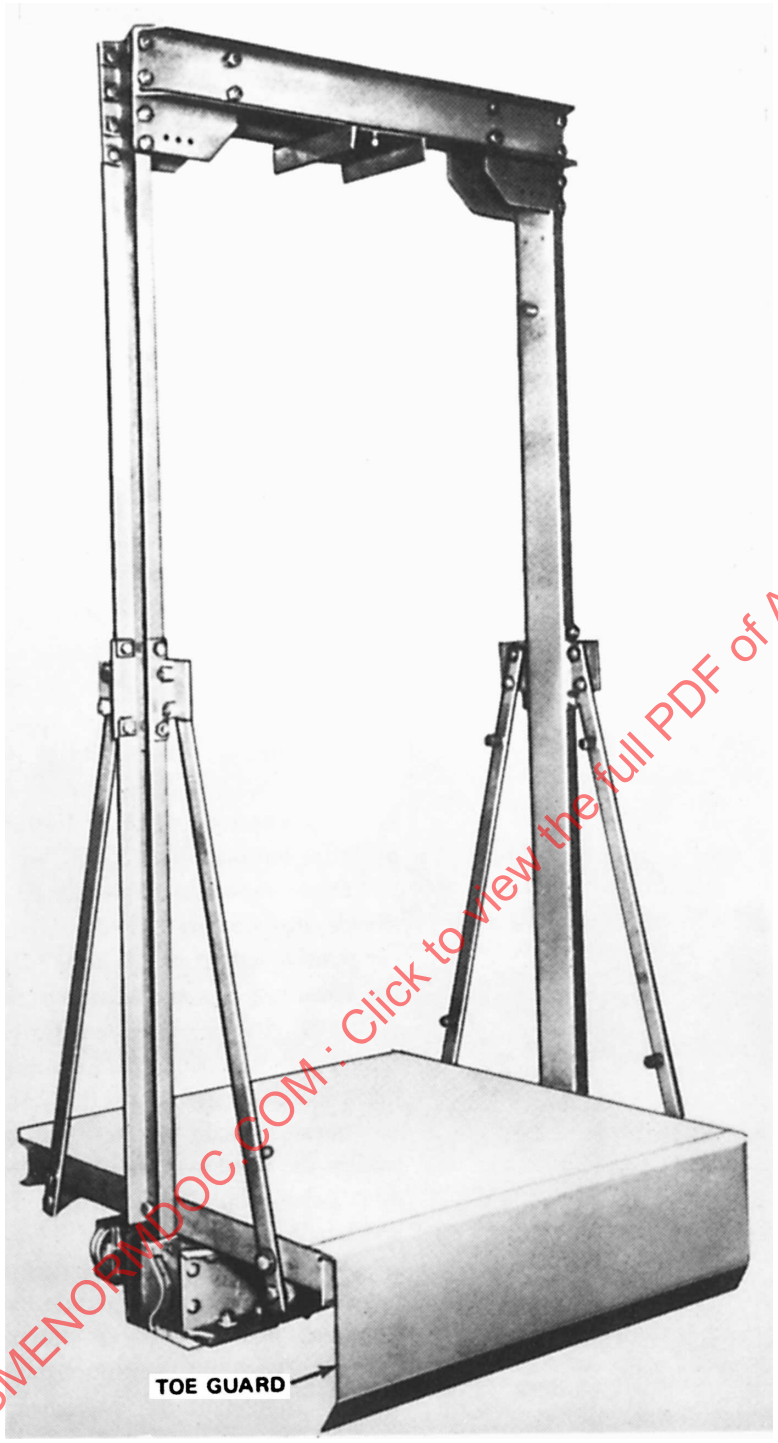
While the use of short side bracing as shown in Diagram 2.15.15(a) was efficient, it sometimes posed a problem due to the short side brace cutting across the side exit opening. The truss brace located at one corner of the car solved the problem by affording a clear rectangular space that did not impede passenger transfer through the side exit as shown in Diagram 2.15.15(b).

2.15.16 Hinged Platform Sills

2.15.16.1 This requirement was revised in ASME A17.1-2013/CSA B44-13 to correct a reference. While this revision contains no technical change to electric contact requirements when a hinged platform sill is provided, the requirements are clearer when wholly contained in 2.15.15.1. Previously, the requirement created confusion by referencing electric contacts applicable to car doors or gates, or by referencing the requirements for mechanical locks and contacts.

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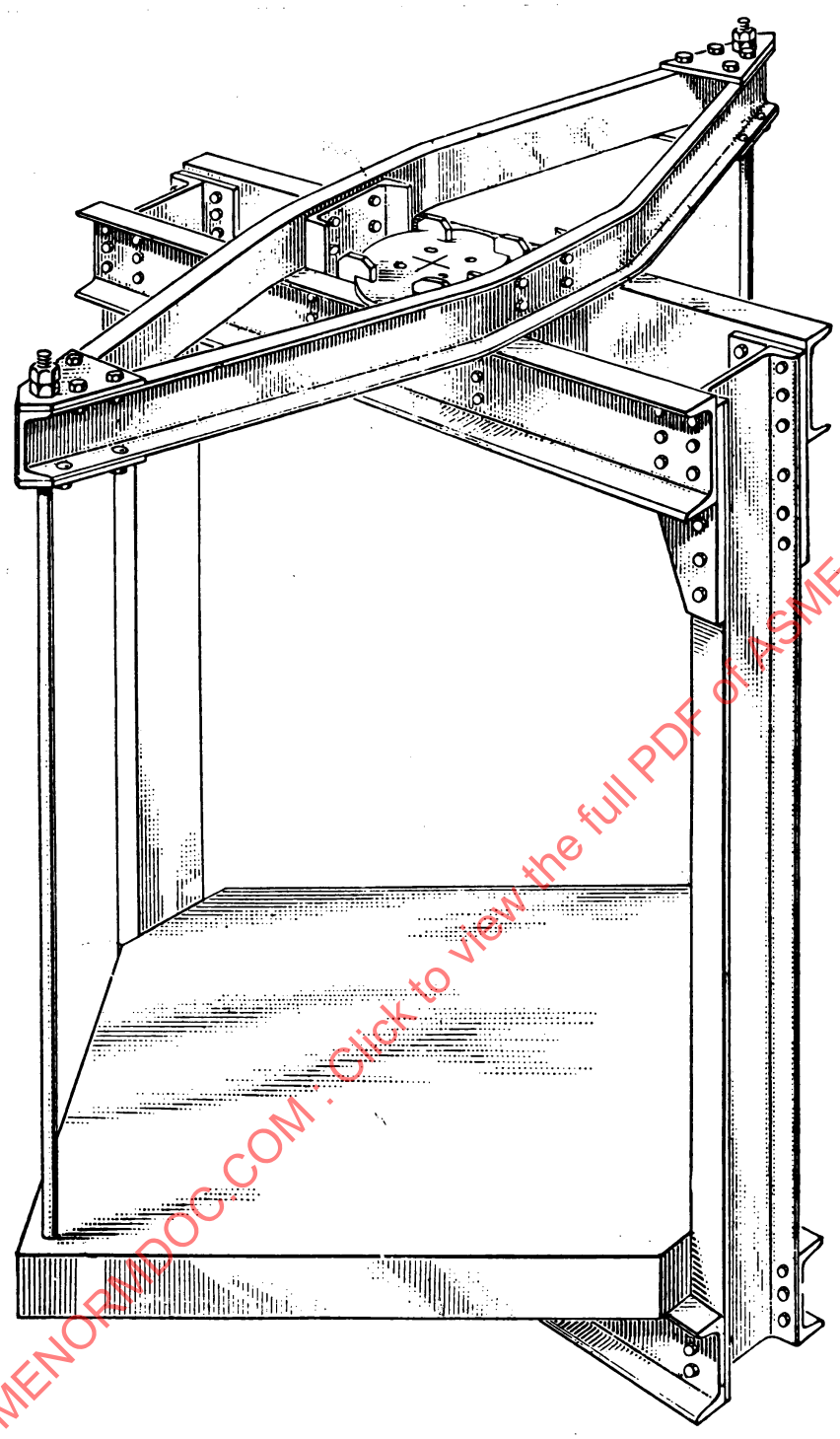
Diagram 2.15.1(a)
Side-Post Car Frame



GENERAL NOTE: Courtesy of National Elevator Industry Educational Program.

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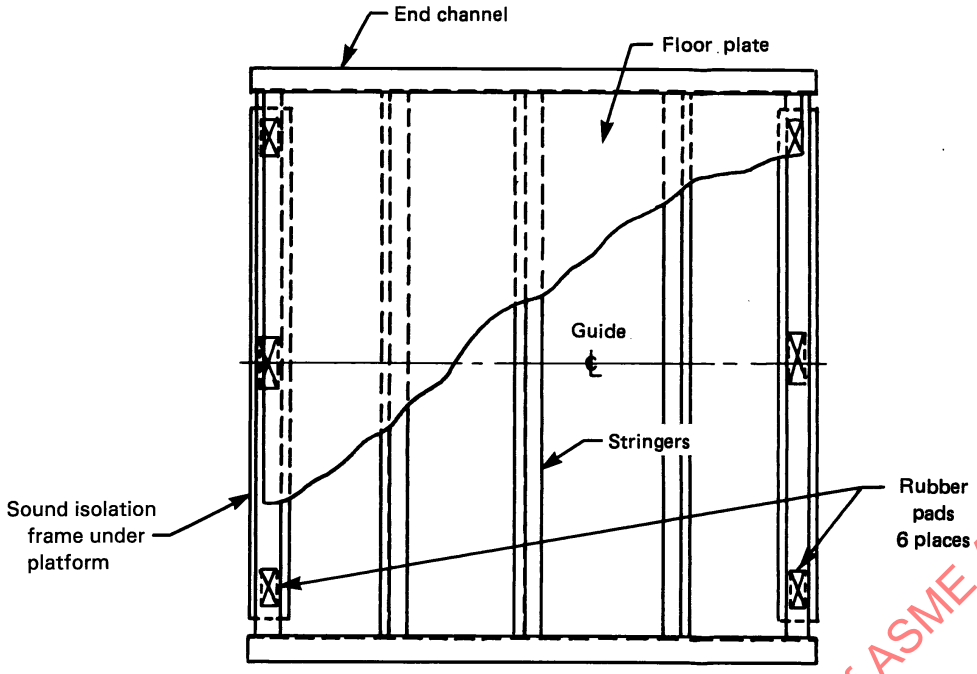
Diagram 2.15.1(b)
Corner-Post Car Frame, Truss, and Platform



GENERAL NOTE: Courtesy of National Elevator Industry Educational Program.

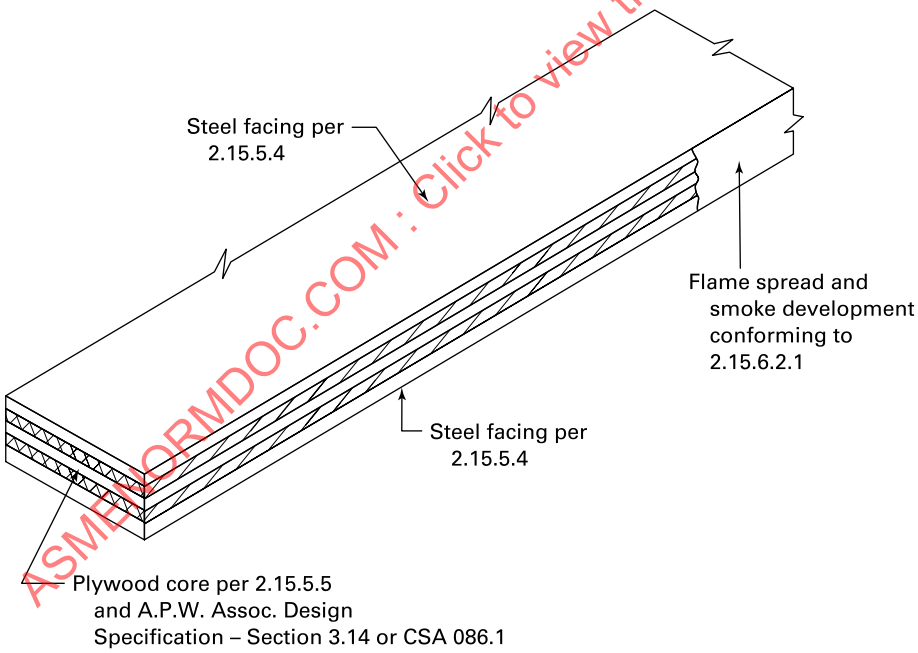
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Diagram 2.15.5
Typical Passenger Elevator Platform Construction



GENERAL NOTE: Courtesy of Otis Elevator Co. and George W. Gibson.

Diagram 2.15.5.4
Laminated Platform



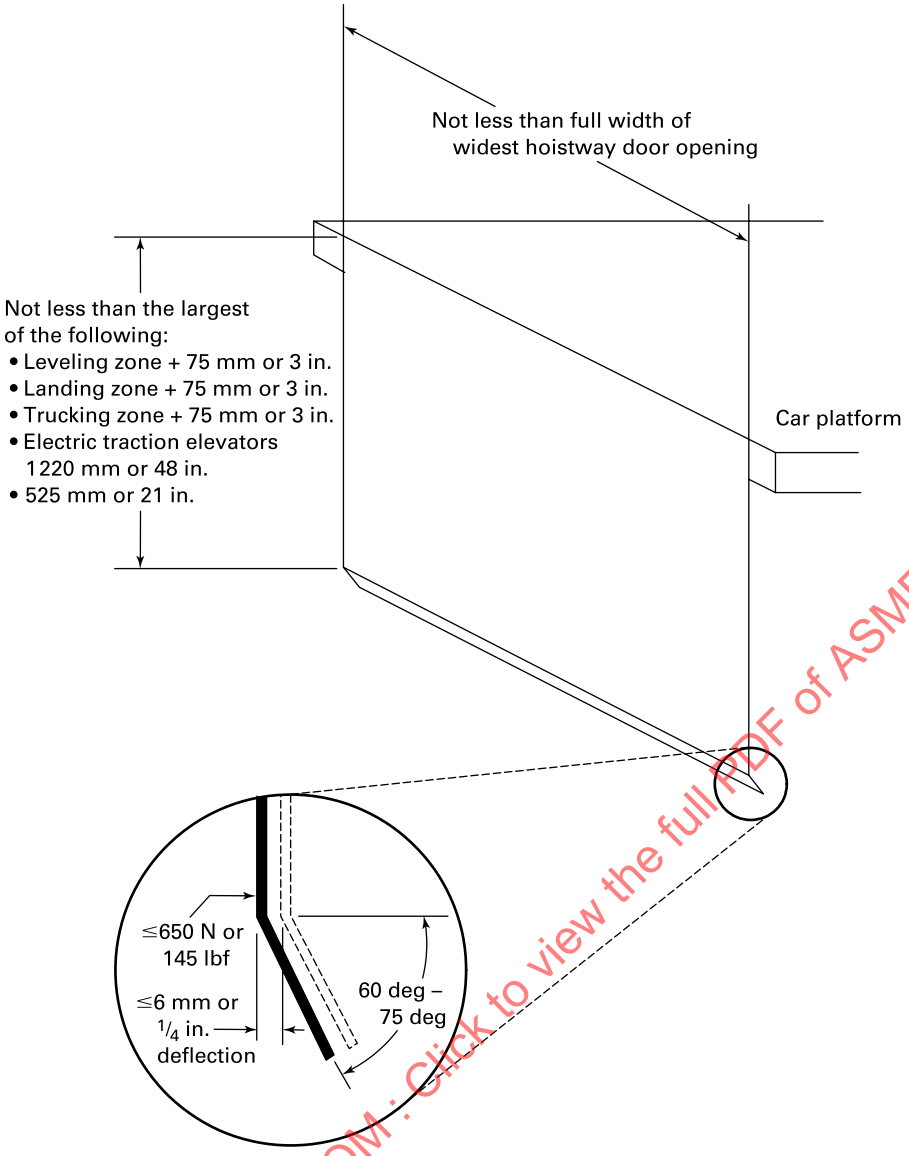
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Chart 2.15.6.2
Requirements for Steel

Specification	Tensile, psi	Yield, psi	Elongation, %
A27 (Castings)	60,000	30,000	24
A36			
(Plates and Bars)	58,000	36,000	28
(Shapes)	58,000	36,000	21
A283 (Plate)	60,000	33,000	23
A307 (Bolts)	60,000	N/A	18
A502 (Rivets)	N/A	N/A	N/A
A668 (Forgings)	60,000	30,000	24

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Diagram 2.15.9
Length of Platform Guard



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Diagram 2.15.13
Typical Rope-Hitch Plate Arrangement

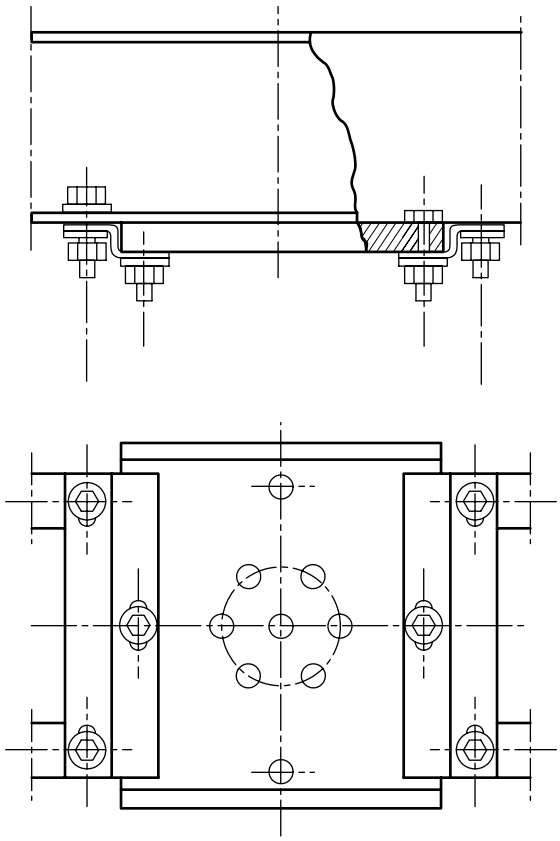
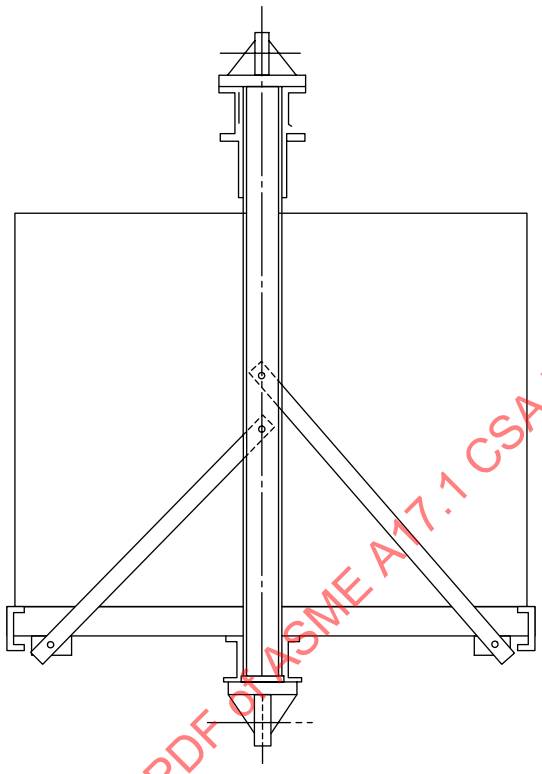


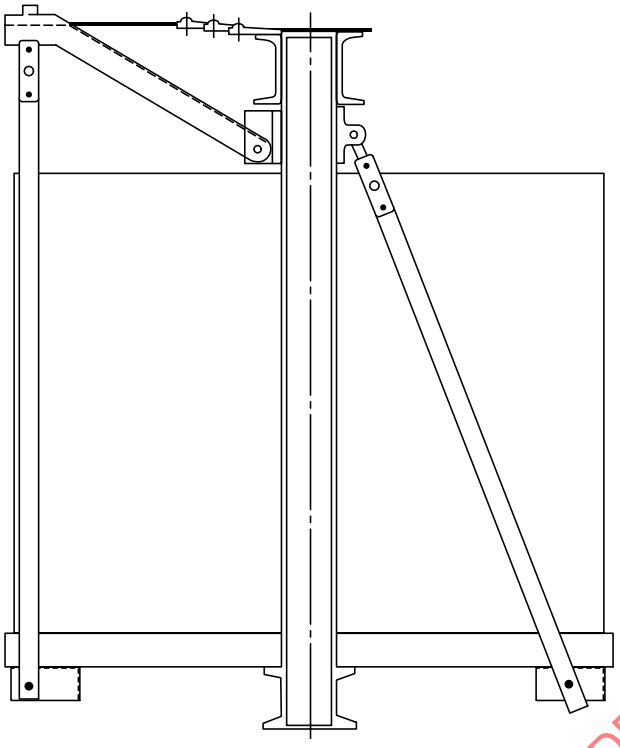
Diagram 2.15.15(a)
Short Side Bracing on Side-Post Elevator



GENERAL NOTE: Courtesy of Otis Elevator Co. and George W. Gibson.

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Diagram 2.15.15(b)
Truss Bracing on Side-Post Elevator



GENERAL NOTE: Courtesy of Otis Elevator Co. and George W. Gibson.

SECTION 2.16
CAPACITY AND LOADING

Requirement 2.16.1 specifies the minimum rated load for passenger elevators in terms of kilograms and pounds. Requirement 2.16.3.2.1 requires that a capacity plate indicating the rated load in kilograms or pounds, or both, be located inside the car.

When local ordinances require the elevator capacity to be also indicated in terms of persons, the number of persons can be calculated by dividing the rated load, if expressed in kilograms, by 72.5 or by 160 if expressed in pounds. The result (quotient) should be reduced to the next lowest whole number. For example, if the result is 14.97, the capacity in terms of persons should be 14.

2.16.1 Minimum Rated Load for Passenger Elevators

2.16.1.1 Minimum Load Permitted. These requirements and those in 8.2.1 establish a minimum rated load for the inside net platform area of passenger elevator cars. See Diagram 2.16.1.1. The Code does not prohibit a rated load greater than the minimum rated load required for a given net platform area. The minimum rated load for a given platform size is to mitigate the possibility of passengers overloading the elevator.

A car enclosure may be equipped with removable panels. When removed, the allowable increase in the net platform area of the car may not exceed 5%. If a 5% increase in the maximum net area were not allowed and the same car was rated at its maximum with the removable panels in place, the car would be in violation of the Code if the panels were removed. The 5% increase is permitted since the actual weight of the removed panels would exceed any additional weight that may normally be placed on the car in the space made available when the panels are removed.

While ASME A17.1/CSA B44 does not have minimum car size requirements, the building codes, ADAAG, ADA/ABA AG, ICC/ANSI A117.1, Uniform Federal Accessibility Standards (UFAS), and ASME A17.1/CSA B44, Appendix E do have such requirements.

2.16.1.3 Carrying of Freight on Passenger Elevators. This application is typically referred to as a "service" elevator. The elevator must comply with all the requirements for a passenger elevator as well as be designed for the applicable classes of freight loading.

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2.16.2 Minimum Rated Load for Freight Elevators

2.16.2.2 Classes of Loading and Design Requirements. See Diagram 2.16.2.2.

2.16.3 Capacity and Data Plates

The capacity plate located in the car provides necessary information for the people using the elevator. The data plate located on the crosshead, on the other hand, provides vital information for maintenance and inspection personnel.

2.16.3.1 Plates Required and Locations. Requirement 2.16.3.1 was revised in ASME A17.1-2019/CSA B44:19 to clarify the location where there is no crosshead or where the crosshead is not exposed. A reference was also added to new Section 8.13. See Handbook commentary on Section 8.13.

2.16.3.2 Information Required on Plates

2.16.3.2.2 The data plate includes the year manufactured. This may not be the same as the Code edition (year) in effect at the time of installation. Typically, the edition of the Code the elevator is required to conform with is determined by the Code in effect (legally adopted) at the time the permit is issued for the installation. See also Handbook commentary on Section 8.9.

Requirement 2.16.3.2.2(f) was added in ASME A17.1-2019/CSA B44:19 to require that the data plate include the percent counterweight overbalance range to align with new requirement 2.24.2.3.5. See Handbook commentary on 2.24.2.3.5 (2.24.2.3).

2.16.3.3 Material and Marking of Permanent Plates. Requirement 2.16.3.3 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13 and remove language that is already addressed in the new section. See Handbook commentary on Section 8.13.

2.16.4 Carrying of Passengers on Freight Elevators

Prior to ASME A17.1-2000 and CSA B44-00, permission had to be granted by the authority having jurisdiction to carry passengers on freight elevators. This provision has been removed and ASME A17.1/CSA B44 permits carrying of passengers, provided the freight elevator complies with all the requirements in 2.16.4, including not being accessible to the general public.

2.16.4.4 Mechanical locks and electric contacts are not permitted.

2.16.4.5 Car gates are not permitted. The car door must conform to passenger elevator door requirements.

2.16.4.7 The factors of safety that apply to passenger elevators are required.

2.16.4.8 As of ASME A17.1a-2008/CSA B44a-08, all vertical door protection requirements are addressed in 2.13.3.4. See Handbook commentary on 2.13.3.4.

2.16.5 Signs Required in Freight Elevator Cars

The signs required for freight elevators are to advise users of the limitations the elevator was designed and installed for. It also addresses which personnel, if any, are permitted to ride on the elevator. The capacity displayed on the sign is expressed in kilograms (kg) and pounds (lb). The Code does not require freight capacity signs in passenger elevators designed to carry freight.

The Class A loading sign was changed in ASME A17.1a-2002 and CSA B44 Update No. 1-02 to clarify the language for persons who are not familiar with the ASME A17.1/CSA B44 Code jargon. They had no idea what the phrase "General Freight Loading" meant. As a result, people unintentionally caused damage and unsafe conditions to Class A elevators by driving forklifts on them, or otherwise loading them improperly.

Requirement 2.16.5 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13 and remove language that is already addressed in the new section. See Handbook commentary on Section 8.13.

2.16.7 Carrying of One-Piece Loads Exceeding the Rated Load

"Capacity lifting one-piece loads" is commonly referred to as a safe lift.

This requirement applies to a limited specific application, when an elevator is used to lift a one-piece load (e.g., safe) that exceeds the rated load. The elevator must have a locking device that locks the car to the guide rails to take the load off the ropes during loading and unloading. The car must be designed to sustain the loads, but allowable stresses in the car frame, platform, ropes, etc., can be increased by 20%.

Safeties must stop and hold the one-piece load, with ropes intact; however, stopping distances do not have to be met. If there is occupied space below the hoistway, the safeties must be able to stop and hold the car independent of the ropes. If a safety was engaged near the bottom of the hoistway and there was insufficient sliding distance available before striking the buffer, the safety would absorb part of the kinetic energy of the descending mass and the buffer would absorb the balance. This condition could occur in an installation with a one-piece load in the car exceeding the rated load as well as on an installation operating without overloads; however, the maximum speed is limited to 0.75 m/s or 150 ft/min as covered in 2.26.1.3. Additional weight may also be added to the counterweight to increase traction.

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2.16.7.5 Requirement 2.16.7.5 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13 and remove language that is already addressed in the new section. See Handbook commentary on Section 8.13.

2.16.7.10 Inspection operation takes precedence over "safe-lift" operation. Requirement 2.26.1.4.1(b)(4)(-b) states that during inspection operation the movement of the car shall be solely under the control of the inspection operating devices. That is, the operation of the car has to be exclusively (solely) under the control of the inspection device.

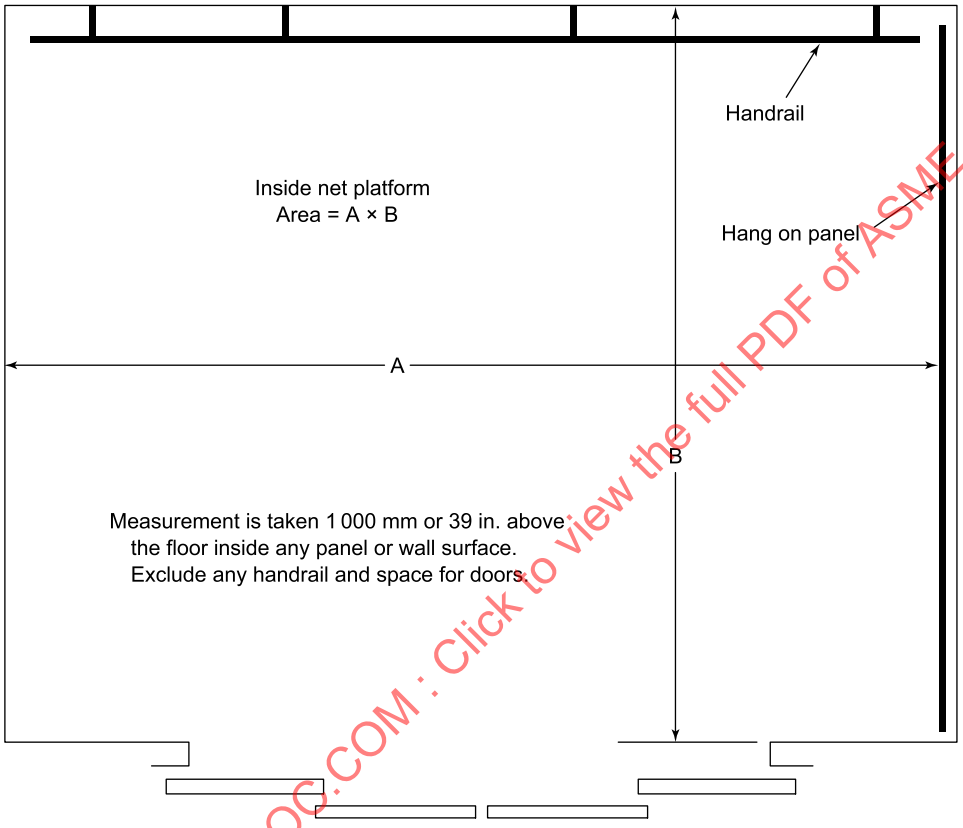
2.16.8 Additional Requirements for Passenger Overload in the Down Direction

These requirements are design criteria. Compliance with these requirements is to be field verified only to the extent specified in Sections 8.10 and 8.11. See Handbook commentary on the referenced requirement.

2.16.9 Special Loading Means

The loads imposed by special loading devices or structures upon the car frame and platform must be included in the design.

Diagram 2.16.1.1
Measurement of Passenger Elevator Inside Net Platform Area

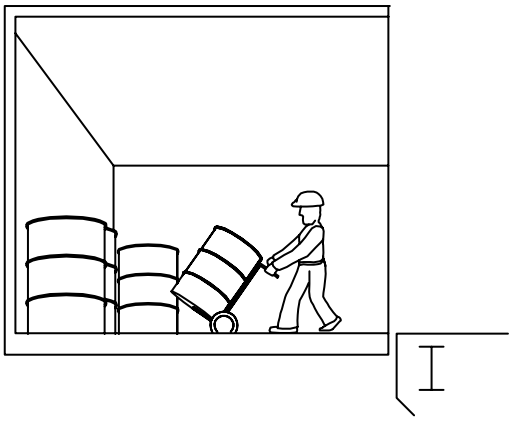


GENERAL NOTE: Courtesy of Zack McCain, Jr., P.E.

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Diagram 2.16.2.2
Freight Elevator Classes of Loading

Class "A"

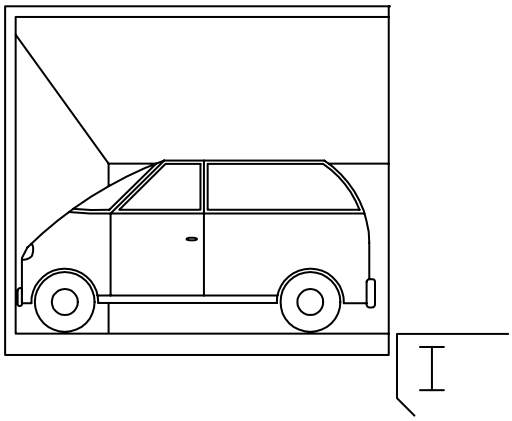


General Freight Loading

Where no item (including loaded hand truck) weighs more than $^1/_4$ rated capacity

Rating not less than 240 kg/m^2 or 49 lb/ft^2

Class "B"

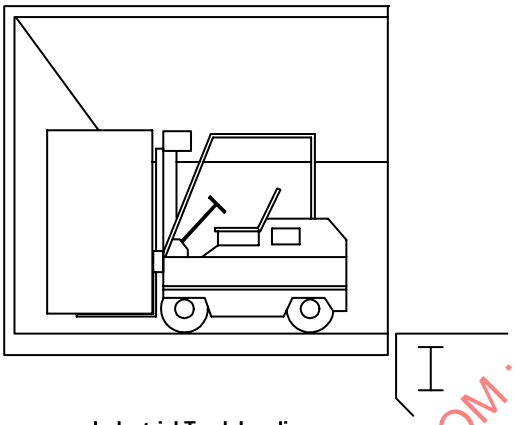


Motor Vehicle Loading

(Automobiles, trucks, buses)

Rating not less than 145 kg/m^2 or 30 lb/ft^2

Class "C1"



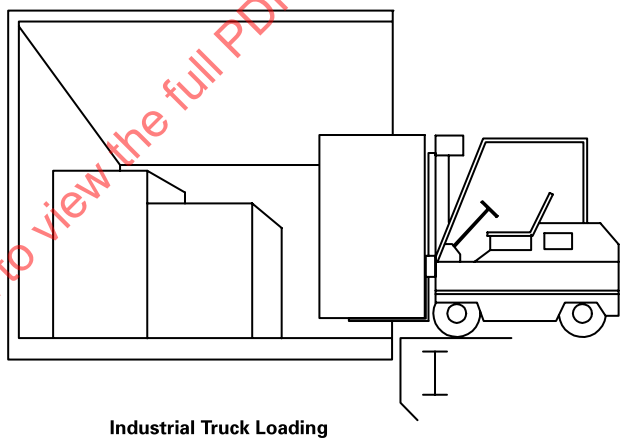
Industrial Truck Loading

Where forklift is carried

Rating not less than 240 kg/m^2 or 49 lb/ft^2

This loading applies where concentrated load including forklift is more than $^1/_4$ rated capacity but carried load does not exceed rated capacity.

Class "C2"



Industrial Truck Loading

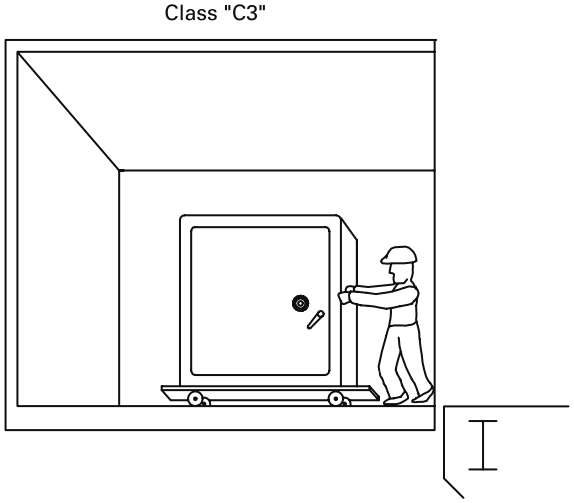
Where the forklift is not usually carried, but is used for loading and unloading

Rating not less than 240 kg/m^2 or 49 lb/ft^2

This loading applies where concentrated load including forklift is more than $^1/_4$ rated capacity but carried load does not exceed rated capacity. This loading also applies where increment loading is used but maximum load on car platform during loading or unloading does not exceed 150% of rated load.

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Diagram 2.16.2.2
Freight Elevator Classes of Loading (Cont'd)



Other Concentrated Loading

GENERAL NOTES:
(a) Courtesy of Building Transportation Standards and Guidelines, *NEII*®-1, © 2000–2022, National Elevator Industry, Inc., Centreville, VA).
(b) For definitions of Classes A, B, and C1 through C3, refer to ASME A17.1/CSA B44.
(c) The pictorial freight loading shown for the different classes of loading is intended for both electric and hydraulic elevators.

SECTION 2.17
CAR AND COUNTERWEIGHT SAFETIES

NOTE: The author expresses his appreciation to George W. Gibson for his extensive contributions to Section 2.17.

ASME A17.1/CSA B44 does not specifically require that all safeties be designed to safely stop an overspeeding descending car or counterweight other than for the condition where the suspension ropes are intact, i.e., not free-fall.

The requirement that Type B safeties conform to the stopping distances specified in 2.17.3 is intended to ensure that a Type B safety will, in a free-fall condition, develop a retardation sufficient to reduce the free-fall speed, resulting in an elongated safety slide or a combination safety and buffer stop within the allowable speed range of the buffer. While the intent is the natural result of a mathematical analysis of the stopping distance equations, it is not notably evident in the specific ASME A17.1/CSA B44 requirements. There are several considerations that influence the formulation of an interpretation of this complex subject of safety stopping. The following provides a rational basis for that interpretation (see ASME A17.1, Interpretation 86-2).

The basic function of an elevator mechanical safety system is to provide a safe stop for the passengers in the event of an overspeeding descending car that cannot be electrically retarded and stopped. This basic function is consistent with historical assurance of passenger safety evidenced in the demonstration of the first "safety hoister" at the Crystal Palace Exposition in 1853 where, upon severing the sole hoist rope, the car was safely stopped, thus signaling the beginning of safe passenger elevator transportation.

The sole embodiment of safety in such early "safety hoisters" to retard and stop a freely falling car was the broken rope wagon spring safety, which engaged the guide rails upon the parting of the single hemp hoist rope. These early "safety hoisters" predated later advances in the art, such as mechanical buffers in the pit, counterweighted elevators, steel wire hoist ropes, and traction machines. Deployment of a single hemp rope on the early safety hoisters in the mid- to latter 1800s necessitated free fall safety protection. The advent of steel wire rope and the eventual replacement of all hemp ropes with steel wire ropes, coupled with enforcement inspections, marked the end of frequent suspension failure.

Clearly, the historical basis for the stopping capability of car safeties must be viewed in relation to their basic function at any point in elevator history. The early safeties had to detect free fall at its onset and apply immediately to retard and stop a freely falling car.

As elevator technology progressed and elevator safety codes were developed, higher degrees of passenger safety were embodied through mechanical and electrical safeguards, and the need for safeties to stop a freely falling car took on less importance throughout most of the U.S. and Canada. In the past 30 years, only a few states, notably Pennsylvania, Wisconsin, and California, and one of the federal government agencies [U.S.

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General Services Administration (GSA)], require free-fall safety tests. Industry practice was to conduct free-fall safety tests under the aegis of the former National Bureau of Standards, one of the early co-secretariats of the A17 Committee, in order to develop proprietary technical data on the stopping performance of safeties.

While the definition of a safety given in Section 1.3 states that free fall is one of several conditions under which a safety is to stop and hold a car or counterweight, there are no design or test requirements in ASME A17.1/CSA B44 to validate such a reference to the free fall stopping condition. The current definition has remained basically unchanged since it first appeared in the 1925 edition of A17.1. When viewed against the design requirements for safeties given in Section 2.17, the definition should have been assessed for consistency and revised accordingly. Therefore, the current definition should be viewed more for its descriptive than prescriptive value in setting forth the many conditions under which safeties may be required to operate. The definition is not intended to convey specific enforceable requirements.

The general requirements for the function of all types of safeties given by 2.17.3 do not specifically state that a car safety be designed to retard and stop a freely falling car whose suspension ropes failed.

Requirement 2.17.3 specifies that the safety have a capability of stopping and sustaining the entire car and rated load from governor tripping speed. Where the elevator carries passengers, 2.16.8, in conjunction with this requirement, ensures a design capability for stopping and sustaining the entire car plus 125% rated load at the applicable speed for that load. Qualification of car weight through the use of the word "entire" directly preceding it appears to have been included to emphasize that the safety had to have sufficient stopping capacity to develop a retardation in order to slow down and hold the car without mentioning the load state of the suspension ropes. However, this needs to be taken in context with acceptance test requirements given in 8.10.2.2.2(ii)(4)(-a), which states in part, "Types B and C safeties shall be subjected to an overspeed test, with the suspension ropes attached ..." and 8.10.2.2.2(ii)(4)(-c), which states in part, "The stopping distances for Type B safeties shall conform to 2.17.3 ..." If the argument can be made that the only basis for the inclusion of the word "entire" is to ensure that a Type B safety has sufficient retarding force inherent in the design, to ensure stopping an entire car in a free-fall condition, then it also must be concluded that free-fall stopping is independent of the stopping distances codified for the non-free-fall condition.

While certain requirements in Section 2.17 refer to safety application related to "breaking or slackening of the suspension ropes" (2.17.7 and 2.18.1), and "parting of the hoist ropes (free fall)," it is the intent of these requirements to activate Type A safeties as quickly as possible in the event of a free fall to avoid buildup of car speed during time delays when the mechanical safety parts are being actuated but not delivering the full retarding force. This buildup of speed is more critical on slow-speed cars using Type A safeties, since the resulting speed of the car when the safety parts engage as a result of governor tripping would be a significantly higher percentage of the rated speed than would occur on higher speed cars using Type B safeties.

In operation, a Type A (instantaneous) safety relies upon the wedging of metal parts between the undercar safety blocks and the guide rails, wherein metal is actually displaced. The name "instantaneous" explains the nature of the retardation to which the elevator and any occupants are subjected. The stop is harshly abrupt, usually in the order of 3.0g to 4.0g. For this reason, the speed allowed for these safeties is limited to 0.75 m/s or 150 ft/min in order to limit the time duration over which the high retardation is impressed upon the car and any passengers.

Nevertheless, while free-fall activation is required for Type A safeties, there are no requirements for the stopping performance in terms of retardation or stopping distance.

The absence of specific requirements for free-fall stopping capability for Type B safeties must be evaluated in relation to the range of stopping distances allowed by 2.17.3 and Table 2.17.3, which are derived from the formulas given in 8.2.6. These formulas for minimum and maximum safety stopping distances can be expressed in terms of the retardations of 1.0g and 0.35g, respectively.

In order to determine whether the Code requires that a Type B safety can hold a freely falling car, it will be sufficient to analyze the singular case of a car that demonstrated a safety stopping distance equal to the maximum slide at the acceptance inspection, such as whose retardation $a = 0.35g = 11.25$ ft/sec^2 in a free-fall mode with rated load in the car.

Mathematical analysis will show that the capability of any Type B safety that complied with the acceptance inspections and tests in stopping a freely falling car is dependent upon several parameters, specifically the magnitude of the masses in the complete system, safety retarding force, vertical location of the car or counterweight in the hoistway when safety application occurs, available traction between the suspension ropes and driving machine sheave, and machine location.

The interrelationship of these parameters determines the dynamic performance of the safeties in controlling the descending car motion. If the analysis of a given system shows that the safety has insufficient retarding force to retard the freely falling car, then the descending car will, in fact, accelerate into the pit at an unsafe speed in excess of the maximum striking speed for which the buffer was designed.

However, if the analysis shows that there is sufficient retarding force to reduce the car speed to a value that is not greater than the speed for which the buffer is designed, then the system will undergo a combination safety and

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buffer stop, thus bringing the passengers to a safe stop, which is the basic intent.

Before analyzing the dynamics of the elevator system, a brief review of the pertinent ASME A17.1/CSA B44 requirements will be made, since the acceptance test requirements differ from the actual failure mode in terms of the various switches, which are in effect normally but rendered inoperative during testing. During normal operation of the elevator system, which includes failure modes when overspeeding can occur, all electrical protection devices are operative. Those related to a safety stop include the governor overspeed switch (2.18.4.1) and safety mechanism switch (2.17.7.2), each of which removes power from the driving-machine motor and brake. Accordingly, a certain amount of the stopping of the car at safety application derives from the dynamic braking of the machine imparted to the car by the traction between the drive sheave and ropes, and the major percentage of the stopping derives from the safety retarding force. However, during the acceptance testing of the safeties on the job site, these switches are temporarily adjusted to open as close as possible to the position at which the car safety mechanism is in the fully applied position. [See 8.10.2.2.2(ii)(4)(-b).]

ASME A17.1/CSA B44 Code requires that the governor overspeed switch be inoperative during the overspeed test to ensure that the machine continues to be powered until the safety applies. The car safety mechanism switch is temporarily adjusted to open as close as possible to the position at which the safety is in the applied position to ensure that the brake does not apply any stopping to the car, but rather that the safety provides the entire retardation and stopping. This requirement ensures that the safety alone provides the required retardation.

The following analysis will show that because of the acceptance test requirements imposed by 8.10.2.2.2(ii)(4), a Type B safety not only will stop an overspeeding car with the ropes intact but will also provide safe stopping for a freely falling car.

The analysis will be made for an elevator arranged with driving machine above, 1:1 roping, without rope or chain compensation, for the sake of simplicity; however, the general methodology is applicable with the appropriate modification to any elevator system.

(a) Overspeeding Car With Counterweight Attached (machine driving). Diagram 2.17(a) is representative of the field acceptance test required by 8.10.2.2.2(ii)(4) in which the driving machine keeps running during the stopping sequence.

The retardation impressed upon the car is found from the general method

(Imperial Units)

$$a = \sum F / \sum M$$

$$a = \left[\frac{W + \alpha(F - C - L - R_h)}{W + \alpha(C + L + R_h)}\right] g \tag{1}$$

The following relationships are representative of the weights used in passenger elevators in the speed range using Type B safeties.

(Imperial Units)

$$\left.\begin{aligned} C &= L \\ W &= C + 0.45L = 1.45L \\ R_h &= 0.15L \end{aligned}\right\} \tag{2}$$

Substituting eq. (2) in eq. (1) yields

(Imperial Units)

$$a = \left[\frac{1.45L + \alpha(F - 2.15L)}{1.45L + 2.15L\alpha}\right] g \tag{3}$$

Equation (3) is evaluated for the maximum allowable stopping distance permitted by 2.17.3 and 8.2.6, in which case $a = 0.35g$. The available traction α for a double wrap traction gearless machine, $\alpha = 2.0$. Therefore,

(Imperial Units)

$$F_{\min} = 2.43L \tag{4}$$

where $F_{\min}$ is the minimum retarding force, which the safety can have.

The maximum retarding force will produce a stop equal to the minimum stopping distance allowed by 2.17.3 and is determined by letting $a = 1.0g$ and

(Imperial Units)

$$\alpha = 20$$

in eq. (3). Therefore,

(Imperial Units)

$$F_{\max} = 4.3L \tag{5}$$

In that the safety stopping performance did not have to meet the test requirements of 8.10.2.2.2(ii)(4), the machine could be considered freewheeling, similar to a frictionless pulley in which the tensions would be constant over the length of hoist rope passing over the machine. In this case, $\alpha = 1$ and eq. (3) becomes

(Imperial Units)

$$a = \left[\frac{F - 0.7L}{3.6L}\right] g \tag{6}$$

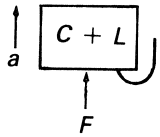
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For the maximum stopping distance, $a = 0.35g$ and eq. (6) becomes

(Imperial Units)

$$F_{\min} = 1.96L \tag{7}$$

(b) Freely Falling Car



The retardation impressed upon the car is

$$a = \left[\frac{F - C - L}{C + L}\right]g \tag{8}$$

Substituting eq. (2) in eq. (8) yields

(Imperial Units)

$$a = \left[\frac{F - 2L}{2L}\right]g \tag{9}$$

In order to develop a retardation

(Imperial Units)

$$F - 2L > 0 \tag{10}$$

Therefore,

(Imperial Units)

$$F > 2L \tag{11}$$

It is clear from eqs. (7) and (11) that, if the retarding force of the safety is too small, a free-falling car will never be retarded, but will be accelerated instead.

However, comparing eq. (4) to eq. (11) shows that by demonstrating conformance to the stopping distance during the overspeed test, in which the machine continues to run as required by 8.10.2.2.2(ii)(4), the safety will retard a free-falling car. This will be examined further.

(c) Overspeeding Car With Counterweight Attached (machine stopped)

This case is representative of the actual safety stop that would occur in an overspeeding system, in which case both the governor overspeed switch and safety mechanism switch would function to remove power from the driving machine motor and brake.

In setting up the system dynamics, the tractive effort at the drive sheave is just the opposite to case (a) above. Therefore, the system retardation is found to be

(Imperial Units)

$$a = \left[\frac{\alpha W - (C + L + R_h) + F}{\alpha W + (C + L + R_h)}\right]g \tag{12}$$

Substituting the relationships from eq. (2) yields

(Imperial Units)

$$a = \left[\frac{1.45L\,\alpha - 2.15L + F}{1.45L\,\alpha + 2.15L}\right]g \tag{13}$$

The minimum safety retarding force that will produce the maximum allowable stopping distance is found as before by setting $a = 0.35g$ and $\alpha = 2$, from which eq. (13) results in

(Imperial Units)

$$F_{\min} = 1.02L \tag{14}$$

The maximum retarding force is found by substituting $a = 1.0g$ and $\alpha = 2$ in eq. (13), from which

(Imperial Units)

$$F_{\max} = 4.3L \tag{15}$$

(d) Summary of Safety Retarding Forces. The safety retarding forces from the above cases are summarized in Chart 2.17.

From Chart 2.17 it is seen that the minimum allowable retarding force must be not less than that shown for case (a) in order to

(1) meet the test requirements of 8.10.2.2.2(ii)(4)
(2) retard a freely falling car

Therefore, the following relationship must be met.

(Imperial Units)

$$2.43L \le F \le 4.3L \tag{16}$$

(e) Evaluation of the Free-Fall Condition. Referring to eq. (11), it is seen that if $F > 2L$, a retardation would be impressed upon a free-falling car. This retardation is given by eq. (9) as

(Imperial Units)

$$a = \left[\frac{F - 2L}{2L}\right]g$$

In order to pass the acceptance test requirements of 8.10.2.2.2(ii)(4), it was shown by eq. (4) that the minimum retarding force must be

(Imperial Units)

$$F_{\min} = 2.43L$$

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Substituting eq. (4) in eq. (9) yields

(Imperial Units)

$$a = 0.215g \tag{17}$$

Diagram 2.17(b) is hypothesized in order to evaluate a free-fall condition.

The buffer striking speed is required by 2.22.4 to be 115% of the rated speed. It is assumed that the governor tripping speed is 25% greater than the rated car speed and that, in a free-fall condition, the car speed would continue to increase during the time it takes to activate the governor and safety system. It is assumed that the car speed at safety activation is 25% greater than governor speed.

Therefore,

(Imperial Units)

$$v_b = 1.15v \tag{18}$$

$$v_g = 1.25v \tag{19}$$

$$v_s = 1.25v_g = 1.5625v \tag{20}$$

The distance the car falls from governor tripping speed to the speed at which the safety activates and starts retarding the car is

(Imperial Units)

$$h_s = \frac{v_s^2 - v_g^2}{2g} \tag{21}$$

The distance the car falls from safety activation speed to buffer striking speed is

(Imperial Units)

$$h_b = \frac{v_s^2 - v_b^2}{2a} \tag{22}$$

The total distance the car falls from governor tripping speed to buffer striking speed is

(Imperial Units)

$$S = h_s + h_b \tag{23}$$

Substituting eqs. (18) through (22) in (23) yields

(Imperial Units)

$$S = 0.44v^2\left[\frac{1}{g} + \frac{1.273}{a}\right] \tag{24}$$

Substituting eq. (17) in (24) yields

(Imperial Units)

$$S = \left[\frac{3.04v^2}{g}\right] \tag{25}$$

The necessary stopping distance to bring the car to a stop under the retardation of $0.215g$ is as follows:

(Imperial Units)

$$S_t = h_s + h_a \tag{26}$$

where

(Imperial Units)

$$h_a = \frac{v_s^2}{2a} \tag{27}$$

Substituting eqs. (21) and (27) in (26) yields

(Imperial Units)

$$S_t = \frac{6.12v^2}{g} \tag{28}$$

Equations (25) and (28) are graphed in Diagram 2.17(c).

(f) Conclusion. The successful use of steel wire rope over the 90-plus years during which ASME A17.1/CSA B44 has been in effect, wherein maintenance and inspection would reveal deteriorating suspension ropes, validates the ASME A17.1/CSA B44 position on safety stopping requirements currently codified. The accident history where total suspension failure occurred is so small as to show that the likelihood of total suspension failure is highly improbable. Notwithstanding, if a safety has been designed, installed, and successfully tested to meet the requirements of 8.10.2.2.2(ii)(4)(d), it will provide a retardation to slow down a freely falling car. The curves in Diagram 2.17(c) cover two conditions.

(1) Diagram 2.17(c) curve 1 gives the total distance from the point at which the governor trips to stop a freely falling car whose initial velocity was equal to the rated speed [eq. (28)].

(2) Diagram 2.17(c) curve 2 gives the total distance from the point at which the governor trips to retard a freely falling car down to the oil buffer striking speed [eq. (25)].

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Analysis shows that in an extreme case, if the safety retarding force were only capable of stopping an overspeeding car whose ropes were intact, within the maximum permissible stopping distance allowed by 2.17.3, it would produce sufficient retardation on a freely falling car to reduce its speed to the speed for which the pit buffer is designed, as required by 2.22.4.1, i.e., 115% of rated speed.

As long as the striking speed of the car has been reduced to that which can be safely absorbed by the pit oil buffer, the car and passengers would be brought to a safe stop within the range of buffer retardations permitted by ASME A17.1/CSA B44. The probability of an elevator carrying a full rated load is considered extremely low since elevators rarely carry their rated load, and, in fact, travel with less than balanced load most of the time. For this reason, it is highly improbable that a fully loaded car would lose its complete suspension and go into a free-fall condition.

Since the high-speed elevators with speeds above 5 m/s or 1,000 ft/min typically use reduced stroke oil buffers arranged with an emergency terminal speed-limiting device as allowed by 2.22.4.1, additional height would be needed to slow the car to rated speed of the reduced stroke buffer. From the foregoing discussion and analysis, it is evident that the maximum stopping distances allowed by ASME A17.1/CSA B44 are indeed safe, not only for an overspeeding car but also for a freely falling car.

When a safety has retarding forces higher than the absolute minimum, which was the case described above, the distances required to stop a freely falling car are reduced accordingly.

The foregoing analysis was based upon a freely falling car carrying full rated load, which is a highly improbable failure scenario since elevators carry less than balanced load most of the time. The analysis given above can be easily modified to reflect a live load less than balanced load and will show that safeties designed to meet present ASME A17.1/CSA B44 requirements will almost always stop a freely falling car before striking the buffer.

2.17.1 Where Required and Location

Prior to the adoption of this requirement, car safeties were occasionally attached to the car crosshead. There was a history of accidents resulting from the actuation of the car safety causing the car frame upright (stile) to part from the car crosshead, notably, on vintage wooden car frames.

On existing installations where the car safety is attached to the car crosshead, particular attention should be paid to the structural condition of the car frame and its connection to the crosshead during an inspection, as well as prior to and immediately following a test.

This requirement was revised in ASME A17.1-2010/CSA B44-10 to allow for suspension means other than wire rope, such as noncircular elastomeric-coated steel suspension members and aramid fiber ropes.

2.17.2 Duplex Safeties

Duplex safeties are pairs of safeties; one safety is located within or below the lower member of the car frame (safety plank), and the other safety normally is attached to the crosshead.

2.17.3 Function and Stopping Distance of Safeties

Stopping distances for Type B safeties are based on a maximum average retardation of 1.0g for the minimum distance; and 0.35g for the maximum distance, when tested with rated load. Using these as limiting design criteria, the safety retarding force can be established. The values are historically derived and ensure stopping the elevator. The driving-machine brake is permitted to provide some assistance in the safety stop conducted for test purposes. During the life cycle of the elevator, safety stops might occur due to overspeed, but these generally occur with a lightly loaded car, in which case the stopping retardations will be higher than the values selected for rated load test purposes. Depending on masses in the system, safety stopping retardations for a lightly loaded car condition can be almost double those that would occur at rated loads.

Retarding force for a Type C safety is provided by the use of one or more oil buffers interposed between the lower member of the car frame and the safety plank, or in the unit assembly consisting of instantaneous safety and oil buffer, as described in 2.22.1.1.

Type A safeties apply a high retarding force upon activation. They typically employ eccentrics and rollers without any flexible medium that would increase the stopping distance. Without such flexible medium, the energy absorbed in stopping the car or counterweight derives from the distortion of metal at the interface between the safety parts and guide rails. The exact amount of distortion cannot be predicted. Accordingly, ASME A17.1/CSA B44 does not specify minimum and maximum allowable stopping distances. For this reason, Type A safeties are limited to elevators having a rated speed of not more than 0.75 m/s or 150 ft/min. Stopping time duration is extremely short.

The title of Table 2.17.3 was revised in ASME A17.1-2019/CSA B44:19 to “Maximum and Minimum Stopping Distances for Type B Car Safeties With Rated Load at Maximum Car Governor Tripping Speed.” The counterweight governor is allowed to trip up to 10% higher than the car governor; therefore, the table is not correct for counterweight safeties.

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2.17.4 Counterweight Safeties

Counterweight safeties are necessary only when there is accessible space below the counterweight runway. Counterweight safeties are also permitted to be used as emergency brakes to protect against ascending car overspeed [2.19.3.2(a)(1)]. See Handbook commentary on Sections 2.6 and 2.19.

2.17.5 Identification and Classification of Types of Safeties

2.17.5.1 Type A Safeties. Type A instantaneous safeties are designed to apply a high retarding force as soon as they are brought into action. A Type A safety generally consists of

(a) a roller normally located in a pocket but operating between a sloping surface and a guide rail, or

(b) an eccentric member pivoted on the car or counterweight structure and brought into contact with the guide rail surfaces

Once the eccentric member or roller is in contact with the guide rail, this device is self-actuated by the operating forces being derived from the mass and motion of the car or counterweight. The governor rope acts only to bring the roller or eccentric member into contact with the guide rail. It is frequently designed to be applied by the inertia of the governor rigging. In addition to operation by means of a speed governor, ASME A17.1/CSA B44 requires operation without appreciable delay in the event of free fall, which may be accomplished by the inertia of the governor and governor rigging or by springs and mechanical linkage actuated by failure or slackening of the suspension ropes. Because it does not afford appreciable slide, the amount of energy it can absorb is distinctly limited; hence, ASME A17.1/CSA B44 limits the maximum rated speed from which it may be used to 0.75 m/s or 150 ft/min. This safety is normally released by raising the car or counterweight. See Diagram 2.17.5.1.

2.17.5.2 Type B Safeties

(a) Wedge Clamp Safeties. Type B wedge clamp safeties are safeties in which a wedge is driven between two pivoted members, the opposite ends of which form or carry the guide rail gripping surfaces. Travel of the wedge increases the pressure on the jaws. No elastic member is provided in the jaw assembly, but one may be provided in the actuating mechanism. The wedges are normally operated by a rotation of right- and left-hand threaded screws working within a drum on which a wire rope attached to the governor rope is wound. These screws may either push or pull the back ends of the safety jaws to cause the faces of the jaws to clamp the guide rail faces by operating through pivot pins. The values are historically derived and ensure stopping the elevator. The operating force is derived from the tension in the governor rope. Because of the inertia effects of the governor and governor rigging and elasticity of the governor rope, the tension on the safety drum rope not only varies from installation to installation, but also varies in the same installation with position of the elevator in the hoistway and with the speed at which the governor jaws apply. Uneven guide-rail thicknesses or bad guide-rail joints produce relatively large variations in the retardation of the car. A drum-type wedge clamp safety is released by means of a wrench from within the car. The wrench generally carries a beveled gear pinion or worm, which engages teeth on the safety drum. Turning the wrench to release the safety rewinds the rope on the safety drum. While the rope is being rewound on the safety drum, great care must be used to maintain tension on the drum rope or the rope may jam on the safety drum causing subsequent failure of the safety mechanism. [See Diagram 2.17.5.2(a).]

(b) Flexible Guide Clamp (FGC) Safeties. A Type B flexible guide clamp safety is one in which the final force applied to the faces of the guide rails is derived from a spring in the jaw assembly, which is compressed or further compressed as the device is being applied. Because of the presence of the spring member, variations in guide-rail thicknesses or a bad guide-rail joint produce comparatively small variations of the pressure on the rail. The mechanism consists of a pair of tapered wedges with sets of rollers between each wedge and a spring-backed inclined surface. When pulled into contact with the guide rail by a governor rope-operated lift rod, the rollers permit these wedges to deflect the spring until the wedges reach a stop after which they slide on the guide rail with substantially constant pressure. Once the wedges are in contact with the rail, the device is self-actuating, the operating force being derived from the mass and motion of the car. In some applications, typically where space is small, a U-shaped spring is used to furnish the pressure directly to rollers. In other applications, a coil spring and pivoted arms are furnished. Because the pressure on the guide rail is determined by the deflection of the spring or springs, the retardation is essentially independent of the speed at which the governor operates and of the tension in the governor ropes. The spring load must be sufficient to handle reasonable overloads allowing for wearing of the parts. Due to the constant retarding force developed by spring deflection regardless of car load, this safety produces higher retardations with a lightly loaded car. This type of safety is normally released by lifting the car or counterweight. [See Diagram 2.17.5.2(b).]

(c) Rollers and Spring-Operated Jaws. Another type of mechanism consists either of a roller or of a roller-operated wedge, which operates between a spring-backed tapered surface and the guide rail. Once the roller is in contact with the guide rail, the device is self-actuating, the operating force being derived from the mass and motion of the car. The governor rope acts only to bring the roller into contact with the guide

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rail after which the governor rope continues to pull through the governor jaws. Characteristics are similar to the wedge-operated type described above without the follower wedge. This safety tends to produce higher retardation rates with a lightly loaded car. To release the car safety, a lever wrench is inserted in the slot in the car floor and is used to compress and reset the spring. See Diagram 2.17.5.2(c).

Requirements 2.17.5.2 and 2.23.6 do not address damage imposed on the guide rail when the safety sets.

2.17.5.3 Type C Safeties (Type A With Oil Buffers)

(a) Buffer(s) Mounted to Auxiliary Plank. Type C safeties develop retarding forces during the compression stroke of one or more oil buffers interposed between the lower members of the car frame and a governor operated Type A auxiliary safety plank applied on the guide rails. Stopping distance is equal to the effective stroke of the buffer. The safety plank in the car sling is independently guided. Due to the inherent Type A safety design described previously, stopping distance of the auxiliary safety plank is very short, providing an operating platform for the oil buffer or buffers with a minimum of car travel. The car is retarded and brought to a stop by an oil buffer or buffers having a stroke calculated for the application to provide smooth retardation. This type of safety is normally released by lifting the car. See Diagram 2.17.5.3.

(b) Buffers Integral With Safety Blocks. Another Type C safety design embodies a unit assembly of an instantaneous (Type A) safety housed with an oil buffer. Each unit assembly is mounted to the car frame and platform structure at each guide rail location. This design eliminates the necessity of a second set of planks. In operation, the Type A safety is activated and stops the integral safety block and oil buffer housing. The car structure is mounted to the buffer plunger and comes to a more gradual stop during the stroke of the oil buffer.

2.17.7 Governor-Actuated Safeties and Car-Safety Mechanism Switches Required

2.17.7.2 This switch prevents severe damage caused by a running drive machine after safety set. Continued operation of the driving machine can sever the ropes or wear the drive sheave.

2.17.8 Limits of Use of Various Types of Safeties

See Handbook commentary on 2.17.5 for discussion on various types of safeties.

2.17.9 Application and Release of Safeties

2.17.9.1 Means of Application. Electric, hydraulic, or pneumatic devices are not considered a reliable positive means for actuation or holding safeties in the retracted position. This requirement prohibits their use.

2.17.9.2 Level of Car on Safety Application. If the car platform went out of level more than the tolerances specified in this requirement, the load on the car could shift, causing structural damage to the car and injury to passengers or freight handlers in the car. The principal causes of cars going out of level are flexible car frame uprights (stiles) and unequal retarding forces between safeties on opposite sides of the car. Diagram 8.2.2(b) illustrates the deformation of the uprights that contributes to the platform going out of level. For this reason, the minimum moment of inertia of the upright is specified by 8.2.2.5.3. See Diagram 2.23.5 for a further explanation of the effect of unequal retarding forces.

2.17.10 Minimum Permissible Clearance Between Rail-Gripping Forces of Safety Parts

See Diagram 2.17.10.

2.17.11 Maximum Permissible Movement of Governor Rope to Operate the Safety Mechanism

The basis for allowable governor pullout distance specified by 2.17.11, which decreases as the car speed increases, is based on the premise that an overspeed could occur in conjunction with a high acceleration such as a freely falling car (broken rope) or an electrical malfunction. If, under such a case, the governor applied when the car speed was at governor tripping speed, the final speed of the car at the time the safeties set and started to apply stopping force would be higher. This would be equal to the sum of the governor tripping speed plus an additional speed increment due to the acceleration acting over the governor pullout distance.

A flexible guide clamp safety classified as a Type F.G.C. safety under the provisions of the 1937 edition of the A17.1 Code is now classified as a Type B safety. This type of safety does not require the continual unwinding of a safety drum rope to fully apply. Instead, safety jaws are quickly applied to the guide rail upon governor activation as the rollers move up the rather steep wedge and on to the flat or nearly flat surfaces. The final pressure on the rails results from spring action associated with safety jaws. It is not necessary that three turns of safety rope be left on the drum after a safety overspeed test. This was recognized in Elevator Maintenance Bulletin Number 5 published by the American Society of Mechanical Engineers in October 1945. The Inspectors' Guide also states that all rope may be pulled from this type of safety.

Three turns of the safety rope required to be left on the drum after safety application ensure a margin of safety against the accidental pulling of all rope off the drum before the safety is fully applied. For additional information, see Handbook commentary on 2.17.5.

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2.17.12 Minimum Factors of Safety and Stresses of Safety Parts and Rope Connections

2.17.12.1 Requirement 2.17.12.1 was revised in ASME A17.1-2022/CSA B44:22 to add bearings to the list of parts of safeties not required to meet the minimum safety factors because ASTM E8 was never intended to address bearings.

2.17.12.4 Historically, phosphor bronze hoisting rope has been used successfully for this rope application. For such application where the rope is subject to limited flexing over sheaves and drums, rope manufacturers recommend galvanized rope. Plain iron wire rope does not satisfy the requirements. For further rope information, contact a supplier of elevator wire rope.

The Code prohibits use of Tiller rope construction for safety connections because it has low wear, abrasion, and crushing resistance. Tiller rope construction employs 6 strands of 42 wires each for a total of 252 wires. Each of the 6 strands is actually a complete 6 × 7 rope containing a fiber center. The 6 strands are closed around a central fiber core. This construction produces one of the most pliable ropes available. The wires, however, are extremely fine, making the rope susceptible to wear, abrasion, and crushing.

2.17.13 Corrosion-Resistant Bearings in Safeties and Safety-Operating Mechanisms

Because the safety is under the car and is apt to be exposed to a corrosive atmosphere from a wet or damp pit, corrosion-resistant bearings are required. Bearings will be stationary most of their life and actually will be called upon to operate only in an emergency when the safety must be applied.

During the Category 1 periodic tests [8.6.4.19.2(b)(1)] at a frequency set by the enforcing authorities (generally 12 months), the governor is tripped at the lowest operating speed of the elevator, causing the safety jaws to engage the rails, and stop the elevator. The purpose of this test is to confirm operability of safety parts and to ensure they are freed up and not impeded by buildup of paint, dirt, or rust.

2.17.14 Marking Plates for Safeties

Requirement 2.17.14 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13 and remove language that is already addressed in the new section. See Handbook commentary on Section 8.13.

2.17.15 Governor-Rope Releasing Carriers

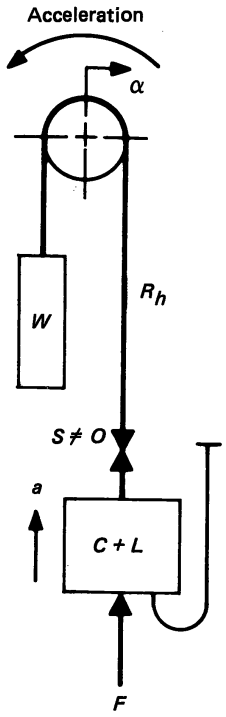
A governor-rope releasing carrier is a mechanical device to which the governor rope may be fastened and which is calibrated to control the activation of a safety at a predetermined tripping force. A releasing carrier is used to minimize the possibility of the inertia of the governor rope tripping the safety during normal acceleration or deceleration. A governor-rope releasing carrier is not required, but if provided, must conform to the requirements of 2.17.15. If the governor-rope releasing carrier could be adjusted beyond the limits specified in this requirement, it might accidentally be overtightened. Under this condition, the governor could trip from an overspeed condition, and the governor rope would not release from the releasing carrier and would pull through the governor jaws, thus not allowing the safety to be actuated. The purpose of these requirements is to limit magnitude of tensile load imparted to the governor rope to a safe working value in order to prevent overloading. See Diagram 2.17.15.

2.17.16 Rail Lubricants and Lubrication Plate

Requirement 2.17.16 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13, change an incorrect reference, and remove language that is already addressed in the new section. See Handbook commentary on Section 8.13.

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Diagram 2.17(a)
Overspeeding Car With Counterweight Attached (Machine Driving)



where

C = car weight, lb
L = rated load, lb
W = counterweight, lb
R_h = hoist rope weight, lb
F = safety retarding force, lb
a = retardation, ft/s^2
g = gravity acceleration, 32.2 ft/s^2
v = rated speed, ft/min
v_b = buffer striking speed, ft/min
v_g = governor tripping speed, ft/min
v_s = car speed at safety activation, ft/min
α = available traction

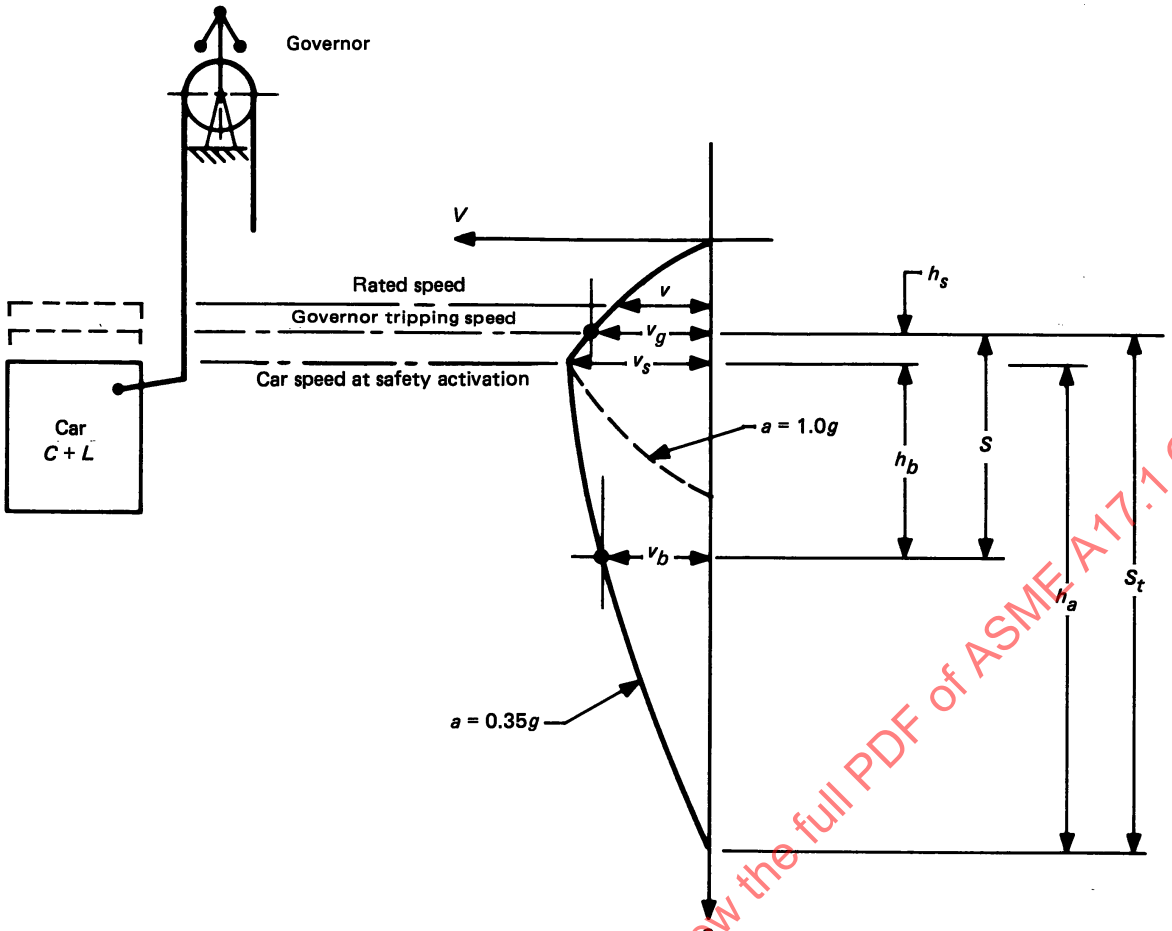
Chart 2.17
Safety Retarding Forces

Case	Situation	Machine	Retarding Force F_{min} [Note (1)]	Retarding Force F_{max} [Note (2)]	Remarks
a	Overspeed	Driving	2.43*L*	4.3*L*	8.10.2.2.2(ii)(4)
b	Overspeed	Free wheel	1.96*L*	4.3*L*	
c	Overspeed	Stopped	1.02*L*	4.3*L*	

NOTES:
(1) F_{min} = The safety retarding force that will produce a maximum stopping distance allowed by 2.17.3, i.e., $a = 0.35g$.
(2) F_{min} = The safety retarding force that will produce a maximum stopping distance allowed by 2.17.3, i.e., $a = 1.0g$.

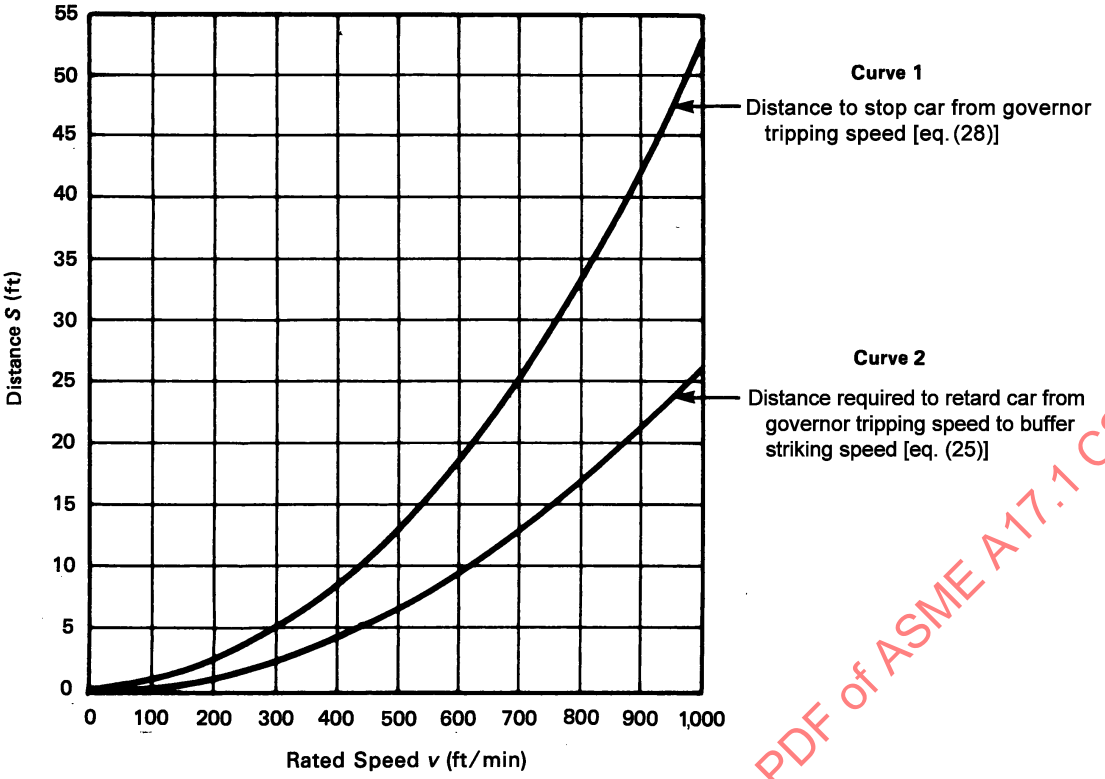
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Diagram 2.17(b)
Free-Fall Conditions



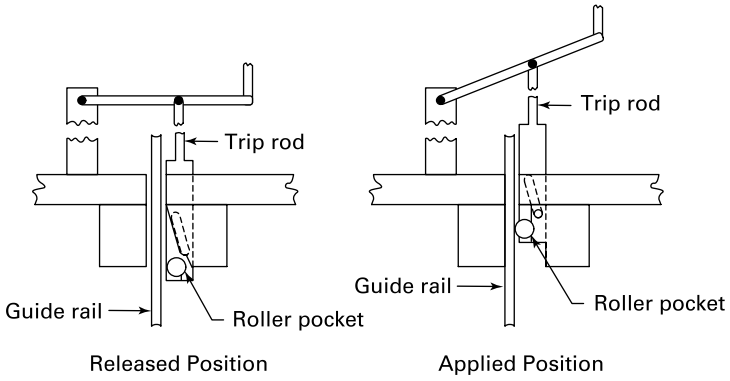
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Diagram 2.17(c)
Stopping Distances

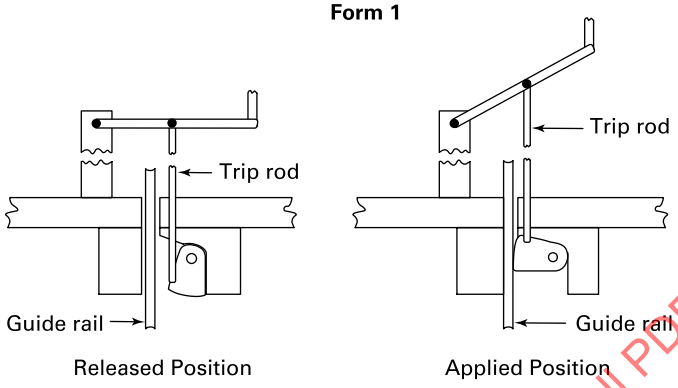


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Diagram 2.17.5.1
Instantaneous Safety, Roller- and Eccentric-Operated



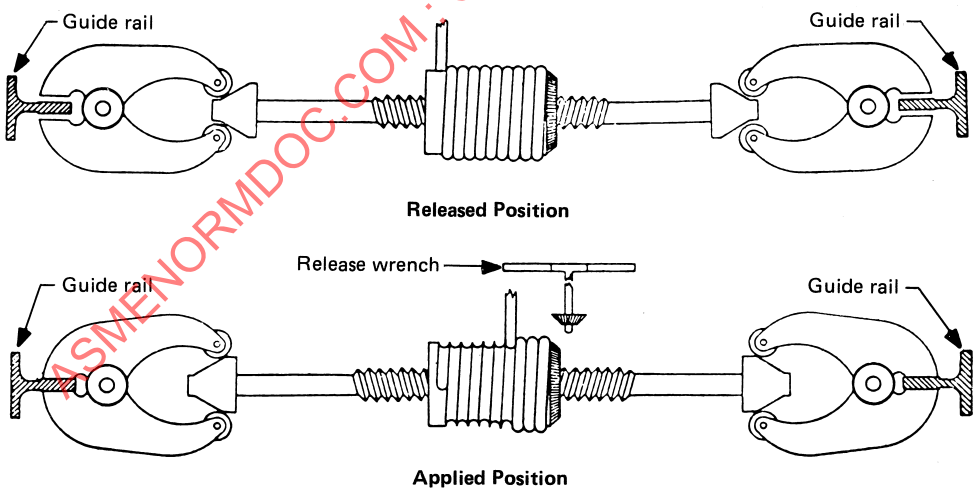
(a) Roller Operated, Form 1



(b) Eccentric Operated, Form 2

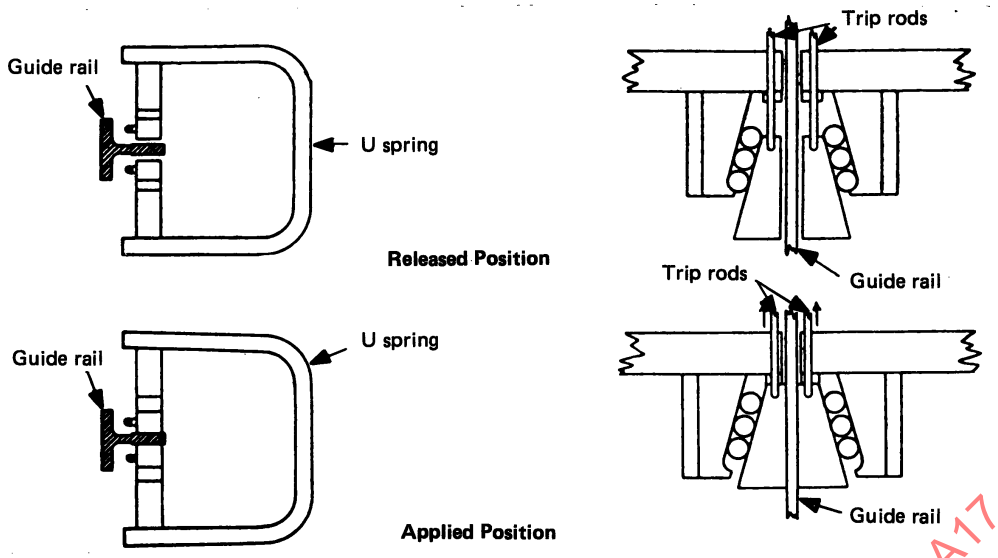
GENERAL NOTE: Double eccentrics are provided for heavy duty.

Diagram 2.17.5.2(a)
Type B Wedge Clamp, Drum-Operated Safety



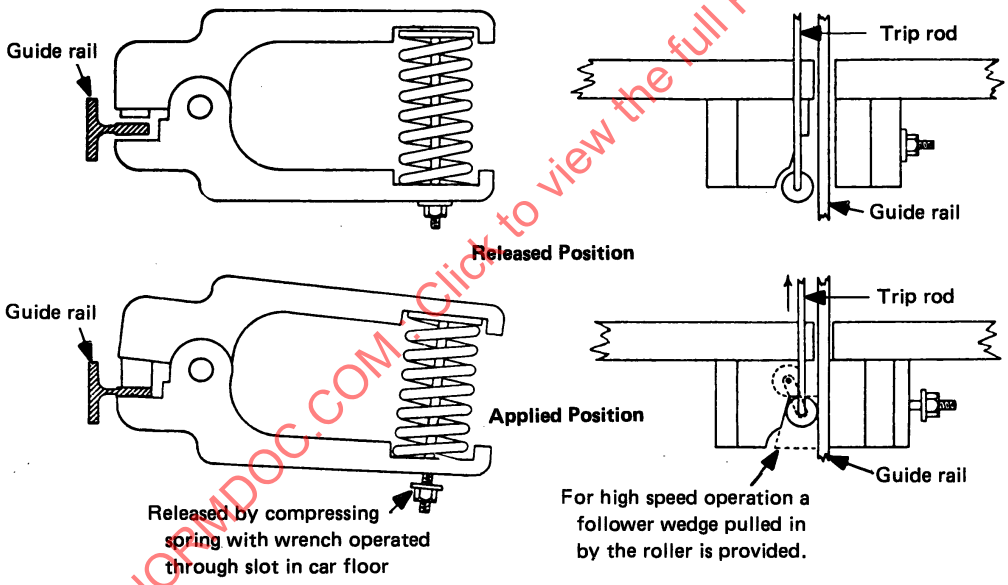
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Diagram 2.17.5.2(b)
Type B Flexible Guide-Clamp Safety, Wedge-Operated



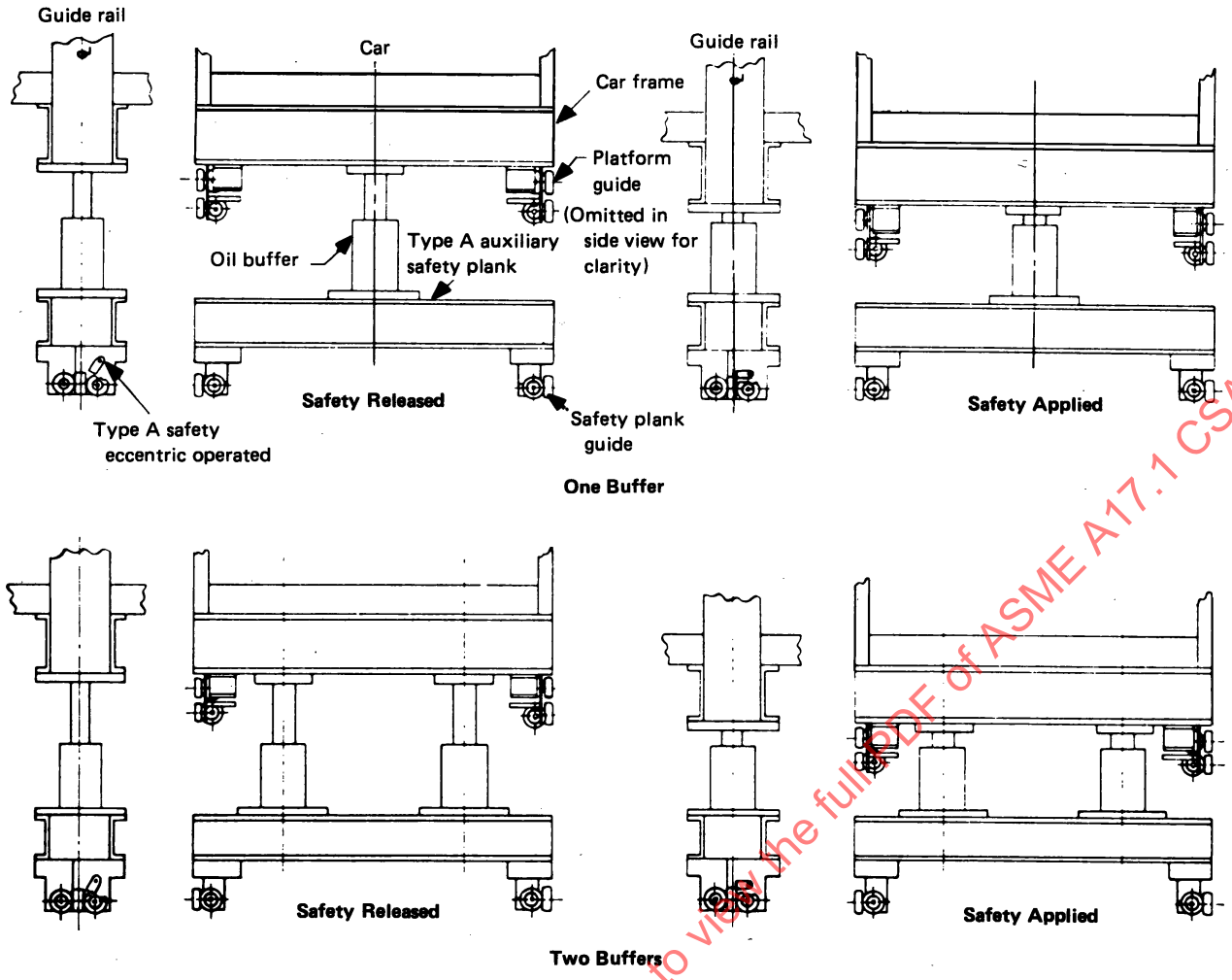
GENERAL NOTE: The U-spring is replaced with clamp and coiled spring for heavy duty.

Diagram 2.17.5.2(c)
Type B Flexible Guide-Clamp Safety, Contact-Roller-Operated



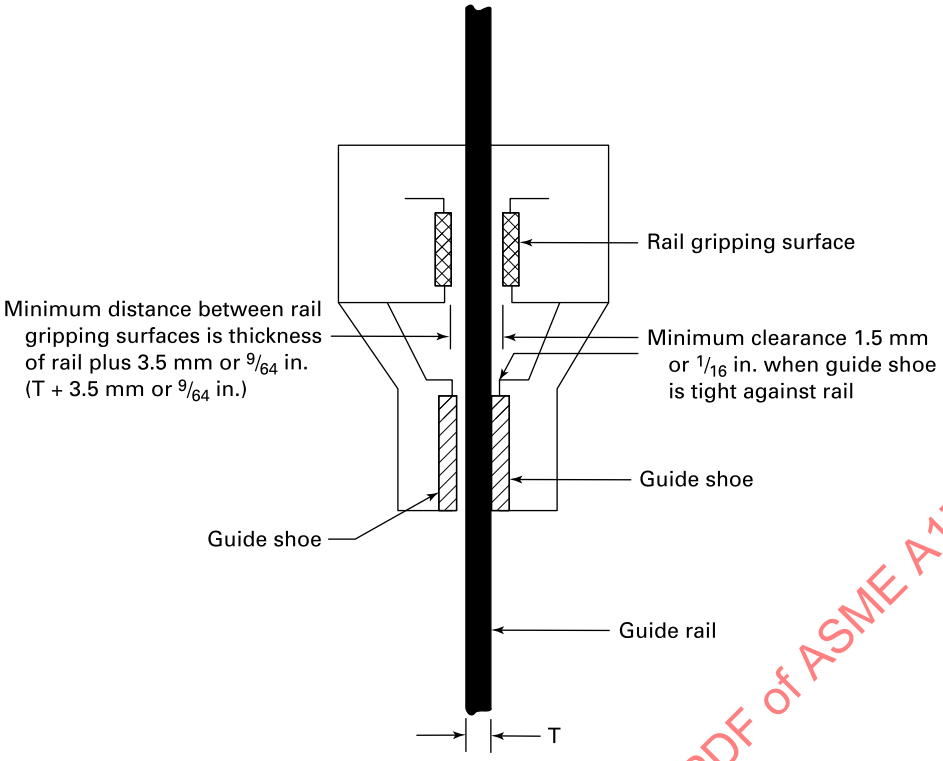
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Diagram 2.17.5.3
Type C Safety



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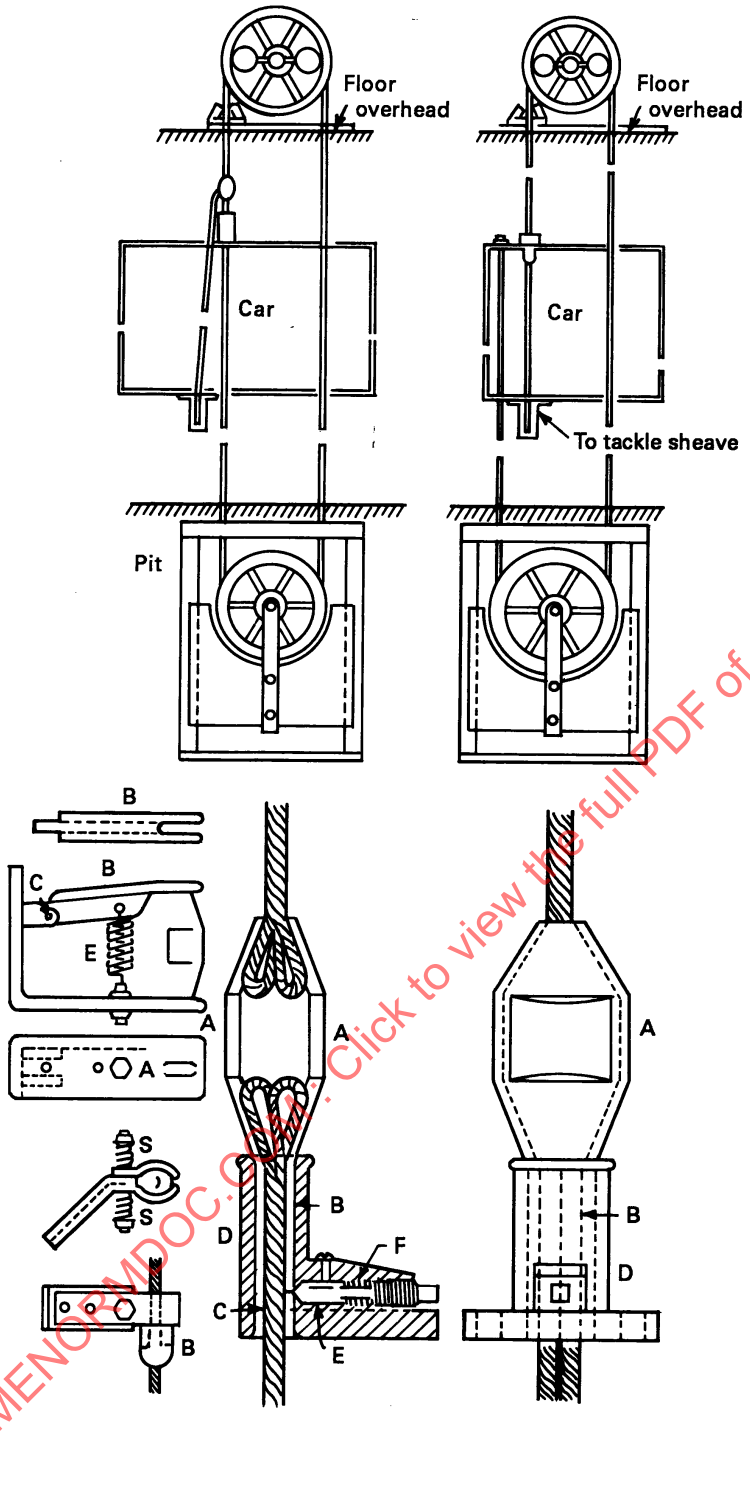
Diagram 2.17.10
Safety Jaw Clearances



GENERAL NOTE: Courtesy of Zack McCain, Jr., P.E.

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Diagram 2.17.15
Typical Governor-Rope Releasing Carrier Arrangements



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SECTION 2.18
SPEED GOVERNORS

NOTE: The author expresses his appreciation to George W. Gibson for his contributions to Section 2.18.

2.18.1 Speed Governors Required and Location

Over the years, many different types of governors have been developed and used. The following is a description of five of the most common types:

(a) flyball governor: A flyball governor is one operated by a pair of flyballs attached to and driven by a vertical shaft. Links attached to the flyball arms lift a collar or sleeve operating against an adjustable compression spring on the shaft. The vertical shaft is driven through a pair of bevel gears by a sheave, which in turn is driven by a governor rope attached to the car. Various gear ratios are generally available to take care of various tripping speeds. When a predetermined speed is reached, the collar is lifted far enough to trip the rope grips. In older elevators they may consist of a pair of grooved, arched pivots pivoted on opposite sides of the down-running side of the governor rope. These jaws grip and stop the rope when they are tripped. Gear teeth are provided to ensure equal travel of the jaws. Where pull-through is desired, one of the grips is spring-backed.

(b) overhead flyball: This is a modification of the usual flyball type. The flyballs are mounted with the points of support below the plane of rotation. When at rest, the flyballs lie inside the lines through their supports. A disk lifted by a pair of levers attached to the ball arms trips the rope grip; because the outward travel of the balls is aided by gravity, small masses may be used.

(c) horizontal shaft governor: A horizontal shaft governor is one with a shaft perpendicular to the plane of the sheave. Pivoted masses, spring controlled, operate a lift rod by means of short arms attached to the masses. By varying the tension of the springs, a considerable range of speeds may be covered.

(d) centrifugal governor: A centrifugal governor (disk governor, bail-type governor, knockout governor) consists of a sheave containing two or more eccentrically pivoted weights normally held by springs within the periphery of the sheave. For a bail or arm carrying a wedge in line with the governor rope, the bail is mounted eccentrically to the sheave. When the speed of the governor rope reaches a predetermined value, the weights are driven outward by centrifugal force until the bail or arm is engaged or moves in a direction of rotation until the wedge member engages the rope and locks it against the sheave. Ordinarily, this type of governor has no provision for a pull-through but when used for moderate or high speeds is arranged with parallel spring-backed jaws, which permit pull-through. Jaw grips are tripped by a link connecting them to a notched disk, normally stationary, which is operated on overspeed by a dog or lug on the inner end of either of the pivoted weights. See Diagram 2.18.1.

(e) jawless governor: This type of governor does not have jaws to grip the governor rope. When the sheave of this type of governor is stopped due to the detection of an overspeed condition, the traction between the sheave and the governor rope also causes the governor rope to stop and therefore actuates the safety mechanism. When these types of governors are used, a switch on the governor tail sheave is required to ensure that the tension in the governor rope is maintained. See Diagram 2.18.1.

2.18.2 Tripping Speeds for Speed Governors

2.18.2.1 Car Speed Governors. Table 2.18.2.1 was revised in ASME A17.1-2016/CSA B44-16 to correct an error that goes back to the harmonization of ASME A17.1 with CSA B44. The ASME A17.1 Code did not require an overspeed switch on governors on elevators with rated speeds of 150 ft/min or less. When the Code was harmonized, an overspeed switch was required on all governors (see 2.18.4.1.1). Requirement 2.18.4.2 specifies that the car speed governor overspeed switch must open in the down direction at 90% of the governor tripping speed for rated speeds over 0.75 m/s or 150 ft/min up to 2.5 m/s or 500 ft/min. The metric values in Table 2.18.2.1 needed to be revised to address speeds up to 0.75 m/s or 150 ft/min. This change brings the SI values in Table 2.18.2.1 into agreement with the imperial values, which were correct.

2.18.3 Sealing and Painting of Speed Governors

If a governor is painted, extreme care must be taken that all bearings and pivoting surfaces are not painted. Governors that have been painted may fail to trip at their required speed and in some cases may fail to trip at any speed. If painted, the governor tripping speed should be tested.

A broken or missing seal indicates that the governor tripping speed mechanism and/or rope retarding means provided for the rope pull-through force (tension) may have been altered. If a broken seal is found, the governor tripping speed and/or rope pull-through force should be tested, making any readjustments that are necessary, and then the governor resealed.

The sealing means required is expressed in performance terms to afford design latitudes in accomplishing the sealing. Regardless of the specific type or method used, the sealing means should be capable of

(a) providing visual indication that readjustment has not been made, and

(b) withstanding the environment, such as temperature and humidity extremes, in which the governor is installed, without being affected. If the sealing means meet the above requirements, it would comply with these requirements. Two means employed are the

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lead-wire seal, which has been employed for many years, and sealing wax.

2.18.4 Speed Governor Overspeed Switches

2.18.4.1 Where Required and Function. The governor must be equipped with a switch, which will cause the power to be removed from the driving-machine motor and brake. Prior to ASME A17.1-2000 and CSA B44-00, the switch was only required for governors that operated Type B and Type C safeties where the rated speed was 0.76 m/s or 150 ft/min and on all governors where static controls were provided. Inherent risk of overspeed exists regardless of speed or type of control (e.g., the motor is always connected to the line but can also have a failure of contactor to the main line). The switch provides protection against overspeed in either direction. A second set of contacts may be provided to regulate the speed of the motor. At times, an additional set of contacts may be provided to limit speed when approaching terminal landings.

Additionally, every car must have a switch located on the car and operated by the safety mechanism, which will cause the power to be removed from the driving machine motor and brake either at the time of or before the safeties engage (2.17.7.2). This additional switch is not practical for counterweight safeties as there typically is no traveling cable to the counterweight.

2.18.4.1.2 This requirement was revised in ASME A17.1-2013/CSA B44-13 to include the requirements in ASME A17.1-2010/CSA B44-10, 2.18.44. The speed governor speed-reducing switch is not an electrical protective device, as it is not listed in 2.26.2. However, it is being treated like an electrical protective device in former requirement 2.18.4.4 by requiring it to be a positively opened switch, though there does not appear to be a valid reason for doing so. In today's controllers, this switch is likely to feed a simple software input that will cause the controller to reduce its speed and stop at the next available floor. If it fails to do so and the car reaches 100% of the governor trip speed, the positively opened speed governor overspeed switch is still there to remove power from the driving-machine motor and brake.

The requirement for the speed governor overspeed switches to be of the manually reset type is now addressed in the area where general requirements for this switch are listed. The requirement for the speed-governor speed-reducing switch to be of the manually reset type is already addressed in 2.18.4.2.5(a), so there is no need to repeat it here.

If an overspeed or speed-reducing switch is tripped, the reason for it being tripped should be determined. An elevator is not allowed to resume normal operation until a tripped switch is manually reset. Were this not the case and a tripped switch was allowed to automatically reset, an associated malfunction might not even be observed.

The same logic holds true for a car safety mechanism switch. An elevator should not automatically resume normal operation after operation of the car safety, as a partially applied safety is probable. The safety should be inspected and, if necessary, reset. If the safety is not properly reset, it may accidentally apply and/or result in equipment damage.

Manually resetting of switches is permitted. There is no safety reason to treat resetting differently than what is permitted for the governor (2.28.6.5).

2.18.4.2 Setting of Car Speed Governor Overspeed Switches. The maximum tripping speeds required for speed governor overspeed switches provide an additional degree of safety by electrically causing an overspeeding elevator to stop or reduce speed before the car safety is applied. Also, see Chart 2.18.4.2(a). This chart only gives the maximum governor tripping speed for elevator car governors. The maximum tripping speed for counterweight governors is higher. There is also a minimum governor tripping speed specified in 2.18.2.2. See Chart 2.18.4.2(b) for minimum governor tripping speeds.

On static control elevators, additional safety provisions are required to protect against equipment failures, such as

(a) the power contactor/relay (2.26.9.5.6) closes (makes), the brake lifts, but the power converter/inverter (2.26.9.5.6) fails to conduct; or

(b) the power converter/inverter (2.26.9.5.6) combination fails "full-on" in a direction opposite to the dictated direction

To protect against the above types of equipment failure, it was agreed that a motion-detection device be required to stop the car if car movement does not agree with motion dictation.

The type of governor would be one where the safety contact opens for an overspeed condition independent of the direction of car travel.

2.18.4.3 Setting of the Counterweight Governor Switch. This requirement was added in ASME A17.1-2000 and CSA B44-00. It requires the switch to open prior to governor tripping speed and not to open at rated speed.

2.18.5 Governor Ropes

2.18.5.1 Material and Factor of Safety. Governor ropes may be preformed or nonpreformed as long as they are of regular lay construction and are iron, steel, monel metal, phosphor bronze, or stainless steel. Tiller rope and lang-lay rope construction are prohibited. See Handbook commentary on Tiller rope 2.17.12.4.

As of the publication of ASME A17.1-2010/CSA B44-10, governor ropes are required to comply with ASME A17.6. The Code also recognized the globally used 6-mm or 0.25-

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in. governor rope including the corresponding factor of safety as codified by EN 81-1.

2.18.5.2 Speed Governor Rope Clearance. If the governor rope rubs against the governor jaws, rope guards, or other stationary parts during normal operation of the elevator, the life of the rope would be drastically reduced and it could part when called upon to actuate the safety. It could also wear the governor jaws and prevent them from providing adequate retarding force.

This requirement clarifies that the requirement applies only to jawless governor systems (those operated by the available traction in the governor sheave groove). It requires enough tension in the governor rope to impart necessary traction to activate the safety. The force required to activate the safety must be greater than tripping the releasing carrier, thus the traction force should trip the releasing carrier, if used, and activate the safety.

2.18.5.3 Governor-Rope Tag. The governor rope data tag gives the inspector the information necessary to ensure that the governor rope is compatible with the design of the governor jaws. This information should be checked against the information on the speed governor marking plate (see 2.18.8 and 8.6.3.4).

Requirement 2.18.5.3 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13 and remove language that is already addressed in the new section. See Handbook commentary on Section 8.13.

2.18.6 Design of Governor-Rope Retarding Means for Type B Safeties

The governor rope for Type B safeties usually has a considerable mass, which could result in damage to the wires or strands of the rope when the governor is actuated. The jaws must permit the pull-through of the governor rope at a predetermined tension. This pull-through value, once set, should remain constant over a period of years. Governor jaws typically do not wear appreciably from stopping the governor rope and safety application or in testing safeties. See Diagram 2.18.6.

2.18.6.2 This requirement was revised in ASME A17.1-2016/CSA B44-16 for consistency with 2.18.5.1.

2.18.6.5 The term "tripped by hand" was intended to convey a performance requirement that the governor be designed to allow for manual activation, by such means as a finger, hand, cable, lever, cam, electromechanical actuation, etc. It was also intended that the method of hand tripping the numerous designs of governors in the marketplace be done safely and without risk of causing equipment damage or danger to personnel performing the test. It was intended that hand tripping be applied to a stationary or relatively slow moving components and not to any components rotating at the same speed as the governor sheave.

2.18.7 Design of Speed Governor Sheaves and Traction Between Speed Governor Rope and Sheave

The governor rope must properly fit into the groove of the governor sheave in order for it to drive the governor at the same speed as the rope. The governor rope should not slip when running in the governor rope sheave. The governor sheave groove must have machined finished surfaces to eliminate excessive wear on the governor rope. The pitch diameter of the governor sheave and the governor tension sheave is regulated in order to reduce the damage caused by a sharp bend in a rope, which will reduce its life.

A governor tension switch is required whenever the governor rope retarding means is dependent solely on the traction relationship between the governor rope and governor sheave (i.e., jawless governor).

2.18.7.2 Design requirements for governor rope activation means were revised in ASME A17.1c-1986 (Rule 206.7) to allow for newer governor designs that did not rely upon rope-gripping jaws to activate the safeties. Requirements are expressed in performance terms, which allow design latitude in accomplishing the governor rope activation function. The requirements for governors for Type A safeties did not limit the rope activation to jaws, whereas ASME A17.1-1986 and earlier versions specifically required jaw activation of the governor rope for Type B safeties. No other option was permitted. See also Handbook commentary on 2.18.5.2.

Aside from conventional overspeed governors with rope-gripping means, such as jaws, another type of governor design had emerged in Europe in the early 1980s, namely, the jawless governor, which relied upon the tractive relationship between the governor rope and sheave. Interest in the North American elevator manufacturing community served as an incentive for inclusion of new designs in the ASME A17.1/CSA B44 Code.

The principle of traction involved is that the ratio of the governor rope tensions from one side of the governor sheave to the other (i.e., higher tension/lower tension), must be less than the available traction between the sheave groove and rope. This requirement is expressed mathematically as follows:

$$\frac{T_1}{T_2} e^{f\theta}$$

where

e = base of natural log (2.71828)

f = apparent coefficient of friction between governor rope and sheave groove

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T_1 = rope tension on heavily loaded side of governor sheave
T_2 = rope tension on lightly loaded side of governor sheave
θ = arc of contact between governor rope and sheave

Tractive force alone without benefit of friction force normally caused by governor jaws would be sufficient to activate safeties. Governor rope tensions include weight of governor rope hanging from each side of the sheave, plus weight of governor tension frame.

The critical items are the magnitude of rope tensions. If governor rope tension frame bottomed out in the pit due to rope stretch, then the incremental force in the governor rope due to tension frame weight would go to zero, the ratio of rope tensions would be compromised, and there might be insufficient traction to activate safeties. A jawed governor, on the other hand, will continue to drive even if the tension frame bottoms out, and if the jaws were triggered, they would still exert a governor rope force sufficient to activate the safeties.

A governor tension frame switch is required (2.18.7.2) whenever the governor rope retarding means is dependent solely on the traction relationship between the governor rope and governor sheave, such as a jawless governor, and is applicable regardless of the types of safeties activated by such governors.

The bottom line is if the governor has rope-gripping jaws, no switch is required. Where a jawless governor is used, a switch is required.

2.18.7.4 As of ASME A17.1-2010/CSA B44-10, governor ropes are required to comply with ASME A17.6. The Code also recognized the globally used governor ropes with diameters less than 9.5 mm or 0.375 in., based on EN 81-1:1998, Clause 9.9.6.4, and the D/d ratios commonly used with these smaller diameter ropes.

Table 2.18.7.4 was revised in ASME A17.1-2010/CSA B44-10 to recognize the use of 9 strand construction of governor ropes. The multiplier is conservative, as 9 strand construction is no less flexible than 8 strand.

2.18.9 Speed Governor Marking Plate

This information should be checked against the information on the governor rope data tag to ensure that the proper governor rope has been installed (see 2.18.5.3 and 8.6.3.2.2). Lubrication added to governor ropes can prevent the governor jaws from retarding the governor rope sufficiently to operate the car or counterweight safety.

Requirement 2.18.9 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13 and remove language that is already addressed in the new section. See Handbook commentary on Section 8.13.

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Diagram 2.18.1
Types of Speed Governors

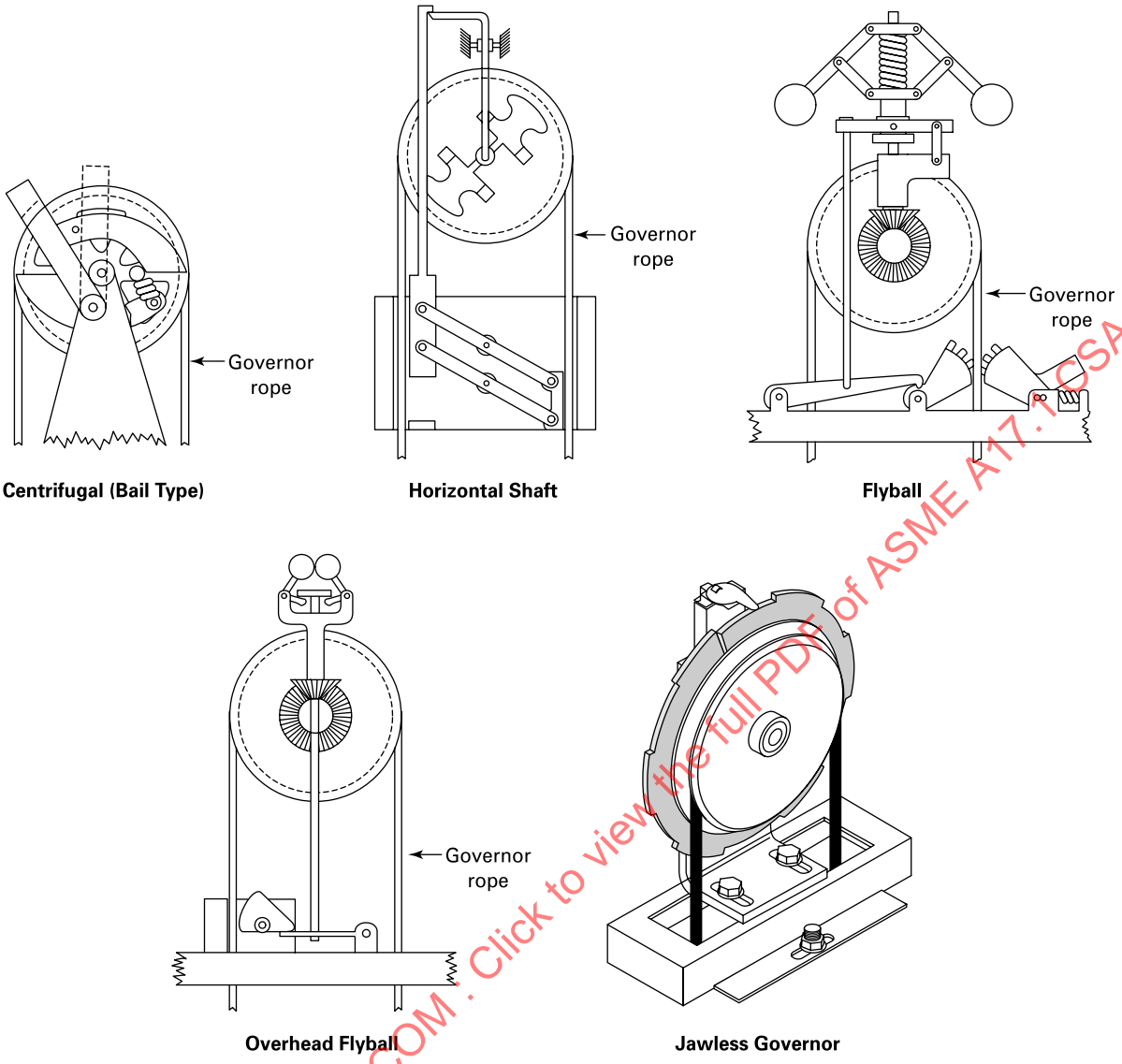


Chart 2.18.4.2(a)
Governor Overspeed Switch Settings

		% Governor Trip Speed — Table 2.18.2.1		
		Down		
Type Control	Rated Speed	Without Speed-Reducing Switch	With Speed-Reducing Switch	Up
Static	All	90	100	90
Other	≤500	90	100	100
	>500	95	100	100

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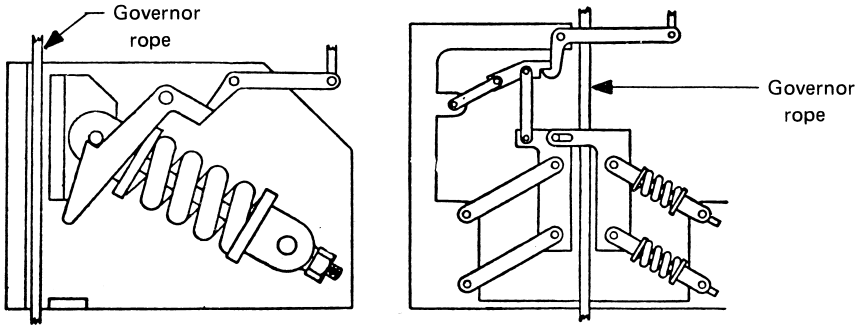
Chart 2.18.4.2(b)
Governor Adjustment Settings

Rated Car Speed, ft/min	Car Governor-Tripping Speed		Cwt. Governor-Tripping Speed [Note (1)]		Car Governor Overspeed Switch Settings, Down Direction			Car Governor Overspeed Switch Settings, Up Direction	Cwt. Governor Overspeed Switch Settings
	Rqmt. 2.18.2.1, Minimum, ft/min	Rqmt. 2.18.2.1, Maximum, ft/min	Rqmt. 2.18.2.2, Minimum, ft/min	Rqmt. 2.18.2.2, Maximum, ft/min	Rqmts. 2.18.4.2.1 and 2.18.4.2.2	Rqmt. 2.18.4.2-.3	Rqmt. 2.18.4.2.5	Rqmt. 2.18.4.2.4	Rqmt. 2.18.4.1
0 to 125	144	175	145	192	Not Required	Not more than 90% of car governor down tripping setting for elevators with static controls	Not Required	Not Required	Counterweight governor overspeed switch required for any speed
150	173	210	174	231					
175	202	250	203	275	Not more than 90% of car governor down tripping setting		Not more than 100% of car governor down tripping setting if a speed-reducing switch is provided	Not more than 100% of car governor down tripping setting	
200	230	280	231	308					
225	259	308	260	338					
250	288	337	289	370					
300	345	395	346	434					
350	403	452	404	497					
400	460	510	461	561					
450	518	568	519	624					
500	575	625	575	687					
600	690	740	691	814	Not more than 95% of car governor down tripping setting				
700	805	855	806	940					
800	920	970	921	1,067					
900	1,035	1,085	1,036	1,193					
1,000	1,150	1,200	1,151	1,320					
1,100	1,265	1,320	1,266	1,452					
1,200	1,380	1,440	1,381	1,584					
1,300	1,495	1,560	1,496	1,716					
1,400	1,610	1,680	1,611	1,848					
1,500	1,725	1,800	1,726	1,980					
1,600	1,840	1,920	1,841	2,112					
1,700	1,955	2,040	1,956	2,244					
1,800	2,070	2,160	2,071	2,376					
1,900	2,185	2,280	2,186	2,508					
2,000	2,300	2,400	2,301	2,640					

NOTE: (1) The counterweight governor-tripping speed must exceed the car governor-tripping speed.

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Diagram 2.18.6
Types of Pull-Through Governor Jaws



SECTION 2.19
ASCENDING CAR OVERSPEED AND UNINTENDED CAR MOVEMENT PROTECTION

NOTE: The author expresses his appreciation to George W. Gibson for his extensive contributions to Section 2.19.

In the mid-1980s, industry awareness was heightened over the number of incidents in which cars ascended into building overheads, some of which resulted in serious injuries and considerable damage, and other incidents involving serious injuries caused by cars leaving the landing with the doors open. As a result, the ASME A17 Committees with the assistance of Authorities Having Jurisdiction undertook a comprehensive study of the scenarios and determined that protection against both ascending car overspeed and unintended car movement must be codified. The causes of either type of accident were attributed to one or more failures described in the Handbook commentary in 2.19.1.

See Chart 2.19.

2.19.1 Ascending Car Overspeed Protection

See Diagram 2.19.1.

2.19.1.1 Purpose. As contradictory as it may sound to nonelevator personnel, elevators can fall up. Traction elevators can overspeed in the up direction because the empty, or lightly loaded, car weighs less than the counterweight. When they do, the results can be extremely serious.

Various failure modes can occur as follows:

(a) failure of brake component(s), such as
- *(1)* pins
- *(2)* links
- *(3)* brake arms
- *(4)* brake shoes
- *(5)* brake lining
- *(6)* brake lining attachment means

(b) loss of coefficient of friction between braking surfaces due to one or more of the following:
- *(1)* glazing
- *(2)* environmental airborne contamination, such as construction dust
- *(3)* environmental fluid contamination of braking surfaces, such as machine lubrication or water from a sprinkler system
- *(4)* brake out of adjustment causing brake shoe linings to drag on braking surfaces, resulting in overheating and the resulting brake fade

(c) failure of brake to release from its electrically restrained position due to brake cores sticking open
- *(1)* mechanical blockage, such as the intrusion of a foreign object becoming entrapped within the brake components
- *(2)* brake cores binding
- *(3)* residual electrical power holding core out

(d) failure of machine component(s), such as
- *(1)* castings, due to presence of hot tears, or blowholes, caused during the metal-cooling process
- *(2)* shafts (sheave and worm gear) due to stress concentration risers at abrupt changes in cross section
- *(3)* gearing, notably worm and worm (ring) gear teeth
- *(4)* bearings
- *(5)* fasteners, such as keys and bolts

(e) traction loss due to
- *(1)* lubricant change
- *(2)* rope change
- *(3)* groove change caused by improper regrooving or wear
- *(4)* groove lining failure, if provided
- *(5)* groove contamination caused by airborne environmental dust, especially construction dust

If traction loss occurs, the brake will be rendered ineffective.

(f) failure in the electrical control system can cause the car to be powered into the overhead, or to leave the landing with the doors open. Electrical failure can be caused by one or more of the following:
- *(1)* drive
- *(2)* dictation
- *(3)* suicide circuit
- *(4)* overspeed governor

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(5) open loop
(6) motor field loss
(7) armature field ground
(8) field protection relay circuit
(9) water contamination

(g) human error attributed to

(1) improper use of jumpers, including failure to remove them

(2) maintenance deficiencies, notably improper brake adjustment

(3) failure during the construction or modernization stage where all safety-related components and means might not yet be operational, or deliberately made inoperative

(4) unsecured car, wherein both car and counterweight are not tied off

When such a failure occurs, the drive sheave starts rotating in a direction dictated by the hoistway masses. If the car loading exceeds balanced load, the car will descend, and once it reaches governor tripping speed, the safety will apply and safely retard and stop the car.

However, if the car loading is less than balanced load, the heavier counterweight will accelerate downward. Since the suspension ropes are intact, the car will be accelerated upward. If there is occupied space below the hoistway, the counterweight is required to have a safety (see 2.6.1), and as soon as the counterweight reaches governor tripping speed, its safety will apply, thus stopping the counterweight. The car will stop also during the safety-stopping interval. If the counterweight has no safety, it will continue to accelerate downward until it strikes its pit buffer.

The dynamics of this scenario will be examined below, since it is representative of the most common situation, i.e., where the counterweight is not provided with safeties. See also Diagram 2.19.1.

If a failure occurred, and the counterweight was heavier than the car plus its load, the elevator would ascend with an acceleration based on the masses in the system. A simple case of a car and counterweight is examined, neglecting the masses of the suspension, compensation and traveling cables, as well as the hoistway friction.

Based on Newton's Second Law of Motion, the runaway acceleration of the car is

$$a = \left[\frac{W - C - kL}{W + C + kL}\right]g$$

In the case of a very lightly loaded car with one passenger, $kL \cong 150$ lb.

For illustrative purposes, a 1 360.7-kg or 3,000-lb rated load is used and the car weight will be taken equal to the rated load, so that

$$C = L = 3{,}000\,\text{lb and } k = 0.05$$

The counterweight will be based on a 45% overbalance. Therefore,

$$W = C + 0.45L = L + 0.45L = 1.45L$$

Substituting these values in the equation for the acceleration yields

$$a = \left[\frac{1.45L - L - kL}{1.45L + L + kL}\right]g = \left[\frac{0.45 - k}{2.45 + k}\right]g = \left[\frac{0.4}{2.5}\right]g = 0.16g$$

Substituting the imperial value for g yields the runaway acceleration of the car,

$$a = 5.15\,\text{ft/sec}^2$$

This scenario can be analyzed further by assuming the elevator has a rated speed of 1.8 m/s or 350 ft/min, and is installed in a 10-floor building with 3-m or 10-ft floor heights. It will be assumed that the elevator is stopped at the fifth floor when the failure occurred. Therefore, the car will accelerate a vertical distance of five floors when it passes the tenth floor. Its speed is determined from the general equation

$$v_c = \sqrt{2as}$$

Substituting numerical values in dimensionally consistent imperial units yields

$$v_c = \sqrt{\frac{2a(\text{ft})s(\text{ft})(60\,\text{sec})^2}{(\text{sec})^2}} = 84.85\sqrt{as}$$

$$= 84.85\sqrt{(5.15)(50)}$$

from which the car speed after accelerating five floors is

$$v_c = 1{,}362\,\text{ft/min}$$

As the car passes the tenth floor with a speed of 58 m/s or 1,362 ft/min, the counterweight descends toward its pit buffer using up the counterweight runby, then its stroke after impact. Since the speed at which the counterweight hits its buffer is significantly higher than the rated buffer striking speed, there will be little retardation during the buffer stroke. During the counterweight descent onto its buffer, the car ascends an additional vertical distance, gaining more speed. Once slack rope develops above the counterweight, gravity acceleration will act to reduce the car ascending speed, but only by a small amount, and certainly not enough speed reduction will occur to prevent the car collision with the underside of the building overhead. See Diagram 2.19.1.1.

The conclusion was obvious: that the ASME A17.1 and CSA B44 Codes had to provide protection against ascending car overspeed. The requirements were codified in ASME A17.1-2000 and CSA B44-00.

Requirement 2.19.1.1 was revised in ASME A17.1-2022/CSA B44:22 to mirror the requirement in 2.19.2.1(a), clarify the requirement, and enable safe sheave shaft design arrangements.

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2.19.1.2 Where Required and Function. The requirements provide protection against ascending car overspeed and/or collision of the elevator with the building overhead by requiring detection of ascending overspeed of the car and operation of an emergency brake.

To ensure the safe functioning of the detection means, redundancy is required so that no single specified fault will lead to an unsafe condition. Checking of this redundancy is also required. Once the detection means is activated, a manual reset of the detection means is required. The emergency brake is required to function in the up direction for an ascending car overspeed only.

2.19.1.2(a)(1)(-b) The requirement recognizes the application of Safety Integrity Level (SIL) rated devices. The requirement exempts Electrical/Electronic/Programmable Electronic Systems (E/E/PES) used for elevator safety that are SIL rated, certified/listed, and labeled/marked in compliance with ASME A17.1/CSA B44 from the requirements in Section 2.19 of "not render(ing) the detection means inoperative."

The basis for the exemption is that the SIL rating of the safety device/function already covers this requirement by assuring device reliability. If the device/circuitry is certified/labeled and if it is applied in accordance with the SIL as indicated for the devices 2.26.2.29 and 2.26.2.30 in ASME A17.1/CSA B44, Table 2.26.4.3.2, then such devices are designed to "not render the detection means inoperative" during service life of the elevator.

2.19.2 Unintended Car Movement Protection

See Diagram 2.19.2.

2.19.2.1 Purpose. The purpose of the requirements is to detect unintended movement of the elevator away from the landing with the car door and hoistway door open. Various failure modes that can result in the car moving away from the landing with the doors open are summarized in 2.19.1.1.

As a result of experience in applying the requirements to contemporary elevator systems, the definition of "intended car movement" was introduced to clarify unintended/intended car movement, specifically with regard to hoistway access operation, bypass, and inspection operation, etc. "Intended car movement" is the controlled movement of an elevator car, including starting, leveling, running, and stopping, due to operation control, motion control, or continuous pressure on an operating device during inspection operation, inspection operation with open door circuits, or hoistway access operation. In this context, the term "stopping" includes the movement of an elevator toward rest once stopping is initiated, and any movement of an elevator due to suspension system elasticity that occurs after the brake is set, since this movement was the result of the intended operation.

An example of a gearless elevator system with static control will illustrate the case of unintended car movement in the downward direction. See also Diagram 2.19.2.1. The elevator has stopped with the doors open above the landing by a vertical distance of 75 mm or 3 in., which is the limit of the inner landing zone as specified in 2.26.1.6.7. The control system recognizes that the elevator must be releveled down toward the landing. As the driving-machine brake is lifted, a drive, or motion command, failure occurs, causing full torque to be applied to the driving machine. While elevators with solid-state controls designed after the early to mid-1970s have levels of redundancy provided, this scenario would require multiple failures to occur, which is a highly unlikely scenario. Nevertheless, given the long life cycle of elevators, it is recognized that elevators installed without the redundancy levels required by ASME A17.1 and CSA B44 after the mid-1970s still exist in the marketplace.

An example of a gearless elevator system with static control will illustrate the case of unintended car movement in the downward direction. The motion of the car in reference to the positions shown in Diagram 2.19.1 is discussed in Chart 2.19.2.1(a). The general analysis is presented for the case of a motion control failure when the car is above the landing.

The example is intended more to demonstrate one of the worst-case scenarios. There might be other failure modes that should be considered, such as a car in motion and landing at a floor. The car accelerates down with an assumed maximum acceleration equal to $\frac{1}{3}g$. Depending on the particular control system and available traction, this dictated acceleration could be higher.

(a) Summary of Motion Equations. The derivation of equations is based on rectilinear motion with constant accelerations and retardations within the specific positions described in Chart 2.19.2.1(b).

(b) Analysis of Motions. For the example, the numerical values shown in Chart 2.19.2.1(c) are used. The total motion of the elevator will be examined to determine the motion during the acceleration phases, the time delay phases, and the stopping phase, to assess the hazard if a passenger were in the open doorway when the unintended motion occurred. The equations shown pertain to an elevator system wherein the motion is rectilinear with uniform accelerations and retardation. The values shown in Chart 2.19.2.1(c) are for illustrative purposes.

(c) Pos 0 to Pos 2. The distance traveled by the car from its starting position (Pos 0) to the bottom of the Inner Landing Zone (Pos 2) below the landing is

$$s_{ILZ} = s_1 + s_2 = 0.075 + 0.075 = 0.15 \text{ m} = 5.9 \text{ in.}$$

The speed attained by the car when it has reached the maximum limit of the Inner Landing Zone below the landing (Pos 2) is

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$$v_2 = 2\sqrt{a_0 s_1} = 2\sqrt{\left(\frac{1}{3}\right)(9.81)(0.075)} = 0.99\ \text{m/s}$$

The corresponding travel time through the upper and lower inner landing zone (i.e., from Pos 0 to Pos 2) is

$$t_{ILZ} = 2\sqrt{\frac{s_1}{a_0}} = 2\sqrt{\frac{0.075}{\frac{1}{3}(9.81)}} = 0.3\text{s}$$

(d) Pos 2 to Pos 4. Since the car will move from Pos 2 to Pos 4 under the same acceleration, a_0, its motion will be analyzed over the time domain over which all the electrical time delays occur. If the system had electrically assisted braking (i.e., dynamic braking capability), it would occur after the first and second time delays. While dynamic braking would become effective after the first and second time delays, not all elevator systems would have it. Therefore,

$$t_{ed} = t_3 + t_4 = 0.075 + 0.075 = 0.15\,\text{s}$$

The speed attained by the car when it has reached Pos 4 is

$$\begin{aligned} v_4 &= v_2 + a_0 t_{ed} = 0.99 + \left(\frac{1}{3}\right)(9.81)(0.15) \\ &= 1.48\ \text{m/s} = 291\text{ft/min} \end{aligned}$$

(e) *Pos 0 to Pos 4.* The distance the car travels from Pos 0 to Pos 4 is

$$s_{0-4} = \frac{v_4^2}{2a_0} = \frac{(1.48)^2}{2\left(\frac{1}{3}\right)(9.81)} = 0.335\ \text{m} = 13.2\ \text{in.}$$

(f) Pos 2 to Pos 4. The distance the car travels from Pos 2 to Pos 4 is

$$s_{2-4} = s_{0-4} - s_{ILZ} = 0.335 - 0.15 = 0.185\ \text{m} = 7.3\ \text{in.}$$

(g) Pos 4 to Pos 5. The car moves from Pos 4 to Pos 5 under the free-wheeling acceleration, a_{fw}, since the acceleration is no longer electrically induced, but rather results from the unbalanced system masses.

The general equation is

$$\begin{aligned} v_5 &= v_4 + a_{fw} t_{fw} = 1.48 + \left(\frac{1}{4}\right)(9.81)(0.25) \\ &= 2.094\ \text{m/s} = 412\ \text{ft/min} \end{aligned}$$

The distance the car travels from Pos 4 to Pos 5 is

$$s_5 = \frac{v_5^2 - v_4^2}{2a_{fw}} = \frac{(2.094)^2 - (1.48)^2}{2\left(\frac{1}{4}\right)(9.81)} = 0.447\ \text{m} = 17.6\ \text{in.}$$

(h) Pos 5 to Pos 6. The distance the car travels from Pos 5 to Pos 6 during the retardation phase is

$$s_6 = \frac{v_5^2}{2a_{eb}} = \frac{(2.094)^2}{2\left(\frac{2}{3}\right)(9.81)} = 0.335\ \text{m} = 13.2\ \text{in.}$$

(i) Pos 1 to Pos 6. The distance the car travels below the landing is

$$\begin{aligned} s_{BL} &= s_2 + s_{2-4} + s_5 + s_6 \\ &= 0.075 + 0.185 + 0.447 + 0.335 \\ &= 1.042\ \text{m} = 1042\ \text{mm} + 41\ \text{in.} \end{aligned}$$

This example illustrated one of the worst-case scenarios. There might be other failure modes that should be considered, such as a car in motion landing at a floor. It shows that the potential hazard to a passenger crossing the threshold if the car were to suddenly experience a drive, or motion command, failure was mitigated by the capability of the mechanical brake system, specifically, the emergency brake. In designing the emergency brake system, the designers and manufacturers must assume that, if a failed driving-machine brake caused the unintended car motion, the emergency brake, on its own, must have the capability to stop the car within the 1 220-mm or 48-in. limit specified in 2.19.2.2(b). This value ensures that a passenger would not be crushed if the car moved away from the landing with the car and landing doors open.

In this example, the failure mode was the control system, and the driving-machine brake would have been effective together with the emergency brake. The retardation due to the combined braking would have been higher than $^2/_3 g$. If the combined braking (driving-machine break and emergency brake) acted to retard the drive sheave, the available traction would limit the retardation to a value somewhere between $^1/_2 g$ and $^3/_4 g$. However, if the combined braking operated to retard the system masses (drive sheave, car, counterweight, ropes, etc.), such as resulting from the use of rope retarding means, safeties, etc. [see 2.19.3(a) and 2.19.3(b)], the retardation in this example would exceed $^3/_4 g$, and could be appreciably higher.

Requirement 2.19.2.1 was revised in ASME A17.1-2019/CSA B44:19 to recognize that failures of gear-shafts can result in ascending car overspeed (free-wheeling of the drive sheave). Requirements 2.24.3 and 2.24.3.1 address fatigue and overload failures of the direct connection means. Consequently, free-wheeling of the drive sheave as a result of failure of the sheave shaft is not evident.

Requirement 2.19.2.1 was revised in ASME A17.1-2022/CSA B44:22 to clarify the requirement and enable safe sheave shaft design arrangements.

2.19.2.2 Where Required and Function. The requirements provide protection against unintended motion of the elevator with the doors open by requiring detection of the unintended motion of the car and operation of an emergency brake for either direction of car motion.

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To ensure the safe functioning of the detection means, redundancy is required so that no single specified fault will lead to an unsafe condition. Checking of this redundancy is also required. Once the detection means is activated, a manual reset of the detection means is required.

The reason for specifying that power be removed from the drive motor of the motor-generator set is because of the concern for protection against the failure of the "suicide circuit." An important consideration in formulating this requirement is the fact that it will prevent regeneration back to the AC line, and in so doing, may extend the braking distance. This protection is required to function on inspection operation.

2.19.2.2(a)(1)(-b) The requirement recognizes the application of Safety Integrity Level (SIL) rated devices.The requirement exempts electrical/electronic/programmable electronic systems (E/E/PES) used for elevator safety that are SIL rated, certified/listed, and labeled/marked in compliance with ASME A17.1/CSA B44 from the requirements in Section 2.19 of "not render(ing) the detection means inoperative."

The basis for the exemption is that SIL rating of the safety device/function already covers this requirement by assuring device reliability. If the device/circuitry is certified/labeled and if it is applied in accordance with the SIL as indicated for the devices 2.26.2.29 and 2.26.2.30 in ASME A17.1/CSA B44, Table 2.26.4.3.2, then such devices are designed to "not render the detection means inoperative" during the service life of the elevator.

2.19.3 Emergency Brake

(a) The emergency brake is a mechanical device independent of the braking system used to hold, retard, or stop an elevator. It is only required to apply should the car overspeed in the ascending direction, or move in an unintended manner in either direction. It is permitted to apply following the actuation of any electrical protective device. Such devices include, but are not limited to, those that apply braking force on one or more of the following:

(1) car rails
(2) counterweight rails
(3) suspension or compensation ropes
(4) drive sheaves
(5) brake drums

(b) The emergency brake is not to be used to provide, or assist in providing, the normal stopping of the car. Examples of devices that may be used as an emergency brake include, but are not limited to

(1) counterweight safety.
(2) rope brake. See Diagram 2.19.3.
(3) sheave jammer, a device that acts on the drive sheave to stop.
(4) secondary brake, if the brake drum is directly connected to the drive sheave [2.19.3.2(a)(5)].

These devices are intended to operate should the primary device fail. A single device may be provided for ascending car overspeed protection and unintended car movement or separate devices may be provided. In the above examples, a counterweight safety could be used for ascending car overspeed but would not provide protection against unintended car movement in the down direction.

Requirements for the elevator braking system (2.24.8) and the elevator driving-machine brake requirements (2.24.8.3) were revised concurrently with the introduction of ascending car and uncontrolled low speed protection in ASME A17.1-2000 and CSA B44-00.

2.19.3.1 Where Required

2.19.3.1.3 This requirement was added in ASME A17.1-2013/CSA B44-13. An ASME A17 Task Group on Reduced Stroke Buffers was formed to review the following items:

(a) allowable reduction of stroke of the buffer
(b) necessary overhead clearance required with the reduced stroke buffer
(c) measures required of the system to ensure the buffer is not struck at a velocity greater than its rating

After completing a hazard assessment, the Task Group identified a deficiency: that when a driving-machine brake failure occurs with the car near the terminal landing, the ascending car overspeed limit may not be reached to activate the emergency brake. In that case, a full stroke buffer should prevent the car from striking the overhead, but with a reduced stroke buffer, not only might the buffer rating be exceeded, but the car might still hit the overhead since the emergency terminal speed-limiting (ETSL) device only removes power from the driving-machine brake, which is what failed to begin with. The Task Group recommended that the ETSL device not be rendered ineffective by a driving-machine brake failure. The revision adds additional requirements to ensure that a reduced stroke buffer is not struck above its speed rating.

Prohibition against activation of a car safety by the ETSL device was removed. If it is permissible to use a car or counterweight safety to provide ascending car overspeed protection or unintended movement protection, then it should also be permissible to use a safety to prevent the car from striking a reduced stroke buffer above its rating. The requirement for retardation less than or equal to 1*g* still applies.

2.19.3.2 Requirements

2.19.3.2(a) Requirement 2.19.3.2(a) was revised in ASME A17.1-2019/CSA B44:19 to clarify the code requirements to recognize the common methods of ensuring that the driving machine brake torque serves to act directly on the driving machine sheave or sheave shaft.

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2.19.3.2(b), 2.19.3.2(c), and 2.19.3.2(d) This requirement was added in ASME A17.1-2013/CSA B44-13. See Handbook commentary on 2.19.3.1.3.

2.19.3.2(e) This requirement was revised in the ASME A17.1a-2008/CSA B44a-08 Addenda to permit the emergency brake to apply to a stationary or moving braking surface when any electrical protective device (2.26.2) is actuated. The rationale for the use of the emergency brake for elevator operations other than ascending car overspeed and unintended motion is that, although not permitted to be used to stop the elevator car on automatic operation, there are other elevator operations (e.g., continuous pressure operation) that may make use of an existing emergency brake device. Today's elevator systems are composed mostly of ACVF traction systems. These systems may not provide inherent dynamic braking on "power off" stopping (e.g., emergency terminal speed-limiting device, inspection/car emergency stop switches, and other possible electrical protective safety devices). Braking assistance to the "driving-machine brake" may be necessary to meet required code stopping performance criteria, or provide elevator personnel with responsive stopping during elevator maintenance and inspection. If used for the additional safety functions, the emergency brake is required to be designed to higher factors of safety. The restricted use of the emergency brake ensures availability when required.

While 2.19.3.2(e) and 2.26.2 were revised to allow the simultaneous application of both the driving-machine brake and emergency brake if an electrical protective device actuated, it should be noted that the application of both brakes (driving-machine break and emergency break) might result in a higher retardation to the passengers, depending on the load in the car, direction of motion, means of emergency braking, and the available traction. Notwithstanding, the weak link will then be based on the loss of traction, and the retardation of the car resulting from the concurrent application of the driving-machine break and emergency break will be limited by the available traction between the drive sheave and suspension means.

2.19.3.2(h) The sign is intended to advise elevator personnel of a hazardous condition if proper precautions are not taken when working on the driving-machine brake and the emergency brake.

2.19.3.2(i)(1) Requirement 2.19.3.2(i)(1) was revised in ASME A17.1-2019/CSA B44:19 because it is recognized that the actuation of the emergency brake may create greater stresses than those created when only activated as described in Requirement 2.19.3.2(i)(2). An emergency brake should be able to meet the requirements of 2.19.3.2 (i)(1) whether or not it is subject to the requirements of 2.19.3.2(i)(2).

2.19.3.2(i)(2) Requirement 2.19.3.2(i)(2) was revised in ASME A17.1-2019/CSA B44:19 to recognize Requirement 2.24.3 in the designing of emergency brake components subject to Requirements 2.19.3.2 (d), (e), or (f). Requirement 2.24.3.2 applies to the stresses created on a machine due to emergency brakes mounted thereto, and only when the emergency brake is located on a driving machine. It is not a requirement that is dependent on whether the emergency brake is activated under normal or continuous-pressure operation. All machine mounted emergency brakes address this requirement in 2.19.4.

Requirement 2.19.3.2(k) was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13 and remove language that is already addressed in the new section. See Handbook commentary on Section 8.13.

2.19.3.3 Marking Plate Requirements. The marking plate is required to provide information for verification of the correct design application.

Requirement 2.19.3.3 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13. See Handbook commentary on Section 8.13.

Requirement 2.19.3.3 was revised in ASME A17.1-2022/CSA B44:22 to reduce the information required to the manufacturer, model number, and any requirements that are critical to performance. Discussions between the ASME Mechanical Design Committee and the ASME Inspections Committee concluded the other information previously required was not useful to elevator personnel. The adequacy of the application should be demonstrated by acceptance and periodic tests and the MCP should include emergency brake maintenance and repair procedures.

2.19.4 Emergency Brake Supports

The requirements provide criteria for the safe design of the respective components/structures subject to forces developed during the retardation phase of the emergency braking and all other loading acting simultaneously, if applicable, with factors of safety consistent with the types of equipment/structures involved.

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Chart 2.19
Traction Elevator Brake Type, Function, and Performance

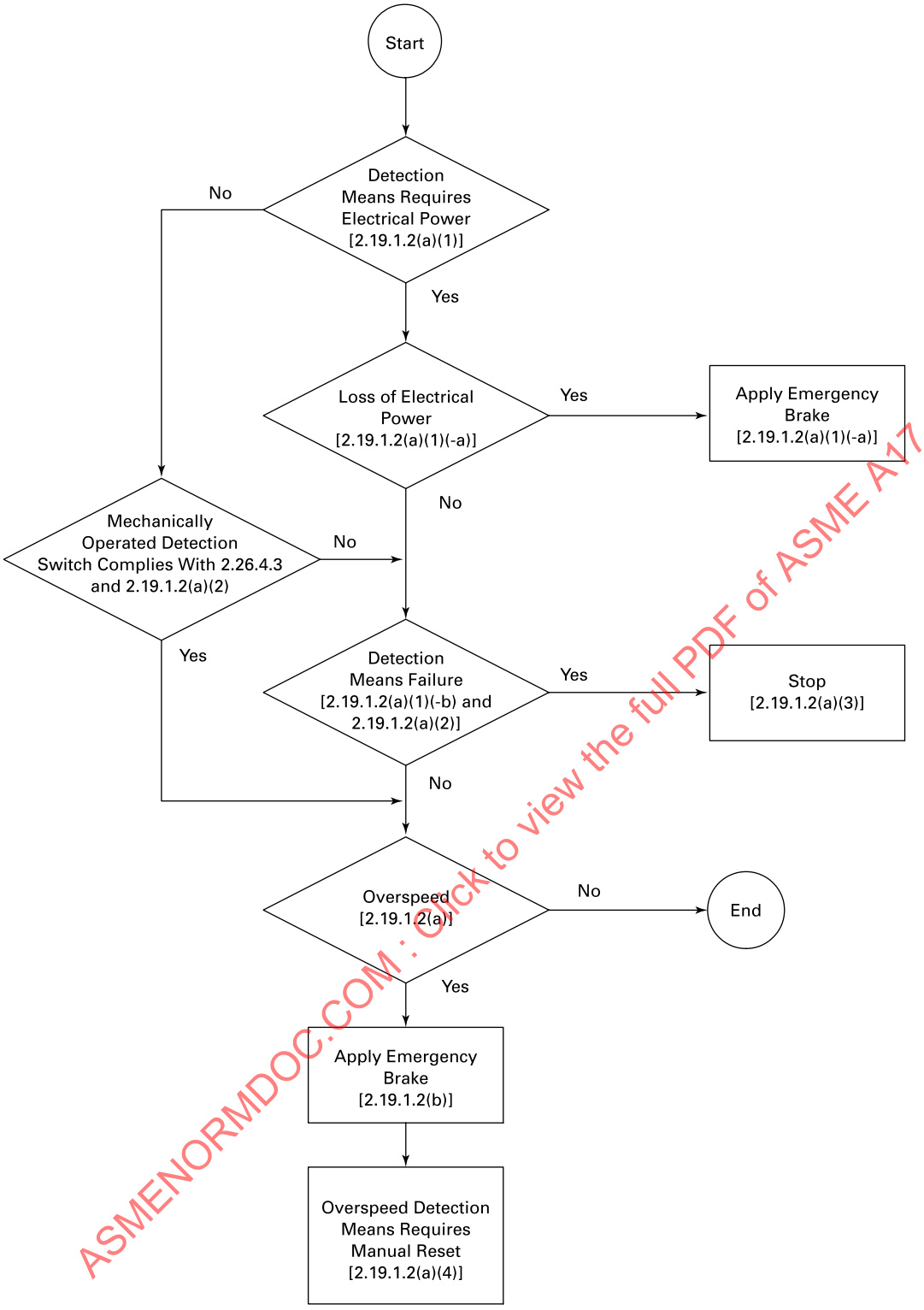
Brake Type	Location	Normal Operation Function	Emergency Operation Function	Performance (Minimum Required)	
				Normal	Emergency
Driving-machine brake (see Section 1.3 and 2.24.8.3)	Electric driving machine (see Section 1.3 and 2.24.8.1)	To hold car stationary at floor [see 2.24.8.3(a) and (b), and 2.26.8] [Note (1)]	Retard car during emergency stops [see 2.24.8.3(c), and 2.26.8.3(c) and (d)]	Hold 125% rated load [see also 2.24.8.3(a)] [Note (2)]	Retard empty car in up direction [see 2.24.8.3(c)]
Braking system (see Section 1.3 and 2.24.8.2)	Not specified	Note (1) (see 2.26.8)	Retard car during emergency stops [see 2.24.8.2, and 2.26.8.3(c) and (d)]	Note (1)	Retard 125% rated load car in down direction [see 2.24.8.2 and 2.16.8] [Note (2)]
Emergency brake (see Section 1.3 and 2.19.3)	Electric driving machine, hoist ropes, compensation ropes, car, or counterweight (see 2.19.3.2)	Not permitted [see 2.19.3.2(c)]	Retard car during ascending car overspeed, unintended movement, and emergency terminal speed limiting, independently of the braking system [see 2.19.1.2(b), 2.19.2.2(b), and 2.25.4.1.1]	Not applicable [see 2.19.3.2(c)]	Retard empty car in the up direction [see 2.19.3.2(a)] up to 110% of governor tripping speed [see 2.19.1.2(a)] Stop unintended motion: 125% rated load down or empty car up [see 2.19.2.2(b) and Note (2)] Reduce the car and counterweight speed such that the rated buffer striking speed is not exceeded (rated load down or empty car up) (see 2.25.4.1.1)

GENERAL NOTE: See Sections 1.3 and 2.19, and 2.24.8.

NOTES:
(1) It is permitted that the braking system or the driving-machine brake function in normal retardation of the elevator car.
(2) For freight elevators not authorized to carry passengers, 100% rated load (see 2.16.8).

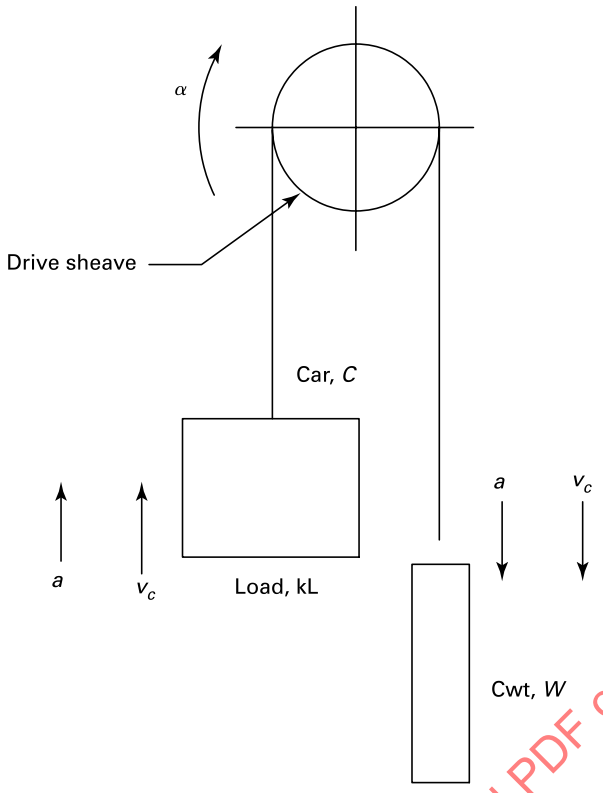
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Diagram 2.19.1
Ascending Car Overspeed Protection



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Diagram 2.19.1.1
Car Ascending Toward Overhead

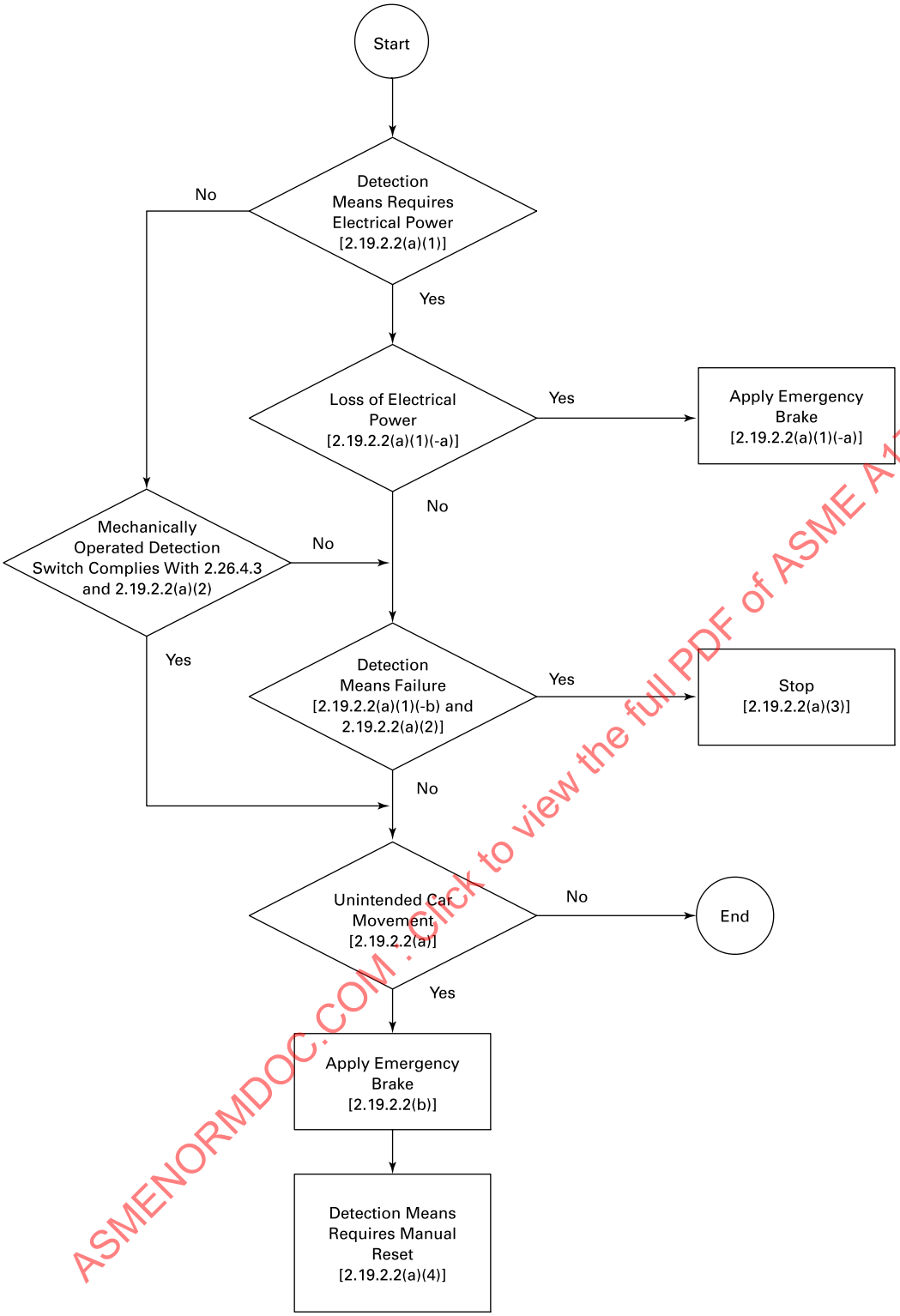


a = acceleration of elevator toward overhead (m/s^2 or ft/sec^2)
C = car weight/mass (kg or lb)
c = subscript denoting car
g = acceleration due to gravity (9.81 m/s^2 or 32.2 ft/sec^2)
k = factor used to describe magnitude of load in car (dimensionless)
L = rated load (kg or lb)
s = vertical distance car accelerates (m or ft)
v_c = car speed (m/s or ft/min)
W = counterweight weight/mass (kg/lb)
α = angular acceleration of drive sheave (rad/s^2)

GENERAL NOTE:
Courtesy of George W. Gibson.

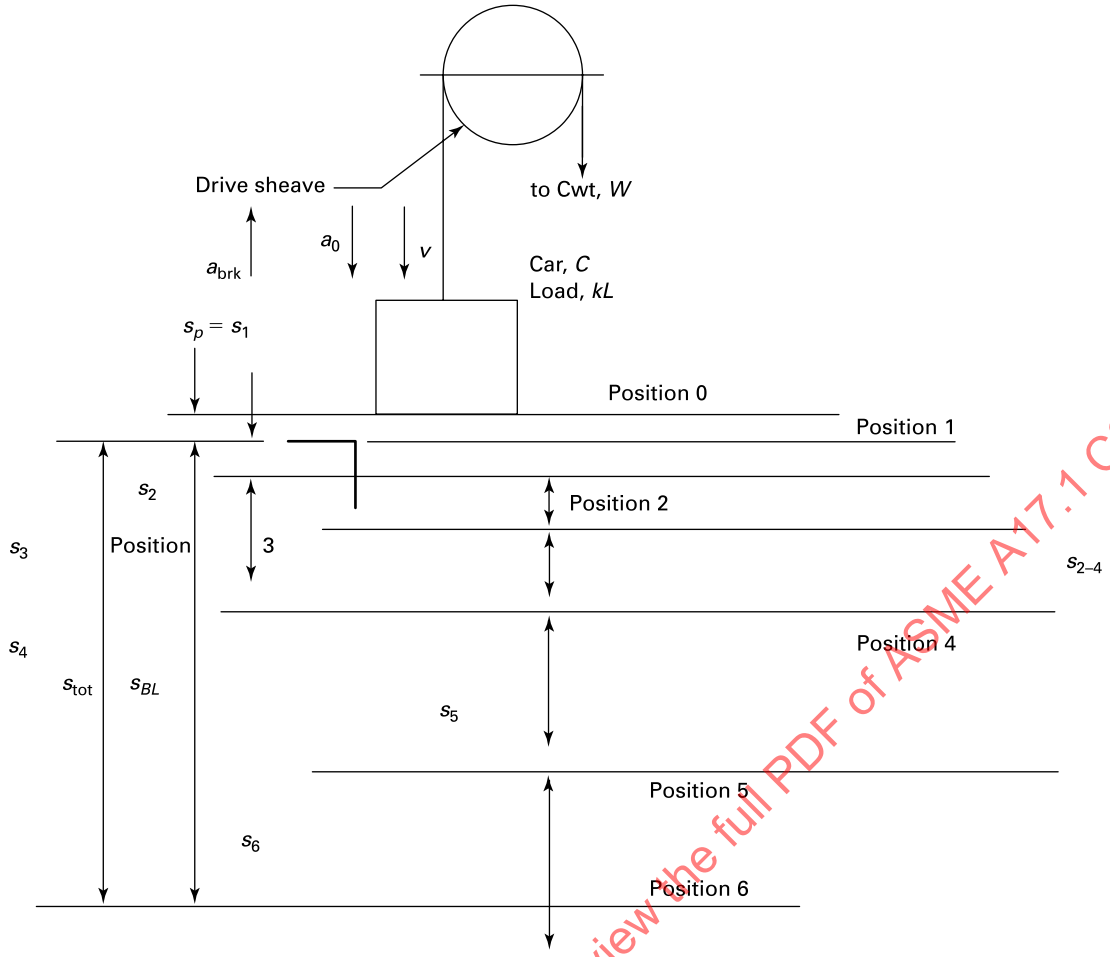
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Diagram 2.19.2
Unintended Car Movement Protection



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Diagram 2.19.2.1
Downward Unintended Car Movement



a_o = initial downward acceleration of elevator due to motion control failure (m/s^2 or ft/sec^2)
a_{brk} = retardation of elevator during total braking (m/s^2 or ft/sec^2)
a_{eb} = retardation of elevator afforded by emergency brake, on its own (m/s^2 or ft/sec^2)
a_{eab} = retardation of elevator afforded by electrically assisted braking, on its own (m/s^2 or ft/sec^2)
a_{fw} = downward free-wheeling acceleration of elevator due to unbalanced masses (m/s^2 or ft/sec^2)
g = acceleration due to gravity (9.81 m/s^2 or 32.2 ft/sec^2)
k = factor used to describe magnitude of load in car (dimensionless)
L = rated load (kg or lb)
s_0 = initial travel of car at Position 0 (m or ft)
s_1 = upper limit of the Inner Landing Zone above the landing (75 mm or 3 in.)
s_2 = lower limit of the Inner Landing Zone below the landing (75 mm or 3 in.)
s_3 = vertical distance car moves from Position 2 to Position 3 during time interval, t_1 (m or ft)
s_4 = vertical distance car moves from Position 3 to Position 4 during time interval, t_2 (m or ft)
s_5 = vertical distance car moves from Position 4 to Position 5 during time interval, t_3 (m or ft)
s_6 = vertical distance car moves during retardation phase from Position 5 to Position 6 during time interval, t_4 (m or ft)
$s_{0\text{-}4}$ = total vertical distance car moves from Position 0 to Position 4 (m or ft)
$s_{2\text{-}4}$ = total vertical distance car moves from Position 2 to Position 4 (m or ft)
s_{ILZ} = vertical distance car travels in upper and lower Inner Landing Zones (150 mm or 6 in.)
s_p = initial vertical height of platform above landing when failure occurs (≤75 mm or ≤3 in.)
s_{BL} = total travel of elevator below the landing due to acceleration and retardation (m or ft)
s_{ed} = travel of elevator during the electrical time delays (m or ft)
$stot$ = total travel of elevator below the landing due to acceleration or retardation (m or ft)
t_o = initial time at onset of drive failure = 0 (s)
t_1 = time duration for the car to move from Position 0 to Position 1 (s)
t_2 = time duration for the car to move from Position 1 to Position 2 (s)
t_3 = time duration for the car to move from Position 2 to Position 3 (s)

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Diagram 2.19.2.1
Downward Unintended Car Movement (Cont'd)

(Cont'd)

t_4 = time duration for the car to move from Position 3 to Position 4 while electrical power is removed from armature loop contactor and brake loop contactor (s)
t_5 = time duration for the car to move from Position 4 to Position 5 while brake torque becomes fully effective; also referred to as t_{fw} (s)
t_6 = time duration for the car to move from Position 5 to Position 6 during total braking retardation (s)
t_{lLZ} = time for car to travel through upper and lower inner landing zones from Position 0 to Position 2 (s)
t_{ed} = sum of all electrical time delays between Position 2 and Position 4 (s)
t_{bd} = mechanical time delay for brake to fully apply braking forces between Position 4 and Position 5 (s)
t_{df} = total time car accelerates due to motion control failure (s)
t_{fw} = total time car accelerates due to free-wheeling of unbalanced system masses; also referred to as t_5 (s)
v_o = initial velocity at onset of drive failure = 0 (m/s or ft/min)
v_1 = downward velocity of the car at the point where the car is passing the landing (Position 1) (m/s or ft/min)
v_2 = downward velocity of the car when it reaches lower limit of inner landing zone (Position 2) (m/s or ft/min)
v_3 = downward velocity of the car when it reaches Position 3 (m/s or ft/min)
v_4 = downward velocity of the car when it reaches Position 4 (m/s or ft/min)
v_5 = downward velocity of the car when it reaches Position 5 ($v_5 = v_{max}$) (m/s or ft/min)
v_6 = downward velocity of the car when it reaches Position 6; $v_6 = 0$ (m/s or ft/min)
v_{max} = maximum downward car speed when driving machine brake applies (m/s or ft/min)
W = counterweight weight/mass (kg or lb)

GENERAL NOTE: Courtesy of George W. Gibson.

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Chart 2.19.2.1(a)
Car Positions and Description of Events

Position	Description of Events	Acceleration
0	The elevator is stopped with the doors open above the landing by a vertical distance, $s_p \le 75$ mm, which is the maximum limit of the Inner Landing Zone as specified by ASME A17.1-2010/CSA B44-10 and later editions, Requirement 2.26.1.6.7. While $s_p \le s_1$, the motion command to relevel would occur when $s_p = s_1$. This would typically occur as passengers exit the car, causing the suspension ropes to contract, moving the car upward. The control system recognizes that the elevator must be releveled down toward the landing. As the driving-machine brake is lifted, a drive, or motion command, failure occurs, causing full torque to be applied to the driving machine to cause the car to descend. The car accelerates down with an electrically induced acceleration, a_0, which is limited to the smaller of two values: either the acceleration due to motor drive torque, or the acceleration at which traction loss could occur at the rapid onset of motion. The landing level is defined by this position.	a_0
1	The car moves down an initial distance, $s_p = s_1$, from Position 0 to Position 1, attaining a speed, v_1, but continues past the landing with an acceleration, a_0, and continues to travel a second distance, s_2, until it reaches Position 2. At this point, the car travel is $s_{ILZ} = s_1 + s_2$.	a_0
2	After traveling the second incremental distance, s_2, during which the acceleration, a_0, is still in effect, the car reaches a speed, v_2, at the maximum limit of the Inner Landing Zone below the landing. As the car travels past Position 2, its position is detected, necessitating the opening of the safety circuit. During the opening of the safety circuit, the car continues to move past the outer limit of the Inner Landing Zone with an acceleration, a_0, during an incremental time, t_3 (first time delay), traveling a distance, s_3, until it reaches Position 3.	a_0
3	When the car reaches this position, it has an attained speed, v_3, and the safety circuit is open, thereby initiating the removal of the electrical power from the driving-machine motor and brake. Since electro-mechanical devices must physically open, there is a time delay, t_4 (second time delay), during which the car continues to move with an acceleration, a_0, traveling a distance, s_4, until it reaches Position 4.	a_0
4	At this point, the car speed, v_4, has been attained, and the electrical power has been removed from the driving-machine motor and brake coil(s) and emergency brake, and the brakes start to apply the combined braking forces. During the time delay, t_5 (third time delay), the car acceleration is no longer electrically induced, and changes from a_0 to a_{fw} due to the unbalanced masses in the elevator system. The mechanical braking forces build up to produce the maximum braking torque. The car travels a distance, s_5, in time, $t_5 = t_{fw}$, during this brake torque build-up to Position 5. If electrically assisted braking is furnished, the retardation, a_{eab}, would occur within the distance, s_5 [Note (1)].	a_0, a_{fw}
5	Since ASME A17.1/CSA B44, Requirement 2.26.2 was revised in the ASME A17.1a-2008/CSA B44a-08 Addenda to permit concurrent braking by the driving-machine brake and emergency brake, most manufacturers are implementing an open electrical protective device by allowing both brakes to apply when the safety circuit opens. At this position, the car speed, v_5, has reached a maximum, and both the driving-machine brake and emergency brake are in the fully applied mode, thereby producing the retardation, a_{brk}, during total braking. For this braking scenario, the emergency brake, on its own, is considered the sole braking means to assess its capability in stopping the car within 1 220 mm of the landing.	a_{fw}
6	The car has been brought to a stop due to the retardation, a_{brk}, or only a_{eb}, over a stopping distance, s_6, over time duration, t_6. The car speed, $v_6 = 0$.	a_{brk}

GENERAL NOTE: Courtesy of George W. Gibson.

NOTE: (1) Retardation due to electrically assisted braking will be taken as $a_{eab} = 0$.

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Chart 2.19.2.1(b)
Summary of Motion Equations

Position	a	v	s	t
0–2	a_0	$v_2 = 2\sqrt{a_0 s_1}$	$s_{ILZ} = s_1 + s_2$	$t_{ILZ} = 2\sqrt{\frac{s_1}{a_0}}$
2–4	a_0	$v_4 = v_2 + a_0 t_{ed}$	$s_{2-4} = \frac{v_4^2}{2a_0} - s_{ILZ}$	$t_{ed} = t_1 + t_2$
4–5	a_{fw}	$v_5 = v_4 + a_{fw} t_{fw}$	$s_5 = v_4 t_{fw} + \frac{1}{2} a_{fw} t_{fw}^2$	$t_{fw} = t_5$
5–6	a_{eb}	$v_6 = 0$	$s_6 = \frac{v_5^2}{2a_{eb}}$	$t_6 = \frac{v_5}{a_{eb}}$

GENERAL NOTE: Courtesy of George W. Gibson.

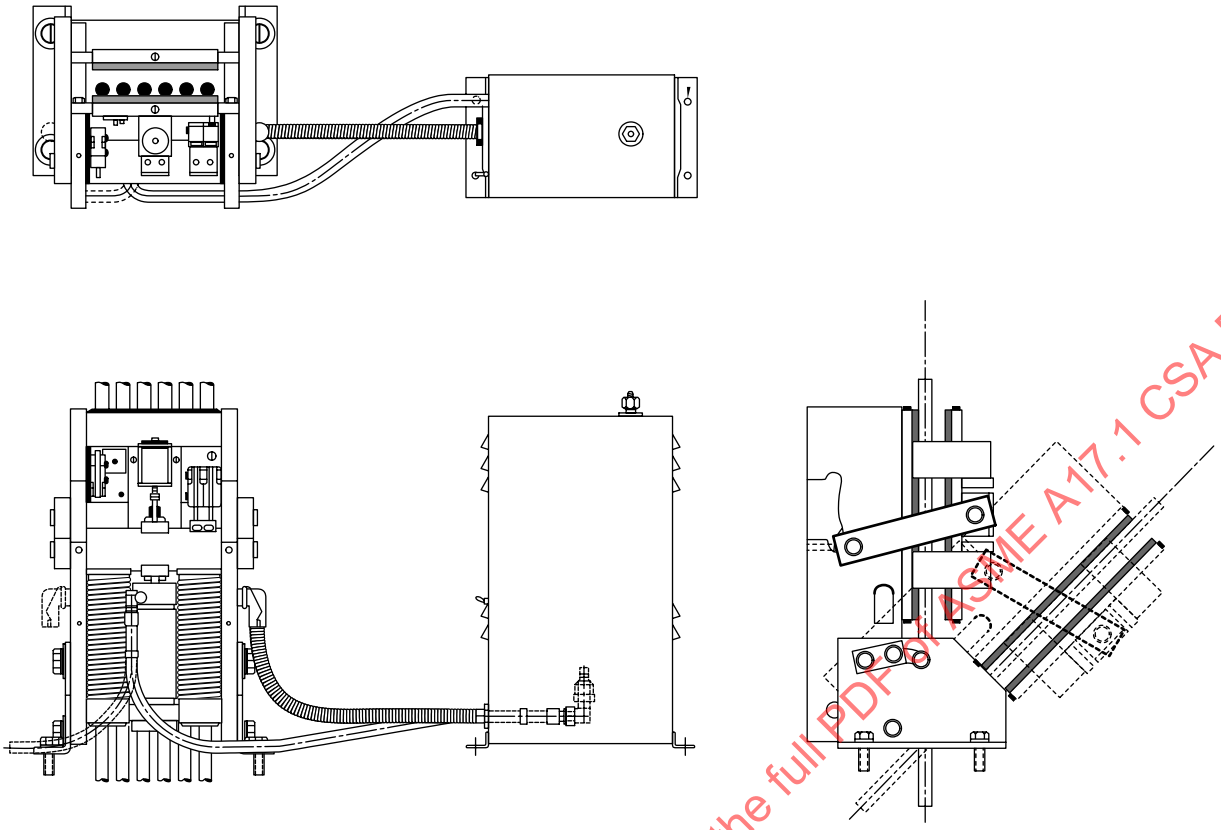
Chart 2.19.2.1(c)
Example Variables

Variable	Value
a_0	$\frac{1}{3}g$
a_{fw}	$\frac{1}{4}g$
a_{eb}	$\frac{2}{3}g$
$s_1 = s_2$	$0.075m$
s_{ILZ}	$0.15m$
t_3	$0.075s$
t_4	$0.075s$
t_{ed}	$0.15s$
$t_5 = t_{fw}$	$0.25s$

GENERAL NOTE: Courtesy of George W. Gibson.

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Diagram 2.19.3
Rope Gripper



GENERAL NOTE: Courtesy of Hollister-Whitney Elevator Corp.

SECTION 2.20
SUSPENSION MEANS AND THEIR CONNECTIONS

NOTE: The author expresses his appreciation to Louis Bialy for his extensive contributions to Section 2.20.

Steel wire rope has been used for many years in the elevator industry, for suspension, compensation, and governor applications.

Due to the large range of applications in this diverse market, many variations of steel wire ropes are in current use. Examples include rope of regular and Lang lay, left and right lay, and preformed and non-preformed. Such ropes may be of a variety of wire materials, from iron to high tensile steel and may be of corrosion-resistant construction. Various core materials including natural and synthetic fiber and steel may also be used. Nominal imperial dimensions as well as SI dimensional ropes are used.

With the appearance in the marketplace of new suspension and compensation means technologies, such as aramid fiber ropes and noncircular elastomeric coated steel suspension members for elevators, the need for standards that will ensure the safe application of these items became evident.

In recognition of the importance of the suspension means as a vital elevator system and the unique practices of the North American industry, ASME A17.6-2010, Standard for Elevator Suspension, Compensation, and Governor Systems, was developed. This standard covers the current applications and provides strength and material criteria as well as testing, compliance, inspection, replacement, and ordering information. The purpose of the standard is to enhance public safety and provide guidance to manufacturers and users of steel wire rope, aramid fiber rope, and noncircular elastomeric coated steel suspension members.

In developing ASME A17.6-2010, extensive test results were studied, and the properties and durability of new suspension and compensation means were examined. Work included visits to major laboratories and manufacturers at which all aspects of aramid fiber ropes and noncircular elastomeric coated steel suspension members were studied. Study of the usage and experience of suspension and governor systems in Europe was also conducted.

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Moreover, comprehensive hazard assessments were carried out to assist in the development of ASME A17.6-2010.

Section 2.20 was significantly revised in ASME A17.1-2010/CSA B44-10 to permit the use of the suspension means addressed by ASME A17.6-2010.

Part 1 of ASME A17.6-2010 constitutes a standard for stranded carbon steel wire ropes for elevators. See Diagram 2.20(a).

This standard covers general requirements for the more common types of stranded steel wire ropes for hoisting, compensation, and governor applications on passenger or freight elevators. Included in the scope of the standard are steel wire ropes in various grades, constructions, and diameters from 4 mm or $^{5}/_{32}$ in. up to and including 38 mm or 1.5 in. manufactured from uncoated wire or metallic coated wire. For specific applications, additional or alternative requirements may apply, provided equivalent safety is maintained.

The standard covers regular lay and Lang lay and preformed and non-preformed elevator rope in nominal imperial dimensions as well as SI dimensions. Various constructions of steel wire rope are covered (i.e., Seale, Warrington, and Filler). The standard covers a broad range of wire materials in current use including iron, traction steel, extra high strength traction steel, 1570 single, 1180/1770 dual, 1370/1770 dual, 1770 single, 1960 single, and 2300 single. Various rope core materials in current use are covered by the standard including natural and synthetic fiber cores and steel cores. The standard covers ropes made from uncoated wires or metallic coated wires (e.g., galvanized). The standard includes criteria for testing and determining specification compliance of steel wire rope, ordering information, and replacement criteria.

In elevator wire rope, the most common arrangements of wires in the strands fall into four types, which determine their specific labels. See Diagram 2.20(a).

Taken in the order of predominant usage, the most common is Seale construction, where each strand consists of a comparatively heavy center wire around which is a layer of nine smaller wires. The outer layer is supported in the valleys formed by the first layer; hence, both layers have the same number of wires. By simple wire count, this strand is designated 1-9-9. The large wires in the outer layer provide abrasion and wear resistance to this type. The filler wire constructions are designed to give more strand flexibility. The 6 small filler wires laid in between the main wires of the inner layer provide a series of valleys into which wires of the outer layer fit nicely. There are twice as many wires in the outer layer as there are wires in the inner layer. By wire count, this type is 1-6-6-12. Warrington construction is less commonly used today. It is made up of 2 layers of wire helically wound about a center wire. There are 6 wires in the inner layer and 12 in the outer layer, the outer layer of wires being alternately large and small. The wire count designation here is 1-6-12.

From the foregoing it will be seen that 8 × 19 Seale simply means a wire rope of 8 strands of Seale construction having 19 wires each for a total of 152 wires. Generally speaking, the more wires per rope, the more flexible the rope. The large outer wires of the Seale construction strand make it comparatively stiffer than the filler wire strand, but eight-strand rope is more flexible than six-strand. Therefore, a 6 × 25 filler wire has more flexible strand construction, but having 6 strands reduces overall rope flexibility. The 8 × 25 filler wire combines both flexibility factors and has 200 total wires (8 × 25).

The term “rope lay” is used to designate the distance along the rope's length that one strand requires for one complete helical turn around the rope. It is approximately equal to 6.5 times the nominal rope diameter.

The factor of safety is defined as the ratio between the minimum load necessary to break the rope, and the load imposed on it in service. However, after a period of service, changes occur in the rope consisting principally of wear in the outer wires and the formation of microscopic fatigue cracks, which develop into broken wires.

The strength of a new rope thus is not a permanent measure of safety. Safety in ropes can only be ensured by continued inspection and prompt removal at the appearance of signs of approaching failure. Visible signs include the number of breaks of outer wires on the worst lay length of the rope, as well as the distribution of these breaks over the various strands. Another is actual rope diameter when reduced due to crown wire wear and core deterioration. See 8.11.2.1.3(cc)(1) and ASME A17.6, for wire rope replacement criteria. See also ASME A17.2, for inspection recommendations.

The service life of a rope is affected by many factors; three in particular should be mentioned: rope lubrication, equal tension between ropes, and sheave diameter. The code does not address equal rope tension, but it is beneficial to ensure that the tensions are as close to equal as practical. In recent years there have been a number of instruments/tools developed to gauge the tension in ropes. Sheave diameter can change due to wear and often results in unequal pitch diameters. The shape of the sheave groove also changes with wear and usually has an adverse effect on traction.

In lubricating traction drive elevator ropes, a lubricant that will excessively reduce friction between the ropes and sheave must be avoided. The ideal lubricant should penetrate the rope strands and thicken sufficiently to remain in place to provide internal lubrication and protect wires from corrosion, but should not produce a greasy or slippery surface. Rope and driving-machine mauufacturers often recommend the viscosity range and other factors of rope lubricant.

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As sheaves wear, not all grooves in the sheave wear at the same rate. This results in a sheave having grooves of different diameters. Individual ropes must therefore travel different distances in a revolution of the sheave, resulting in ever changing tensions and slipping of some ropes. This can accelerate rope wear.

Requirement 2.24.2 specifies that for hoist ropes, no sheave pitch diameter shall be less than 40 times the rope diameter. The pitch diameter is 30 times for special purpose personnel elevators, private residence elevators, and limited use limited application elevators. (See requirements 5.7.18.2, 5.3.1.16.2, and 5.2.1.24.3.) The most obvious advantage of a large sheave is that it reduces the strain and fatigue due to bending the wires of the rope. Another advantage, not quite so apparent, is that the larger the sheave the less the radial pressure between rope and sheave, thus longer rope and sheave life.

Elevator wire rope application considerations include preforming and prestretching.

Preforming is a wire rope fabrication technique whereby the helical shape of the strands in their position in the finished rope is permanently formed before the strands and fiber core are assembled into rope. The nonpreformed wire rope does not have its wires and strands constrained in their final position in the rope; therefore, the ends must be held with wire bands called seizings. In nonpreformed wire rope, severed wires or strands will tend to straighten out. In preformed rope, they do not. The advantages of preformed rope are increased flexibility and longer useful life. Disadvantages are increased rope stretch and greater difficulty in detecting broken wires during service inspection because broken wires tend to lay in the rope and do not flare out. This can also be an advantage since broken wires that flare out will often damage other wires when they pass through the sheave grooves.

Construction stretch is permanent stretch and primarily due to progressive embedding of the wires into the fiber core in the kneading action as new ropes run over sheaves. This process is experienced fairly rapidly in the early stages after installation of the ropes and diminishes with time over a period, which can extend from a few months to over a year. That is why it is important to make frequent tension checks/adjustments for new ropes. This construction stretch may also result in the need to shorten the ropes early in their life.

Prestretching is finish treatment of rope, which removes most of the initial (construction) stretch before ropes are installed. It is used to eliminate the need for shortening ropes, following installation, especially in high-rise installations. See Diagram 2.20(a).

Part 2 of ASME A17.6-2010 constitutes a standard for aramid fiber ropes for elevators. See Diagram 2.20(b).

This standard covers the general requirements for aramid fiber ropes for suspension and compensation applications on elevators. It includes a description of terms specific to this standard and terminology applicable to this technology. It covers dimensional characteristics, material properties, and tolerances. Both circular and noncircular configurations are covered. Testing and compliance as well as replacement criteria are also addressed.

Aramid fiber rope is typically composed of high tensile aramid fibers spun into high strength yarn that are protected by wear sleeves and laid in strands. The strands are typically impregnated with polyurethane, polyester, or other suitable material to reduce abrasion. The strands are laid in a rope configuration typically around an impregnated aramid core similar to the lines of steel wire rope. A typical arrangement includes a number of elastomeric coated indicator elements each made from a conducting material such as carbon fiber. Such indicator elements serve to monitor the residual strength of the rope. The rope is enclosed in a cover made from polyurethane or other suitable material, which functions to contain the load carrying members, protect the latter against abrasion, and transmit traction from the sheave to the load carrying members.

Part 3 of ASME A17.6-2010 constitutes a standard for noncircular elastomeric coated steel suspension members for elevators. See Diagram 2.20(c).

This standard covers the general requirements for noncircular elastomeric coated steel suspension members for suspension and compensation applications on elevators. It includes a description of terms specific to this standard and terminology applicable to this technology. It covers dimensional characteristics, material properties, and tolerances for both the steel cords and elastomeric coating. Testing and compliance as well as replacement criteria are also addressed.

A noncircular elastomeric coated steel suspension member comprises a number of steel cords located longitudinally in the same plane and held in place by an elastomeric coating. The cords each comprise an assembly of steel strands made from steel wires, surrounding a central core. The cords in effect resemble small diameter steel wire ropes. The elastomeric coating material serves to hold the cords in position, prevent abrasion of the cords, and transmit traction from sheave to cords. The cords can also be used to monitor the residual strength of the noncircular elastomeric coated steel suspension member.

2.20.1 Suspension Means

This Section limits the means of suspension to those recognized and described in the ASME A17.6-2010 standard. Suitable care must be taken to protect the suspension means during the installation or modernization,

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particularly in view of the fact that nontraditional suspension means are permitted.

See Handbook commentary on 8.7.2.21 as to why new ropes are required.

2.20.2 Suspension Means Data

The suspension means data plate is installed by the manufacturer to advise maintenance and inspection personnel what suspension members the equipment was designed for. The suspension means tag should be checked against the suspension means data plate at the time of inspection to ensure that the proper suspension means are installed. It should also be checked at the time of suspension system replacement to ensure that the proper suspension members are being installed on the elevator.

2.20.2.1 On Crosshead Data Plate. Requirement 2.20.2.1 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13. See Handbook commentary on Section 8.13.

2.20.2.2 Data Tag at Suspension Means Fastening. The month and year of suspension members' installation [2.20.2.2.2] provides criteria for replacement of a single damaged suspension member.

(a) The replacement suspension member must come from the same suspension member manufacturer and be of the same construction and material. Data for replacement suspension members must correspond to the data for the entire set of suspension members, as indicated on the Suspension Means Data Tag.

(b) If the suspension members have been shortened once, it is doubtful whether the replacement suspension member can be made to perform uniformly with the original suspension members, since the two components of suspension member stretch (i.e., construction and elasticity) will affect the performance of the new suspension member, whereas the original suspension members will only be affected by elastic stretch.

(c) Diameter reduction and crown wire wear, where applicable, must be considered.

(d) Suspension member tension will have to be monitored closely, particularly when the replacement suspension member is first put into service. Unequal suspension member tension can accelerate severe sheave wear on high-speed elevators equipped with steel wire ropes.

(e) Suspension means lubrication could be detrimental to the system, for the reasons discussed in the Handbook commentary on Section 2.20. Requirement 2.20.2.2.2(n) was incorporated in ASME A17.1/CSA B44 to advise if lubrication is acceptable, and, if acceptable, establish criteria for lubrication.

Requirement 2.20.2.2 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13 and remove language that is already addressed in the new section. See Handbook commentary on Section 8.13.

2.20.3 Factor of Safety

The factors of safety noted in Chart 2.20.3 are based on static load conditions. ASME A17.1/CSA B44 does not address the dynamic condition caused at safety application or buffer engagement during which a condition known as car or counterweight jump occurs. After the ascending car or counterweight jumps, it falls back, taking up the slack in the suspension ropes, and induces a dynamic tension in the ropes that retards and stops the falling mass. The smaller the jump, the higher the rope factor of safety during fall back.

While the well-proven factor of safety criteria has been preserved in ASME A17.1/CSA, provision has been made for other considerations where suspension means are different from traditional steel wire ropes. It is required that technical criteria for essential safety requirements and parameters, such as minimum factor of safety, monitoring, residual strength, replacement, etc., shall be selected on the basis of best engineering practice compatible with the product technology, including performance testing under elevator operating conditions for its range of application.

It is further required that the minimum factor of safety for any suspension means shall be not less than the values shown in Chart 2.20.3 except that the factor of safety of steel wire suspension ropes with diameters equal to or greater than 8 mm or 0.315 in. but less than 9.5 mm or 0.375 in. shall be not less than 12 or they shall meet the requirements of 2.20.8.2. See also Chart 2.20.3.

The factors of safety (FS) ≥ 12 selected for steel wire ropes in the range, 8 mm ≤ d ≤ 9.5 mm, are based on the European Code, EN 81-1:1998, Clause 9.2.2(a), and that ropes of these sizes have been successfully deployed on many applications.

The requirement has been written in performance-based language with an assurance that existing factors of safety will be used as a minimum while allowing alternative suspension means.

The most vital issue regarding suspension strength is the residual strength at the point at which the suspension means should be replaced. Thus, the significant factor of safety is that which will ensure safe operation at the point of replacement. Code criteria for steel wire ropes have historically been shown, by testing, to provide a residual strength of 60% at replacement. The same residual strength criterion is appropriate for aramid fiber ropes and noncircular elastomeric coated steel suspension members. (See ASME A17.6, sections 2.9.4 and 3.7.4.)

Extensive study of the degradation of both aramid fiber ropes and noncircular elastomeric coated steel suspension members indicate that decreases in strength are a function of bending fatigue and/or internal fretting, which is directly dependent on the total number of bending cycles, and bending radius. The bending radius is determined by the sheave pitch diameter. Thus their residual strength is predictable based on

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the test data. See also *Wire Ropes: Tension, Endurance, Reliability* by Klaus Feyrer (Springer, 2007).

Requirement 2.20.3 and Table 2.20.3 were revised in ASME A17.1-2016/CSA B44-16 to replace "good engineering practice" with "sound engineering practice." See Handbook commentary on 2.15.6.3.

2.20.5 Suspension Member Equalizers

If operation of equalizers is determined to be proper when inspected as required by 8.11.2.1.3(bb), load fluctuations will not be large enough to cause stress reversals and therefore induce fatigue failures.

2.20.7 Rope Turns on Winding Drums

This requirement ensures that the ropes will not be pulled off the drum when the car reaches its maximum overtravel in the down direction. Experience has shown that one turn is adequate.

2.20.8 Suspension Means Monitoring and Protection

A hazard assessment on all suspension systems indicated that appropriate requirements relating to the various systems would be beneficial. Requirements were developed relating to protection against traction loss, broken suspension members, and suspension member residual strength.

2.20.8.1 Protection Against Traction Loss. All electric traction elevators are required to be provided with traction loss detection means to detect loss of traction between suspension members and drive sheave. [See 8.6.1.2.1(g).] This means is required to meet specific criteria.

It should be noted that relative motion between suspension members and a drive sheave is independent of normal creep (see Section 1.3) of the suspension members. Compliance with the detection requirement can be accomplished by any method that will determine the relative position of the suspension means with respect to the rotational position of the drive sheave. As an example, this can be accomplished by timers, position, and velocity measuring devices.

Failure of any suspension member or a traction sheave can occur due to loss of traction between the suspension members and driving sheave. A means to detect traction loss is necessary to effect removal of power from the driving-machine motor and brake before either of these component failures could occur. The requirements have been written in performance language enabling manufacturers to set appropriate parameters for type of suspension used and method of detection, but still have quantifiable criteria for verification purposes. The requirements cover all types of suspension members and traction sheave materials. The requirement recognizes the following:

(a) Over the last few decades, ratios of the car weight to rated load (C/L) have decreased due to design optimization and use of lighter weight materials, thereby increasing the potential for traction loss as an empty, or lightly loaded, car approaches the top terminal landing.

(b) Measures to detect and protect against loss of traction were implemented by elevator manufacturers, even though not required by the ASME A17.1/CSA B44 Code. This has contributed to the safety record of steel wire ropes. Making these measures mandatory merely formalizes the status quo and does not unnecessarily penalize elevators provided with steel wire ropes, but in fact, establishes a common denominator for design safety. Certain inspections and tests, such as traction tests and maintenance or repair actions may cause the loss of traction. During these periods, it may be necessary to render these protection means ineffective. The Maintenance Control Program (MCP), 8.6.1.2.1, is required to provide precautions for performing such actions when the protection means is made inoperative or ineffective. The method of system verification will depend on suspension system design and must be provided in the MCP.

It is essential that, before an elevator is returned to service after actuation of traction loss detection means, the suspension means are inspected to determine if they meet the replacement criteria of ASME A17.6, requirements 1.10, 2.9, and 3.7 and, if so, are replaced. In addition, the traction sheave shall also be examined and repaired or replaced, if necessary.

This requirement provides detection of traction loss between the suspension means and the drive sheave within specified parameters. The robustness of the suspension means design is specified in engineering tests in 2.20.11. These parameters are taken from ASME A17.1/CSA B44, requirement 5.8.1.7.2, and are also based on requirements in EN 81-1, Code Sections 12.10.1 and 12.10.2. These codified requirements in ASME A17.1/CSA B44 and EN 81 are valid in typical elevator applications. The requirement mandates the removal of electrical power from the driving-machine motor and brake similar to the requirements of EN81-1, Clause 12.10.1. This is more stringent than ASME A17.1/CSA B44 requirement 5.8.1.7.2.

The new requirements in ASME A17.1/CSA B44-2010 provide additional assurance that traction loss detection means will not be made ineffective by EMC, failure of power to be removed from the driving-machine motor and brake, failure of a single ground, or any permanent device not permitted by the ASME A17.1/CSA B44 code. Activation of traction loss detection means is required to cause the power to be removed from the driving-machine motor and brake.

Once loss of traction is detected these requirements ensure shutting the elevator system down and taking remedial action before restoration of service by elevator personnel.

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Requirement 2.20.8.1(d) was revised in ASME A17.1-2019/CSA B44:19 to correct the referenced requirement.

Requirement 2.20.8.1 was revised in ASME A17.1-2022/CSA B44:22 to update the references.

2.20.8.2 Broken Suspension Member. All electric traction elevators, excluding those with steel wire ropes greater than or equal to 8 mm, are required to be provided with a broken suspension member detection means. This means is required to meet specific criteria.

The requirement was developed to mitigate risks identified in the hazard assessment. "Stop the car in a controlled manner" means a stop in which the car is decelerated at a typical rate during a normal stop, but not necessarily at a landing. It is undesirable to have the car stop away from an opening and entrap passengers unnecessarily. This would also allow stopping away from a landing if the car was in a long express zone.

Requirement 2.20.8.2 was revised in ASME A17.1-2022/CSA B44:22 to

(a) update the references

(b) prevent a car at a landing from starting when the broken suspension means is actuated

(c) use the same Section 1.3 defined term "next available landing" as used in requirement 2.20.8.3 and remove the condition of "only when moving for registered demand"

(d) acknowledge the car may not stop in a controlled manner due to the "bird nesting" of the broken suspension means and that the car may not be able to reach the next available landing

(e) minimize entrapments by requiring the car to attempt to run to the next available landing and automatically open the doors

2.20.8.3 Suspension Member Residual Strength. All electric traction elevators, excluding those with steel wire ropes, are required to be provided with residual strength detection means. This means is required to meet specific criteria.

All suspension means must be able to be inspected visually, mechanically, or electronically. Where the suspension member cannot be seen due to coatings or coverings, monitoring will be required to automatically stop the car if the residual strength of any suspension means drops below 60%. The system is also required to prevent the elevator from restarting after a normal stop at a landing.

Requirement 2.20.8.3 was revised in ASME A17.1-2022/CSA B44:22 to update the references and requirements for the residual strength detection means. Safety operations are required to be operative when the residual strength is 60% or greater. When actuated, the detection means must prevent the car from automatically starting if it is at a landing and must cause the car to move to the next available landing if in travel. Once stopped the doors are required to open and then reclose. The door open button must remain operational. The change makes the detection means ineffective when the elevator is on Phase I Emergency Recall Operation, Phase II Emergency In-Car Operation, Occupant Evacuation Operation (OEO), operation under Earthquake Emergency Conditions, or Flood Detection Operation.

The suspension means are installed with a minimum factor of safety as described in Table 2.20.3; therefore, even at 60%, the suspension means have enough strength to operate the limited additional trips during an emergency. Keeping the elevators available for those emergency operations is important for passengers and emergency responders.

By requiring Phase I Emergency Recall Operation to remain operative, the arriving firefighters can immediately account for elevators instead of consuming manpower to investigate cars shutdown away from the lobby and possible entrapments. Removing elevators from firefighters during Phase II operation would have a significant impact on their effectiveness by significantly increasing time to access the floor(s) on fire, reducing the ability to quickly rescue the injured, and reducing the ability to move mobility-limited occupants away from dangerous conditions.

Flood Detection Operation and OEO are necessary to move passengers to a safe level to egress the building in emergencies. OEO can move occupants to a safe level more quickly, help reduce congestion in stairwells, and allow better access for firefighters. Flood Detection Operation can also help protect equipment in a flood emergency.

Keeping earthquake operation available to evacuate passengers from an elevator and to move the car away from a counterweight derailment is also an important safety enhancement.

2.20.9 Suspension Member Fastening

2.20.9.1 Type of Suspension Member Fastenings. The prohibition of the use of U-bolt-type rope clips is intended to preclude fastenings where a U-bolt clip would be directly involved in attachment of a suspension member to a fastening device. U-bolt-type fastenings have a tendency to damage suspension members due to over tightening, thus reducing suspension member strength. They also have a tendency to loosen during normal use. U-bolt-type fastenings are not prohibited for fastening governor ropes.

Current requirements provide for approval of rope fastenings other than individual, tapered, babbitted rope sockets, resin filled rope sockets, or wedge rope sockets on the basis of adequate tensile engineering tests (see Section 1.3) by a qualified laboratory. Fatigue is not a problem on suspension member sockets because the actual variations in stress due to the changing loads are very small in comparison to the stresses to which the sockets are continuously subjected.

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In addition, suspension member sockets are not subjected to reversing cyclical load.

Since ASME A17.1/CSA B44 specifies a very high factor of safety for the hoist suspension means and the hoist suspension means loading cycle never reaches a zero load condition, the cycles necessary to reach fatigue failure are many more times the cycles for suspension member replacement by wear or degradation of the load carrying elements. Elevator suspension design is basically forgiving to fatigue problems at the fastening because of flexibility and elasticity. This has been substantiated by extensive testing over time.

2.20.9.2 Adjustable Shackle Rods. Adjustable shackle rods provide means for adjusting suspension member tension members. Suspension members on traction elevators should be adjusted to substantially equal tension to ensure that each member carries its share of the load. If a set is out of balance, members under lesser tension may soon show excessive wear from creeping action in the sheave grooves. In the case of steel wire ropes, this will likely cause premature wear on sheave grooves. Unequal tension can result from improper adjustment of the shackle rods, broken equalizer springs, or rope stretch but can also be caused by sheave grooves of unequal depth. If suspension members and sheave grooves are not at the same depth, the length of travel of all suspension members will be unequal and thus loading will be unequal.

2.20.9.3 General Design Requirements

2.20.9.3.5 Fabricated sockets are permitted subject to certain conditions.

For new technologies such as noncircular elastomeric coated steel suspension members, fabricated terminations lend themselves to ensuring high quality safe products. Welded structures manufactured to 8.8.1 and 8.8.2 will meet or exceed strength and endurance requirements of cast or forged components. This configuration is in use extensively in Europe and around the world. Testing to 2.20.9.9.1 or 2.20.9.5.1 is required. The requirement is applicable to all suspension technologies permitted by ASME A17.1/CSA B44.

2.20.9.3.6 Thread specifications control tolerance of mating manufactured parts to ensure the strength of threaded connections will meet design requirements.

2.20.9.7 Method of Securing Wire Ropes in Tapered Sockets

2.20.9.7.2 Seizing of Rope Ends. Alternate methods of seizing the ends of wire ropes to be socketed (other than using annealed iron or wire), such as banding, are acceptable if they serve to prevent strands from untwisting. Seizing should be removed after the fastening has been completed, as it serves no further purpose.

2.20.9.7.9 Inspection of Sockets After Completion. See Diagram 2.20.9.7.9.

2.20.9.8 Antirotation Devices. This requirement prevents damage to suspension member and loss of suspension member tension due to rotation.

2.20.9.9 Wedge Noncircular Elastomeric-Coated Steel Suspension Member Sockets. Wedge socket assemblies for noncircular elastomeric coated steel suspension members are permitted provided that certain conditions are met. These conditions are consistent with requirements for wedge sockets for steel wire ropes and aramid fiber ropes.

2.20.10 Auxiliary Rope Fastening Devices

2.20.10.9 Requirement 2.20.10.9 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13 for the data tag and to remove language that is already addressed in the new section. See Handbook commentary on Section 8.13.

2.20.11 Suspension Member Test

It is required that each type of suspension means designed to support elevator cars or counterweights be subjected to engineering testing specified in 8.3.12, except for certain suspension means. The purpose for testing and the reasons for exempting certain suspension means are elaborated below.

During construction of an elevator, it is necessary to recognize that all safety functions or safeguards may not yet be installed or must be bypassed outside the restrictions of 8.6.1.6.1. To ensure suspension system dependability under these circumstances, an engineering test is required. (See 8.3.12.)

Implementation of requirement 2.20.8, Suspension Means Monitoring and Protection, will provide thorough and effective requirements to ensure suspension means will not part as a result of loss of traction during automatic operation of the elevator. However, it is recognized that during construction, and replacement or repair, carried out under inspection operation, the suspension means monitoring and protection system may be bypassed or otherwise rendered ineffective. During these phases of elevator operation, it is prudent to ensure the suspension means will not part if traction is lost. Moreover, it is recognized that during safety tests and buffer tests performed at acceptance and periodically, as well as during emergency stops, it is common that traction is lost. It is wise to ensure that damage to the suspension means that could jeopardize performance does not occur.

One of the most effective ways of ensuring suspension means integrity is to require appropriate engineering tests to verify endurance. Two tests are required — one to address conditions pertaining to construction, and the other relating to traction loss as a result of emergency stops or testing required by Code. Engineering test

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reports are required to document both test procedure and results.

The test required by 8.3.12.2 is to verify durability of the suspension system for a reasonable interval of time; testing is performed at inspection speed. This level of endurance must consider conditions found in construction, where a falling counterweight is the one unprotected mode of failure in a loss of suspension scenario that would endanger elevator personnel. Such unprotected conditions only occur during construction when inspection speeds are being used.

During construction startup, the first time traction is required to move a car generally occurs in getting a newly built platform running at inspection speed. The first movement is typically done with a construction/inspection operating device. Using constant pressure, operation elevator personnel observe relative movement to confirm correct motor and control system wiring. In this case, loss of traction is determined visually. If the platform or counterweight does not move, it would be noticed almost immediately.

Movement of the car from startup to adjustment is typically performed by elevator personnel while riding the car to complete construction. During this period, the motor field sensing means required by 2.26.2.4 may not yet be assembled, or the drive motor control system may not yet be fully functional. Under these circumstances, the car is still operating at inspection speed, and loss of traction will be observed visually. To provide a conservative criterion for establishing suspension means durability, a loss of traction test duration of 4 min was deemed appropriate to ensure that parting would not occur at inspection speed. This is based on the premise that during construction, with all suspension means protections systems intentionally bypassed, slippage between suspension means and traction sheave could inadvertently occur. It is also unlikely that such an occurrence would not be noticed promptly. Based on this data, the committee determined 4 min to be a conservative and appropriate duration on which to base the criterion.

One construction procedure common to many computer-controlled systems uses inspection hoistway scanning. This is often a semiautomatic function, where the car travels the length of the hoistway at inspection speed to record floor locations and establish positional baselines. During this mode of operation, speed-monitoring devices and suspension means protective devices are functional, any loss of traction would be sensed, and the elevator would be stopped before suspension system failure.

In establishing load criteria for suspension member testing, the following would be taken into account:

(a) Maximum load for which a suspension member is qualified is selected by the elevator manufacturer.

(b) The manufacturer can be guided by two parameters in establishing the maximum capacity/load in a suspension member:

(1) The factor of safety parameter, which comes from a specific Code requirement; or

(2) Limiting groove/surface pressure established by the manufacturer.

(c) Selection criterion for suspension member is based on the gross load (car weight + rated load + compensation + traveling cables). Rated load is only a part of that selection criterion.

Testing required by 8.3.12.3 is to verify suspension system durability when traction is lost as a result of an emergency stop or a Code required test such as a buffer test or a safety test. It is essential that the suspension means is not damaged to the point where replacement would be necessary, hence the reference to the replacement criteria of ASME A17.6 as the condition for passing the test. This test recognizes that duration is dependent on system dynamics, considering initial momentum of moving masses and frictional resistance of suspension means moving over a stalled drive sheave. To verify system durability, three successive tests over substantially the same portion of the suspension means are required. The concept of three successive tests without violating a criterion is well established (e.g., 8.3.2.5.1, Retardation Tests.)

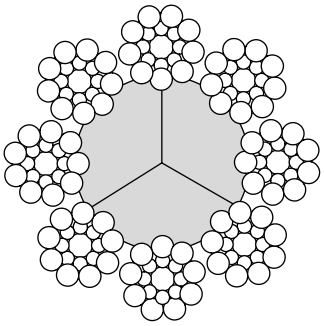
This requirement specifically exempts Engineering Tests for suspension means conforming to 2.20 with steel wire rope diameters not less than 9.5 mm or 0.375 in. and with outer wire diameters not less than 0.56 mm or 0.024 in., steel wire ropes with diameters not less than 8 mm or 0.315 in., with outer wire diameters not less than 0.48 mm or 0.019 in. used with a factor of safety not less than 12, and steel wire ropes conforming to the requirements of 5.2.1.20, 5.3.1.12, 5.4.8, 7.2.6, and 7.5.6. The reason for the exemption is that requirement 2.20.8 covers all suspension means, thus codifying the current industry practice of stopping the elevator before a suspension member would part should loss of traction occur. During construction when protection means may not be in place, and during emergency stops or Code required testing when traction may be lost, history has not shown it necessary to verify the integrity of steel wire ropes 9.5 mm or 0.375 in. or larger in diameter or steel wire ropes conforming to the requirements of 5.2.1.20, 5.3.1.12, 5.4.8, 7.2.6, and 7.5.6. Engineering testing of these would merely reveal what is already well established and would impose an unnecessary burden.

By implementing 2.20.8 and engineering tests in 8.3.12, which are consistent with similar tests required by the Code, the suspension system integrity will be ensured. Documentation of engineering tests provides verification.

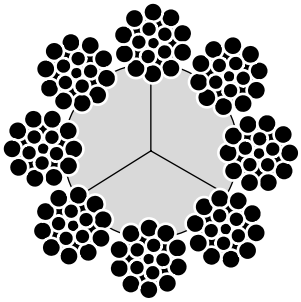
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Diagram 2.20(a)
Typical Wire Rope Construction

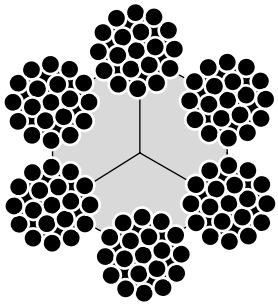
Standard Hoist Ropes



(a) 8 × 19 Seale
[Note (1)]

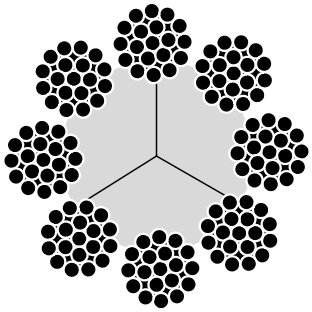


(b) 8 × 21 Filler Wire Type U

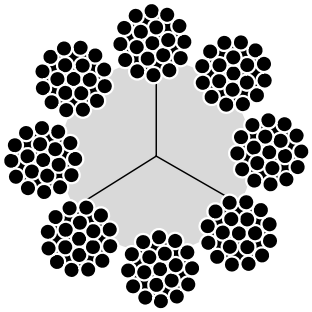


(c) 6 × 25 Filler Wire

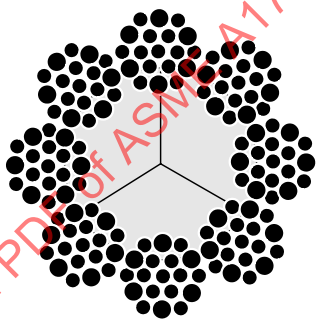
Compensation Ropes | **Governor Ropes**



(d) 8 × 25 Filler Wire
[Note (2)]

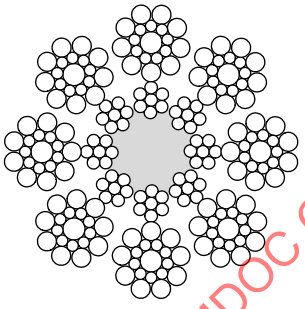


(e) 8 × 25 Filler Wire
[Note (2)]

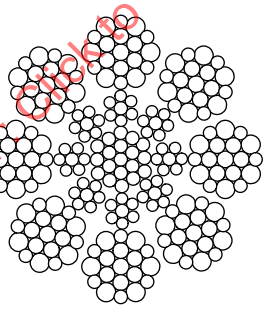


(f) 8 × 19 Warrington
[Note (2)]

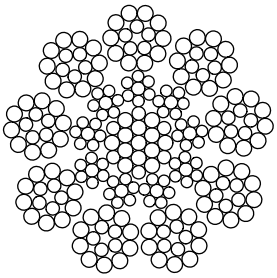
Designs Used in North America



(g) Dual-Strand Rope



(h) 8-Strand Steel Core



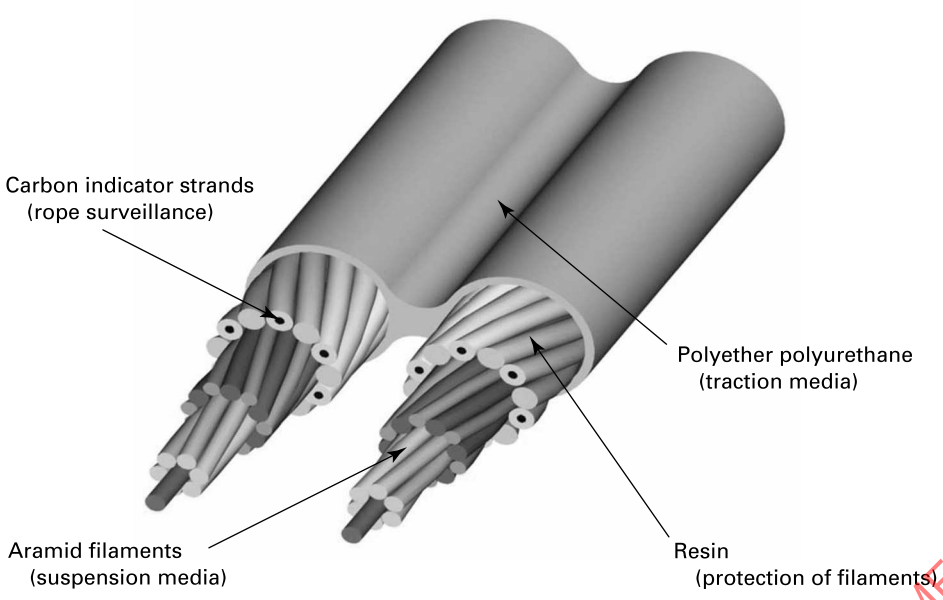
(i) 9-Strand Steel Core

GENERAL NOTE: Both traction and iron grade are used for compensation and governor ropes.

NOTES:
(1) These ropes can be compacted for high fatigue usage.
(2) Use 8 × 19 Warrington for $^{3}/_{8}$-in. and $^{7}/_{16}$-in. diameter ropes. Use 8 × 25 filler wire for $^{1}/_{2}$-in. and larger ropes.

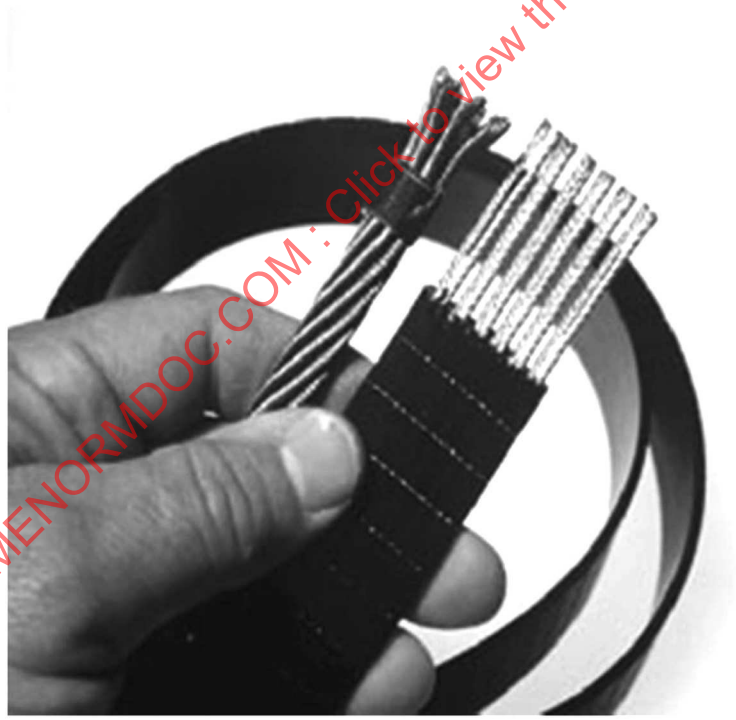
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Diagram 2.20(b)
Aramid Fiber Rope, Twin Rope TR12



GENERAL NOTE: Courtesy of Schindler Elevator Co.

Diagram 2.20(c)
Noncircular Elastomeric-Coated Steel Suspension Member



GENERAL NOTE: Courtesy of Otis Elevator Co.

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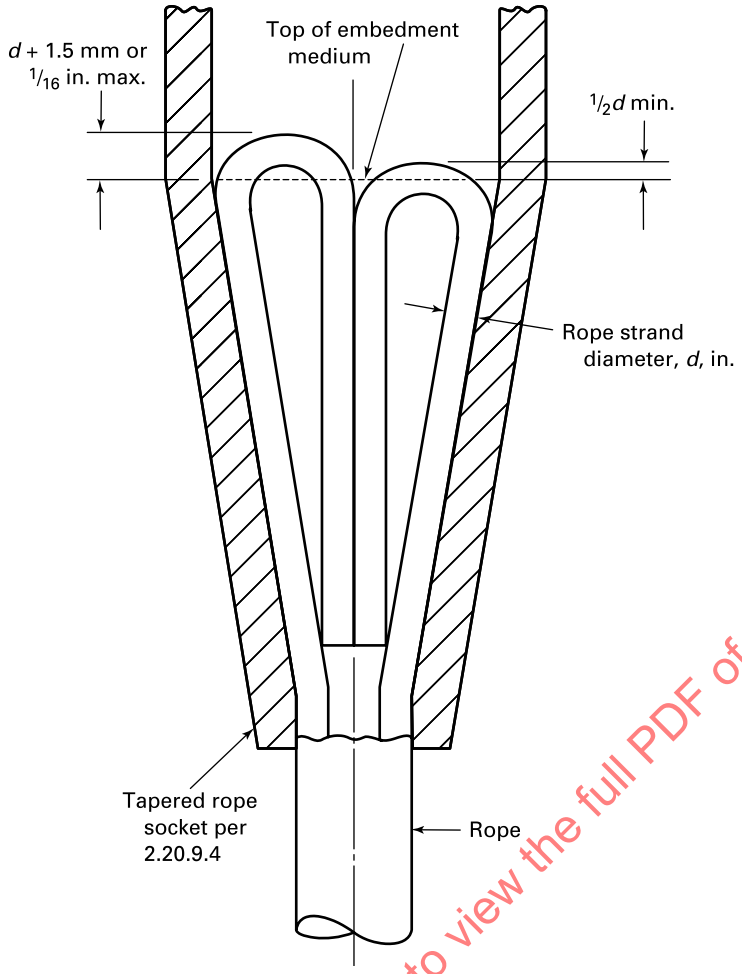
Chart 2.20.3
Design Requirements — Traction Elevator Suspension System

Suspension		Factor of Safety (FS) (2.20.3)	Traction-Loss Detector and Protection (2.20.8.1)	Broken-Suspension-Member Detector and Protection (2.20.8.2)	Suspension-Member Residual-Strength Detection (2.20.8.3)
Type	Diameter, *d*, or Size				
SWR	$d \geq 9.5$ mm	FS ≥ Table 2.20.3	Required	Not required	Not required
	8 mm ≤ d < 9.5 mm	FS ≥ 12	Required	Not required	Not required
		FS ≥ Table 2.20.3	Required	Required	Not required
	4 mm ≤ d < 8 mm	FS ≥ Table 2.20.3	Required	Required	Not required
AFR	Any	FS ≥ Table 2.20.3	Required	Required	Required
		FS ≥ SEP	Required	Required	Required
CSM	Any	FS ≥ Table 2.20.3	Required	Required	Required
		FS ≥ SEP	Required	Required	Required

GENERAL NOTES:
(a) AFR = aramid fiber ropes
(b) CSM = noncircular elastomeric-coated steel suspension members
(c) SEP = sound engineering practice
(d) SWR = steel wire ropes

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Diagram 2.20.9.7.9
Cross-Section Through Tapered Rope Socket Showing Maximum and Minimum Projection of Loops Above Embedment Medium



SECTION 2.21
COUNTERWEIGHTS

2.21.1 General Requirements

2.21.1.1 Frames. Where a counterweight employs filler weight material that is only retained in sealed containers, the structural design of each container must be adequate to withstand the lateral forces induced by the loose material and must be adequately sealed to ensure that there will be no loss of filler (weight) material during normal service, safety engagement, or buffer engagement.

Requirements similar to those prescribed for car frames are also appropriate for counterweight frames. See the Handbook commentary on 2.15.1.

2.21.1.2 Retention of Weight Sections. Where tie rods are used as the retention means, two tie rods are required to pass through all weight sections. The tie rods are not required to be secured to the frame. For example, two tie rods pass through all the counterweight sections and the bottom member of the frame only.

In lieu of using tie rods, some companies weld the counterweight subweight section to the frame. Angle retainers at the top of the counterweight are also utilized. When properly designed, these methods conform to ASME A17.1/CSA B44 requirements.

2.21.1.3 Guiding Means. Counterweight frames are guided by sliding guide shoes or roller guides. This requirement was revised in ASME A17.1-2013/CSA B44-13 to improve the safety of the guiding means by requiring a minimum factor of safety while eliminating language that is overly prescriptive. The requirement also prohibits displacements greater than 13 mm or 0.5 in. that could occur on sliding members when gibs are lost or on roller guides when a roller fails.

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2.21.2 Design Requirements for Frames and Rods

2.21.2.3 Factor of Safety

2.21.2.3.3 The requirements provide criteria for the safe design of the respective components/structures, subject to forces developed during the retardation phase of the emergency braking and all other applicable loading acting simultaneously, with factors of safety consistent with the types of equipment/structures involved.

2.21.3 Cars Counterbalancing One Another

One car counterbalancing another is prohibited due to the probability that both cars cannot be level with a landing at the same time. Rope stretch due to loading and unloading will vary on each car. Releveling one car will make the other out of level with its landing.

2.21.4 Compensation Means

Requirements for "compensating means" are included under Section 2.21, which is the general section for counterweights due to the common understanding that compensation is related to counterbalancing or counterweighting.

The purpose of compensation is to partially or fully counteract weight of the suspension ropes. This requirement does not dictate that compensation must be either chain or rope, and it is not the intent to restrict or specify the type of compensation permitted. The intent is to specify that the compensation means (rope, chain, etc.) be fastened structurally to the counterweight and car and that, if ropes are used with a tension sheave, a means of individual rope adjustment must be provided.

Compensation means other than rope or chain may be used. Any method of fastening that transfers the load due to the weight of the compensation to the counterweight or car frame is permissible.

The wording "breaking load" is defined in ASTM E6-94, Standard Terminology Relating to Methods of Mechanical Testing, which "covers the principal terms relating to methods of mechanical testing of solids."

The wording "minimum breaking force" is defined in ASTM A413/A413M-93 Standard Specification for Carbon Steel Chain, and in ISO 4344:1983, Steel wire rope for lifts.

Minimum breaking load or breaking force satisfies the requirement to use a load or force value that must be met or exceeded when a representative part sample of the compensation means is submitted to a standard tensile test. Also, it would conform to other standards, which already have definitions consistent with the above wording.

Using the required factor of safety of 5 for compensation means with the minimum breading force, for chain, agrees with an early recommendation "using 80% of the working load limit as criteria." Working load limit of chain has a ratio of 4:1 factor of safety in relation to its minimum breaking force, and applying 80% on it will result exactly in 5 for the accumulated factor of safety, which agrees with the Code required factor of safety of 5 for compensation means.

2.21.4.1 Connections. The requirements cover the complete compensation system. There is no safety justification for requirements that the means must be fastened to the frame of the car and/or counterweight, provided the point of fastening conforms to the strength requirements.

2.21.4.2 Tie-Down Compensating Means. These requirements are met by the use of compensating ropes, which run from the underside of the car, down to the pit, around a compensating rope sheave, and then up to the bottom of the counterweight. The compensating rope sheave is installed in a frame, which limits its vertical movement.

Tie-down compensation requirements were incorporated in ASME A17.1 during the 1930s and in CSA B44-1960 when it was found that under certain conditions elevator safety stops may occur at greater than 1*g*. In order to prevent this from happening on high speed elevator systems, tie-down compensation was introduced. The purpose is to transfer energy from the counterweight to the elevator car and actually speed the car up decreasing the deceleration rate to less than 1*g*. This can happen when either car or counterweight stops on safety and could happen at the terminals when either is approaching the overhead and the other engages the buffer. Also, see the Handbook commentary on 2.20.3.

SECTION 2.22
BUFFERS AND BUMPERS

NOTE: The author expresses his appreciation to George W. Gibson and Dennis Kalgren for their contributions to Section 2.22.

2.22.1 Type and Location

2.22.1.1 Type of Buffers. A buffer is a device that provides a controlled stop of a descending car or counterweight traveling beyond its normal limit of travel. A buffer absorbs and dissipates the kinetic energy of a moving car or counterweight. An oil buffer uses oil as a medium, which absorbs and dissipates kinetic energy. A spring buffer utilizes a spring to absorb and store the energy of the descending car or counterweight. See Diagram 2.22.1.1.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to recognize elastomeric buffers as "equivalent types," to define a maximum rated speed for their use, and to note any possible environmental considerations. An elastomeric buffer is an energy-accumulation-type buffer with nonlinear characteristics (such as a

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polyurethane buffer) using resilient materials to cushion the impact force of the descending car or counterweight.

A common version of a Type C safety incorporates an oil buffer between the safety plank and lower car frame member, thus eliminating the need for a separate oil or spring buffer located in the pit. Such Type C safeties having a traveling buffer use solid bumpers in the pit rather than buffers. See Diagram 2.17.5.3.

Another design of a Type C safety embodies a unit assembly of an instantaneous (Type A) safety housed with an oil buffer. Each unit assembly is mounted to the car frame and platform structure at each guide rail location. This design eliminates the necessity of a second set of planks.

2.22.1.2 Location. Normally, car and counterweight buffers or bumpers are located between a pair or car or counterweight rails. They need not be positioned in this location as long as the car frame and the counterweight frame are designed accordingly.

2.22.2 Solid Bumpers

A bumper is a device, other than an oil, spring, or elastomeric buffer, designed to stop a descending car or counterweight beyond its normal limits of travel by absorbing the impact. Solid bumpers are normally constructed of a solid block or blocks of wood or rubber.

Solid bumpers are only permitted for electric elevators with Type C safeties (2.22.11), or hydraulic elevators (3.22.1.5), and screw-column elevators (4.2.13), which have maximum speeds in the down direction of 0.25 m/s or 50 ft/min. The striking speed for an electric elevator with a rated speed of 0.25 m/s or 50 ft/min could be much greater based on the requirements of 2.18.8.1 and 2.18.2.1. For example, Table 2.18.2.1 permits a 0.25 m/s or 50 ft/min car to have a governor tripping speed of 0.89 m/s or 175 ft/min.

Requirement 2.22.2 was revised in ASME A17.1-2016/CSA B44-16 to limit the speed of application of solid bumpers on electric elevators, to be consistent with the requirements for hydraulic elevators.

2.22.3 Spring Buffers

2.22.3.1 Stroke. The spring buffer stroke is the distance contact ends of the spring can move under a compressive load until all coils are essentially in contact. The stroke may be reduced by a fixed stop built into the assembly. In this case, the stroke will be the distance the spring can be compressed until the stop is contacted. This is described as the distance the spring can be compressed until it is a solid unit.

Requirement 2.22.3.1 was revised in ASME A17.1-2019/CSA B44:19 to clarify the referenced requirement.

2.22.3.2 Load Rating

(a) ASME A17.1/CSA B44 contains three requirements for spring buffers. All three requirements must be fulfilled to comply with the requirements:

(1) A minimum buffer stroke is required for a given car speed.

(2) The spring buffer must be capable of supporting, without being compressed solid, a minimum static load of 2 times the combined weight of the car and its rated load, for car buffers and 2 times the weight of the counterweight for counterweight buffers.

(3) The spring must be compressed solid with a static load of 3 times the weight of the car and its rated load, for car buffers and 3 times the weight of the counterweight for counterweight buffers.

The load and load rating requirements given by 2.22.3.2.1 and 2.22.3.2.2 can be expressed by the following general equation:

$$3 \geq \frac{R}{W} \geq 2$$

A special case of this equation is shown by taking the two right-hand terms in this equation, and taking it at the limit when $R = 2W$.

This rating specified in 2.22.3.2.1 is equivalent to the dynamic load, which is equal to the car weight plus its rated load when decelerated from rated speed to zero car speed at the retardation equal to $1.0g$. It should be noted that there are three equivalent terms conventionally used to describe the rate of speed reduction namely, retardation, deceleration, and negative acceleration.

The general equation describing the buffer impact is:

$$R = W + W\left(\frac{a}{g}\right)$$

Substituting the retardation, $a = 1.0g$, in this equation and simplifying yields

$$R = 2W$$

where

a = retardation (m/s^2 or ft/sec^2)
g = acceleration due to gravity (9.81 m/s^2 or 32.2 ft/sec^2)
R = load rating of buffer assembly (kg or lb)
W = car weight + rated load (kg or lb)

(b) To better illustrate how the three spring buffer requirements are interrelated and interdependent, the following examples are given:

(1) Example A. Rated car speed = 1.02 m/s or 200 ft/min or 3.333 ft/sec

Assume a spring buffer having the following parameters:

R = load rating = 2 (car weight + capacity) = 2 268 kg or 5,000 lb

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K = spring constant = 25.0 kg/mm or 1,400 lb/in.
s = stroke = 102 mm or 4 in. = the minimum permitted by the ASME A17.1/CSA B44 Code for a car speed of 1.02 m/s or 200 ft/min

(-a) The spring buffer deflection, d, is

(Imperial Units)

$$d = \frac{R}{K} = \frac{5{,}000}{1{,}400} = 3.57 \text{ in. or } 0.2975 \text{ ft}$$

(SI Units)

$$d = \frac{R}{K} = \frac{2\,268}{25} = 90.7 \text{ mm}$$

This meets requirement 2.22.3.2.1, i.e., buffer supports load without being compressed solid.

(-b) The average retardation, which is shown as $-a$, from rated car speed [1.02 m/s or 3.333 ft/sec] to zero car speed over a distance of 90.7 mm or 0.2975 ft is

(Imperial Units)

$$-a = \frac{v^2}{2s} = \frac{(3.333)^2}{2(0.2975)} = 18.67 \text{ ft/s}^2 \text{ or } 0.56g$$

(*SI Units*)

$$-a = \frac{v^2}{2s} = \frac{(1.02)^2}{2(0.0907)} = 5.7 \text{ m/s}^2$$

(-c) The spring buffer deflection, d', at 3 times car weight plus rated capacity is

(Imperial Units)

$$P_3 = \frac{3R}{2} = \frac{3(5{,}000)}{2} = 7{,}500 \text{ lb}$$

(*SI Units*)

$$P_3 = \frac{3R}{2} = \frac{3(2\,268)}{2} = 3\,402 \text{ kg}$$

(Imperial Units)

$$d' = \frac{P_3}{K} = \frac{7{,}500}{1{,}400} = 5.3 \text{ in. (theoretically)}$$

(*SI Units*)

$$d' = \frac{P_3}{K} = \frac{3\,402}{25.0} = 136 \text{ mm (theoretically)}$$

This meets the requirements of 2.22.3.2.2, i.e., the buffer became fully compressed (solid) at d' = 4 in.

(2) Example B. Rated car speed = 1.02 m/s or 200 ft/min or 3.333 ft/sec.

Assume a spring buffer with a spring constant double that of the spring buffer in Example A under the same dynamic load [2 268 kg or 5,000 lb]

R = 2 268 kg or 5,000 lb
K' = $2K$ = 2 (1,400)
= 50.0 kg/mm or 2,800 lb/in.

(-a) The spring buffer deflection, d, is

(Imperial Units)

$$d = \frac{R}{K'} = \frac{5{,}000}{2{,}800} = 1.786 \text{ in. or } 0.149 \text{ ft}$$

(SI Units)

$$d = \frac{R}{K'} = \frac{2\,268}{50} = 45.4 \text{ mm}$$

This meets requirement 2.22.3.2.1, i.e., buffer supports load without being compressed solid.

(-b) The average retardation, a, from rated car speed (3.333 ft/sec) to zero car speed over a distance of 0.149 ft is

(Imperial Units)

$$-a = \frac{V^2}{2s} = \frac{(3.333)^2}{2(0.149)} = 37.28 \text{ ft/s}^2 \text{ or } 1.158g$$

(SI Units)

$$-a = \frac{V^2}{2s} = \frac{(1.02)^2}{2(0.0454)} = 11.4 \text{ m/s}^2$$

The retardation is double that under Example A.

(-c) The spring buffer deflection, d', at 3 times car weight plus rated capacity is

P_3 = 3 402 kg or 7,500 lb (same as Example A)

(Imperial Units)

$$d' = \frac{P_3}{K'} = \frac{7{,}500}{2{,}800} = 2.69 \text{ in.}$$

(SI Units)

$$d' = \frac{P_3}{K'} = \frac{3\,402}{50} = 68 \text{ mm}$$

This does not compress the buffer solid (stroke = 100 mm or 4 in.) and, therefore, does not comply with 2.22.3.2.2.

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Now, assume that a fixed stop is added and located such that the buffer stroke is reduced to 64 mm or 2½ in.; the buffer now will also comply with 2.22.3.2.2; however, it will not comply with 2.22.3.1, which specifically requires a minimum stroke be not less than 100 mm or 4 in. for a rated car speed of 1.00 m/s or 200 ft/min. Therefore, the addition of a fixed stop at a location that will satisfy the compression requirements will not satisfy the stroke requirement of 2.22.3.1.

The above examples indicate that the spring constant will be essentially the same with either the fixed stop design or the full compression design in order to comply fully with the buffer stroke and compression requirements of ASME A17.1/CSA B44.

2.22.3.2.3 Where there is occupiable space below the hoistway the rating of the spring buffers is increased to reduce the load that can be transmitted to the building structure. This reduces the probability of building damage in the event the buffers are struck by the car or counterweight.

2.22.3.3 Marking Plates. For many years predating the 1980s, spring buffers typically consisted of a single helical spring buffer. In the early 1980s, it was apparent that many manufacturers were employing spring buffer designs containing one or more springs per spring buffer assembly. A spring buffer may consist of an assembly of one or more springs, some of which could be removable. By providing a marking plate for each spring buffer assembly showing the assembly load rating, stroke, and number of springs, an inspector can determine that no springs have been removed. If the springs can be removed, they must be identified and the identification indicated on the marking plate. This is often a number stamped into each spring at the top or bottom and shown on the marking place.

It is the intent of the requirements to require a marking plate that has been permanently and legibly marked and that this marking plate be provided with the spring buffer assembly. A loose marking plate fastened to the spring buffer assembly by a wire tie would comply with this requirement.

Requirement 2.22.3.3 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13 and remove language that is already addressed in the new section. See Handbook commentary on Section 8.13.

2.22.4 Oil Buffers

The lower the buffer striking speed, the less the jump of an ascending car or counterweight. One advantage to the use of reduced stroke oil buffers (2.22.4.1.2) at reduced engagement speeds is that the car or counterweight jump is less than that obtained with full stroke buffers at buffer-rated strike speeds.

The oil buffer retardation is required to not exceed an average of 9.81 m/s^2 or 32.2 ft/sec^2 (1.0g) if the descending mass (car or counterweight) struck it at 115% of rated speed. A typical oil buffer instrumented when tested would show the general graph of the retardation versus time as indicated in Diagram 2.22.4.

The area under the actual retardation curve is usually found by either a direct integration method or by numerical integration as follows:

(a) Direct Integration

(Imperial Units)

$$\text{Average retardation } a_{\text{avg}} = \frac{\int_o^t a\,dt}{t}$$

(b) Numerical Integration

(Imperial Units)

$$\text{Area} = \sum_{l=1}^{N} A(l)\Delta t$$

$$\text{Average retardation } a_{\text{avg}} = \frac{\sum_{l=1}^{N} A(l)\Delta t}{N\Delta t}$$

where

N = number of elemental areas under the curve

In order to comply with this requirement, it is necessary that

$$a_{\text{avg}} \leq 1.0g$$

See Diagram 2.22.4.

2.22.4.1 Stroke. The oil buffer stroke is the oil displacement movement of the buffer plunger or piston excluding the travel of the buffer plunger accelerating device. Requirement 2.22.4.1.2 refers to what is commonly known as a reduced stroke buffer. A reduced stroke buffer is commonly found where the pit is not deep enough, as might be found on a high-speed installation where the standard oil buffer stroke is extremely long. A reduced stroke buffer can be used on any installation even if the pit is deep enough for the installation of a full-stroke buffer.

More than 50 years ago, ASME A17.1 Code developers recognized that the era of urban development would necessitate higher speed elevators than had previously existed and that product safeguards still had to be ensured. Of necessity, safeguards had to be compatible with the state of the art equipment design and be practical. One concern related to passenger safety as a car approached the terminal landings. The results of early

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study by the developers of ASME A17.1 were requirements for oil buffers that would absorb kinetic energy of a descending mass (car or counterweight) whose speed exceeded rated speed, but was less than the speed at which the safeties would apply. This terminal stop would be regulated so that an average retardation of a 9.81 m/s^2 or 32.2 ft/sec^2 (1.0g) was not exceeded.

As car speeds increased, required buffer stroke sizes had to increase and new factors entered the picture. Notably, the lack of commercially available buffer sizes for higher speeds; building conditions precluded the use of pit depths required to accommodate the longer buffer strokes; and the lack of sufficient overhead height above the top floor.

The 1931 Edition of ASME A17.1 addressed this issue wherein normal stroke oil buffers could not be used. The ASME A17 Committee concluded that reduced stroke buffers could be used subject to the following provisions:

(a) there is a device that would detect speed of a descending mass (car or counterweight) had been reduced to a predetermined speed that could be retarded with an average of not more than 9.81 m/s^2 or 32.2 ft/sec^2 (1.0g) by a reduced stroke buffer; and

(b) an emergency terminal speed-limiting (ETSL) device, independent of the normal terminal stopping device, is provided that would automatically reduce car speed as it approached a terminal landing

This premise has been the basis of numerous ASME A17.1/CSA B44 requirements (e.g., 2.22.4.1, 2.25.4.1), which have been in the Code for 50-plus years, covering thousands of safe elevator installations all over the country and throughout the world. Clearly, the premise has withstood the test of time.

The use of reduced stroke buffers requires the inclusion of additional control circuits and devices. Commercially, the designation is called “reduced stroke buffers and potential switch slowdown,” which ASME A17.1/CSA B44 calls “emergency terminal speed-limiting device.” See Diagram 2.22.4.1.2.

The reduced stroke buffer/potential switch slowdown feature has no effect on elevator operation, provided elevator slowdown at the terminal is normal. In a very common design, the car speed is checked by means of a switch mounted on the car overspeed governor and a switch located in the hoistway or in the machine room, which is activated when the car is a predetermined distance from the buffer engagement point. If car speed is correct, a normal terminal slowdown occurs as indicated by the speed-distance curve, *AD*. If, however, the car is going too fast at this predetermined checkpoint, *C*, in the hoistway, the switch indicates this condition and the ETSL device goes into operation, removing power from the driving-machine motor and brake, thereby assuring that the car strikes the buffer at a speed not exceeding the rated striking speed (v_{ss}) of the reduced stroke buffer. Curve ACFH shows this emergency slowdown during which the retardation results from Newton's Second Law of Motion.

This operational feature is also intended to ensure that if traction is lost during an emergency stopping condition, the hoist ropes will slide over the drive sheave, but will be sufficiently retarded so that the car will strike the buffer at a speed for which the buffer has been designed and rated. Curve HE shows this final car motion during the buffer retardation. This retardation is a function of the movement of the oil through the internal orifices within the buffer. When the car strikes the reduced stroke buffer at a speed within its buffer rating, average retardation cannot exceed 1.0g.

Table 2.22.4.1 was revised in ASME A17.1-2013/CSA B44-13. Prior to and during the harmonization process, there were transcription errors and errors of conversion in the table. These were not material differences and no buffer strokes were changed.

2.22.4.5 Plunger Return Requirements. These requirements ensure that an oil buffer that has been compressed will return to its fully extended position in case the car or counterweight strikes the buffer again. A spring-return oil buffer is one that employs a mechanical spring to return the buffer plunger or piston to its fully extended position. A gas spring-return oil buffer is one that employs pressure from a compress gas to return the buffer plunger or piston to its fully extended position.

The requirements of 2.22.4.5 address spring-return buffers utilizing a gas spring rather than a mechanical spring. A switch is required by 2.22.4.5(c) to shut the elevator down if there is a gas leak and the buffer does not return to its fully extended position after being compressed. The gas is only used to extend the buffer after it has been compressed and does not provide for the controlled stopping of the buffer.

Requirement 2.22.4.5 was revised in ASME A17.1-2016/CSA B44-16 to include design requirements relating to lateral movement of the plunger (2.22.4.5.2) as a proactive measure to ensure effective oil buffer operation. Testing after manufacture is not as effective as addressing the issue in the design stage.

2.22.4.6 Means for Determining Oil Level. This requirement was revised in ASME A17.1-2013/CSA B44-13 to allow transparent sight gauges. Transparent sight gauges are permitted provided they are designed in accordance with good engineering practice and resist shock loading or pressure rise as a result of impact, and are not to be stained by the presence of buffer oil. Buffers with transparent sight gauges have been used in Europe for over 9 yr. Of the more than 5,400 buffers installed, there have been no reports of false-positive oil levels; shattering of the acrylic sight gauge has been reported in only 0.125% of the installed units and resulted from manufacturing defects that caused leakage around the sight gauge seal. All buffers are type

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tested and subjected to acceptance and periodic tests that demonstrate the suitability of materials used in the sight gauge.

Most oil buffers are provided with two ports: one at the minimum oil level line, and the other at the maximum oil level line. A dipstick is another method employed to comply with this requirement. Where only one port is provided, the oil must be maintained at the level of that port.

2.22.4.7 Type Tests and Certification for Oil Buffers. This requirement permits the testing of only one of a series of buffers of the same type and design as a basis for approval of other buffers in the same series of oil buffers. Also, see the Handbook commentary on 8.3.2.

2.22.4.8 Compression of Buffers When Car Is Level With Terminal Landings. An elevator may be arranged to use reduced stroke oil buffers subject to the requirements of 2.22.4.1.2 and at the same time utilize up to 25% precompression of the buffer stroke as permitted by this requirement. If precompression is used, the buffer must be of the mechanical spring-return type. Gas spring-return-type buffers cannot be used with precompression.

ASME A17.1/CSA B44 does not address the simultaneous application of 2.22.4.8 and 2.25.4 since they cover independent conditions described as follows:

(a) Under normal elevator operation, the elevator comes into the bottom terminal landing at normal slowdown speeds for which precompression of the buffer stroke is permitted. Under this case, the emergency terminal speed-limiting devices are inoperative.

(b) Under an emergency condition, the emergency terminal speed-limiting devices, as required by 2.25.5, will function to reduce the speed of the car to a level that can be retarded by a reduced stroke buffer not in excess of 9.81 m/s^2 or 32.2 ft/sec^2 (1.0g). Under this case, precompression of the buffer is not used.

Requirement 2.22.4.8 was revised in ASME A17.1-2022/CSA B44:22 to update a reference.

2.22.4.10 Load Ratings of Oil Buffers. Requirement 2.22.4.10 was revised in ASME A17.1-2019/CSA B44:19 to clarify the referenced requirement.

2.22.4.11 Buffer Marking Plate. The oil buffer is an energy dissipating device. The marking plate requires that information that is necessary to describe the capacity of the buffer, namely, the maximum load and the maximum speed that it has been designed to safely withstand. Inherent in the speed rating is the minimum stroke. The viscosity of the oil will affect the buffer performance. The oil viscosity used during the type testing is required to be stated on the marking place.

The stroke of the buffer is necessary information for the inspector in determining compliance with 2.22. In some cases, when the buffer is fully compressed, there is still 25 mm or 1 in. to 100 mm or 4 in. of the plunger protruding from the body of the buffer, and therefore, the stroke cannot be readily measured.

The gas composition requirement for the marking plate in 2.22.4.11(f) is analogous to the buffer oil requirement specified in 2.22.4.11(a) and 2.22.4.11(c).

Requirement 2.22.4.11 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13 and remove language that is already addressed in the new section. See Handbook commentary on Section 8.13.

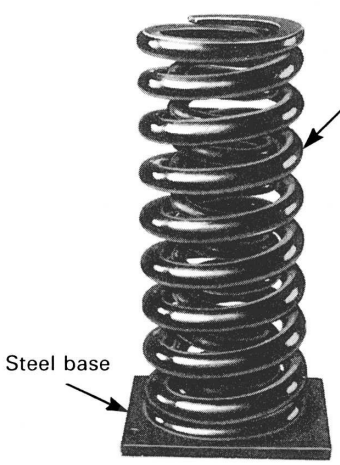
2.22.5 Elastomeric Buffers

This requirement was added in ASME A17.1-2016/CSA B44-16 to define performance, testing, and marking requirements as well as environmental limitations for elastomeric buffers. The buffer stroke is necessary to verify that top and bottom clearances for cars and counterweights comply with Sections 2.4 and 3.4.

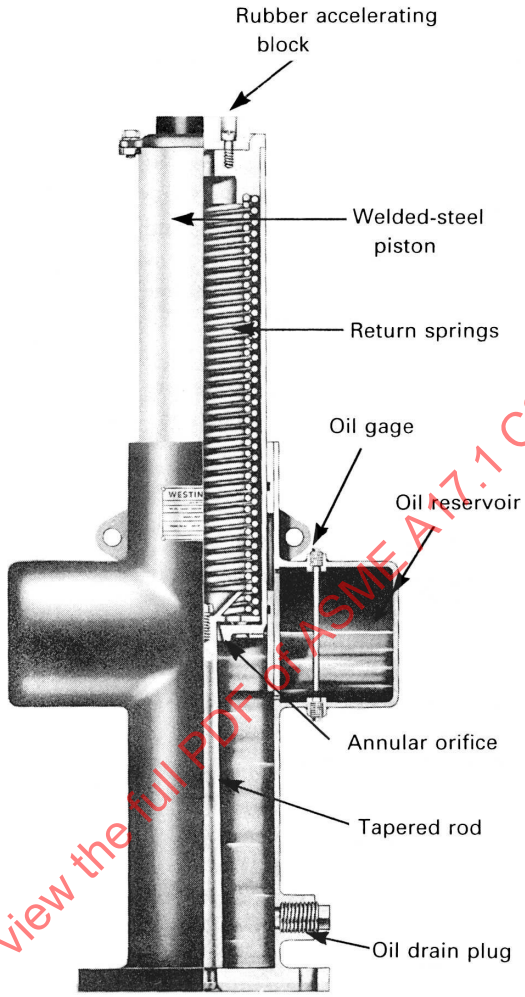
2.22.5.1 Retardation Requirement 2.22.5.1(c) was deleted in ASME A17.1-2019/CSA B44:19 because application of the elastomeric buffers has the same system speed limitation as that of the spring buffers. The requirement specified within subclause (c) has been determined via type testing (as required by ASME A17.1/CSA B44–2016) to have significant impact on the applicable load ranges for the current elastomeric buffers that have been used within North America for more than 15 years. The original objective was to codify the elastomeric buffers based on the decades of elevator industry experience that used this type of buffers both within North America and outside North American markets. It should be noted that the elastomeric buffers are required to comply with the retardation performance for empty car plus 70 kg (1 passenger representation) and full duty load. The elastomeric buffer retardation requirements of subclauses (a) and (b) are the same as those that have applied to oil buffers for decades.

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Diagram 2.22.1.1
Typical Spring and Oil Buffer



Typical Spring Buffer

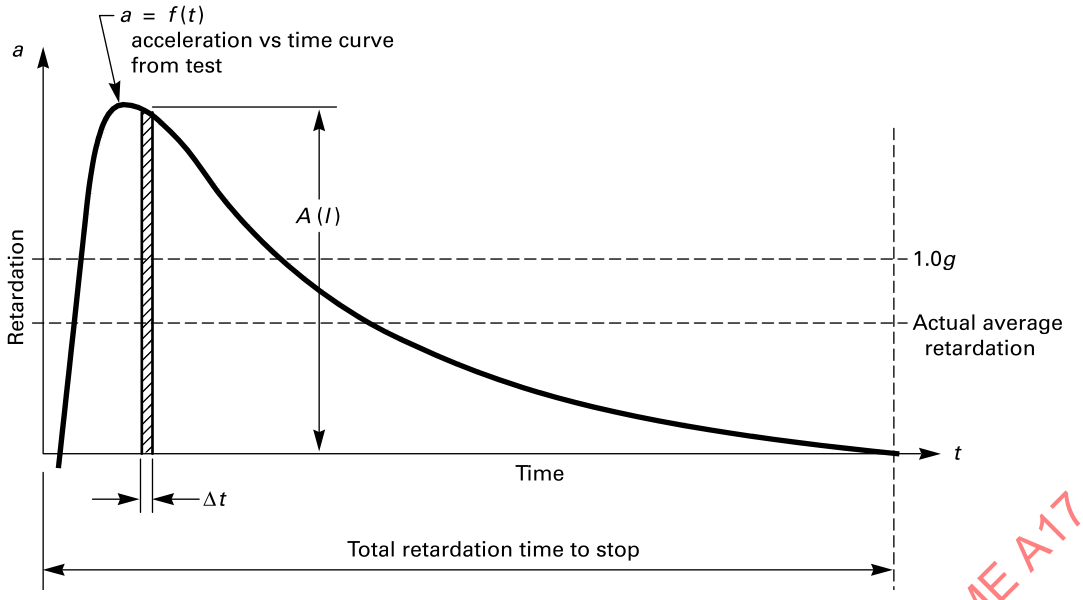


Typical Oil Buffer

GENERAL NOTE: Courtesy of Schindler Elevator Co.

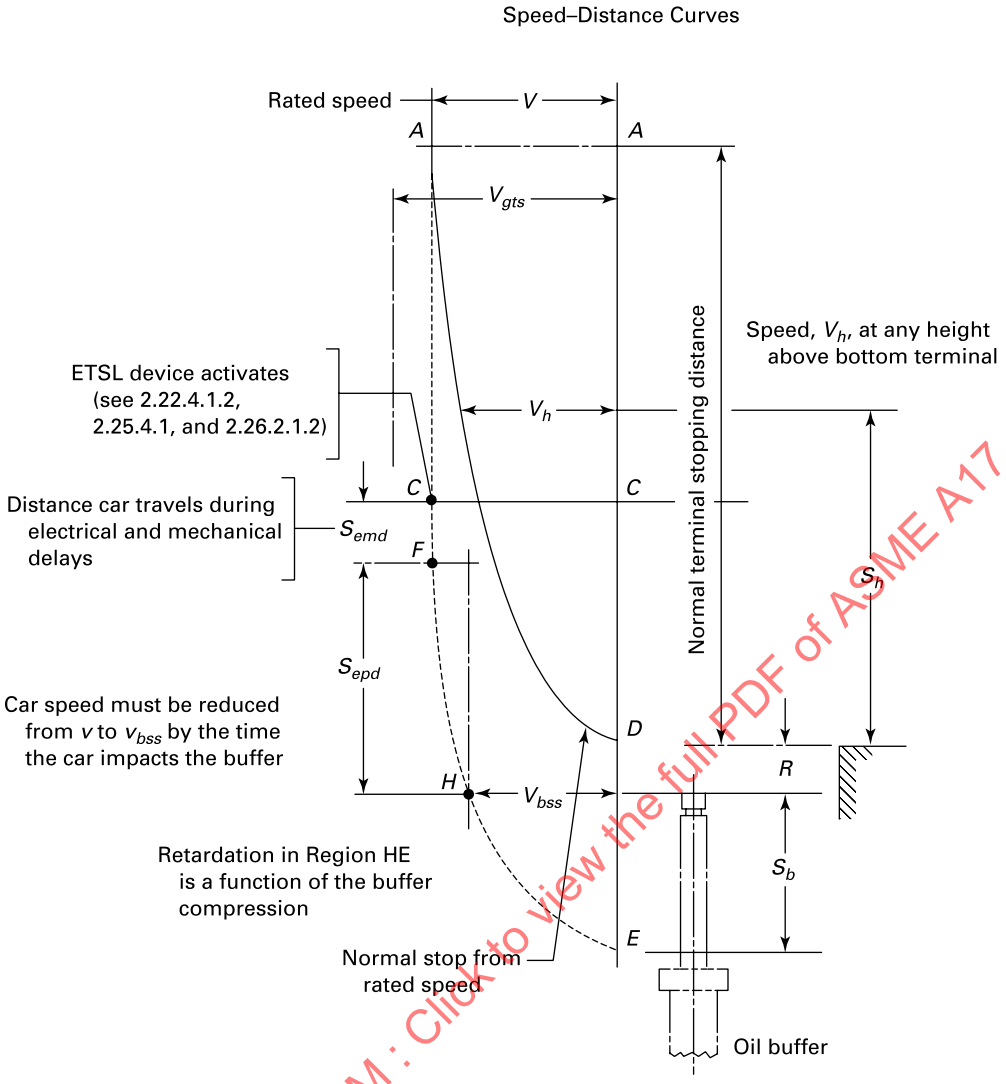
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Diagram 2.22.4
Oil Buffer Retardation Versus Time



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Diagram 2.22.4.1.2
Reduced Stroke Oil Buffers With Emergency Terminal Stopping Devices



GENERAL NOTE: Courtesy of George W. Gibson.

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SECTION 2.23
CAR AND COUNTERWEIGHT GUIDE RAILS, GUIDE-RAIL SUPPORTS, AND FASTENINGS

NOTE: The author expresses his appreciation to George W. Gibson for his extensive contributions to Section 2.23.

2.23.1 Guide Rails Required

Guide rails are machined guiding surfaces installed vertically in a hoistway, with the exception of inclined elevators (see Sections 5.1 and 5.4). They direct and restrain the course of travel of an elevator car or counterweight, when provided, within a predetermined path. They also provide the support for the car during safety application.

2.23.2 Material

This requirement applies to all load-bearing components of the guide-rail assembly. It does not apply to, nor does ASME A17.1/CSA B44 address, materials used for other minor components such as thin gauge kicker shims used for adjusting rails or brackets.

The term “select wood” means wood that is clear and knot free, with a straight, close grain structure, without any visible defects such as splits and checks. Wood types that comprise the “Select(ed)” category as defined in the wood technology field, would comply with this requirement.

2.23.2.2 Requirements for Metals Other Than Steel. Cast iron is an alloy of iron, carbon, and silicon that is cast in a mold and is hard, nonmalleable, and brittle. Being brittle, it will not withstand all the forces that could be applied to a guide rail during normal loading and running, and at safety application.

2.23.3 Rail Section

When carrying an eccentric load, the car is prevented from tilting by the guide shoes or rollers pressing on the rails. The rail acts as a beam supported by the brackets and must have sufficient strength to carry these forces and also sufficient stiffness to keep the front edge of the platform level with the landing as loads enter or leave the car.

The properties of the rail include the section modulus and moments of inertia about both axes. The section modulus is the parameter used to determine the strength of a structural component; the moment of inertia is the parameter used to assess the rigidity, or stiffness. It is used to determine the deflection of a structural component.

On passenger elevators where the eccentric loads are small, rail forces are not significant. However, on freight elevators with large eccentric loads, rail forces can be substantial. When an elevator or counterweight stops due to a safety application, guide rails act as columns and must be designed accordingly.

Shapes other than conventional T shape are allowed as long as they meet the requirements of 2.23.3. Examples of other shapes that have been used are round rails (see Diagram 2.23.3) and omega rails. Since round sections have uniform properties, they are ideally suited as columns. Round rail has been used on hydraulic elevators and counterweights where a safety would not be applied.

2.23.4 Maximum Load on Rails in Relation to the Bracket Spacing

2.23.4.1 With Single Car or Counterweight Safety. At safety application, the rail acts as a column. Cross-sectional areas must increase as the load increases. Weight per foot of a guide rail is directly proportional to the cross-sectional area. In addition to cross-sectional area, a column must be supported at certain intervals or it tends to buckle if the points of support are too far apart. The distance between the points of support to prevent buckling depends on the moment of inertia of the rail.

Horizontal forces, designated as R_1 in Diagram 2.23.5, are developed due to differences in retarding forces between safety components on opposite sides of the car. These differences naturally occur due to manufacturing tolerances on all the safety parts, coupled with the surface condition of the guide rails.

A safety application on a pair of rails also tends to spread the rails and thereby cause one of the safeties to pull away from the rail. If supports cannot be provided at sufficiently close intervals or if these supports become so numerous as to be impractical, the section of the rail must be reinforced between brackets. This is accomplished by means of channels or other structural sections fastened to the back of the rail. See Diagram 2.23.4.1.

While the strength and stiffness of the rail, with or without backing, is important, the strength and stiffness of the structure to which the rails are fastened is equally important. This may be brick or concrete walls, steel framing, or other means, depending on the building construction.

It frequently happens that the structural supports of the hoistway enclosure are a considerable distance from the desired location of the rail, in which case it may be necessary to provide columns of sufficient strength to resist bending as well as torsion due to the force on the side of the rail. This tends to twist the column with the torsional (twisting) moment.

Attendant to the general subject of guides and guide rails is the performance parameter referred to as car ride quality. This is one of the important criteria by which an elevator's performance is judged. The principal factors that influence car ride, are those that produce horizontal excitations (accelerations and retardations), that act upon the car, described as follows:

(a) Curvature and twist of the rails is caused by misalignment at installation or is due to building compression. Long, gentle curvatures to the rails occurring over several

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spans do not represent as big a problem as do distortions occurring in localized spans; however, it should be recognized that, in any case, when the deflection of the guide rail exceeds the available float embodied in the roller guide, an excitation will be imparted to the car.

(b) Being manufactured items, the rails are subject to tolerances, which may produce a step (displacement) due to this buildup of tolerances at the tongue and groove joint.

(c) Guide shoe forces due to any cause produce rail deflections whose magnitudes increase and decrease as a function of car position, which, in turn, is a function of the square of the car speed. These forces occur typically as a result of an eccentric live load in the car, which is the most frequent load condition that occurs due to the random manner in which passengers distribute themselves. In addition, unbalanced cars produce guide shoe forces at all positions in the hoistway. Evenly balanced cars also produce guide shoe forces as they move away from the center of their rise.

(d) Transverse rope vibrations included in the hoist ropes and/or compensating ropes caused by hitch points moving sideways cause a transverse excitation to the end of the ropes due to the horizontal deflection of the rails or by hoistway wind disturbances due to stack effects or building sway or due to rope oscillations acting on short rope lengths as the car approaches the upper terminal.

(e) The displacement of air around a single car produces forces against the side of the car. In the case of multiple cars, the turbulence produced by cars passing each other in adjacent common hoistways causes side loads on the cars which, in turn, set up horizontal forces. Unevenness in air pressure is produced by projections extending into the hoistway, which also produces horizontal forces on the car.

ASME A17.1/CSA B44 does not set a maximum spacing for rail brackets rather it specifies the maximum load on the rails in relation to bracket spacing. Bracket spacing is permitted to exceed those shown in ASME A17.1/CSA B44, Figures 2.23.4.1-1 and 2.23.4.1-2, subject to the requirements of 2.23.5 and the requirement that the rail deflection caused by the application of the safety, shall not exceed 6.4 mm or ¼ in. per rail.

The term "reinforcement" refers to structural additions to a member in order to increase those properties that increase rigidity, such as moment of inertia, section modulus, cross-sectional area, radius of gyration, etc. There are many types of reinforcement that are used in a safe and satisfactory guide-rail design.

This requirement and ASME A17.1/CSA B44, Figures 2.23.4.1-1 and 2.23.4.1-2 do not apply to a hydraulic elevator unless it is equipped with a safety.

2.23.5 Stresses and Deflections

This requirement also applies to hydraulic elevators with or without safeties. See Diagram 2.23.5.

2.23.5.3 Allowable Stress Due to Emergency Braking. This requirement provides criteria for the safe design of the respective components/structures subject to forces developed during the retardation phase of the emergency braking and all other applicable loading acting simultaneously, with factors of safety consistent with the types of equipment/structures involved.

2.23.8 Overall Length of Guide Rails

The extreme positions of travel are the highest and lowest positions that the car or counterweight could physically reach under any circumstance.

The compressed car buffers establish the lowest position. The highest position is dependent upon the type of elevator system involved. In the case of a traction elevator, the highest position would be a function of the counterweight buffer stroke of the descending mass and a function of the gravity stopping distance of the ascending mass. In the case of a winding-drum machine, the highest position would be the underside of the overhead structure. In the case of a hydraulic elevator, the highest position would be determined by the location of the plunger stops.

2.23.9 Guide-Rail Brackets and Building Supports

See Diagrams 2.23.9(a) and 2.23.9(b).

2.23.9.2 Bracket Fastenings. Lag bolts (screws) are an acceptable means of attaching guide-rail brackets to a wood building structure, provided the attachment complies with the stress and deflections specified in ASME A17.1/CSA B44.

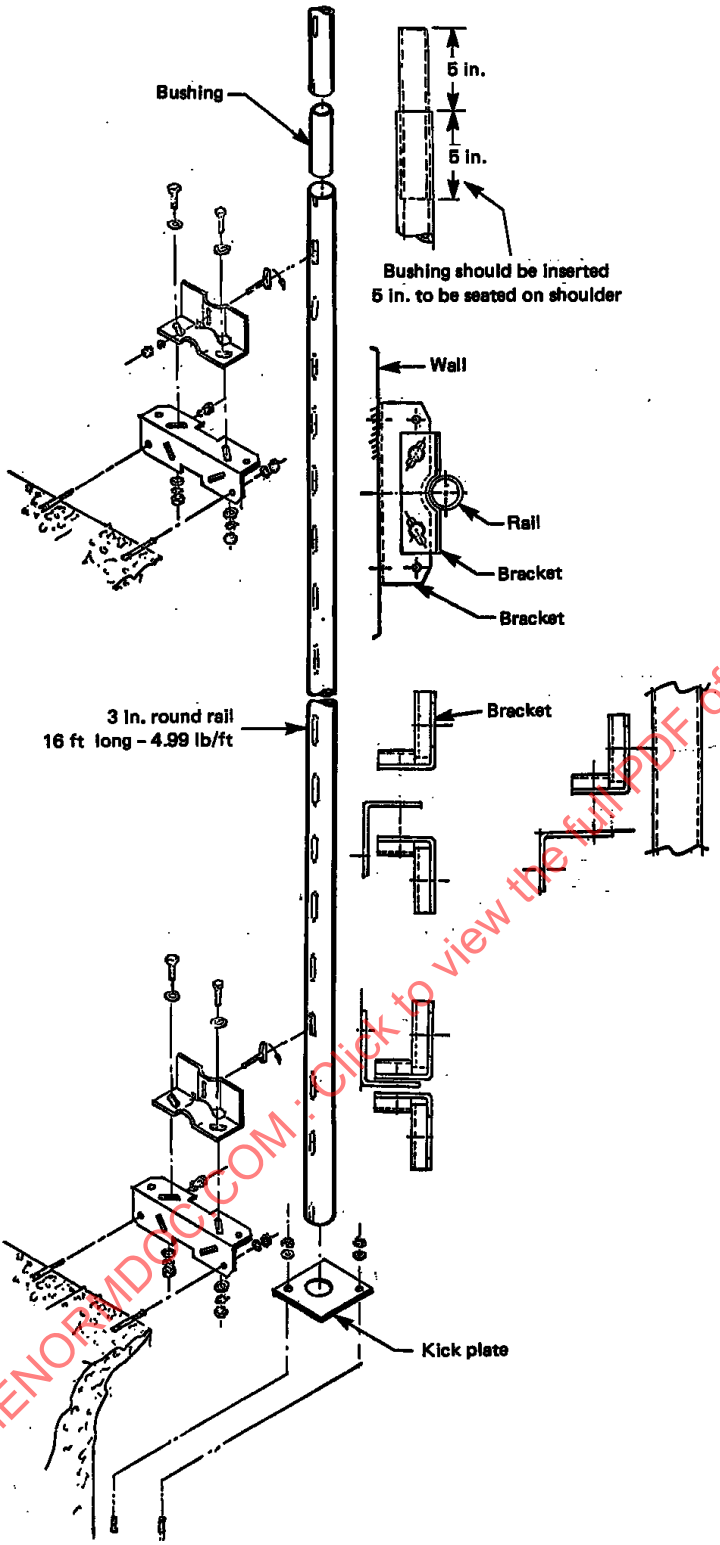
2.23.10 Fastening of Guide Rails to Rail Brackets

This requirement defines the type of fastenings that must be used and not the method in which they must be installed. Sound engineering practice requires the designer to arrange the fastenings between the guide rails and their brackets in such a manner as to effectively transfer the loads through the connections with the allowable stresses and deflections while maintaining the accuracy of rail alignment. The loads include those induced at loading, running, and safety application, and those caused by support movement, if applicable.

When guide rails are welded to their brackets, the welding procedure and design must comply with 8.8.2. Qualified welders are required to do the welding, which must be done in accordance with the requirements of the American Welding Society (see Section 8.8). The manufacturer may qualify the welder or, at his option, have the welder qualified by a professional engineer or recognized testing laboratory. The usual method of fastening guide rails to their brackets is with rail clips. Sliding rail clips are used to compensate for building compression. See Diagram 2.23.10.

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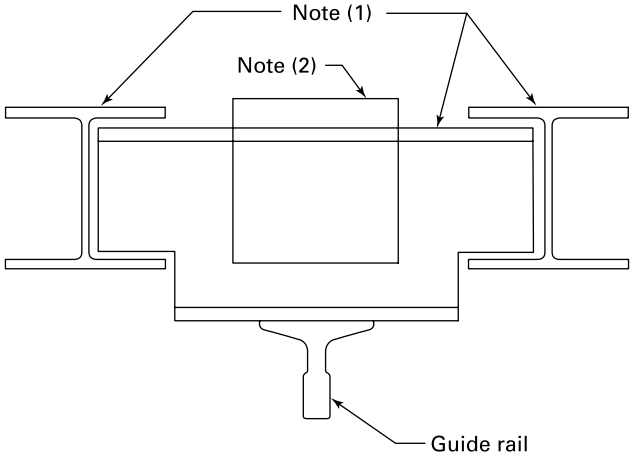
Diagram 2.23.3
Typical Round Rail Arrangement



GENERAL NOTE: Courtesy of Otis Elevator Co. and George W. Gibson.

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Diagram 2.23.4.1
Vertical Rail Column Supports

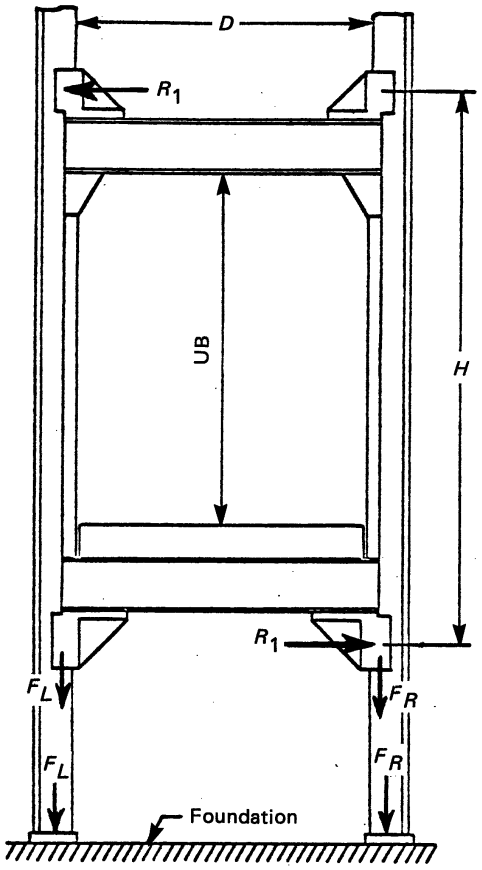


GENERAL NOTES:
(a) Courtesy of Building Transportation Standards and Guidelines, *NEII*®-1, © 2000–2022, National Elevator Industry, Inc., Centreville, VA
(b) Maximum deflection of rail column supports not to exceed 3 mm or $\frac{1}{8}$ in.

NOTES:
(1) Vertical rail column supports and cross-tie members are required and provided by other than the elevator supplier when rated load exceeds 3 500 kg or 8,000 lb. The size of the rail columns are determined by others from rail forces furnished by the elevator supplier.
(2) Alternate method of rail column support, as shown, by other than the elevator supplier when rated load is 3 500 kg or 8,000 lb or less. The size of the columns are determined by others from rail forces furnished by the elevator supplier.

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Diagram 2.23.5
Guide-Rail Forces at Safety Application



W = gross load to be stopped (lb) (car wgt. + live load)
a = retardation (ft/s^2)
F_L = stopping force – LH safety (lb)
F_R = stopping force – RH safety (lb)
k = percent load carried by RH safety

$$F_L + F_R = W\left(1 + \frac{a}{g}\right)$$

$$F_R = W\left(1 + \frac{a}{g}\right) k$$

$$F_L = W\left(1 + \frac{a}{g}\right)(1 - k)$$

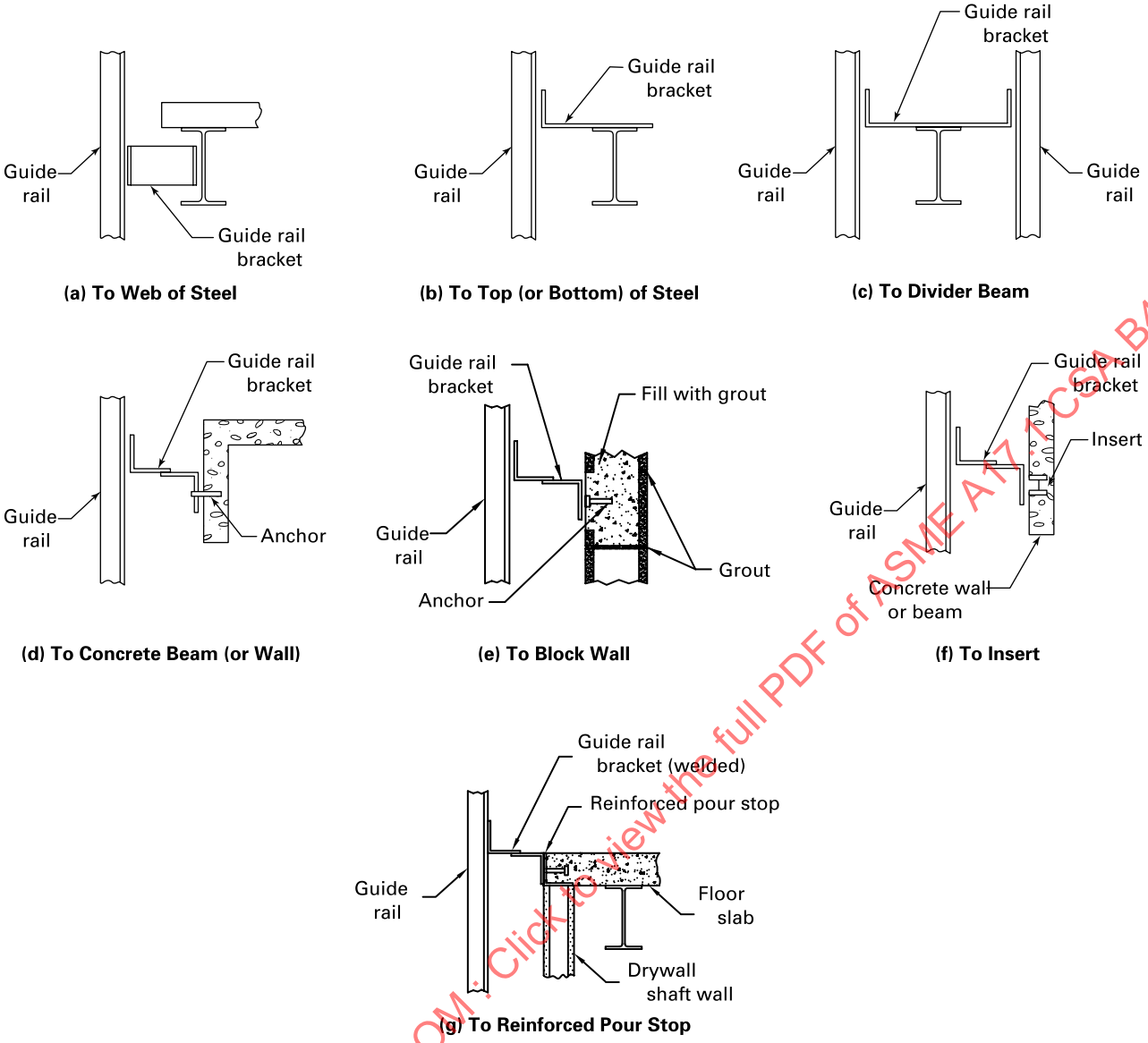
Guide Rail Force

$$R_1 = \frac{WD}{2H}\left(1 + \frac{a}{g}\right)(2k - 1)$$

GENERAL NOTE: Courtesy of Otis Elevator Co. and George W. Gibson.

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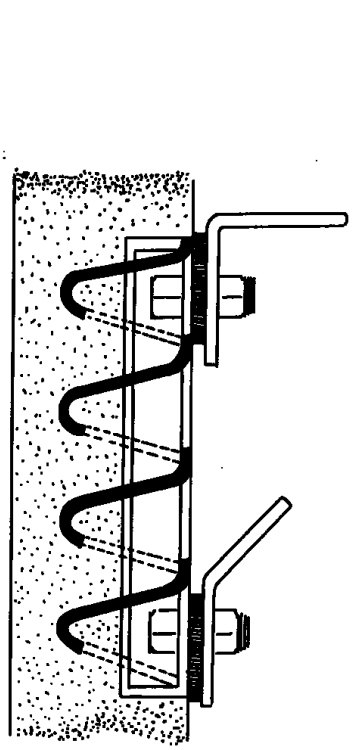
Diagram 2.23.9(a)
Guide-Rail Bracket Fastening Details



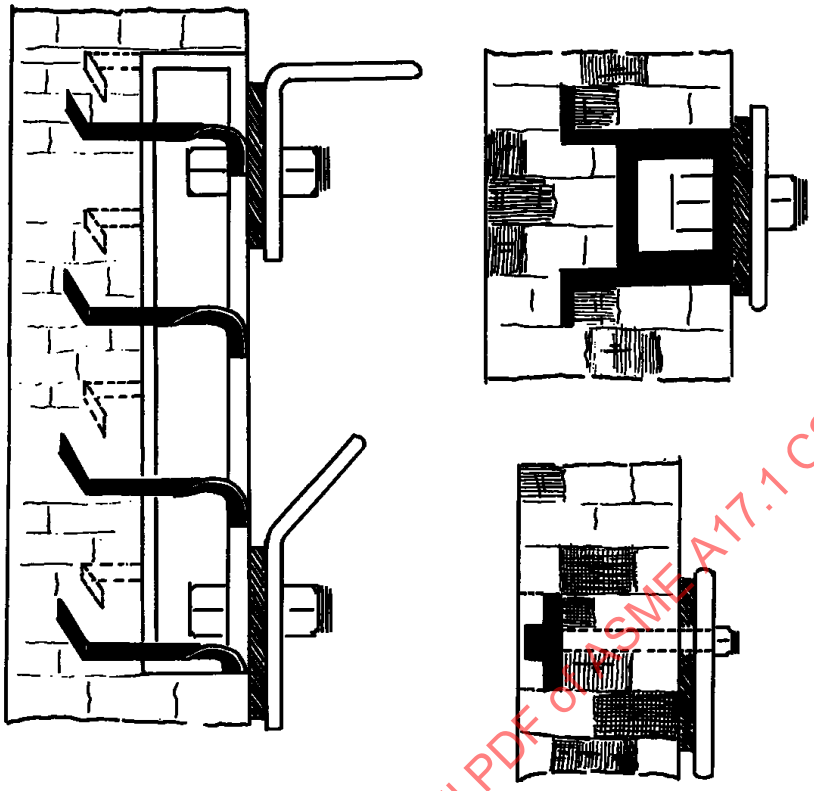
GENERAL NOTE: Courtesy of Building Transportation Standards and Guidelines, *NEII*®-1, © 2000–2022, National Elevator Industry, Inc., Centreville, VA.

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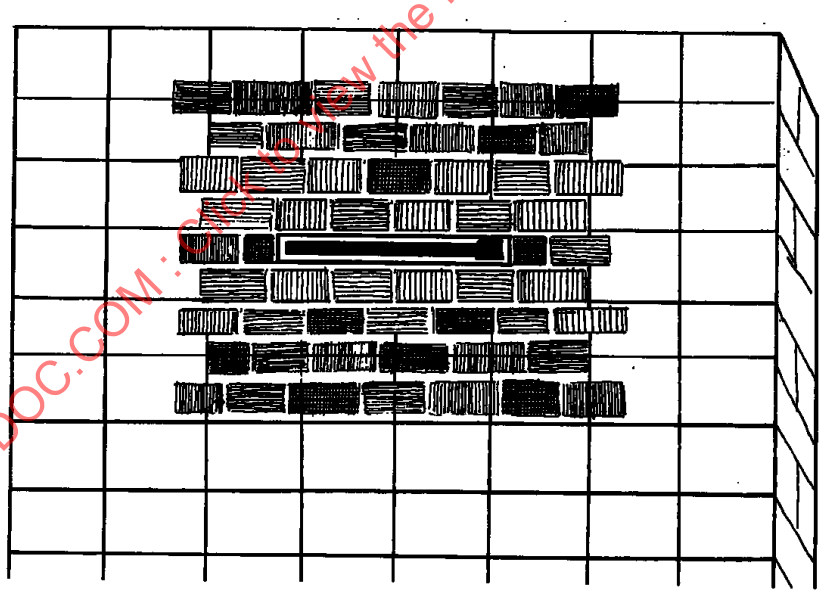
Diagram 2.23.9(b)
Typical Guide-Rail Bracket Inserts



Insert in a Concrete Wall



Brick Insert and Anchor

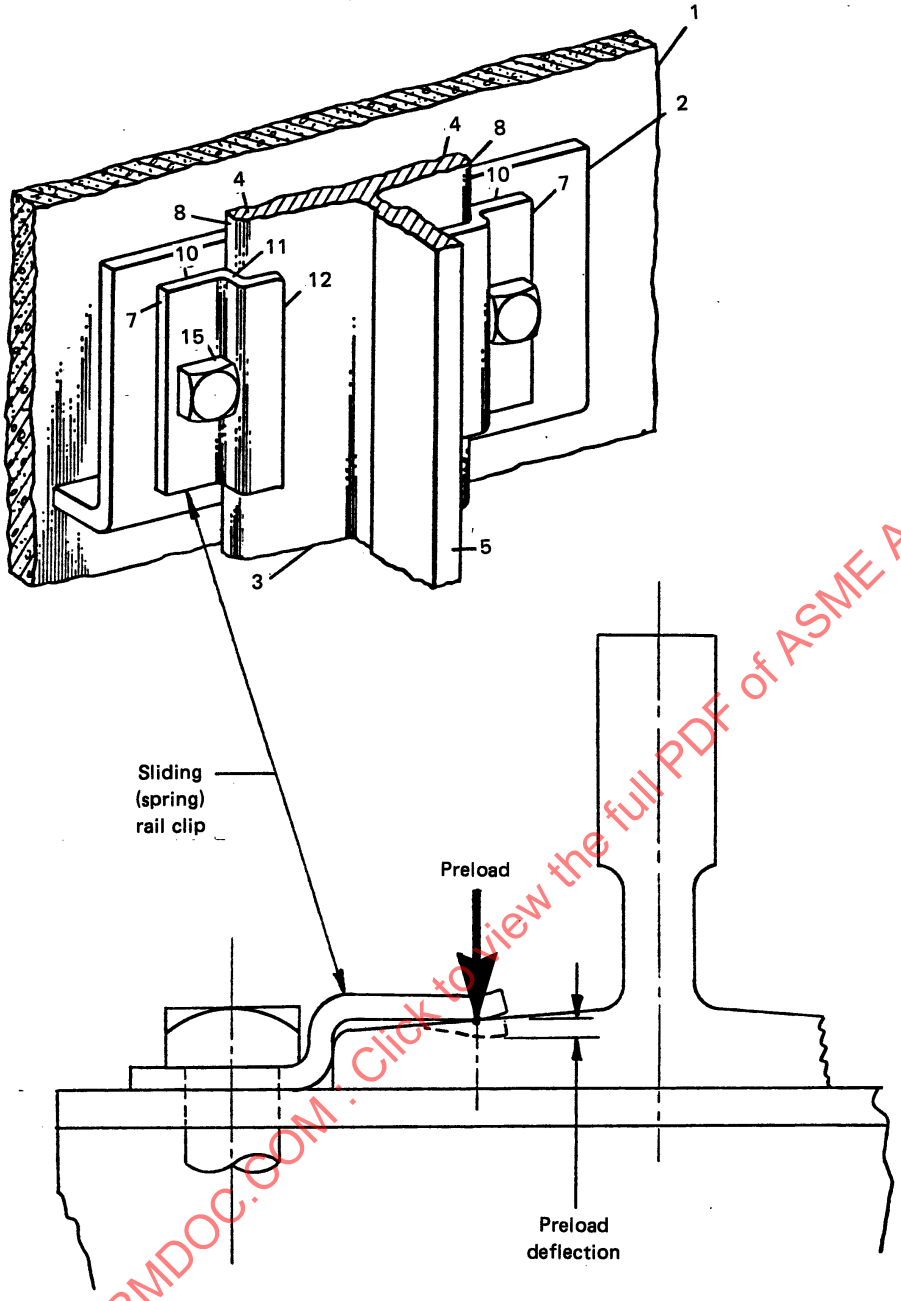


Brick Panel in Tile Wall for Bracket Support

GENERAL NOTE: Courtesy of National Elevator Industry Educational Program.

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Diagram 2.23.10
Typical Sliding Rail Clip



GENERAL NOTE: Courtesy of Otis Elevator Co. and George W. Gibson.

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SECTION 2.24
DRIVING MACHINES AND SHEAVES

NOTE: The author expresses his appreciation to George W. Gibson for his extensive contributions to Section 2.24.

2.24.1 Type of Driving Machines

A traction machine is an electric machine in which the tractive effort, or friction forces between the suspension (hoisting) rope and driving-machine sheave is used to move the elevator car and counterweight. A conventional worm and gear machine is shown in Diagram 2.24.1(a). This type of machine is between 65% and 80% efficient depending on the gear ratio, whereas the helical geared machine shown in Diagram 2.24.1(b) has approximately 90% to 95% efficiency. Helical geared machines tend to generate more noise than worm geared machine. Both types of geared machines are considered low-to-medium-speed machines. A high-speed gearless traction machine is illustrated in Diagram 2.24.1(c). A winding-drum machine is a gear-driven machine in which suspension ropes are fastened to and wind on a drum in order to move the car. See Diagram 2.24.1(d).

There was significant concern by the ASME A17 Committee over the inherent safety problems related to drum machine installations that predated A17.1-1955. There is no single written record that completely documents the Committee's deliberations on this subject more than 70 years ago; however, the following safety-related points guided the ASME A17 Committee in prohibiting the use of drum machines for passenger elevators due to a history of accidents.

The car or counterweight, where provided, could be pulled into the building overhead due to a failure of the normal and final terminal stopping devices, resulting in a breakage of the suspension ropes or rope shackles, thus dropping the car or counterweight. Counterweighted cars could hang up in the guide rails causing slack suspension ropes and a collision between the car counterweight and drum counterweight. Light duty drum machine elevators usually were arranged without a counterweight. On heavier duties, counterweighting was often provided to obtain economies of reduced machine size and reduced operating cost. The counterweighting was generally done in two ways, namely, by providing a drum counterweight or by providing both a drum counterweight and a car counterweight. The latter method reduced the total load on the drum machine. When used, both the drum and car counterweights would run in the same guide rails. The car counterweight suspension ropes terminated on the car. The counterweight had to weigh less than the empty car to permit acceleration and retardation under all conditions without slackening the suspension ropes. The weight of the car counterweight plus the weight of its ropes, in combination with the friction of the guide shoes and dry wooden guide rails, would produce too light a car condition, resulting in a hung-up car. This condition would cause slack ropes on the car side and the drum counterweight section would run into the stalled car counterweight section. This was the reason for disallowing counterweighted drum machine installations.

Upon release of the car safety, cars often fell taking up slack rope. While some manufacturers had various types of safeties, such as the roll type and flexible guide clamp, both of which were generally released after safety application by lifting the car, many early-type safeties were the drum-operating type or the block and tackle type wedge safety. These latter types produced slack suspension ropes at safety application. To release these types of safeties, the mechanic would have to get inside the car and reset them through a hole in the car platform floor. On many occasions, the mechanic would forget to first take up the slack in the ropes before getting on the car and releasing the safety. When the mechanic did release the safety, the car would free fall 1.5 m or 5 ft to 1.8 m or 6 ft, resulting in broken legs or other serious injuries.

There were numerous injuries to elevator personnel while they were trying to take up the slack in the suspension ropes. The ropes have to be manually reseated back into their proper drum grooves. The mechanics and inspectors would reach out to help guide the ropes into their grooves while the drum was rotating, which frequently resulted in the amputation of fingers and hands.

Rope damage occurred due to slack ropes running over themselves as they wind on the drum because of the fleet angle generated as the ropes enter or leave the drum.

Suspension ropes frequently broke due to fatigue of the rope at its termination on the car or counterweight hitch. The suspension ropes will be vertical in one position of car travel. For all other positions, there will be a side pull on the rope that fatigues the section of rope at its entry to its termination, necessitating periodic reshackling unless auxiliary rope fastenings are provided. In addition, the ropes tend to twist as they are loaded and unloaded, thus imposing a rope torsion on the rope sections already under fatigue by side forces. Failure of the ropes at the drum clamp was occasionally cited, but this was less prevalent because of the reserve or spare turns of rope provided on the drum.

The chances of dropping an elevator because of worn or corroded ropes increased because the number of suspension ropes was limited to one or two to keep the drum size within reasonable limits. The limited number of suspension ropes, caused excessive car bounce at starting and stopping.

Because it was necessary to have access to the rope termination or clamp inside the drum, the drum embodied a spoke construction at its ends. Drum spokes often fractured.

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In an effort to overcome some of the above problems, ASME A17.1/CSA B44 introduced certain safety features as follows:

(a) A final stop motion device, also known as a "machine automatic," or "machine limit," which is a mechanical device incorporated with the drum machine, mechanically monitored the position of the suspension ropes on the drum in order to prevent the car or counterweight, where provided, from being pulled into the building overhead. This device was arranged with mainline contacts. The operation of these contacts at either terminal opens the mainline circuits to the motor and brake and stops the car from full speed within the top and bottom overtravel.

(b) A slack rope switch monitors the suspension ropes to detect whether the suspension ropes slacken and, if so, stop the machine.

(c) A potential switch was arranged with the power contacts located in the main power lines to the drive motor and the control circuits. Its purpose was to remove all power from the drive motor and control circuits when activated by either the slack cable device or the final contact in the machine automatic.

Even with these safety features, the basic safety to the riding public as well as to personnel responsible for servicing and inspecting drum machine installations could not be ensured, and most of the hazards described above continued, as did the record of accidents.

At the September 18, 1940, meeting of the ASME A17 Executive Committee, the following motion was passed: "Voted that the next edition of the Code shall prohibit drum type machines except for certain specified uses."

The ASME A17 Committee approved a proposal by the elevator manufacturers that disallowed the use of drum machines for elevators except uncounterweighted, freight elevators with rise less than 12.5 m or 40 ft and car speed not exceeding 0.25 m/s or 50 ft/min. This change appeared in the 1955 edition of ASME A17.1 and has continued unchanged since that time.

2.24.2 Sheaves and Drums

2.24.2.1 Material and Grooving. Sheaves used with suspension and compensating members are required to be constructed of materials conforming to 2.24.2.1.1 and provided with finished grooves to eliminate excessive wear on the suspension members, or are permitted to be lined with nonmetallic groove material. Liners may be installed to increase traction and to prolong the life of the ropes. See Diagram 2.24.2. Drums must comply with 2.24.2.1.2. Sheaves and drums must comply with 2.24.3 for the factors of safety.

2.24.2.1.1 Sheaves. Driving machine sheaves must be integral with or directly attached to driving-machine shafts. Sheaves must be provided with steel shafts and metal bearings. Sheaves constructed of plastic, fiber reinforced plastic, or combinations thereof must be nonregroovable. Where nonmetallic sheaves are used, permanent and legible marking must be provided on or adjacent to the nonmetallic sheaves stating, "Regrooving of sheave is not permitted."

2.24.2.2 Minimum Pitch Diameter. The pitch diameter is regulated to ensure that the ropes do not have too sharp a bend, which in turn would reduce their life expectancy.

2.24.2.3 Traction. There are no requirements establishing a maximum permissible amount of slippage of the suspension members since there is no way to establish such a limitation that would be suitable for all designs, capacities, and speeds of elevators. Some suspension member movement relative to the drive sheaves is normal for all traction elevators and typically manifests itself as creep.

Creep is a slight incremental, natural movement of the suspension members over their arc of contact with a driving sheave due to the tractive force (i.e., unequal tensions in the suspension means at the points of entry and exit from the driving sheave, their tensile elasticity, and friction work, occurring in the direction of greater tension. Creep is independent of the direction of rotation of the driving sheave. It exists in all traction systems and is not to be confused with the loss of traction.

Requirement 2.24.2.3.1 provides the traction requirements for steel wire ropes, 2.24.2.3.2 provides requirements for aramid fiber ropes, and 2.24.2.3.3 provides requirements for noncircular elastomeric-coated steel suspension members.

Traction loss occurs when the required traction exceeds the available traction. Ability to lose traction in the event of either a car or counterweight over-traveling at the lower terminals and compressing its buffer is a fundamental safety characteristic of traction elevators. Of course, excessive slippage can result in accelerated sheave wear and other problems. ASME A17.2, Guide for Inspection of Elevators, Escalators, and Moving Walks, mentions slippage but, like ASME A17.1/CSA B44, does not provide specific guidance to quantify an acceptable amount.

The following analysis documents one method of determining available traction developed in a drive sheave by considering the oscillation frequency of a suspended mass. It is applicable to traction systems arranged with steel wire ropes.

Consider the simple spring-mass system shown in Diagram 2.24.2.3(a), consisting of a mass, M, spring with constant, k, and a drive sheave.

The drive sheave will be rotated in each direction and the resulting motions studied. Let Q = available traction.

(a) *Case 1 — Counterclockwise Rotation.* The free-body diagrams of each element in the system are shown in Diagram 2.24.2.3(b).

δ_o = static deflection of spring to support static load = $r\theta_o$

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δ = deflection of spring due to moving system = $r\theta$
r = drive sheave radius
k = spring constant of spring
α = angular acceleration

For the weight, ($\Sigma V = 0$). Therefore

(Imperial Units)

$$T_m = W\left(1 - \frac{a}{g}\right) = W\left(1 - \frac{r}{g}\alpha\right) \quad (1)$$

When the rope is slipping, the ratio of tensions in the ropes is equal to available traction. This is expressed as, $T_s/T_m = Q$, from which

(Imperial Units)

$$T_s = QT_m \quad (2)$$

The load acting on the spring is

(Imperial Units)

$$T_s = k(\delta_o + \delta) \quad (3)$$

Equating (2) to (3) and substituting the angular relationships yields

(Imperial Units)

$$T_m = \frac{kr}{Q}(\theta_o + \theta) \quad (4)$$

Equating (1) to (4) and substituting $\alpha = d^2\theta/dt^2$ in eq. (1) yields

(Imperial Units)

$$\frac{Wr}{g}\left(\frac{d^2\theta}{dt^2}\right) + \frac{kr\theta}{Q} + \frac{kr\theta_o}{Q} - W = 0 \quad (5)$$

In the static equilibrium position, eq. (1) becomes

(Imperial Units)

$$T_m = W \quad (6)$$

and eq. (4) becomes

(Imperial Units)

$$T_m = \frac{kr\theta_o}{Q} \quad (7)$$

Equating (6) to (7) yields

(Imperial Units)

$$W = \frac{kr\theta_o}{Q} \quad (8)$$

Substituting eqs. (8) and (5) yields

(Imperial Units)

$$\frac{d^2\theta}{dt^2} + \frac{k/Q}{W/g}\theta = 0 \quad (9)$$

Equation (9) has the general simple harmonic motion form

(Imperial Units)

$$\frac{d^2\theta}{dt^2} + p^2\theta = 0 \quad (10)$$

where

(Imperial Units)

$$p^2 = \frac{k/Q}{W/g} \quad (11)$$

therefore

(Imperial Units)

$$p = \sqrt{\frac{k/Q}{W/g}} = \sqrt{\frac{k}{QM}} \quad (12)$$

The frequency, f_1, equals

(Imperial Units)

$$f_1 = p/2\pi = \frac{1}{2\pi}\sqrt{\frac{k}{QM}}\ (\text{cps}) \quad (13)$$

The circular frequency, ω_1, equals

(Imperial Units)

$$w_1 = 2\pi f_1 = p = \sqrt{\frac{k}{QM}}\ (\text{rad/s}) \quad (14)$$

(b) Case 2 — Clockwise Rotation. The free-body diagrams of each element are shown in Diagram 2.24.2.3(c).

For the weight, ($\Sigma V = 0$). Therefore

(Imperial Units)

$$T_m = W(1 + a/g) = W(1 + \frac{r}{g}\alpha) \quad (15)$$

When the rope is slipping, the ratio, $T_m/T_s = Q$, from which

(Imperial Units)

$$T_s = T_m/Q \quad (16)$$

The load acting on the spring is

(Imperial Units)

$$T_s = k(\delta_o - \delta) \quad (17)$$

Equating (16) to (17) and substituting the angular relationships yields

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(Imperial Units)

$$T_m = Qkr(\theta_o - \theta) \tag{18}$$

Equating (15) to (18) and substituting $\alpha = d^2\theta/dt^2$ in (15) yields

(Imperial Units)

$$\frac{Wr}{g}\left(\frac{d^2\theta}{dt^2}\right) + Qkr\theta + W - Qkr\theta_o = 0 \tag{19}$$

Noting again that, in the static equilibrium position, eq. (15) becomes

(Imperial Units)

$$T_m = W \tag{20}$$

and eq. (18) becomes

(Imperial Units)

$$T_m = Qkr\theta_o \tag{21}$$

Equating (20) to (21) yields

(Imperial Units)

$$W = Qkr\theta_o \tag{22}$$

Substituting (22) in (19) yields

(Imperial Units)

$$\frac{d^2\theta}{dt^2} + \frac{Qk}{W/g}\theta = 0 \tag{23}$$

Equation (23) has the same form as the simple harmonic motion equation given by (10), i.e.,

(Imperial Units)

$$\frac{d^2\theta}{dt^2} + p^2\theta = 0$$

where

(Imperial Units)

$$p^2 = \frac{Qk}{W/g} \tag{24}$$

therefore

(Imperial Units)

$$p = \sqrt{\frac{Qk}{W/g}} = \sqrt{\frac{Qk}{M}} \tag{25}$$

The frequency, f_2, equals

(Imperial Units)

$$f_2 = p/2\pi = \frac{1}{2\pi}\sqrt{\frac{QK}{M}}\ (\text{cps}) \tag{26}$$

The circular frequency, ω_2, equals

(Imperial Units)

$$w_2 = 2\pi f_2 = p = \sqrt{\frac{Qk}{M}}\ (\text{rad/s}) \tag{27}$$

Taking the ratio of circular frequencies, ω_2/ω_1, equals

(Imperial Units)

$$\frac{w_2}{w_1} = \sqrt{\frac{Qk/M}{k/QM}} = \sqrt{Q^2} \tag{28}$$

from which the available traction

(Imperial Units)

$$Q = \frac{w_2}{w_1} \tag{29}$$

The preceding equation can be applied to actual measurements taken in an elevator system by locking one mass in place, say, the counterweight, driving the drive sheave in one direction, then the other, and measuring the frequency of the car, i.e., time period for car to move from one extreme to another. See Diagram 2.24.2.3(d).

It is not necessary to remove power from the driving-machine motor and brake in order to comply with 2.24.2.3.4(b). Stalling of the driving machine can be achieved without disconnecting power to the driving-machine motor and brake. The motor current can be controlled to limit the torque output to a level where the motor will stall, i.e., not be able to raise the empty car weight or the counterweight into the overhead.

During a category 5 safety test, or during acceptance testing, it is permitted for either the drive to stall or the suspension means to lose traction.

It is not necessary to refer to 2.26.3 (contactors) and 2.26.4.3 (contacts) because no electromechanical disconnecting means is required in order to stall the driving machine. The occurrence of a single ground or a software system failure is only required to not affect those items in 2.26.9.3.1(a) through 2.26.9.3.1(e). Stalling of the driving machine is not one of the items considered in 2.26.9.3.

Requirement 2.24.2.3.5 was added in ASME A17.1-2019/CSA B44:19 to add a requirement to provide a data plate displaying the acceptable percent counterweight overbalance range. The percent counterweight overbalance is the percent of the elevator's rated capacity that the counterweight is heavier than the car. Correct counterweight overbalance has an impact on safe elevator operation by ensuring that traction is not lost. This information will also be useful to convey safe overbalance

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limits if the elevator weight is changed/altered at a future date.

2.24.2.4 Minimum Sheave and Drum Diameter. The minimum depth of metal at the bottom of the drive sheave groove is the numerical value established by the designer of the sheave based on compliance with the minimum factor of safety for a specific sheave material specified in 2.24.3. Other design criteria may also be used to establish this minimum depth. This requirement applies only to drive sheaves.

ASME A17.1/CSA B44 does not require that sheaves be manufactured to allow regrooving. The number of permissible regroovings would relate to the minimum groove bottom diameter established by the sheave designer and the amount of material removed by each successive regrooving. If regrooving of the drive sheave is done multiple times without regard to the thickness of the remaining metal between the bottom of the finished grooves and the rim of the sheave, the sheave rim might become weakened and no longer comply with the factor of safety requirements of 2.24.3.

2.24.3 Factor of Safety for Driving Machines, Sheaves, and Drums

The factor of safety referenced, applies to the ultimate strength of the materials for stress calculations. The factor of safety relates to all the machine components subject to load including the motor, brake, driving sheave, deflector and secondary sheaves, gearing, shafting, etc. The high factor of safety is intended to account for impact, stress concentrations, and stress reversals that cause fatigue. In all cases, however, the responsibility of the designer goes beyond the simple application of a minimum allowable factor of safety. It is necessary to consider the application, shock loading, fatigue service, manufacturing variations, and the possibility of overloading, to ensure that the equipment will provide reliable and safe operation throughout its life. Factor of safety requirements were added in ASME A17.1-2010/CSA B44-10 for sheaves using plastic, fiber-reinforced plastic, or combinations of these.

The method of computation of the resultant sheave shaft load is addressed in 2.24.3.1.2. The magnitude of this resultant load is a function of the geometric relationship of the machine drive sheave and deflector/secondary sheave, the respective sheave diameters, the number of rope wraps around the sheaves, and the areas of contact.

Requirement 2.24.3 was revised in ASME A17.1-2022/CSA B44:22 to require brake components to conform to the same factors of safety as driving machines.

2.24.3.2 Factors of Safety at Emergency Braking. The requirement provides criteria for the safe design of the respective components/structures subject to forces developed during the retardation phase of the emergency braking and all other applicable loading acting simultaneously with factors of safety consistent with the types of equipment structures involved.

2.24.4 Fasteners and Connections Transmitting Load

The bolt or other member when in place should be so tight that there will be no relative motion between the bolt and the involved member when the driving machine is operated. There is no requirement in ASME A17.1/CSA B44 for shrink-fitting all members that are connected together to transmit torque. Neither is it the practice of all manufacturers to always use a shrink-fit for such connections.

The Code requirement recognizes that good engineering practice would ensure that when transmitting torque, all fasteners share load uniformly, or alternatively, the connection is designed to have enough friction between the clamped surfaces generated by the fasteners.

2.24.4.1 Fasteners and Rigid Connections. This requirement was revised in ASME A17.1-2013/CSA B44-13 to ensure that when transmitting torque, all bolts share load, or alternatively, the connection is designed to have enough friction between the clamped surfaces generated by the fasteners.

2.24.6 Cast-Iron Worms and Worm Gears

The use of cast iron is prohibited for worms and worm gears as it is a commercial alloy of iron, carbon, and silicon that is hard, brittle, and nonmalleable, which thus has a tendency to break easily.

2.24.8 Braking System and Driving-Machine Brakes (See Diagram 2.19.1)

Machine brake system requirements were completely revised in ASME A17.1-2000 and CSA B44-00, and in concurrence with introduction of ascending car/overspeed and unintended car movement protection (see Section 2.19). Prior to ASME A17.1-2000 and CSA B44-00, there was no requirement for the driving-machine brake to have the capability to decelerate the car to buffer striking speed. The brake is also required to hold the car at rest with rated load or 125% of rated load for passenger elevators and freight elevators permitted to carry passengers (see 2.16.8) and 100% of rated load for freight elevators. See Diagram 2.24.8 and Chart 2.24.8.

The maximum retardation limit, $a \leq 1.0\ g$, that a braking system can cause is cited directly in the requirements cited in Chart 2.24.8. Minimum retardation is not specified directly with a value, but is inferred in the following text in ASME A17.1/CSA B44 requirements: "Any deceleration not exceeding 9.8 m/s^2 or 32.2 ft/sec^2 is acceptable provided that all factors, such as, but not limited to,

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system heat dissipation and allowable buffer striking speeds are considered."

Kinetic coefficient of friction between the brake lining, whether drum or disc type, is dependent upon the pressure, temperature, and relative speeds of the contact surfaces. The effects of temperature and the heat dissipation afforded by the design of the brake components, will influence the effectiveness of the brakes as they become heated. Reduction in braking effectiveness is called brake fade. Therefore, the designer must account for these effects in the design of the brake components.

Regardless of car loading, or direction of car motion, the braking system must have sufficient capacity, even in the case of loss of main line power, to retard the descending mass (car or counterweight) to a maximum speed for which the respective pit oil buffer is designed and certified [see 8.3.2.6.2(a)].

Where full stroke oil buffers are provided (see 2.22.4.1.1), the maximum speed at which the governor overspeed switch can be set is approximately equal to the rated buffer striking speed (i.e., $v_{\text{gosmax}} \approx v_{bss}$), as seen in Tables 2.18.2.1 and 2.22.4.1. Therefore, it is only necessary that the braking system produce any retardation greater than zero, so as to prevent the descending mass (car or counterweight) from increasing its speed beyond the rated buffer striking speed.

However, where reduced stoke oil buffers are used (see 2.22.4.1.2), the braking must retard the descending mass to a value not exceeding the reduced buffer stroke rating. Since braking retardation must reduce speed of a descending mass (car or counterweight) to a lower value over a finite distance, required braking capacity will be greater when using reduced stroke oil buffers than when using full stroke buffers. If a descending mass strikes a buffer at a speed within the buffer rating, then the descending mass will be retarded on the buffer at a retardation not exceeding $1.0g$ (i.e., $a \leq 1.0g$), which is permitted by 2.22.4.1.1.

2.24.8.3 Driving-Machine Brake. Requirement 2.24.8.3 was revised in ASME A17.1-2022/CSA B44:22 to require brake components to conform to the same factors of safety as driving machines.

2.24.8.4 Means for Manual Release. A manual brake release is not required by ASME A17.1/CSA B44, but is permitted. Performance requirements allow for the use of manual brake release tools. These requirements apply only if a manual brake release is provided. If provided, provisions must be made to prevent accidental activation.

2.24.8.5 Marking Plates for Brakes. The plate contains vital information required to maintain brakes in safe operating condition.

Requirement 2.24.8.5 was revised in ASME A17.1-2019/CSA B44:19 to reference new Section 8.13 and remove language that is already addressed in the new section. See Handbook commentary on Section 8.13.

Requirement 2.24.8.5 was revised in ASME A17.1-2022/CSA B44:22 to require the driving-machine brake data and marking plate to address adjustable and nonadjustable brakes and to align with 8.6.4.6.2. The revision also added classifications for adjustable brakes and nonadjustable brakes as well as different methods of sealing adjustable and nonadjustable brakes.

2.24.8.6 Driving-Machine Brake Design. The contact area between the brake and drum determines the ability of the brake to absorb energy and, therefore, affect the stopping capacity of the brake. See Diagram 2.24.8.6.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to replace "good engineering practice" with "sound engineering practice." See Handbook commentary on 2.15.6.3.

2.24.8.7 Identification, Classification, and Seals on Driving-Machine Brakes. Requirement 2.24.8.7, including subsections, was added in ASME A17.1-2022/CSA B44:22 to require the driving-machine brake data and marking plate to address adjustable and nonadjustable brakes and to align with 8.6.4.6.2. The revision also added classifications for adjustable brakes and nonadjustable brakes as well as different methods of sealing adjustable and nonadjustable brakes.

2.24.9 Indirect Driving Machines

These design requirements ensure that belt and chain driving machines provide equivalent safety to that which is provided by the other types of driving machines permitted by ASME A17.1/CSA B44.

Requirement 2.24.9 was revised in ASME A17.1-2019/CSA B44:19 to correct an out-of-date reference.

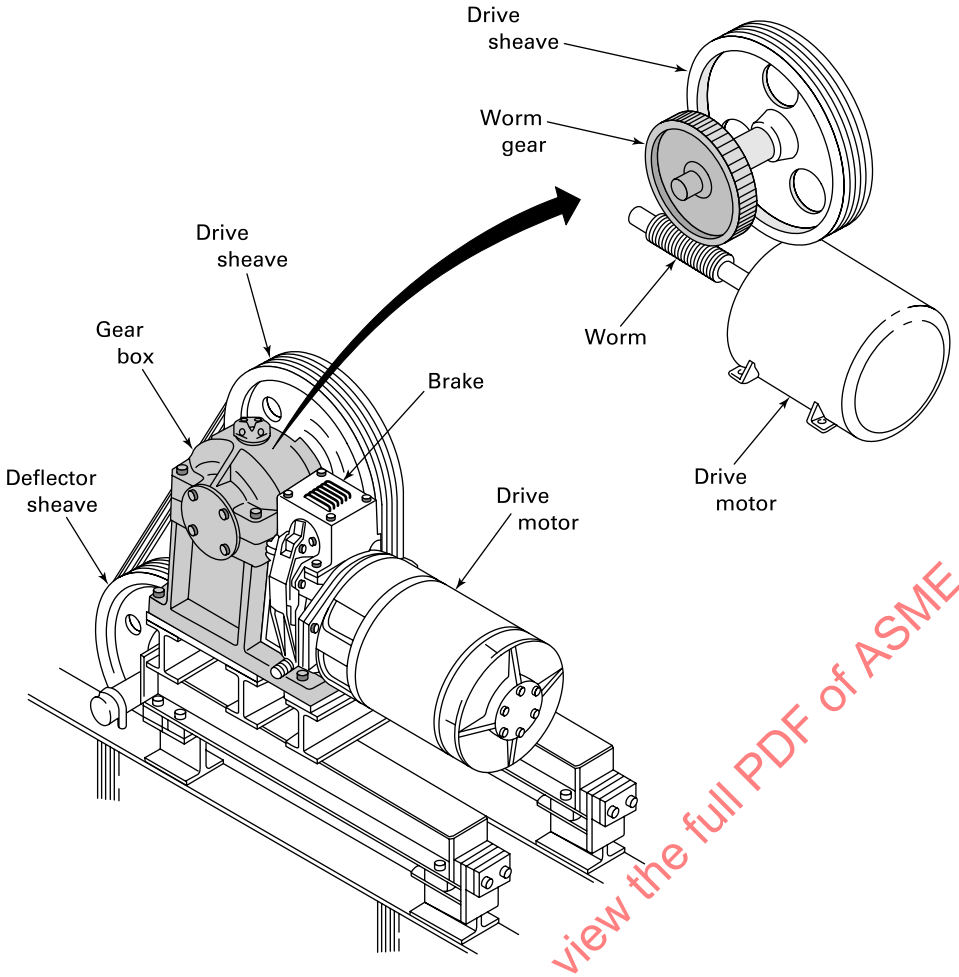
2.24.10 Means for Inspection of Gears

Means of access to geared machines in order that vital components may be visually inspected is very helpful. This is particularly valid for worm-geared machines where the gear is usually manufactured from nonferrous materials, such as bronze, and the worm shaft is steel. Early warning of impending failure can be obtained by inspecting the contact surfaces of such worm wheels. With helical gear machines and similar devices, the gears are usually less likely to show visible degradation before failure; however, even in these cases it can be useful to have some means of inspection of the gearing and lubricant.

With modern inspection probes, such as borescopes, it is not necessary that the inspection access provide direct visual access to all contact or wear surfaces. However, it is helpful if access is provided such that surfaces not directly visible may still be inspected if desired with instruments, such as borescopes.

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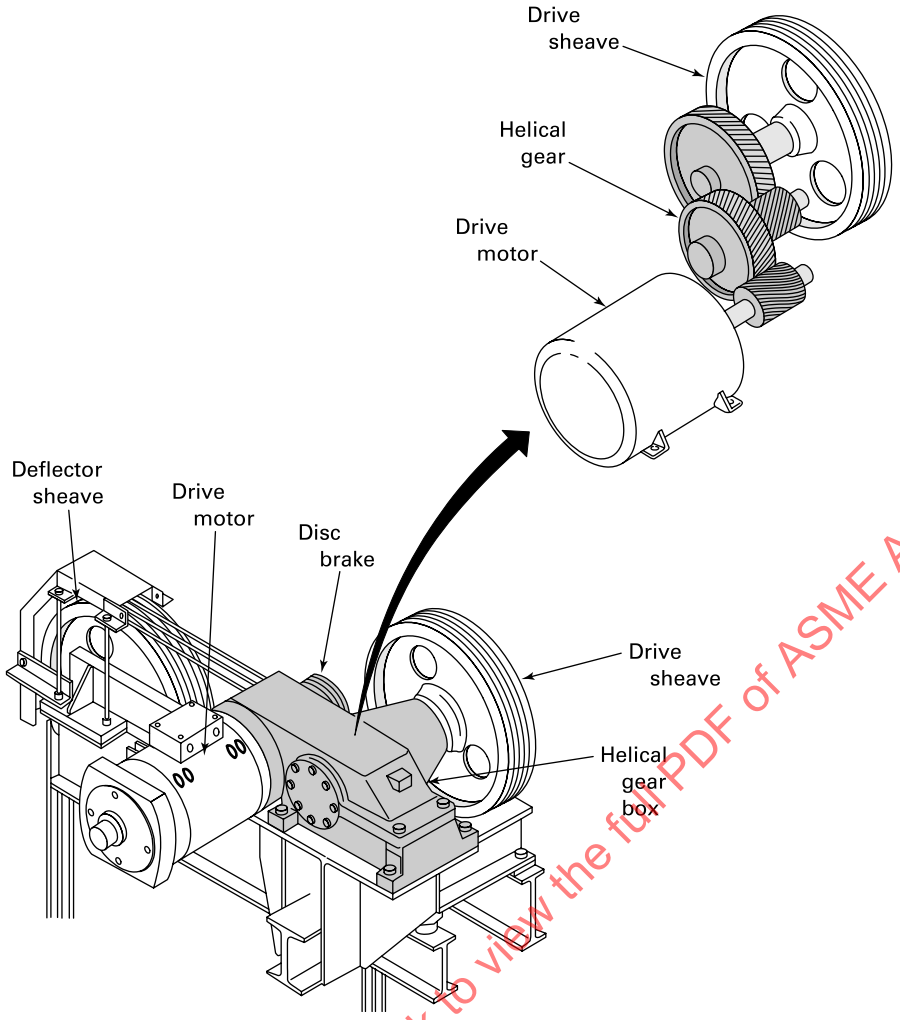
Diagram 2.24.1(a)
Worm and Gear Machine



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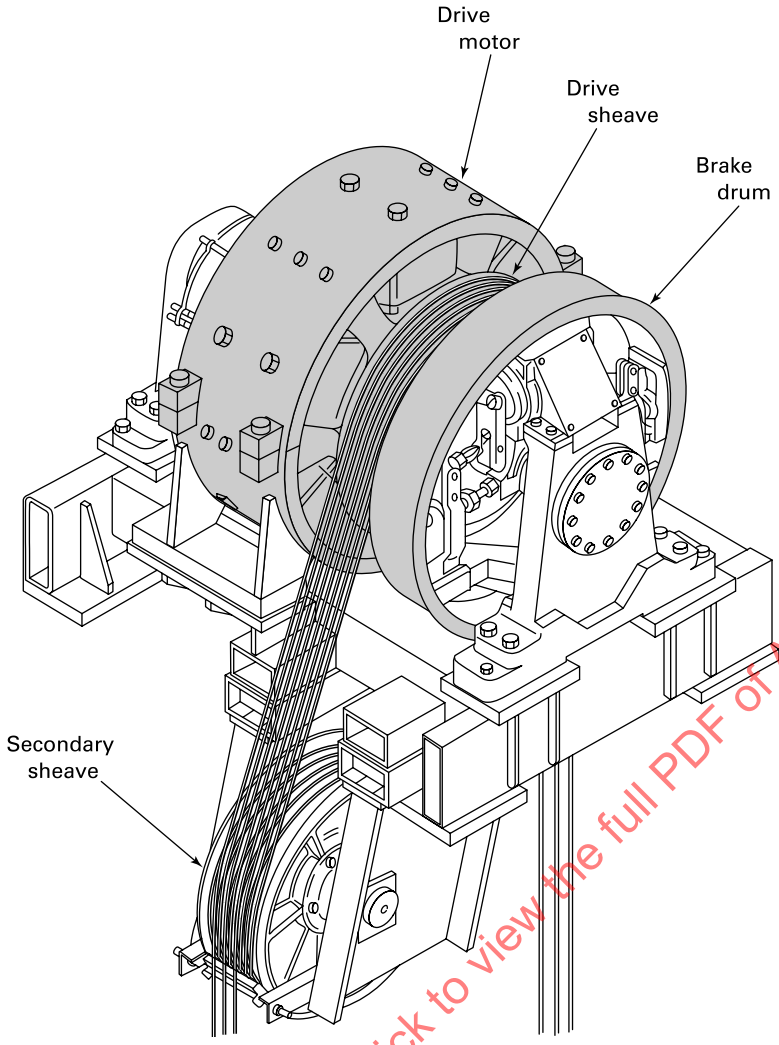
Diagram 2.24.1(b)
Helical Gear Machine



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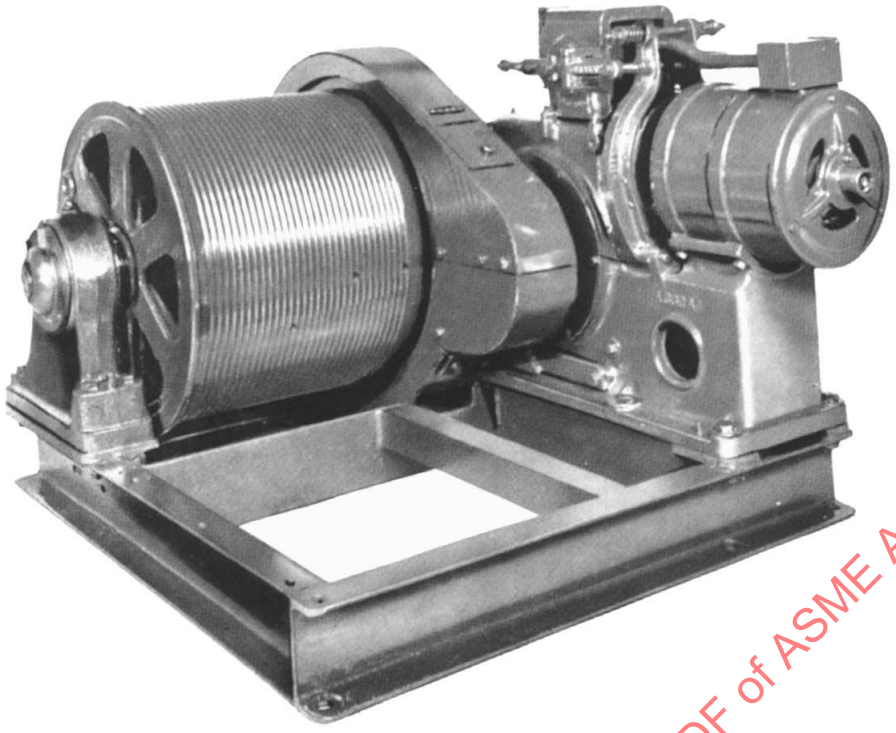
Diagram 2.24.1(c)
Gearless Machine



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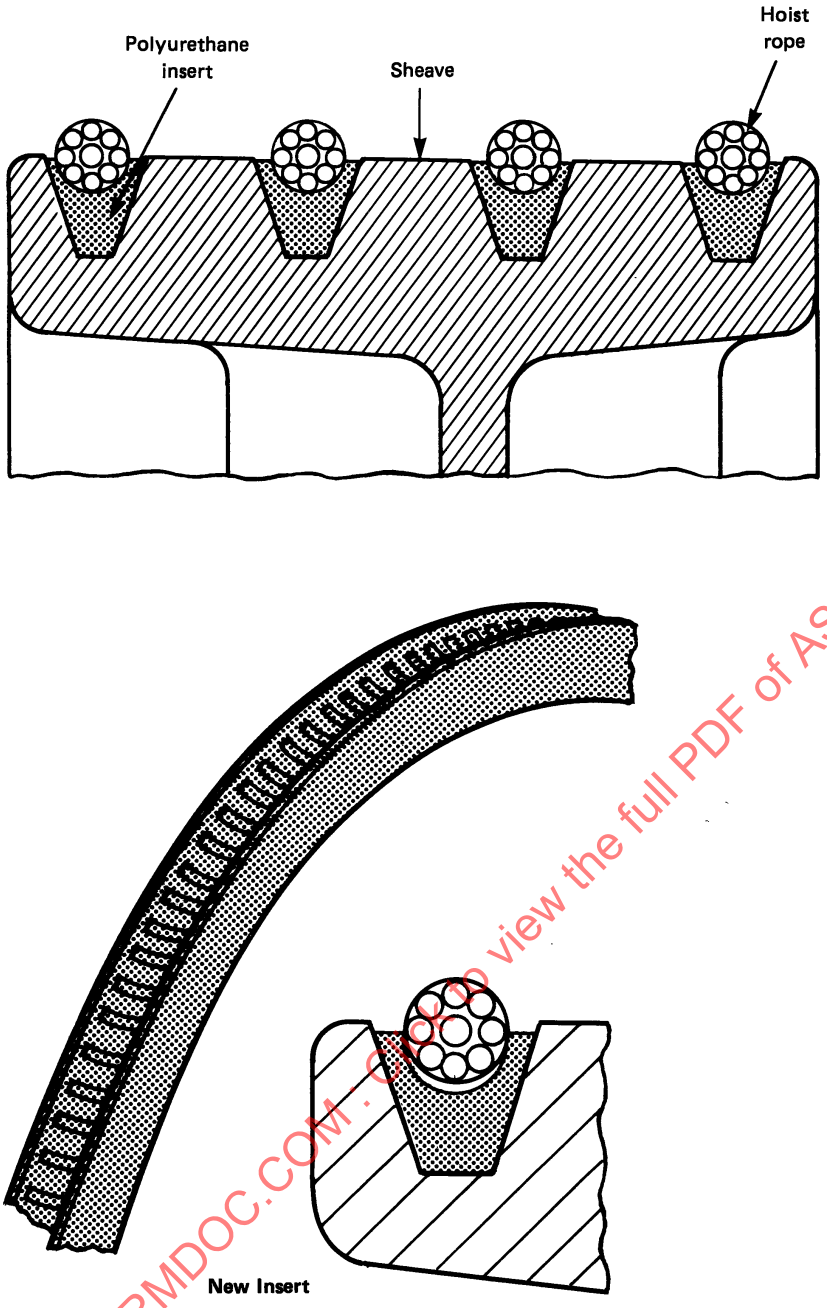
Diagram 2.24.1(d)
Typical Winding-Drum Machine



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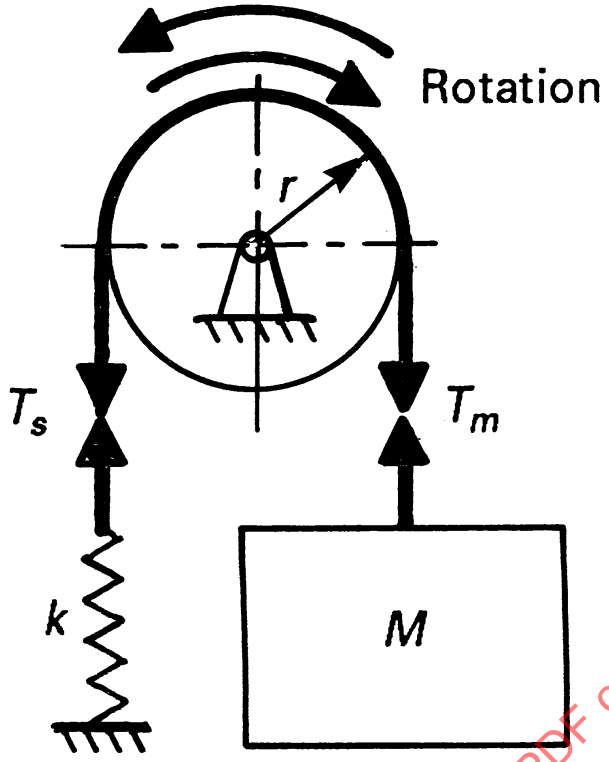
Diagram 2.24.2
Typical Sheave Groove Liners



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Diagram 2.24.2.3(a)
Simple Spring-Mass System



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Diagram 2.24.2.3(b)
Case 1 — Counterclockwise Rotation

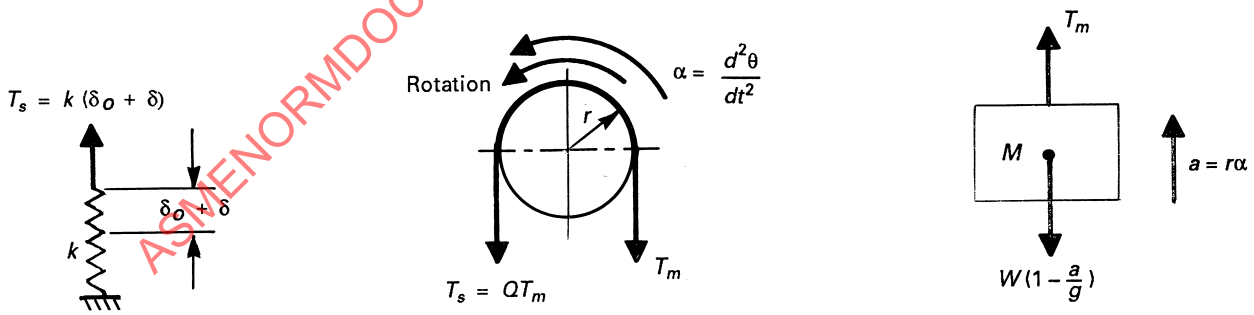


Diagram 2.24.2.3(c)
Case 2 — Clockwise Rotation

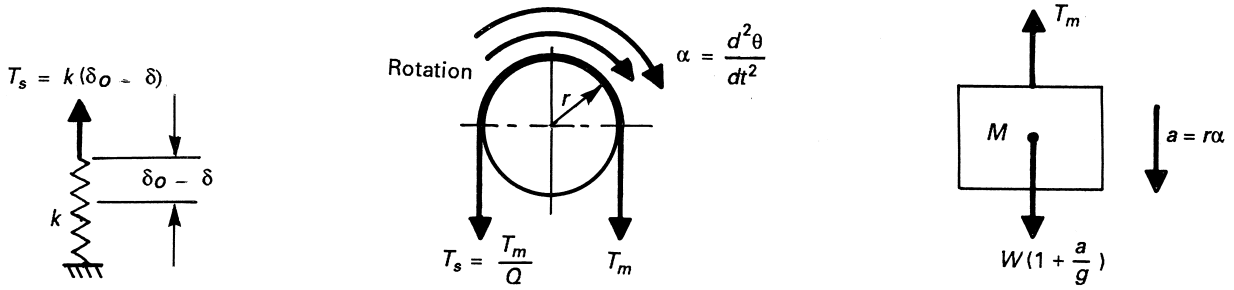
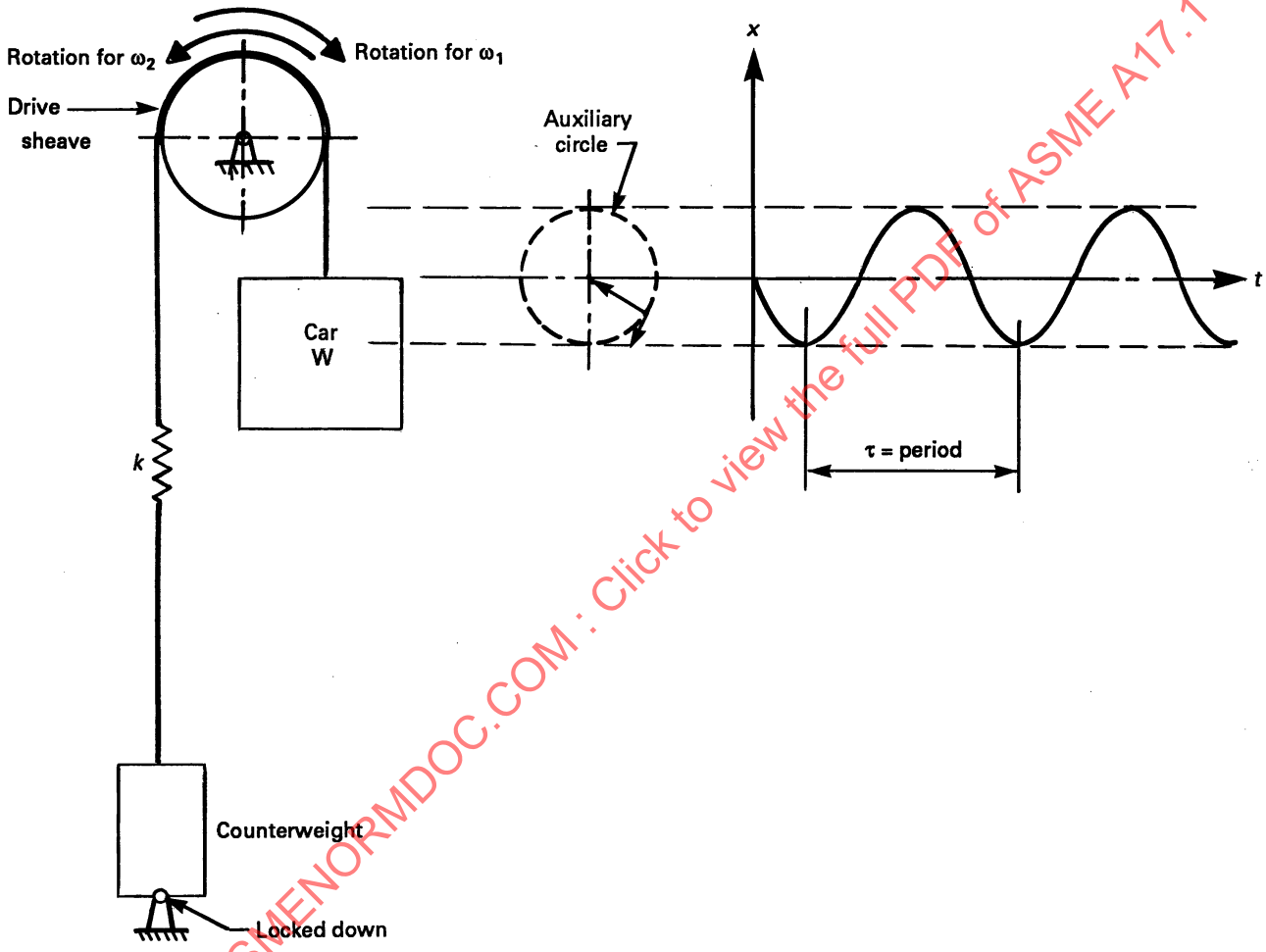


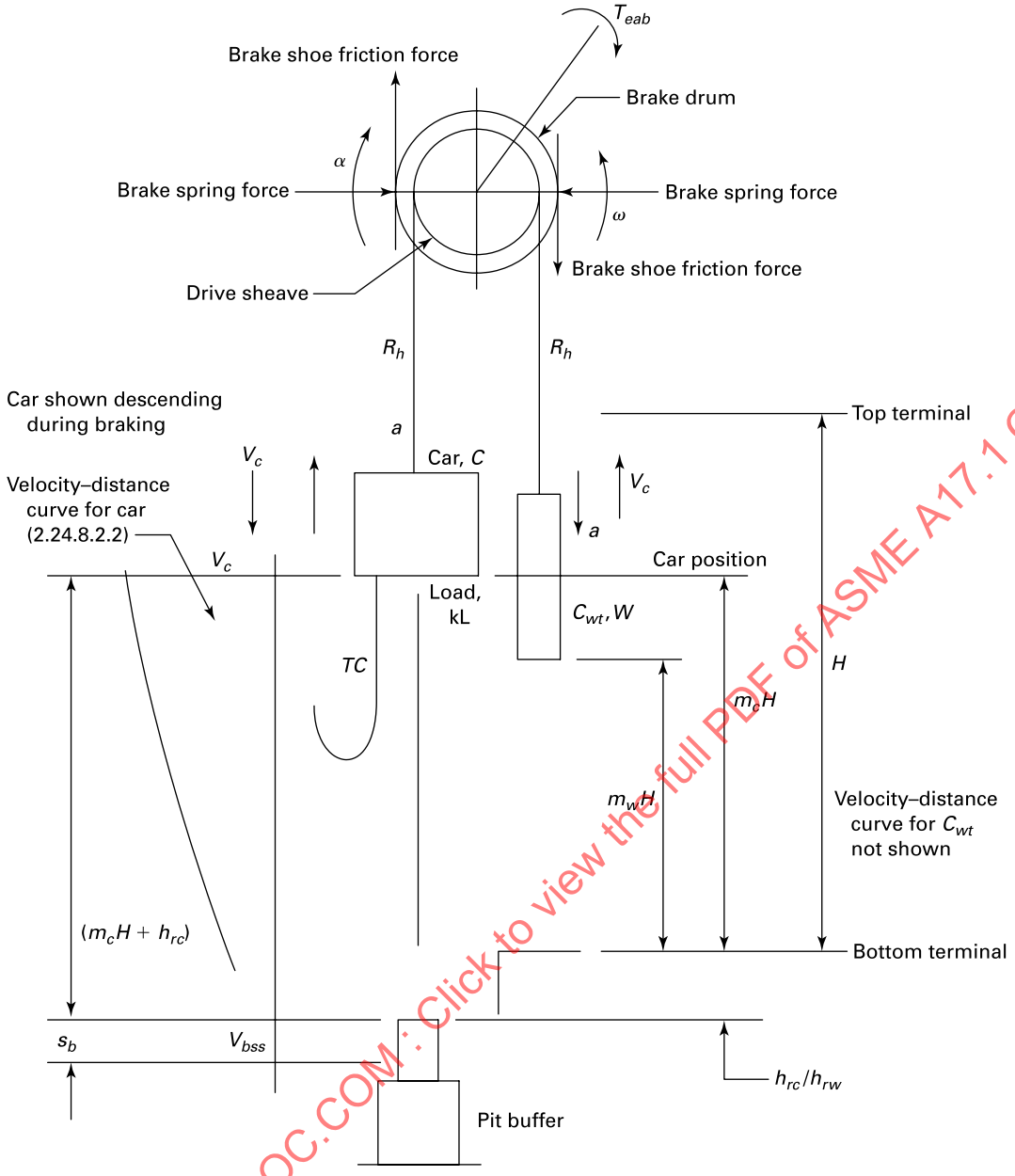
Diagram 2.24.2.3(d)
Frequency



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Diagram 2.24.8
Braking System and Driving-Machine Brake



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Chart 2.24.8
Braking System and Driving-Machine Brake

A17.1/B44 Requirement	Car Position	Car Direction	Design Parameters for Braking Operation [Notes (1)-(4)]						Effective Braking System (2.24.8.2.1)	
			Car Load, km_L				Retardation, a			
			Pass	Frgt	Car Speed, v_c	Oil Buffer Stroke [Note (3)]	a_{min} [Note (5)]	a_{max} [Note (6)]	Machine Brake Alone [Note (7)]	Electrically Assisted Braking [Note (8)]
2.24.8.3(a)	At rest (static)	N/A	k = 1.25 (2.16.8)	k = 1.0	0	N/A	N/A	N/A	T_{bms}	N/A
2.24.8.3(b)	At rest (static)	N/A	k = 0	k = 0	0	N/A	N/A	N/A	T_{bms}	N/A
					$v_{gos} \geq$ 2.07 m/s	Full Reduced	$a > 0$			
2.24.8.3(c)	Moving (dynamic)	Up	k = 0	k = 0	1.26 m/s $\leq v_{gos} <$ 2.07 m/s	Full Reduced	$\frac{V_{gos}^2 - V_{wbss}^2}{2(q_w H + h_{rw})}$	1.0g	T_{bmk} [Note (9)]	Not Allowed
					$v_{gos} \leq$ 1.26 m/s	Spring [Note (3)]	$a > 0$			
					$v_{gos} \geq$ 2.07 m/s	Full Reduced	$a > 0$			
2.24.8.2.2	Moving (dynamic)	Up	k = 0	k = 0	1.26 m/s $\leq v_{gos} <$ 2.07 m/s	Full Reduced	$\frac{V_{gos}^2 - V_{wbss}^2}{2(q_w H + h_{rw})}$	1.0g	$T_{bmk} + T_{eab}$ [Note (5), (9)]	$T_{bmk} + T_{eab}$ [Note (5), (9)]
					$v_{gos} \leq$ 1.26 m/s	Spring [Note (3)]	$a > 0$			
					$v \geq$ 1.75 m/s	Full Reduced	$a > 0$			
2.24.8.2.2	Moving (dynamic)	Down	k = 1.25 (2.16.8)	k = 1.0	1.0 m/s $\leq v <$ 1.75 m/s	Full Reduced	$\frac{V^2 - V_{cbss}^2}{2(q_c H + h_{rc})}$	1.0g	$T_{bmk} + T_{eab}$ [Note (5), (9)]	$T_{bmk} + T_{eab}$ [Note (5), (9)]
					$v \leq$ 1.0 m/s	Spring [Note (3)]	$a > 0$			

a = retardation of elevator system at braking, m/s^2 or ft/s^2
a_{max} = maximum retardation of elevator system at braking, m/s^2 or ft/s^2
a_{min} = minimum retardation of elevator system at braking, m/s^2 or ft/s^2
C = car weight/mass, kg or lb
c = subscript denoting car
H = travel/rise, m or ft
h_{rc} = distance from lower landing to top-of-car buffer, mm or in.
h_{rw} = distance from lower landing to top of counterweight buffer, mm or in.
k = factor used to describe magnitude of load in car, dimensionless
L = rated load, kg or lb
m = position ratio used to describe the vertical location of the car in the hoistway ($0 \leq m \leq 1$) (dimensionless)
N/A = not applicable
R_c = mass/weight of compensation ropes/chains, kg or lb, if provided
R_h = mass/weight of suspension ropes, kg or lb

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Chart 2.24.8
Braking System and Driving-Machine Brake (Cont'd)

A17.1/B44 Requirement	Car Position	Car Direction	Design Parameters for Braking Operation [Notes (1)-(4)]						Effective Braking System (2.24.8.2.1)	
			Car Load, km_L			Retardation, a				
			Pass	Car Speed, v_c	Oil Buffer Stroke [Note (3)]	Frgt	Machine Brake Alone [Note (7)]	Electrically Assisted Braking [Note (8)]	a_{min} [Note (5)]	a_{max} [Note (6)]

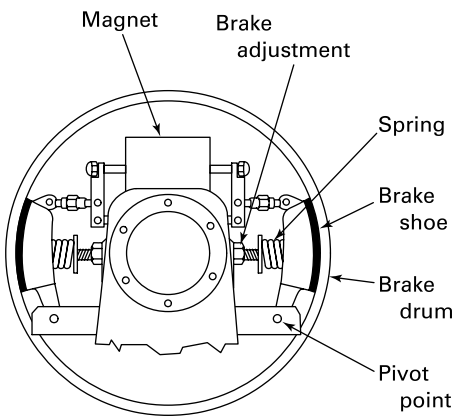
s_b = buffer stroke, mm or in
T_{bmk} = kinetic brake torque due to mechanical brake, on its own, N·m or ft-lb
T_{bms} = static brake torque due to mechanical brake, on its own, N·m or ft-lb
T_{eab} = kinetic brake torque due to electrically assisted braking, N·m or ft-lb, if provided
TC = mass/weight of traveling cable(s), kg or lb
v_c = car speed, m/s or ft/min
v_{cbss} = striking speed for which the car buffer is rated based on its stroke, m/s or ft/min
v_{wbss} = striking speed for which the counterweight buffer is rated based on its stroke, m/s or ft/min
v_{gos} = speed at which the governor overspeed switch is set to operate in the up direction, m/s or ft/min
v_{gosmax} = maximum speed at which the governor overspeed switch is set to operate in the down direction, m/s or ft/min
W = counterweight weight/mass, kg or lb
w = subscript denoting counterweight
α = angular retardation of drive sheave/brake drum at braking, rad/s^2
ω = angular speed of drive sheave/brake drum at braking, rad/s

GENERAL NOTE: Courtesy of George W. Gibson.

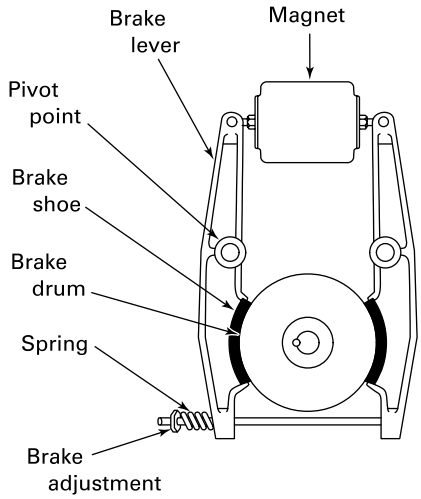
NOTES:
(1) Buffer type application speeds overlap at v = 1.0 m/s:
  (a) Spring buffers: $0 \le v \le 1.0$ m/s
  (b) Oil buffers: $v \ge 1.0$ m/s
(2) Values for v_{gos} per A17.1/B44 Table 2.18.2.1. Values for $v_{bsr} = 1.15v$ per A17.1/B4 Table 2.22.4.1.
(3) Except where spring buffers are shown for speeds, $v \le 1.0$ m/s (200 fpm) per Rule 2.22.1.1.1 and Table 2.22.3.1.
(4) Dimensionally consistent terms must be used in the formulae in this Table.
(5) "All factors such as, but not limited to, system heat dissipation and allowable buffer striking speeds are considered." [References: Rules 2.24.8.2.2 and 2.24.8.3(c)]
(6) If the braking retardation, $a_{brksys} > a_{\alpha}$, the car will continue to move, decoupled from the control system, subject only to Newton's Second Law of Motion. See ISO/TR 11071-1:2004, Points Agreed Upon, Sect. 11.3.2, which states, "It is recognized that, even though the machine has been stopped, the required normal traction may not be maintained, which may permit continued movement of the car."
(7) Delay in brake application in an emergency is not permitted (see ISO/TR 11071-1:2004, Table A.9, Item 6). The brake must apply automatically when any electrical protective device is activated [2.26.8.3(c)], or there is a loss of power to the driving machine brake [2.26.8.3(d)].
(8) The term "electrically assisted braking" is defined as "the retardation of the elevator, assisted by energy generated by the driving-machine motor" (reference: A17.1/B44, Section 1.3).
(9) "The loss of main line power shall not reduce the brake system capacity below the requirements stated here" (reference: 2.24.8.2.2, last sentence).

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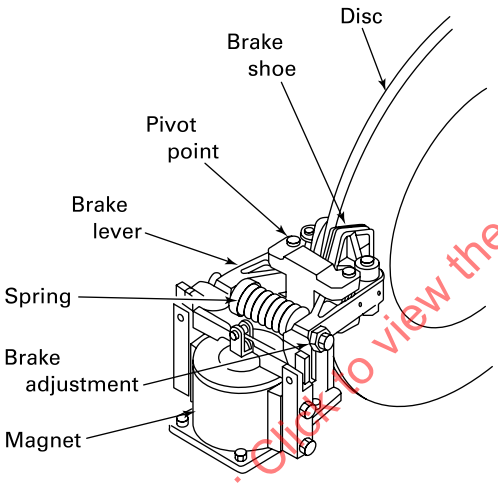
Diagram 2.24.8.6
Typical Brake Arrangements



(a) Internal Brake



(b) External Brake



(c) Disc Brake

GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

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SECTION 2.25
TERMINAL STOPPING DEVICES

NOTE: The author expresses his appreciation to Barry Blackaby, Joseph Busse, and Andy Juhasz for their contributions to Section 2.25.

When in doubt about any of ASME A17.1/CSA B44 and safety requirements, check the definitions in Section 1.3 and the NEC® Section 620-2, or CEC Section 38-002. The following are of particular interest when reviewing the electrical requirements:

braking, electrically assisted
certified
certified organization
control, motion
control, operation
control system
controller
controller, motion
controller, motor
controller, operation
hoistway access switch
labeled/marked
landing zone
leveling
leveling device
leveling zone
listed/certified
normal stopping means
operating device
operation, inspection
signal equipment (NEC®)
static switching
terminal speed-limiting device, emergency
terminal stopping device, emergency
terminal stopping device, final
terminal stopping device, machine final (stop-motion switch)
terminal stopping device, normal

Wiring Diagram 2.25/2.26 captures the essential ASME A17.1/CSA B44 requirements of Section 2.25 and will be referred to in the Handbook commentary. The following legends are used in the wiring diagrams and referenced in the Handbook commentary:

C1	Potential Relay #1 (Safety String for Electrical Protective Devices)
C2	Potential Relay #2 (Safety String for Electrical Protective Devices)
CD1	Car Door Relay #1 (Energized When Car Door Contacts Closed)
CD2	Car Door Relay #2 (Energized When Car Door Contacts Closed)
LD1	Landing Door Relay #1 (Energized When Hoistway Door Contacts Closed)
LD2	Landing Door Relay #2 (Energized When Hoistway Door Contacts Closed)
NOR1	Normal Operation Relay #1 (Energized When on Automatic, i.e., “Normal” Operation)
NOR2	Normal Operation Relay #2 (Energized When on Automatic, i.e., “Normal” Operation)
AUD	Access Enable Switch Operation
#1	Brake Coil Circuit Relay #1
#2	Brake Coil Circuit Relay #2
1	Motor Circuit Relay or Contactor #1
2	Motor Circuit Contactor #2
3	Car Door Bypass Relay #1 (Energized When Car Door Bypass Switch in Bypass Position)
4	Car Door Bypass Relay #2 (Energized When Car Door Bypass Switch in Bypass Position)
5	Hoistway Door Bypass Relay #1 (Energized When Car Door Bypass Switch in Bypass Position)
6	Hoistway Door Bypass Relay #2 (Energized When Car Door Bypass Switch in Bypass Position)
M	Motor, or Motor Armature
G	Generator Armature
MC	Motor Control Device
DZ	Door Zone (Check)

See introduction to ASME A17.1/CSA B44 Handbook commentary on Section 2.26.

2.25.1 General Requirements

The first paragraph of this requirement indicates that mechanically or magnetically operated optical or solid-state devices for determining car position and speed are permitted to be used for normal terminal stopping devices, emergency terminal stopping devices, and emergency terminal speed-limiting devices. The second paragraph indicates that mechanically operated switches are required for the final terminal stopping devices.

The revision incorporated in ASME A17.1-1996 permitted the use of mechanically and magnetically operated optical- or static-type devices to determine car position for emergency terminal speed-limiting devices required by 2.25.4.1. Prior to ASME A17.1-1996, the Code permitted the use of nonmechanical-type switches for determining car speed only. The revision has no impact on safety performance since 2.25.4.1.5 and 2.25.4.1.9 cover the failure protection requirements for the nonmechanical devices. The revision permitted the same level of performance language afforded to the requirements for

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the speed-monitoring devices and is more appropriate in today's elevator motor controller.

2.25.2 Normal Terminal Stopping Devices

Nonautomatic elevators, such as those with constant pressure push-button or car switch control, require normal terminal slowdown devices to stop the car at or near the terminal floor, in the event the operator forgets to initiate a stop.

Automatic elevators, on the other hand, have a hoistway position control mechanism (e.g., floor controller, selector or other device) to automatically slow down and stop the car at landings where a car and/or hall call is registered. A failure of the normal stopping means at an intermediate floor might be an inconvenience, but a failure at a terminal landing could allow the car to strike the buffer at full speed. For this reason, ASME A17.1/CSA B44 has required the stopping devices at the terminal floor to meet certain safety requirements.

Variable voltage elevators were almost universally controlled by resistors and relay contacts in series with the generator field. These relays could easily be deenergized by the normal terminal stopping devices.

When the term "device" is used in 2.25.2, the intent of the text is to permit devices other than mechanical switches (i.e., magnetic, optical, and solid state devices). See Diagrams 2.25.2(a) and 2.25.2(b).

2.25.2.1 Where Required and Function. The "normal terminal stopping device" is required to function independently of the operation of the "normal stopping means" and the "final terminal stopping device," but the "normal terminal stopping device" may be used as the "normal stopping means" on elevators with rated speeds of 0.75 m/s or 150 ft/min or less.

A "normal stopping means" is that portion of the motion control that initiates a slow down and stopping of the car in automatic operation at landings in response to an operating device such as a car and/or hall button, destination dispatch system, or car switch.

A "normal terminal stopping device" is the "device(s) to initiate slow down and stopping of an elevator, dumbwaiter, or material lift car automatically at or near a terminal landing." (See Section 1.3 and Diagram 2.25.2.1.)

"Function independently" are the key words in assessing the distinction between the normal stopping means and the normal terminal stopping device. Strict "independence" between the two stopping systems may be difficult to interpret. Taken together, the two words in 2.25.2.1.2, "function independently," give a clearer meaning for the performance objective. The practical way to confirm that the two stopping systems function independently is by a test method recommended by the equipment manufacturer or elevator installer.

As an example on automatic elevators, a possible system failure of the normal stopping means that would then require the normal terminal stopping system to slow the car and stop at the terminal (floor) as intended would be the loss of correct hoistway position reference by the normal stopping means. Were this to occur, it would be possible for the elevator to approach the terminal and not initiate its normal slowdown. This is analogous to an attendant on a nonautomatic elevator forgetting to slow the car by manual actuation of a car switch.

In this example, another device (normal terminal stopping device) must independently signal the control system that the terminal zone is being approached. A reasonable test procedure would be to show that when the normal stopping means hoistway position reference is corrupted, that upon actuation of the normal terminal stopping device, a backup slowdown signal is received, resulting in controlled slowdown into the terminal floor.

Another practical way to demonstrate a normal stopping means versus normal terminal stopping may be to show a higher level of motor torque by direct measurement of motor current or by display devices, as the normal terminal stopping slowdown and stop is occurring.

The terminology of "normal terminal stopping device" can be misunderstood, since the intent is that the device and its associated control mechanism actually slow the car under motor control. A more appropriate understanding of the term may be "normal terminal slowdown and stopping device."

ASME A17.1-2013/CSA B44-13 included new requirements that clarified the independence in more specific terms. The requirements were further revised in ASME A17.1-2016/CSA B44-16 to clarify the intent of the term "devices." The performance intent of normal terminal stopping is stated as follows:

> The normal terminal stopping devices (i.e., those devises used for sensing relative changes in car position) shall function independently of the operation of the normal stopping means and of the final terminal stopping device, such that the failure of the normal stopping means and/or the failure of the final terminal stopping devices shall not prevent the normal terminal stopping device from functioning as specified [that is, from stopping the car at or near the terminal landing].

Clarification of what is permitted in terms of common elements between the normal stopping means or final terminal stopping device and the normal terminal stopping device is then provided in the body of the requirements along with monitoring requirements and design/performance requirements. These all relate to the hoistway terminal position-sensing function of the sensing devices of normal stopping, normal terminal stopping, and final terminal stopping devices. There are

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numerous methodologies used to demonstrate compliance with the requirement.

2.25.3 Final Terminal Stopping Devices

At the time the 1955 edition of ASME A17.1 was being prepared, it was felt that there was a need to eliminate car contact with the overhead structure and for continuous functioning of the top final terminal stopping switch.

In complying with the minimum bottom counterweight runby requirement in 2.4.2 and the minimum stroke requirements specified for spring and oil buffers in 2.22.3 and 2.22.4 for various rated car speeds, the distance of the top final terminal stopping switch operation is determined by the sum of the counterweight runby plus 1½ times the buffer stroke requirement, with a minimum distance of 600 mm or 2 ft.

The final terminal stopping device automatically causes the power to be removed from an electric elevator driving machine motor and brake independent of the function of the normal terminal stopping device, the operating device, or any emergency terminal speed-limiting device after the car has passed a terminal landing.

This requires that separate and independent final limit switches be provided to complete the driving machine motor and brake circuit in either direction of travel. It is difficult to verify by field inspection that when the final limit is operated, it directly causes the switch to drop out, and that a solid-state device is not interfacing between the two operations. On some controllers, this may be verified by observing the hard wiring from the terminal studs to the final limit and tracing the hard wiring directly to the coil of the contactor required. See Diagram 2.25.3.

2.25.3.2 Where Required and Function. This requirement was revised in ASME A17.1-2016/CSA B44-16 to recognize elastomeric buffers as "equivalent types."

2.25.3.3 Location

2.25.3.3.1 This requirement was revised in ASME A17.1-2010/CSA B44-10 to permit traction machine elevators to have the final terminal stopping device(s) located either in the hoistway or on the car. For elevator control systems where control functions are located on the car, it is logical that the final terminal stopping device(s) could be located on the car and wired directly into the control. It is also possible that the final terminal stopping device(s) could be located on the car and the control is located elsewhere (e.g., machine room, control room, control space). The case of final terminal stopping device(s) located on the car and the potential for faulty wiring of the signal through a traveling cable requires that the design shall be such that any single ground or short circuit shall not render the final terminal-stopping device ineffective.

Location of the final terminal stopping device(s) in the hoistway is thought to be a very stable mounting location. If the final terminal stopping device(s) are located on the car, it is also very important to provide a physically stable mounting location where it would be unlikely that the final terminal stopping device(s) could be accidentally damaged or moved from their adjusted actuating positions.

2.25.3.3.2 Winding-drum machines must have a final terminal stopping switch located in the hoistway and a machine final, which is also referred to as a stop-motion switch.

2.25.3.4 Controller Devices Controlled by Final Terminal Stopping Device. These longstanding legacy Code requirements have been coordinated well in intent as other Code sections have been developed over the years (2.26.9.3, 2.26.9.4, and 2.25.2.12). The wording in 2.25.3.4 was clarified in ASME A17.1-2010/CSA B44-10 to update to currently used terminology. The previous word "switches" was replaced with the more generic "device(s)." Any "device" could be employed that complies with existing requirements in other sections. For example, a single failure of a relay (relay = "device") shall not render any electrical protective device ineffective [see 2.26.9.3(a)]. Final terminal stopping devices are electrical protective devices; see 2.26.2.11.

2.25.3.5 Additional Requirements for Winding-Drum Machines. This requirement refers to the machine final, which is a final terminal stopping device operated directly by the driving machine. It is used on winding-drum machines and is also referred to as a stop-motion switch. See Diagram 2.25.3.5.

2.25.4 Emergency Terminal Stopping Means

Provisions are provided for emergency terminal speed-limiting devices used with reduced stroke buffers and emergency terminal stopping devices for static control elevators with rated speeds over 1 m/s or 200 ft/min, i.e., where oil buffers are required. See Diagram 2.25.4.

2.25.4.1 Emergency Terminal Speed-Limiting Device. The emergency terminal speed-limiting (ETSL) device is a device that automatically reduces the car speed by removing the power from the driving-machine motor and brake as it approaches a terminal landing, independent of the operation of the normal terminal stopping device if the latter fails to slow the car as intended. An ETSL device is required when a reduced stroke buffer is used. It causes the car to slow down by virtue of an emergency stop using the braking system to at least the speed at which the buffer is rated.

The words "entirely independent" of the operation of the normal terminal stopping device were removed from ASME A17.1-2013/CSA B44-13 and replaced with specific

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requirements detailing the independence. The relative greater importance of ETSL is evident in these requirements. The position-sensing devices must be separate devices. However, the actuating means and mounting members can be common with certain assurances of monitoring and design integrity.

For the speed-sensing portion of ETSL, Code requirements were expanded in ASME A17.1-2013/CSA B44-13 to detail the level of independence either by separate devices or by redundant monitoring of a common device. An example of the latter would be the use of a high-performance encoder that is commonly used as the speed feedback device for both normal terminal stopping and ETSL, along with the use of a second, perhaps less sophisticated encoder whose output is used to monitor and compare the speed sensing of the primary encoder. This sort of "cross-checking" of speed sensing from redundant devices would provide compliance with the requirements.

The issue of "friction" as related to ETSL car position was expanded on and clarified in ASME A17.1-2013/CSA B44-13. The revised requirements permit position-sensing devices (e.g., an encoder) driven by the overspeed governor, provided there is either a means of car position correction via some other control mechanism, or redundant position information derived from a second device (e.g., another encoder).

The performance objective of an ETSL stop is that buffer striking speed is not exceeded, which is critical for reduced stroke buffer applications. Engagement of the buffer(s) is not prohibited by 2.25.4.1. Performance variables such as maximum attainable speed when approaching the terminal zone, car load, demands on the braking system, and the maximum available deceleration rate of the machine brake and traction system all contribute to whether or not the car gets stopped before buffer engagement.

As an example, for an elevator with a contact speed of 8.12 m/s or 1,600 ft/min and a reduced stroke buffer rated for 5.08 m/s or 1,000 ft/min, when the emergency terminal speed-limiting device is activated, the car speed would be reduced from 8.12 m/s or 1,600 ft/min to 5.08 m/s or 1,000 ft/min at or just before contacting the buffers. See Diagrams 2.25.4.1 and 2.26.2.

The present requirement permits the use of mechanically operated, magnetically operated, optical, or solid-state devices for determining both car position and speed. Requirements 2.25.4.1.5 and 2.25.4.1.9 cover the failure protection requirements to ensure safety.

In the development cycle of the ASME A17.1-2013/CSA B44-13 Code, an ASME A17 Task Group reviewed the following items related to the application of reduced stroke buffers:

(a) allowable reduction of stroke of the buffer

(b) necessary overhead clearance required with the reduced stroke buffer

(c) measures required of the system to ensure the buffer is not struck at a velocity greater than its rating

During a hazard assessment, the Task Group discovered a scenario related to the occurrence of a driving-machine break failure with the car near the terminal landing. In certain cases, the ascending car overspeed detection may not be reached to activate the emergency brake. In that case, a full stroke buffer should prevent the car from striking the overhead, but with a reduced stroke buffer, not only might the buffer rating be exceeded, but the car might still hit the overhead since the ETSL device only removes power from the driving-machine brake, which is what failed to begin with. The ETSL device is now required to engage the emergency brake if the car is detected to not slow down at the terminal with the driving-machine brake set. Alternatively, it is permitted to simply engage the emergency brake upon ETSL activation. These requirements ensure that a reduced stroke buffer is not struck at above its speed rating in this type of failure scenario.

Prohibition against activation of a car safety by an ETSL device was removed. If it is permissible to use a car or counterweight safety to provide ascending car overspeed protection or unintended movement protection, then it should also be permissible to use a safety to prevent the car from striking a reduced stroke buffer above its rating. Also note the requirement for the retardation not in excess of 1*g* still applies.

2.25.4.1.9 The failure protection requirements were added in ASME A17.1-1996 when magnetically operated, optical, or solid-state devices are used for determining car position and speed. See Diagram 2.25.4.1.

2.25.4.2 Emergency Terminal Stopping Device. The requirements are performance oriented, which permits latitude in compliance. Operation of the emergency terminal stopping (ETS) device must "function independently" of the normal terminal stopping device and the normal speed control system.

ASME A17.1-2013/CSA B44-13 included new requirements that clarified the meaning of "function independently" in more specific terms. The performance intent of emergency terminal stopping device is now stated as follows:

> The emergency terminal stopping device shall function independently of the normal terminal stopping device and the normal speed control system such that the failure of the normal terminal stopping device and/or the failure of the normal speed control system shall not prevent the emergency terminal stopping device from functioning as specified.

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Position-sensing devices must be separate devices. However, the actuating means and mounting members can be common with certain assurances of monitoring and design integrity.

For the speed-sensing portion of the ETS device, ASME A17.1-2013/CSA B44-13 requirements were expanded to detail the level of independence either by separate devices or redundant monitoring of a common device. An example of the latter would be the use of a high-performance encoder that is commonly used as the speed feedback device for both the normal speed control system and ETS, along with the use of a second, perhaps less sophisticated encoder whose output is used to monitor and compare the speed sensing of the primary encoder. This sort of "cross-checking" of speed sensing from redundant devices would provide compliance with the requirements. Common actuating means are permitted, and depending on the type, monitoring of the means is required.

The issue of "friction" as related to the actuating means of ETS speed-sensing feedback devices was addressed in ASME A17.1-2013/CSA B44-13. Revised requirements clarified that speed-sensing devices are permitted to be driven by traction (e.g., a belt-pulley system), friction (e.g., a tach wheel driven by a brake drum surface), or flexible couplings, provided that there is monitoring to detect signal loss and, upon detection, that power is removed from the driving-machine motor and brake.

Acceptable ETS devices used to derive ETS position and speed signals include but are not limited to

(a) a tachometer or encoder on the drive sheave, motor shaft, or governor independent from the normal control, or otherwise designed for redundancy or reliability against failure

(b) tooth wheel or tapes or a device that converts pulses to speed

(c) hoistway-mounted position switches; speed switches activated by governor

These are all acceptable speed- and position-measuring devices and can be verified by physical observation on the job site.

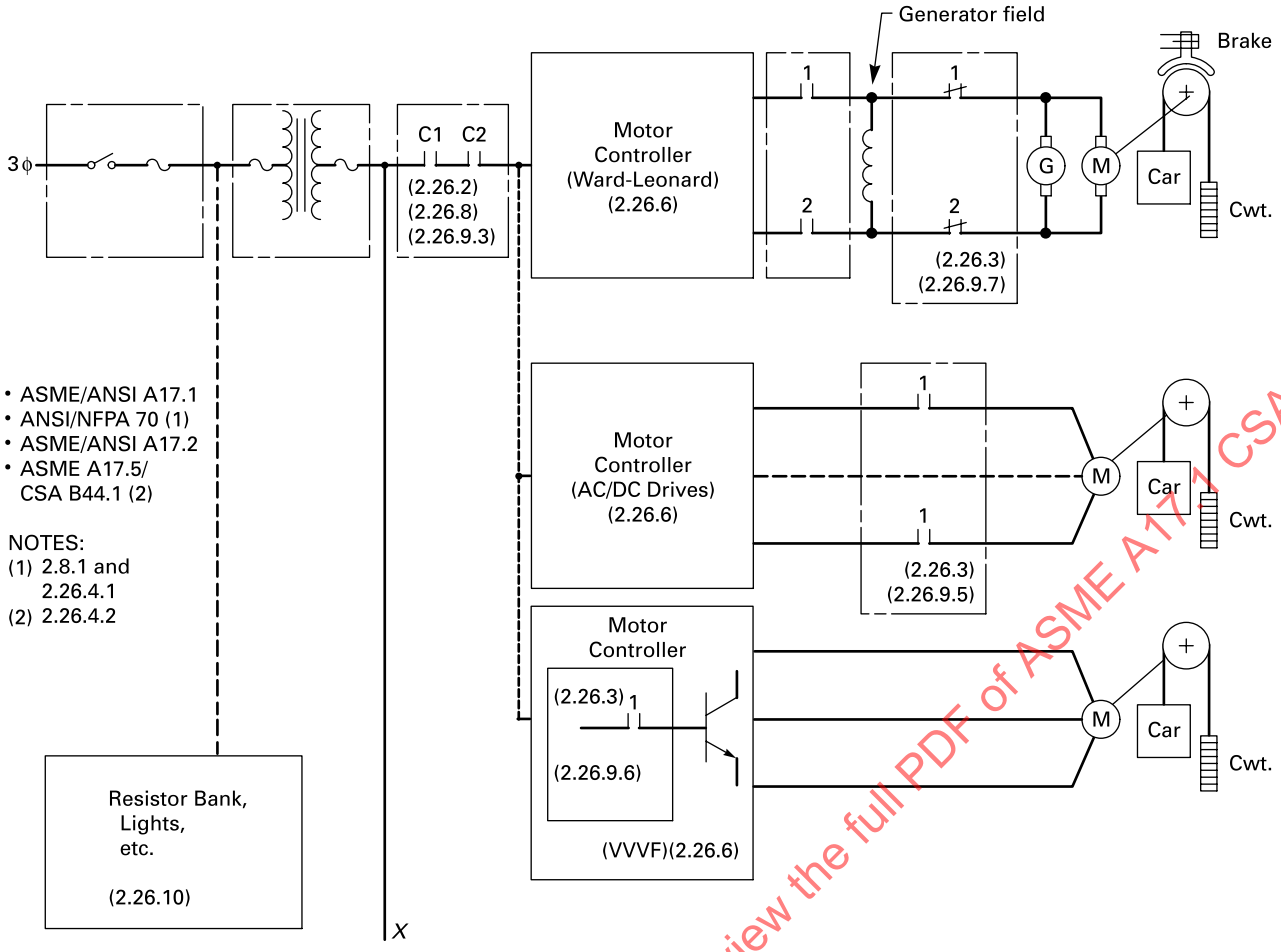
An example of a specific design approach using the primary control system tachometer or encoder for the ETS function would be to provide redundant devices for measuring car speed and/or position, and to continuously check and verify agreement between the separate devices. The ETS device is an electrical protective device, and as such, is covered under protection against single failures in 2.26.9.3 and 2.26.9.4.

A test procedure for this type of operation should be prepared by the installer or the manufacturer.

For demonstration of ETS, both the normal stopping means and the normal terminal stopping are disabled. Actuation of the ETS device causes an emergency stop by disconnecting power from the driving-machine motor and brake. Note that if the elevator stops before the terminal floor level, it is acceptable for the car to restart and attempt to get to the terminal floor to avoid passenger entrapment. See Diagram 2.25.4.

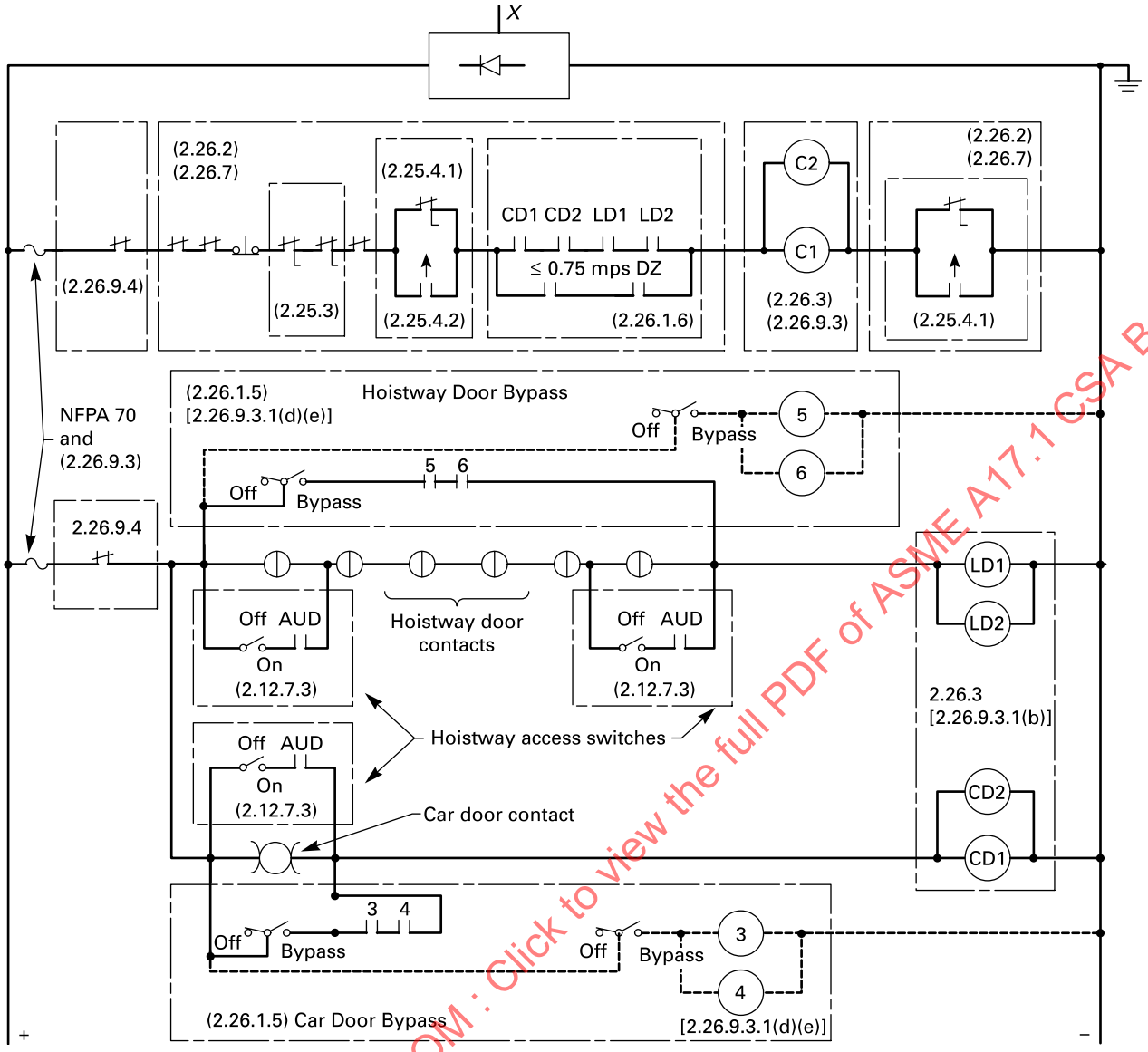
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Diagram 2.25/2.26
Conceptual Wiring Diagram



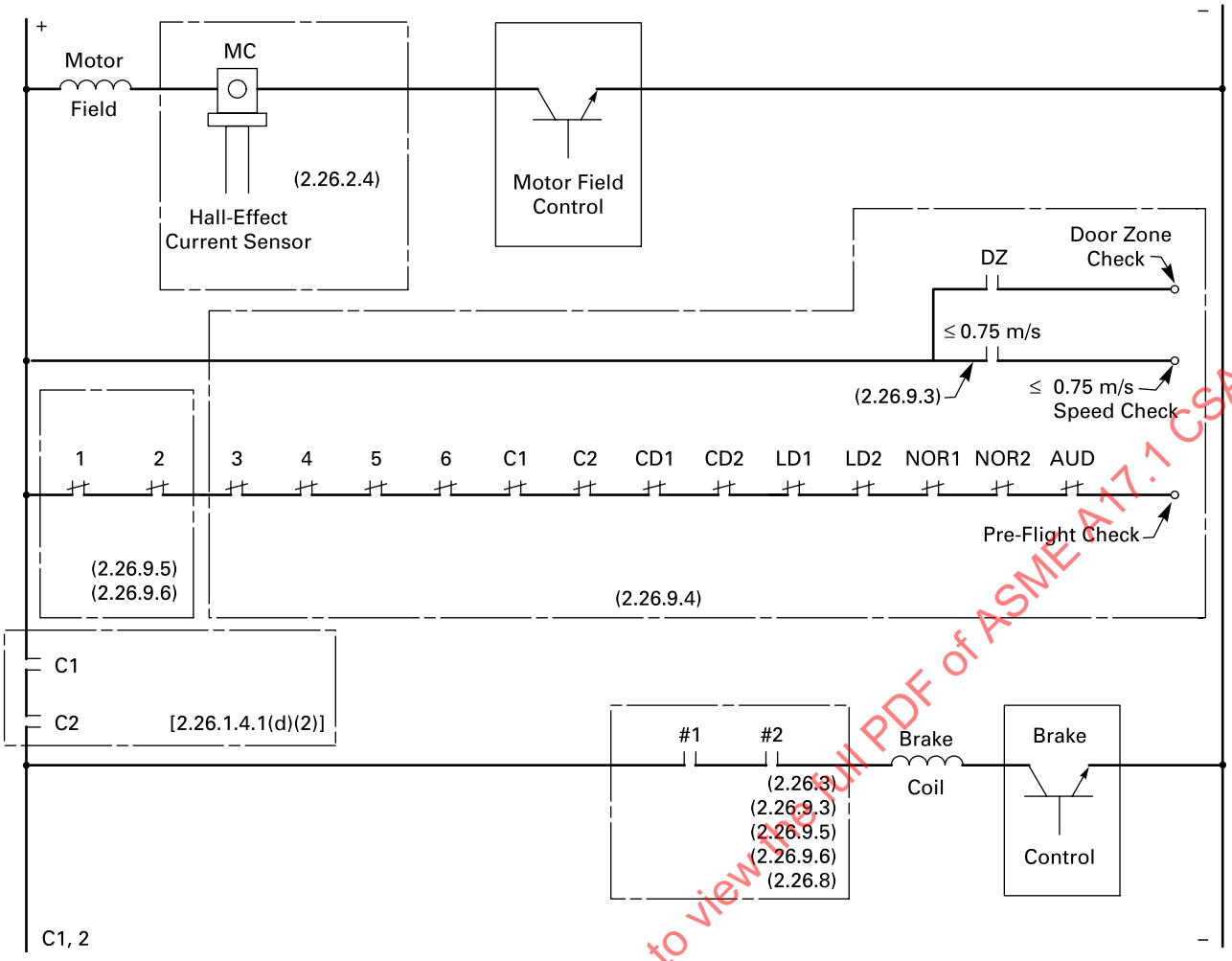
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Diagram 2.25/2.26
Conceptual Wiring Diagram (Cont'd)



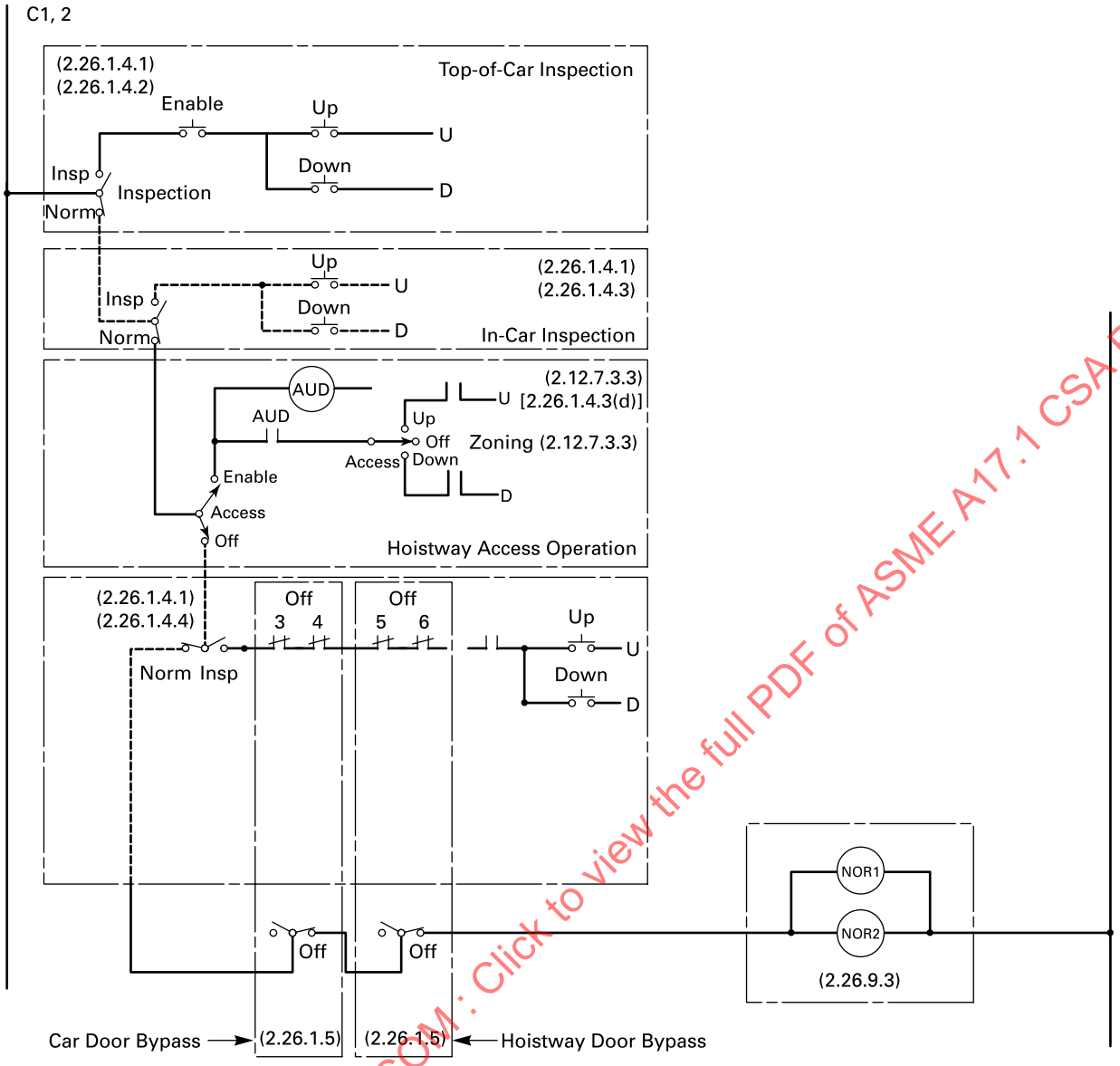
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Diagram 2.25/2.26
Conceptual Wiring Diagram (Cont'd)



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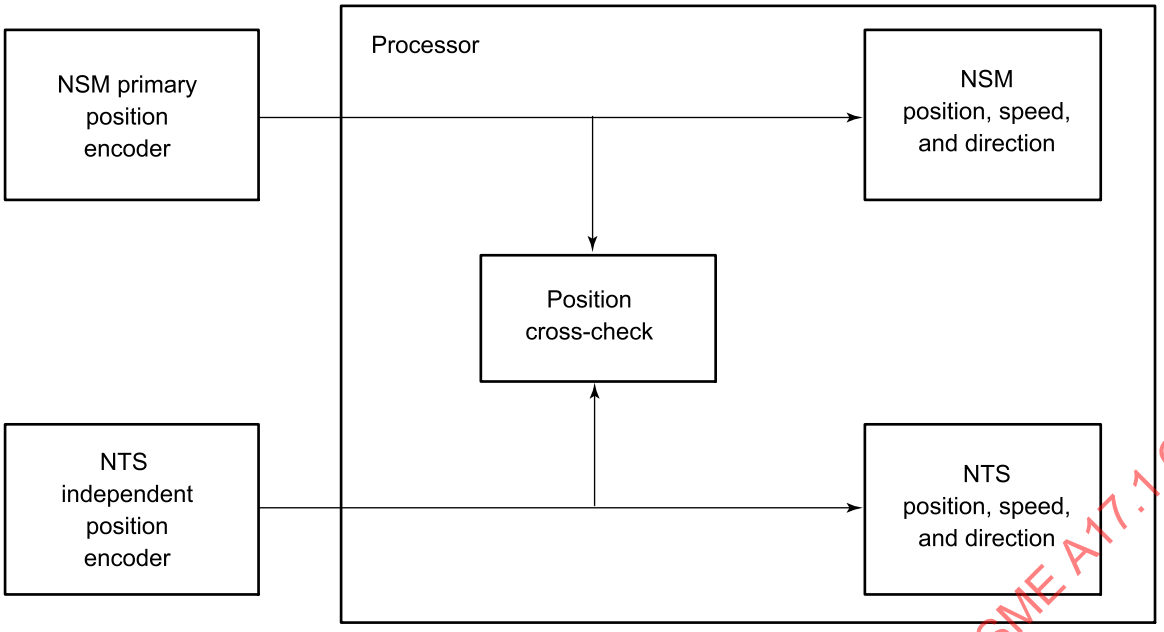
Diagram 2.25/2.26
Conceptual Wiring Diagram (Cont'd)



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.25 for Diagram legends.

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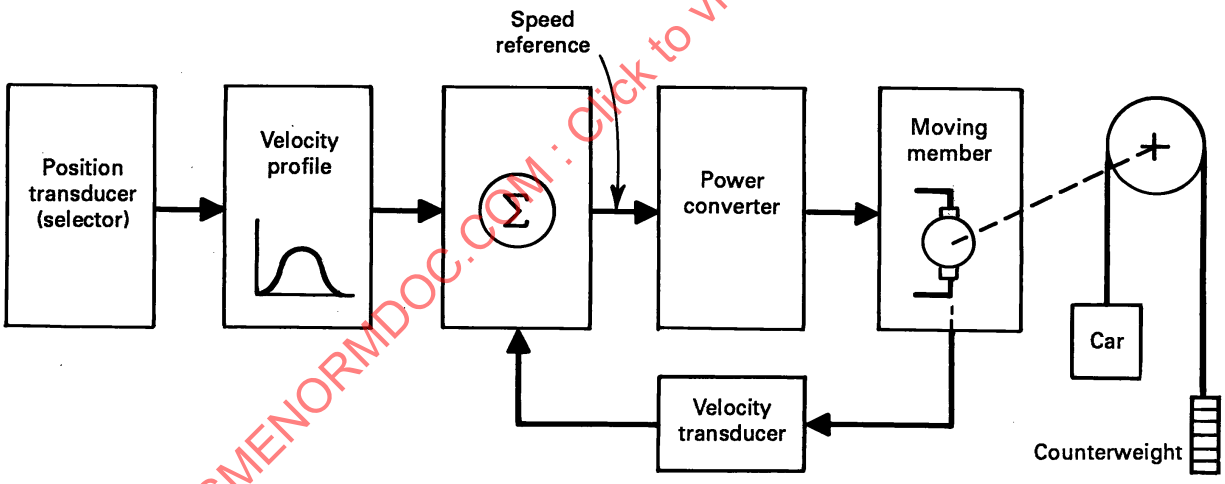
Diagram 2.25.2(a)
Functional Independence Diagram for NTS Position



Legend:
NSM = normal stopping eans
NTS = normal terminal stopping

GENERAL NOTE: Courtesy of Joseph Busse.

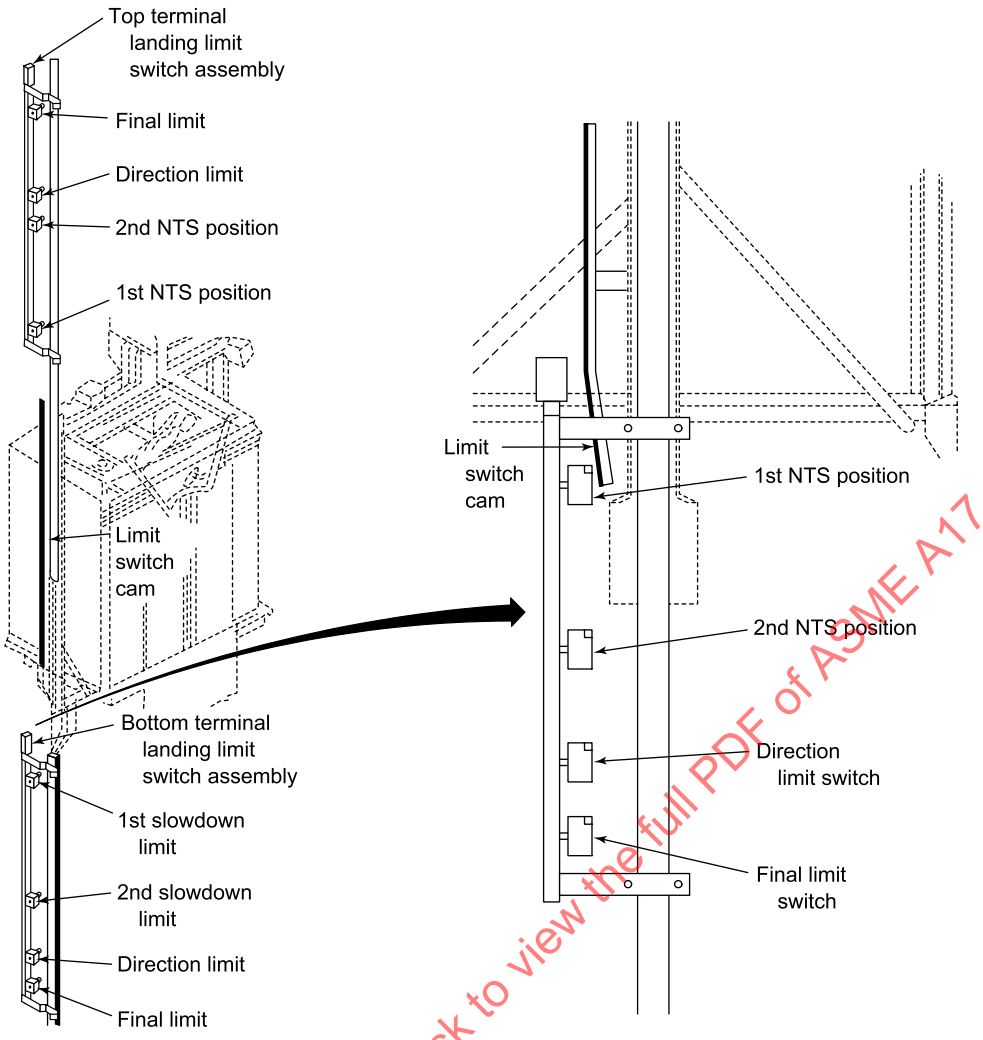
Diagram 2.25.2(b)
Functional Diagram for Normal Speed/Position



GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

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Diagram 2.25.2.1
Example of an NTS Device

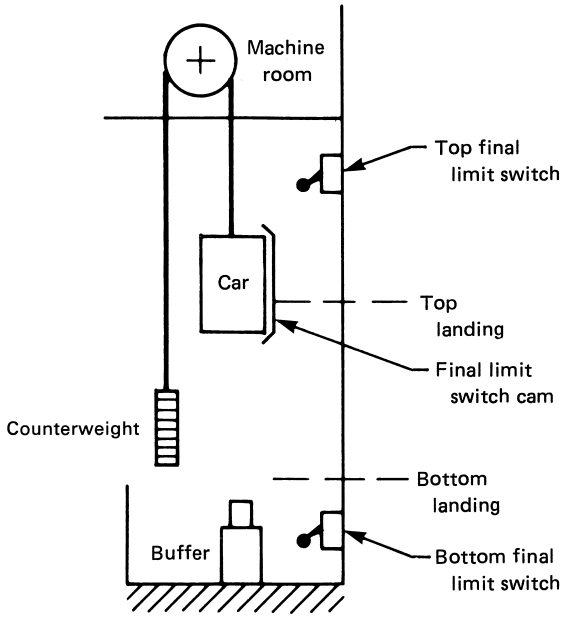


Legend:
NTS = normal terminal stopping

GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

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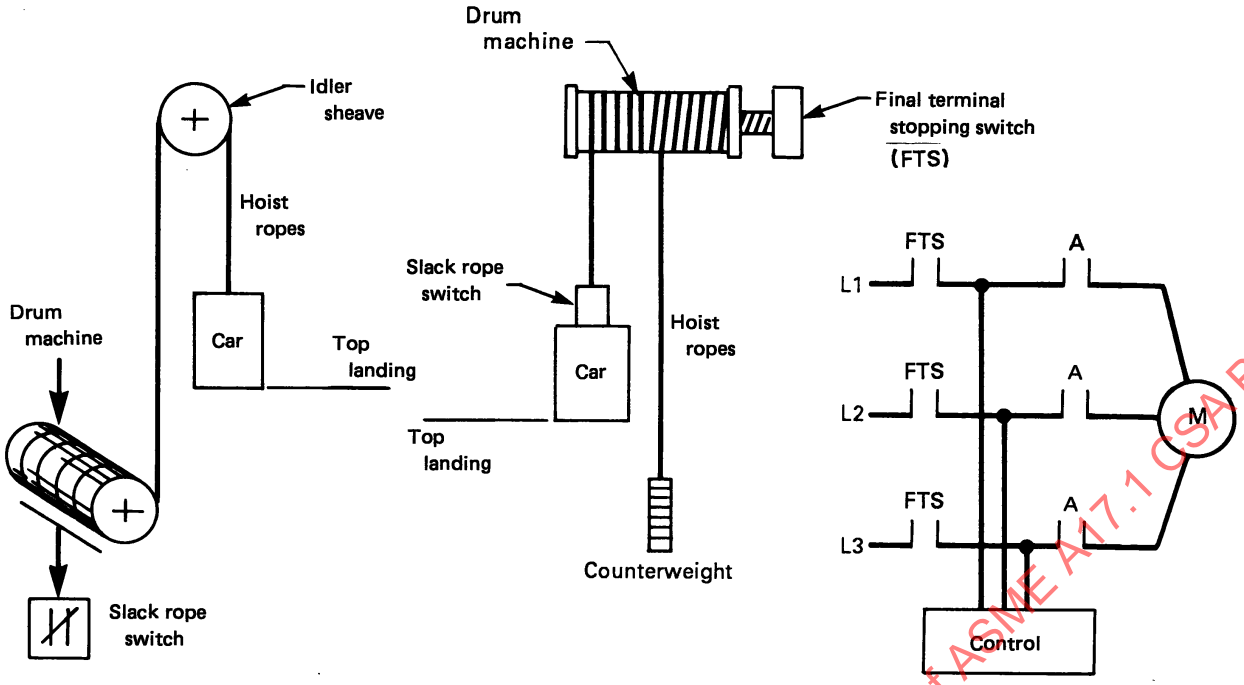
Diagram 2.25.3
Typical Final Terminal Stopping Device Hoistway Location



GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

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Diagram 2.25.3.5
Typical Final Terminal Stopping Device, Winding-Drum Machine

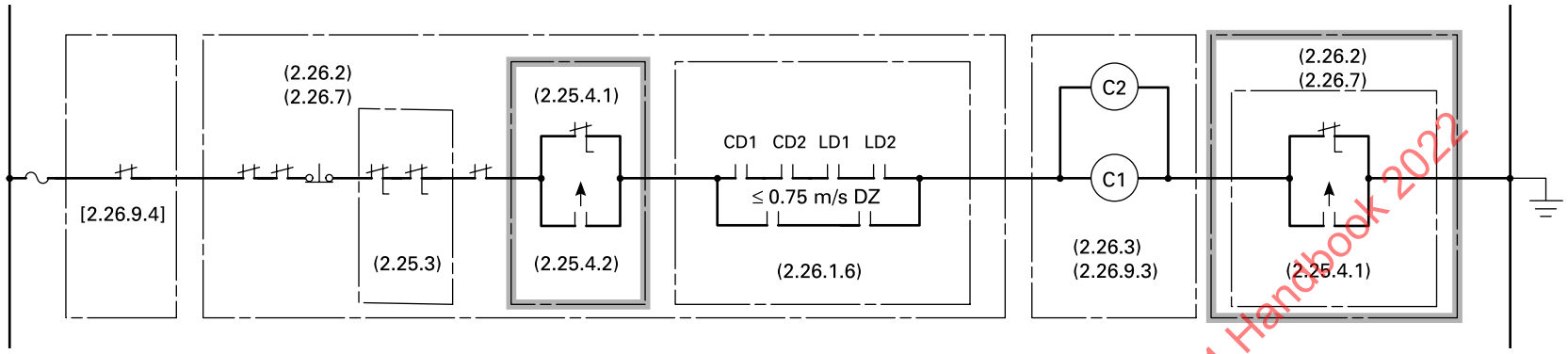


where
L1, L2, L3 = mainline power
A = driving machine motor contactor
FTS = final terminal stopping switch

GENERAL NOTE: Courtesy of Joseph Busse.

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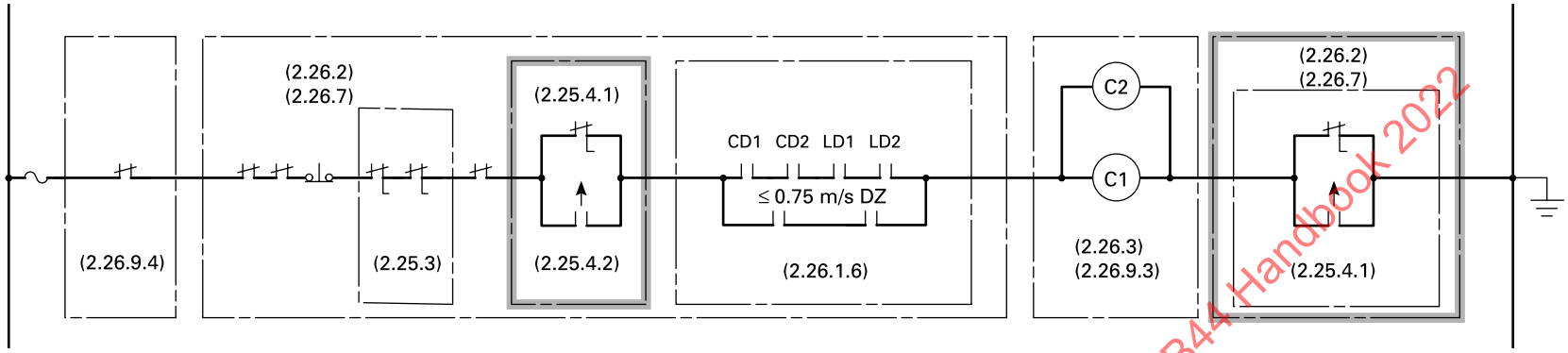
Diagram 2.25.4
Safety Circuit Concept for Emergency Terminal Stopping Means



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.25 for Diagram legends.

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Diagram 2.25.4.1
Safety Circuit Concept for Emergency Terminal Speed-Limiting Device



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.25 for Diagram legends.

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SECTION 2.26
OPERATING DEVICES AND CONTROL EQUIPMENT

NOTE: The author expresses his appreciation to Vince Robibero, Barry Blackaby, Joseph Busse, and Andy Juhasz for their extensive contributions to Section 2.26.

ASME A17.1/CSA B44 and ASME A17.7/CSA B44.7, along with referenced standards (e.g., ANSI/NFPA 70, CSA C22.1, CSA B44.1/ASME A17.5, ICC/ANSI A117.1, ADA AG, etc.), are concerned with the safe design, installation, use, operation, and accessibility of elevators over the life of the equipment. Primary safety concerns in ASME A17.1/CSA B44 include operation at terminals (2.25); overspeed (2.26.9.8, 2.26.10, and Sections 2.18 and 2.19); leveling with open car and landing doors (2.26.1.6); equipment failures (hardware and software) (2.26.9.3, 2.26.9.4, and Section 2.19); and fire and shock hazards (2.26.4.1 and 2.26.4.2).

The principles of elevator control systems have evolved over more than a century. The elevator must continue operating in a safe manner or revert to a more restrictive safe state in the event of any single or combined elevator control hardware or software failure (e.g., 2.26.9.3). Traditional wisdom suggests operational safety is greatest when the car is stopped. Therefore, elevator system design requires positive actions (signals) to allow the elevator system to change to any other state other than stopped. Traditionally, elevator safety has been achieved by following proven methods, requirements, and procedures, which have evolved from past system design. A control algorithm is generally proven to be safe by analyzing all possible hazards and showing by adherence to industry-accepted practices such as conducting FMEAs, FTA, and hazard/risk analysis, that each potential hazard is successfully mitigated. Where it is not possible to predict every failure mode (e.g., large scale integrated circuits and programmable electronics), other methods such as using checked redundancy, N-version programming, diversity, or safety integrity level (SIL) mandated reliability can be used to demonstrate that all hazards have been successfully mitigated.

System safety requires that from the initial conceptual design, through the actual hardware and/or software design, construction, installation, and maintenance of the elevator installation, safety will not be compromised.

With the availability and most frequent use of high performance, fast response time solid-state devices [see Section 1.3 for "static control" and "motor control" and Diagram 2.26(a)] in the 1960s, questions were raised about the adequacy and/or suitability of the ASME A17.1 and CSA B44 Codes that were in existence at the time.

With the first complete rewrite and reorganization of the ASA A17.1-1955 edition behind them, the ASME A17 Code writers were concerned about the potential hazards peculiar to this type of equipment. In particular, the ASME A17 Code writers were concerned with potential failure of static power devices and the resulting hazardous conditions that could exist should the failure occur while the car was in the process of leveling and/or was at a landing with open doors.

(a) Doing a risk analysis, the ASME A17 Code writers (i.e., Solid-State Subcommittee) identified a number of potential hazardous conditions resulting from catastrophic static control failures. For example

(1) a full-on power amplifier failure while the car is at floor level with the doors open could subject the car to a high acceleration rate and cause it to move away from the floor

(2) a failure while the car is leveling into the floor could cause it to travel past the floor with the doors open without stopping

(3) a failure could cause the car to come to a stop within the leveling zone, but considerably short of the floor

(4) a failure could cause the car to stop short of the floor, reverse direction, and move away from the floor with the doors open

(b) As a result of this risk analysis, ANSI A17.1(e)-1975 was published and included

(1) new definitions for "static control," "solid-state device," and "static switching" [Section 3 (Section 1.3)]

(2) restricted power-opening of car and hoistway doors to within 300 mm or 12 in. of the floor for static control systems [Rule 112.2 (2.13.2)]

(3) the requirement that speed governor overspeed switches operate in both directions to provide motion (direction) sensing to protect against the condition where the motor contactor closes, the brake lifts, and the drive (motor controller) fails to conduct [Rule 206.4 (2.18.4)]

(4) speed monitoring and inner landing zone for leveling operation [Rules 210.1e(6) and (7) (2.26.1.6.6 and 2.26.1.6.7)]

(5) requirements for AC variable voltage drives [Rule 210.9(d) (2.26.9.5)]

(c) Additional revisions were published in ANSI/ASME A17.1-1981 and included the following:

(1) a new technology section was added to the Preface advising the Authority Having Jurisdiction (Regulatory Authority) to exercise good judgment in granting exceptions to new products and/or new systems where it is equivalent to that intended by the present Code requirements.

(2) the "motor field sensing means" requirements were revised to allow the use of drives that use field-switching causing the motor shunt field current to pass through zero [Rule 210.2(d) (2.26.2.4)].

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(3) single-failure requirements were revised to include solid-state devices [Rule 210.9(c) (2.26.9.3)].

(4) DC drive requirements were added for the first time [Rule 210.9(d) (2.26.9.5)].

Subsequently, requirements were added for VVVF drives [ANSI/ASME A17.1-1984, Rule 210.9(e)] (2.26.9.6) and the entire control system architecture was redefined in ASME A17.1-1996 [Section 3 (Section 1.3)].

(d) With the ASME A17.1-2000 and CSA B44-00 editions, the following additional safety requirements were added; these will be discussed in more detail in the appropriate Handbook commentary:

(1) expanded section on inspection requirements (2.26.1.4)

(2) expanded single-failure requirements, including software system failures and cyclical checking for failures (2.26.9.3 and 2.26.9.4)

(3) EMI immunity requirements (2.26.4.4)

(4) contactor and relays in critical operating circuits (2.26.3)

(5) ascending car overspeed and unintended car movement protection [protection against control, machine and brake failures (Section 2.19)]

(e) ASME A17.1-2007/CSA B44-07 adopted additions and revisions related to electrical/electronic/programmable electronic system (E/E/PES), commonly referred to as "PES," within Definitions (Section 1.3) and the following areas:

(1) hoistway access operating requirements (2.12)

(2) Ascending Car Overspeed Protection (2.19.1)

(3) Unintended Car Movement Protection (2.19.2)

(4) Control and Operating Circuits (Section 2.26)

See detailed E/E/PES information under Handbook commentary on 2.26.4.3, 2.26.8, and 2.26.9.

Finally, whenever in doubt about the meaning of any requirement, please check the definitions in Section 1.3.

The following are of particular interest when reviewing the electrical requirements:

braking, electrically assisted
certified organization
control, motion
control, operation
control system
controller
controller, motion
controller, motor
controller, operation
electrical/electronic/programmable electronic system (E/E/PES)
hoistway access switch
electrical/electronic/programmable electronic (E/E/PE)
labeled/marked
landing zone
leveling
leveling device
leveling zone
listed/certified
mode of operation — low demand mode
mode of operation — high demand or continuous mode
normal stopping means
operating device
operation, inspection
proof-test
safety integrity level (SIL)
signal equipment (NEC®)
static switching
terminal-speed limiting device, emergency
terminal-stopping device, emergency
terminal-stopping device, final
terminal-stopping device, machine final (stop-motion switch)
terminal stopping device, normal

Wiring Diagram 2.25/2.26 captures the essential Code requirements of Sections 2.25 and 2.26 and will be referred to in the Handbook commentary. The following legends are used in the wiring diagrams and referenced in the Handbook commentary:

C1	Potential Relay #1 (Safety String for Electrical Protective Devices)
C2	Potential Relay #2 (Safety String for Electrical Protective Devices)
CD1	Car Door Relay #1 (Energized When Car Door Contacts Closed)
CD2	Car Door Relay #2 (Energized When Car Door Contacts Closed)
LD1	Landing Door Relay #1 (Energized When Hoistway Door Contacts Closed)
LD2	Landing Door Relay #2 (Energized When Hoistway Door Contacts Closed)
NOR1	Normal Operation Relay #1 (Energized When on Automatic, i.e., "Normal" Operation)
NOR2	Normal Operation Relay #2 (Energized When on Automatic, i.e., "Normal" Operation)
AUD	Access Enable Switch Operation
#1	Brake Coil Circuit Relay #1
#2	Brake Coil Circuit Relay #2
1	Motor Circuit Relay or Contactor #1
2	Motor Circuit Contactor #2
3	Car Door Bypass Relay #1 (Energized When Car Door Bypass Switch in Bypass Position)
4	Car Door Bypass Relay #2 (Energized When Car Door Bypass Switch in Bypass Position)

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5 Hoistway Door Bypass Relay #1 (Energized When Car Door Bypass Switch in Bypass Position)
6 Hoistway Door Bypass Relay #2 (Energized When Car Door Bypass Switch in Bypass Position)
M Motor, or Motor Armature
G Generator Armature
MC Motor Control Device
DZ Door Zone (Check)

2.26.1 Operation and Operating Devices

2.26.1.1 Types of Operating Devices. An operating device is a car switch, push-button, lever, or other manual device used to actuate a control. All operating devices must be of the enclosed electric type to protect against accidental contact (i.e., prevent electric shock), which is a requirement of the NEC® Section 620.4, CEC Section 38-004, and ASME A17.5/CSA B44.1. See Diagrams 2.26(a) and 2.26(b) and definitions for operating devices in Section 1.3.

2.26.1.2 For Car-Switch Operation Elevators. If the switch did not return to the stop position when the operator's hand was removed, the car would continue in its direction of travel until the final terminal limit was engaged and thus possibly trap the passengers in a stalled elevator. The normal stop position of the handle of a lever-type operating device is the center position. A lever-type operating device that meets these requirements is commonly called a self-centering switch.

2.26.1.3 Additional Operating Devices for Elevators Equipped to Carry One-Piece Loads Greater Than the Rated Load. The operating device for one-piece (safe lift) operation has to be of the continuous pressure type, located near the driving machine or with means provided to visually observe the driving machine, with the speed restricted to 0.75 m/s or 150 ft/min. See Handbook commentary on 2.16.7.

2.26.1.4 Inspection Operation. Inspection operation is provided for the use of elevator personnel. When the elevator is being moved, the operator must have complete control of the elevator. Continuous-pressure operating means afford the operator complete control over car movement. As soon as pressure is removed, the car stops; when pressure is restored, the car moves in the desired direction. The speed is limited to a speed considered safe when operating from top of the car.

Portable devices on top of the car allow operators to stand where necessary to perform their duties (see Handbook commentary on 2.14.1.6), which may be desirable on some larger cars. If the device could be unplugged or removed from the car, it may not be available when needed; thus, the requirement that if the device is portable it cannot be removed. The location of the stop switch being readily accessible from the hoistway entrance ensures safety as the user will always know where to find it and take control before he gets on top of the car. If the means of transferring the control to the car top operating station were other than on top of the car, it would not be convenient and there could be a tendency to ride the top of the car without actuating the top of the car operating device. The requirements for inspection operation were extensively revised and reorganized in ASME A17.1-2000 and CSA B44-00.

ASME A17.1-2000 and CSA B44-00 established inspection and hoistway access switch operation hierarchies as follows:

(a) top-of-car inspection.
(b) in-car inspection.
(c) hoistway access operation.
(d) other permitted locations for inspection operation.

See Chart 2.26.1.4 and Handbook commentary on 2.26.1.5.

This prevents overriding top-of-car inspection by other means that could place elevator personnel on the car top in a hazardous situation.

ASME A17.1-2013/CSA B44-13 clarified what is permitted in terms of common elements between the speed-sensing devices for the normal speed control system and the independent means for limiting speed on inspection operation, along with monitoring requirements and design/performance requirements. The changes clarify that independence is limited to the speed-limiting means as compared to normal speed control. Provisions and requirements reflect acceptable industry practices. Furthermore, the speed-sensing means is permitted to be the same device as long as some other method (e.g., speed feedback device or other speed-related variable) is utilized to continuously verify the primary speed-sensing device.

2.26.1.4.1 General Requirements. General requirements for inspection operation and transfer switch have been grouped under this requirement. Transfer switch labeling requirements were added in ASME A17.1-2000 and CSA B44-00, and functional requirements are defined for both “INSP” and “NORMAL” positions. The requirement clarified that “positively opened contacts” are required only when transferring from “NORMAL” to “INSP” and not from “INSP” to “NORM.” Requirements also clearly specify that automatic power door opening and closing shall be disabled anytime that the inspection transfer switch is in “INSP” position. ASME A17.1-2000 and CSA B44-00 added requirements for inspection operating devices, including labeling requirements, and separated “operation” from “operating devices” requirements. The requirements also clarify that car doors may be held closed electrically on inspection operation.

ASME A17.1-2007/CSA B44-07 added a second paragraph to 2.26.1.4.1(d)(1), which adds a requirement for redundant speed monitoring consistent with the requirement for leveling and releveling and the

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requirements of 2.26.9.3(c), (i.e., 0.75 m/s or 150 ft/min maximum inspection speed cannot be exceeded due to a single device failure).

2.26.1.4.2 Top-of-Car Inspection Operation. All of the additional requirements for top-of-car inspection operation are grouped together in this requirement. Requirements were added in ASME A17.1-2000 and CSA B44-00 for permanent location of the stop switch, location of the transfer switch including a requirement that the transfer switch be designed to prevent accidental transfer from "INSP" to "NORM" position, and provisions for permitted locations of operating devices. ASME A17.1-2000 and CSA B44-00 added requirements for an "ENABLE" device to protect against accidental activation or failure of the inspection operating devices. The inspection-operating device is permitted to be portable as long as the "ENABLE" and an additional "STOP" switch are included within the portable unit. Personnel safety has been adequately addressed by requiring the stop switch to be readily accessible from the hoistway entrance.

ASME A17.1b-2009/CSA B44b-09 added requirements to ensure that the top-of-car inspection operating device can be reached from a refuge area by elevator personnel while they are on the car top (see 2.14.1.6.2).

Requirement 2.26.1.4.2 was revised in ASME A17.1-2022/CSA B44:22 to clarify that the transfer switch can be located in the portable unit.

2.26.1.4.3 In-Car Inspection Operation. All of the additional requirements for in-car inspection operation are grouped in this requirement. A separate switch or switch position is required to enable hoistway access switches.

2.26.1.4.4 Machinery Space Outside the Hoistway, Machine Room, Control Space Outside the Hoistway, Control Room, Pit, Landing, and Working Platform Inspection Operations. All of the additional requirements for inspection operation are grouped in this requirement for the following permitted locations:

(a) machinery space outside the hoistway machine room

(b) control space outside the hoistway control room

(c) pit landing

(d) working platform

See Diagrams 2.26.1.4(a) and 2.26.1.4(b) and Chart 2.26.1.4.

2.26.1.5 Inspection Operation With Open Door Circuits. The purpose of these requirements is to eliminate the use of jumpers to bypass door and gate contacts, and to replace jumpers with devices and operation requirements that should reduce the exposure to faulty door circuits. A proposal was originally made by the International Union of Elevator Constructors (IUEC) to the CSA B44 Technical Committee and ASME A17 Main Committee on November 5, 1995 and May 25, 1998, respectively. A meeting of ASME A17 and CSA B44 representatives was held on December 8, 1998 to address the IUEC proposal. The general consensus was that

(a) jumpers should be prohibited

(b) the bypass means should be located in the controller

(c) the speed should be limited to inspection speed or less

(d) a single failure of the bypass equipment should not permit the elevator to revert to automatic operation

(e) if the bypass is left "ON" after the problem is corrected, the car shall not be able to revert to automatic operation

Instances where jumpers have been used to bypass car and landing door electrical contact circuits and inadvertently left in place after servicing the elevator have resulted in serious accidents. It has become evident that some means should be provided to inhibit the use of jumpers across door contact circuits.

There are two main hazards associated with using jumpers:

(1) They can be left in place and still be effective when the car is returned to service (high speed operation and carrying passengers).

(2) They can be connected to the wrong terminals and cause any number of unsafe conditions.

The requirements specify that the permanently wired bypass switches be effective only on inspection operation.

Prior to ASME A17.1a-2002 and CSA B44-00 Update No. 1-02, inspection operation from the machine room with car or hoistway door circuits bypassed was permitted under prescribed conditions, but not required.

Due to much discussion and further consideration, permission to provide inspection operation from the machine room with car or hoistway door circuits bypassed was removed from the Code in ASME A17.1a-2002 and CSA B44-00 Update No. 1-02. Requirements 2.26.1.5.4, 2.26.1.5.5, and 2.26.1.5.6 were changed to permit operation with open door circuits only when top-of-car inspection operation or in-car inspection operation is activated, and 2.26.1.5.10 was deleted.

See Diagrams 2.26.1.4(b) and 2.26.1.5.

Requirement 2.26.1.5 was revised in ASME A17.1-2010/CSA B44-10 to clarify the required location of the car door and hoistway door bypass switches including that they are permitted to be provided in the Inspection and Test Panel even if the controller enclosure is also located outside the hoistway.

Requirement 2.26.1.5 was revised in ASME A17.1-2019/CSA B44:19 to use the new terms "door closed detection means" and "door locked detection means" and to include SIL rated devices.

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Requirement 2.26.1.5.5, Car Door Bypass, was revised in ASME A17.1a-2008/CSA B44a-08 to include bypass provisions for car door interlocks and hoistway door electric contacts.

Requirement 2.26.1.5.5 was revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means."

Requirement 2.26.1.5.6 was revised in ASME A17.1-2019/CSA B44:19 to use the new term "door locked detection means."

Requirements 2.26.1.5.7 and 2.26.1.5.8 were revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means" and to include SIL rated devices.

NOTE: Additional operational safety intended to mitigate potential hazards related to the use of jumpers is found under 2.26.5.

2.26.1.6 Operation in Leveling or Truck Zone. Generally speaking, all modern controlled elevators have "leveling" and are designed to stop and maintain a certain accuracy level between the car and landing sills, as passengers enter and leave the car. ASME A17.1/CSA B44 addresses the car platform to hoistway door sill vertical distance (leveling) in 2.26.11, where ANSI/ICC A117.1, ADAAG, or ADA/ABA AG is not applicable. See Handbook commentary on 2.26.11.

The term "leveling" has been around the elevator industry for a very long time. In the early days (1910s to 1920s) automatic leveling was more important on freight elevators where the platform had to be flush with the floor for industrial fork lift loading, cart loading, and tailboard loading of trucks. This was done first by an auxiliary elevator machine coupled to the drive machine to turn it at slow leveling speed, called micro machine leveling.

Following auxiliary micro machine leveling, main machine leveling was introduced in the 1920s to 1930s, where the hoist motor was designed to have sufficient torque to operate at leveling speeds.

Passenger elevators, on the other hand, were operated by attendants using car switch control, who brought elevators into the vicinity of the floor. The skill of a passenger car attendant was limited to car speeds up to 1.5 m/s or 300 ft/min, above which the attendant could not react fast enough, resulting in the missing of landings and poor stopping accuracy.

On passenger elevators, automatic leveling was first added with resistance control, where the attendant initiated the stop, but the actual slow down and leveling was completely automatic. When first introduced it was known as "automatic floor stop" and/or "flying stop" operation.

With the introduction of "signal control" operation and the use of generator field control (a.k.a., variable voltage or Ward-Leonard control) all the attendant had to do was press the "START" or "DOOR CLOSE" button and the elevator automatically accelerated and decelerated in response to car and hall calls ("operating devices") and leveled into the landing with an accuracy of approximately ±13 mm or ±½ in.

Ward-Leonard control (i.e., generator field control) was the control system of choice until the 1970s for high-speed installations (and even for the lower car speeds and especially for freight elevators) where leveling accuracy was particularly important. The Vertical Transportation Handbook by George Strakosch (New York, John Wiley & Sons), suggests that for a quality installation, the elevator should come to a stop at a floor within a prescribed leveling tolerance of ±7 mm or ±¼ in. and maintain that tolerance during releveling as passengers enter and leave the car.

Automatic leveling (or releveling) occurs when the control of the elevator position is taken off main operation and control of leveling speed and final stop is by a leveling device (see Section 1.3). See Handbook commentary on Sections 2.25 and 2.26, and 2.13.2.1.2.

2.26.1.6.5 A change was made in the ASME A17.1a-2002 and CSA B44-00 Update No. 1-02 to not permit operation by a car-leveling device with two separate car and hoistway door entrances in the open position. That application would not be in compliance with ADAAG, ICC/ANSI A117.1, ADA/ABA AG, and ASME A17.1/CSA B44 Appendix E.

2.26.1.6.6 Two general categories of systems can be designed to meet these requirements. One type of system monitors the car speed with a comparator-type device. The other is a speed-saturated system in which the drive system, under worst-case fault conditions, would be incapable of moving the car at a speed exceeding 0.75 m/s or 150 ft/min. Safety requirements of systems employing the speed-monitoring technique are such that a malfunction of a component involved in the operation of the car (e.g., a tachometer "failing open," causing the car speed to increase) would not result in a corresponding failure in the speed monitor, which employs the tachometer as a speed-indicating device.

An independent means is required to limit the leveling speed even if the rated speed is 0.75 m/s or 150 ft/min or less.

See Diagram 2.26.1.6.

ASME A17.1-2013/CSA B44-13 included expanded requirements that clarified the independence in more specific terms. Clarification of what is permitted in terms of common elements between speed-sensing devices for the normal speed control system and the independent means for limiting speed on inspection operation was provided in the body of the requirements along with monitoring requirements and design/performance requirements. Changes clarified that independence is limited to the speed-limiting means as compared to the normal speed control. Provisions and requirements listed reflect acceptable industry practice. Furthermore, the

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speed-sensing means is permitted to be the same device as long as some other method (e.g., speed feedback device or other speed-related variable) is utilized to continuously verify the primary speed-sensing device.

2.26.1.6.7 This requirement provides protection in the event the car stops with the doors open within the leveling zone, but outside the "inner zone." In this instance, the car would not be permitted to relevel. The car would be permitted to restart if the doors were closed and all other conditions for the initiating circuits were satisfied. In the event that the car stops with the doors open within the leveling zone, but outside the inner zone, and reverses direction, the car would be stopped and not permitted to restart.

2.26.1.7 Executable Software. Requirement 2.26.1.7 was added in ASME A17.1-2019/CSA B44:19 to provide requirements for documentation for the installation of software related to A17.1 safety functions in a similar manner as current code requires for field wiring diagrams. Each version of software must have a unique software identifier (USI) to distinguish when changes are made. The requirements also allow for field adjustable parameters used by the executable software provided that they do not alter the USI. Parameter changes cannot cause the USI to change because it is necessary to maintain the integrity and traceability of the executable software functionality and the USI associated with it. A means is required in the control system to view the USI on- site, so that inspectors and mechanics can identify the installed software USI.

Requirement 2.26.1.7.1 was revised in ASME A17.1-2022/CSA B44:22 to require a USI update when there are changes to test enable operation (see Handbook commentary on 2.26.14). Additionally, a USI update is now required for software changes related to operating modes restricted to Group 1, restricted openings of car doors, additional requirements for passenger overload in the down direction, and functions that are required by the Code to be manually reset.

Requirements 2.26.1.7.1 and 2.26.1.7.2 were revised in ASME A17.1-2022/CSA B44:22 to point to the requirements for the means to permit on-site software download or to modify parameters of executable software requiring a USI. See Handbook commentary on 2.26.13.

2.26.2 Electrical Protective Devices

Where a malfunction of an elevator component and/or device can create a serious hazard for elevator users, the operation of such components and/or devices has to be checked by an "electrical protective device." See Diagram 2.26.2. For example, doors not closing [2.26.2.14 or 2.26.2.15] or an elevator not making a normal stop at the terminals [2.26.2.16 or 2.26.2.11].

Also, an electrical protective device may be necessary to ensure safety of elevator mechanics, such as the stop switches on the car top, in the pit, or machinery spaces. New wording was incorporated in ASME A17.1-2000 and CSA B44-00 to establish general requirements for electrical protective devices in 2.26.4.3 that they have contacts that are positively opened. Where positively opened contacts are not required (i.e., where solid state and/or programmable electronics are permitted) those electrical protective devices have to be designed to protect against single failures of those devices (e.g., 2.26.2.12, 2.26.2.29, and 2.26.2.30).

All electrical protective devices have the same response when "activated (operated, opened)," i.e., cause power to be removed from the elevator driving machine motor and brake, thereby reverting to a known safe state, meaning that the elevator comes to a stop.

The phrase "remove power from the driving machine motor and brake" is used extensively throughout ASME A17.1/CSA B44. The word "power" is used in the sense of "driving power." Requirement 2.26.2.2 provides further clarification for a particular class of control systems by stating that "It is not required that the electrical connections between the elevator driving machine motor and the generator be opened in order to remove power from the elevator motor."An effective way to make a fast and controlled stop on a DC machine is to maintain the motor field excitation while removing driving power from the motor armature and providing a dynamic braking path for motor armature current. The clear intent of the phrase "remove power from the driving machine" is to require that the elevator stops in the most expeditious and safe manner. The language is general and performance oriented, and as such covers a wide variation of elevator drive control systems.

It is also permitted to apply the emergency brake upon actuation of any electrical protective device. For example, during the actuation of emergency terminal speed limiting (2.262.12), simultaneous activation of the braking system and the emergency brake may occur. This has been clarified in ASME A17.1a-2008/CSA B44a-08. Additional requirements in Section 2.19 permit application of the emergency brake during the stopping of the elevator while on continuous pressure operation (e.g., inspection operation).

System safety is based on the principle that the safest state achievable is when the elevator(s) are stopped. Therefore, to allow the car to move beyond the stopped state requires positive action (energize "Potential Relay #1 and #2" in Diagram 2.26.2). To allow the elevator system to enter any state beyond the stopped state requires that all electrical protective devices must not be in the "activated, operated, or opened" state.

The following is an overview of significant revisions incorporated in ASME A17.1-2000 and CSA B44-00:

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(a) a number of sections had editorial changes made for clarity. Also deleted "cause power to be removed from the elevator driving-machine motor and brake," since this requirement is now covered in the opening paragraph of 2.26.2.

(b) Requirement 2.26.2.6 — clarified since broken ropes, tape, or chain switch is the same electrical protective device regardless of the function of the rope, tape, or chain.

(c) Requirement 2.26.2.28 — car door interlock added to harmonize with CSA B44 requirements.

(d) Requirement 2.26.2.23 — car access panel locking device added to harmonize with CSA B44 requirements.

(e) Requirement 2.26.2.32 — hoistway access opening locking device added to harmonize with CSA B44 requirements.

(f) Requirement 2.26.2.29 — ascending car overspeed protection device, to provide protection against ascending car overspeed to prevent collision of the elevator with the building overhead and to harmonize with CSA B44 requirements. To ensure the safe functioning of the detection means, redundancy is required so that no single component fault (hardware or software) will lead to an unsafe condition.

(g) Requirement 2.26.2.30 — unintended car movement device; to prevent movement of the elevator away from the landing when the car and hoistway doors are open and to harmonize with CSA B44 requirements. To ensure the safe functioning of the detection means, redundancy is required so that no single component fault (hardware and/or software) will lead to an unsafe condition.

2.26.2.1 Slack-Rope Switch. See Diagram 2.25.3.5.

2.26.2.3 Compensating-Rope Sheave Switch. See Handbook commentary on 2.21.4.2 and Diagram 2.26.2.3.

2.26.2.4 Motor Field Sensing Means. See Diagram 2.26.2.4.

ASME A17.1-2013/CSA B44-13 clarified the intent and scope for the device to detect overspeed due to loss of motor field, and expanded upon the phrase "independent of the operation of the governor overspeed switch" based on past accepted practice, without changing the scope of the existing requirements. Common actuating means (such as the governor shaft or sheave) and common mounting means are permitted and would be in compliance with the required independence.

2.26.2.5 Emergency Stop Switch. The original need for the in-car emergency stop switch is easily understood. When passenger elevators were equipped with perforated car doors, or no doors at all, pinching hazards and the possibility of crushing between hoistway walls and sills existed. However, on today's modern passenger elevators with solid enclosures, these hazards have been eliminated.

Although accidents have been prevented by the use of emergency stop switches, evidence is overwhelming that more accidents and problems are caused by their misuse.

(a) Due to misuse, the emergency stop switch was initially prohibited by the states of Wisconsin and Florida, which reported positive results. Some examples of misuse reported are as follows:

(1) Robbery, muggings, and other violent crimes are perpetrated after actuating the emergency stop switch, stopping the car between floors.

(2) The emergency stop switch is actuated while the car is leveling, causing an unsafe condition where people can trip while going into or out of the car.

(3) The stop switch is operated while the doors are open, possibly negating stretch-of-cable leveling and causing the same tripping hazard.

(4) The emergency stop switch is pushed inadvertently in a crowded car and passengers remain trapped, thinking there is an equipment failure.

(5) Passengers have stopped the car between floors and opened the hoistway door, jumping to the floor below. This sometimes results in the passenger falling back into the hoistway, causing serious injury or death.

(6) Operating an emergency stop switch on a high-speed elevator at full speed could result in a severe abrupt stop, which may injure the passengers.

(b) ASME A17.1/CSA B44 provides many safety requirements for the protection of passengers as follows:

(1) Requirement 2.11.6. Passenger elevator hoistway doors shall be so arranged that they may be opened by hand from within the elevator car only when the car is within the unlocking zone. (See Section 1.3.)

(2) Requirement 2.13.2. Power opening can occur only when the car is at rest or leveling. On elevators with static control, power cannot be applied to open car doors until the car is within 300 mm or 12 in. of the landing.

(3) Requirement 2.26.1.6.6. This limits the leveling speed to a maximum of 0.75 m/s or 150 ft/min with doors open.

(4) Requirement 2.26.1.6.7. Requires an inner landing zone extending not more than 75 mm or 3 in. above and 75 mm or 3 in. below the landing. A car shall not move if it stops outside the inner landing zone unless the doors are fully closed.

(5) Requirement 2.26.9.3(b). Prevents the car from starting to run if any hoistway door interlock is unlocked or hoistway door or car gate electric contact is not in the closed position.

(6) Requirement 2.26.9.5. Requires two devices to remove power independently from the driving machine motor each time the car stops.

All of these requirements not only add to safety, but also directly protect the entrance when the car is at or away from the floor.

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The European Code CEN-EN 81 has prohibited the in-car emergency stop switch basically for the same reasons. Moreover, other countries have reported frequent misuse of the emergency stop switch.

Thus, ASME A17.1/CSA 44 prohibits publicly accessible emergency stop switches in passenger elevators and requires a stop switch in the car that is either key operated or located behind a locked cover (2.26.2.21). The in-car stop switch is comparable in function to the stop switch in the pit or on the car top; it is useful for inspectors and maintenance mechanics, and therefore is required, but in a form inaccessible to the public.

An emergency stop switch is required in a freight elevator as perforations are permitted in freight car enclosures. An emergency stop switch also needs to be accessible to stop an elevator if the load shifts due to improper stacking.

When the emergency stop switch is placed in the "STOP" position, power must be removed from the elevator driving machine motor and brake. The failure of any spring used in the switch must not cause a switch in the "STOP" position to revert to the "RUN" position. Emergency stop switches conforming to these requirements are also required in locations such as machinery spaces and control spaces (2.7.3.5), in the pit (2.2.6), and on top of the car (2.26.2.8).

Requirement 2.26.2.5 was revised in ASME A17.1-2016/CSA B44-16 to prohibit the use of toggle or push-to-run switches for emergency stops for safety reasons. Toggle and push-to-run switches can be inadvertently moved to the "RUN" position, placing elevator personnel at risk of being injured due to unexpected movement of the elevating device. Push-to-stop switches, if inadvertently actuated, will cause the elevator to be in a safe state.

2.26.2.9 Car-Safety Mechanism Switch. See Handbook commentary on 2.14.7, 2.18.4.1, and 2.18.4.3 and Diagram 2.26.2.9.

2.26.2.10 Speed Governor Overspeed Switch. See Handbook commentary on 2.18.4.1, 2.18.4.2, and 2.18.4.3 and Diagram 2.26.2.10.

2.26.2.11 Final Terminal Stopping Devices. See Handbook commentary on 2.25.3 and Diagram 2.25.3.

2.26.2.14 Hoistway Door Interlocks and Hoistway Door Closed Detection Means. Requirement 2.26.2.14 was revised in ASME A17.1-2019/CSA B44:19 to use the new terms "closed detection means."

2.26.2.15 Car Door and Gate Closed Detection Means. Requirement 2.26.2.15 was revised in ASME A17.1-2019/CSA B44:19 to use the new terms "closed detection means."

2.26.2.19 Motor-Generator Overspeed Protection. See Diagram 2.26.2.19.

2.26.2.21 In-Car Stop Switch. See Handbook commentary on 2.26.2.5.

2.26.2.22 Buffer Switches for Gas Spring-Return Oil Buffers. See Diagram 2.26.2.22.

2.26.2.25 Blind Hoistway Emergency Door Electric Contact. ASME A17.1-2013/CSA B44-13 was revised to allow an electric contact and a lock rather than an electromechanical device or interlock. Added safety is provided due to requirements for a Group 1 Security key, a cylinder-type lock having not less than five pins or five discs, which is self-locking, and the requirement for a hinged self-closing barrier independent of the door.

2.26.2.33 Firefighters' Stop Switch. ASME A17.1b-2009/CSA B44b-09 revised this requirement to establish uniformity and consistency for firefighters' stop switch required by 2.27.3.3.7 where firefighters need to operate the switch with a gloved hand. The Code prohibits "push to run" buttons, which could be moved to the run position by closing a cover.

2.26.2.36 Working Platform Electrical Device. Requirement 2.26.2.36 was revised in ASME A17.1-2019/CSA B44:19 to editorially correct the referenced requirements.

2.26.2.37 Retractable Stop Electrical Device. Requirement 2.26.2.14 was revised in ASME A17.1-2019/CSA B44:19 to editorially correct the referenced requirements

2.26.2.38 Ladder Electrical Device. Requirement 2.26.2.38 was revised in ASME A17.1-2022/CSA B44:22 to update the title and to reference the new device required in 2.2.4.2.8 for detection of persons on a pit ladder. See Handbook commentary on 2.2.4.2.

2.26.2.39 Sway Control Guide Slack Suspension Detection Means. This is an electrical device that operates whenever any of the suspension members of the sway control guide become slack. This device is required to be of the manually reset type. This sway control guide electrical device is added to Table 2.26.4.3.2 and is assigned a SIL rating of 2.

2.26.3 Contactors and Relays for Use in Critical Operating Circuits

ASME A17.1-2000 and CSA B44-00 added requirements for electromechanical operated contactors and relays used to satisfy the requirements of 2.26.8.2 and 2.26.9.3 through 2.26.9.7 where those contractors and relays are to be used in critical operating circuits.

It is important to note that 2.26.3 is a requirement for contacts, if such contacts are used for the monitoring of the critical electromechanical contactors or relays. This language clearly stipulates that monitoring of critical

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device operation could be achieved by means other than the monitoring contacts on the devices.

If contacts are used for monitoring, the key element of the requirement is that the monitoring contact should not change state if the contact in the critical circuit has not changed state. One method to ensure compliance is to use a relay/contactor that satisfies the following requirements:

(a) if one of the break contacts (normally closed) is closed, all the make contacts are open

(b) if one of the make contacts (normally open) is closed, all the break contacts are open

Springs may be used, but spring failures shall not cause monitoring contact(s) to indicate an open critical circuit contact if the critical circuit contact is not open. Requirement 2.26.3 does not specifically mandate the use of "force-guided" contacts, although that would be a compliant design approach.

Another method of monitoring critical devices would be to measure the voltage or current on the load side of the contact in the critical circuit itself. As an example (see Wiring Diagram 2.25/2.26), the voltage on the load side of the #1 and #2 relay contacts could be monitored to ensure that these devices open the brake circuit after every stop of the elevator. Requirement 2.26.3 would not apply to this example, because a separate "monitoring contact" is not used. However, the essential safety requirement is still complied with.

2.26.4 Electrical Equipment and Wiring

2.26.4.1 See also Diagram 2.26.4.1(a) and Charts 2.26.4.1(b) and 2.26.4.1(c). The Handbook commentary on 2.26.4.1 is broken into three sections:

(a) General Commentary on ANSI/NFPA 70, Article 620 up through the 2014 edition

(b) Highlights of the new and revised requirements in ANSI/NFPA 70-2017

(c) Highlights of the new and revised requirements in CSA C22.1-18

General Commentary on National Electrical Code® NFPA 70, Article 620

NOTE: While the following commentary is on the National Electrical Code® (NEC®), it may also apply to similar requirements in the Canadian Electrical Code (CEC).

Section I. General

620.2. Definitions

Clearly defines the terms used in Article 620. Definitions that pertain to multiple Articles were relocated to Article 100 in NFPA 70-2017.

New technology has expanded the traditional meaning and use of the terms "controller" and "control system." This stems from the use of the microprocessor and other micro electronics that now permits a control system's and controller's functions to be physically distributed in different locations. The use of this new micro technology also changes the "safety" aspects of the use of such equipment when their voltage levels are low and their power levels are typically measured in micro and mill watts. The definitions recognize this and separate the control system and controller into its functional parts, while maintaining the traditionally defined controller in the newly defined "Motor Controller." It is within this "Motor Controller" that the high voltage and high power portion of the controller is contained, and with which the major traditional safety concerns exist. The 1996 NEC® rewrite of Article 620 and subsequent editions use these new definitions to address and specify the proper safety concerns of these controllers, "Motor," "Motion," and "Operation."

With the advent of the so-called machine-room-less elevator (MRL), elevator and escalator equipment has been placed in other than the traditional machine room or machinery space. Control rooms and control spaces now exist. All these rooms and spaces have their unique safety concerns that are addressed in ASME A17.1/CSA B44. They have been defined compatibly with ASME A17.1/CSA B44, and the terminology is also used in Article 620 as appropriate.

620.3. Voltage Limitations

The voltage limitation is to provide protection for the passenger. The greatest danger is energizing some conductive, noncurrent carrying part of the car/landing devices (i.e., operating devices) through a fault. There is adequate provision for safety in the NEC® to protect trained mechanics when working on equipment. In Section 110.27(A), the requirements for guarding live parts against accidental contact are stated only for systems operating at 50 V or more, which seems to indicate that all voltages at 50 V or more, are considered hazardous. Since the 1925 edition of the ASME A17.1 Safety Code for Elevator and Escalators, the maximum nominal voltage permitted for operating device circuits was limited to 300 V to ground. The first edition of the ASME A17.1 Elevator Safety Code (1921) limited the voltages to 750 V.

620.3. Voltage Limitations

620.3(A) Elevator drive technology is using voltage levels above 600 V within the motor controller cabinet, functionally associated equipment, and the interconnecting wiring. Voltages over 600 V are permitted as long as the equipment conforms to the appropriate CSA and ANSI standard established under the provisions of the Canadian and National Electrical Codes. Elevator/escalator and related electrical equipment has to be certified under the provisions of CAN/CSA B44.1-ASME/ANSI A17.5, a harmonized North American Standard; therefore,

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the fire and shock concerns of the Canadian and National Electrical Codes are addressed.

620.3(B) and (C) Include requirements for lighting, heating, and air-conditioning circuits.

620.5. Working Clearances

The terms used in 620.5(A) are correlated with the definition requirements in 620.2. The equipment in 620.5(A) may be moved so that the intended requirements of Section 110.26(A) are complied with. The conditions described in 620.5(B), (C), and (D) guard against electrical shock under the conditions where only qualified persons will examine, adjust, service, and maintain the equipment. Also, see 110.26(A), and 110.26(A)(1)(b). Working clearances are applicable to all electrical equipment in this article, not only those in the machine room.

Section II. Conductors

620.11. Insulation of Conductor

Covers temperature ratings, flame ratings, and minimum insulation voltage rating of hoistway door inter-lock wiring, traveling cables, and other related wiring. Also, recognizes flame-retardant, limited smoke, low toxicity, and low corrosivity insulating materials. The FPN indicates minimum acceptable requirements for flame-retardant insulation.

620.12. Minimum Size of Conductors

Clarifies that conductors smaller than No. 14 AWG, up to and including No. 20 AWG, may be used in parallel for lighting circuits, provided that the resultant equivalent ampacity of the parallel conductors is at least equal to that of 14 AWG copper. 620.12(B) permits smaller than No. 24 AWG if listed for the purpose. Shielded cables interconnecting microprocessors in an elevator distributive system come in sizes smaller than No. 24 AWG.

620.13. Feeder and Branch Circuit Conductors

620.13(A) Due to the duty cycle nature of the equipment, the actual current for short periods of time may exceed the nominal nameplate value, but there are also operational periods of time when actual current levels are well below the nameplate value, as well as periods of time when the actual current is zero. Table 430.22 (E) is based on equivalent root mean square (rms) heating current — that is to say, a current that will cause the equivalent heating in the conductors as a continuous duty cycle. The FPN to 620.13(A) is to remove the confusion as to the values in Table 430.22(E) and to show that currents in excess of the nominal rating will be seen during the duty cycle.

620.13(B) The heating of conductors depends on the rms current value, which may be reflected by the name-plate current rating of the motor controller. The name-plate current rating of a motor controller for a duty cycle may be determined by the elevator manufacturer based on the design or application. See also FPN in Table 620.14. The following calculation will illustrate this concept.

EXAMPLE: The elevator manufacturer decides to rate his controller on the full load up (worst case) load condition. Assume an elevator using an adjustable speed drive of the SCR converter type has the input power at 460-3-60 and the elevator DC motor has the following duty cycle currents:

(a) motor accelerating full load up = 150 A DC for 2 s
(b) motor running full load up = 75 A DC for 3.5 s
(c) motor decelerating full load up = 55 A DC for 2 s

There are 240 starts per hour and the elevator operates at 50% duty cycle (i.e., half time on, half time off). The controller power transformer is located within the controller cabinet and has a 460 V primary and a 300 V secondary. The controller contains power supplies for the machine brake, motor field, and internal drive controls, which draw 10 A (assumed continuous) from the AC line at the primary of the input transformer.

The motor RMS current over the duty cycle is calculated as: where

For 240 starts per hour, the interval between starts is 15 s. For 50% duty cycle, the idle time T_i = 7.5 s.

Solving for I_{dcrms}

Reflecting this to the AC line input side of the controller transformer,

Combining this RMS current with the constant drive power supply current of 10 A, I_{Total} = 37 A + 10 A = 47 A. This is the nameplate rating the elevator manufacturer has chosen for the controller. I_{Rated} = 47 A.

620.13(C) A motor controller may be supplied by a power transformer, which changes the line voltage (primary) to the input voltage (secondary) required by the motor controller. The conductors supplying the power transformer carry current at line voltage to supply the motor controller through the power transformer. The input (primary) nameplate current of the power trans-former includes the motor controller load on the trans-former secondary (referred to the transformer primary) and the transformer losses.

620.13(D) Table 430.22(E) contains factors to adjust the nameplate current rating of elevator (intermittent duty) rotating equipment based on the time rating of such equipment, e.g., 30 min, 60 min, or continuous. These factors "normalize" the current for intermittent duty application to continuous duty application, which Article 430 is primarily concerned with.

The 125% factor in the 1993 and previous editions of Section 620.13(B) applied to an elevator system with multiple motors. This applies to the feeder conductors supplying a bank of elevators. If the substantiation for (A), (B), and (C) apply to individual components of a single elevator, then it must follow that a feeder conductor, which supplies several cars described in (A), (B), and (C), will be subject to the sum of the currents of the equipment it directly supplies as determined in (A), (B), and (C). In the 1990 NEC® and previous editions, Section 430-24 required 125% of the largest motor current rating for

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both continuous and noncontinuous duty motors. With the 1993 NEC® change to Section 430-24, there appears to be no justification for the 125% factor that used to be in 620.13(B) for intermittent duty application. Examples 9 and 10 in Appendix D illustrate requirements. See Diagram 2.26.4.1(d).

620.15. Motor Controller Rating

This rule recognizes that when an elevator application does not require the full nameplate rating of the motor in conjunction with a motor controller, which limits the available power to the motor, such as an adjustable speed drive system, that a motor controller of smaller rating than the motor nameplate rating is suitable.

620.16. Short-Circuit Current Rating

This rule was added in NFPA 70-2017 to require the short-circuit current withstand rating to be marked on the controller and for the controller to be installed with that rating.

Section III. Wiring

620.21. Wiring Methods

Conductors are to be installed in the specified types of raceway or are to be of the type specified except as permitted in 620.21(A) through (C). See Diagrams 2.26.4.1(e) through 2.26.4.1(h).

620.21(A)(1)(e) The requirement limits the length of hard service cords used to connect sump pumps and oil recovery units to 6 ft or 1.8 m to allow for easy service and replacement.

620.22. Branch Circuits for Car Lighting, Receptacle(s), Ventilation, Heating, and Air Conditioning

See Diagram 2.26.4.1(i).

620.23. Branch Circuit for Machine Room or Control Room/Machinery Space or Control Space Lighting and Receptacle(s)

Harmonized with the Canadian Electrical Code CSA C22.1, Section 38-023, and ASME A17.1/CSA B44, requirement 2.7.9. A safety problem could be created for persons if the lighting were connected to the load side of GFCI receptacles (i.e., person trying to exit space or reset receptacles without lighting). NFPA 70-2017 was revised to require separate branch circuits for lighting loads and receptacle loads to enhance safety.

620.24. Branch Circuit for Hoistway Pit Lighting and Receptacle(s)

Harmonized with the Canadian Electrical Code CSA C22.1 Section 38-024 and ASME A17.1/CSA B44, requirement 2.2.5. A safety problem could be created for persons if the lighting were connected to the load side of GFCI receptacles (i.e., person trying to exit space or reset receptacles without lighting). NFPA 70-2017 was revised to require separate branch circuits for lighting loads and receptacle loads to enhance safety.

620.25. Branch Circuit for Other Utilization Equipment

A separate branch circuit is required for other utilization equipment not identified in 620.22, 620.23, and 620.24 that is associated with the functioning of the elevator, such as door operator controllers, light curtains, etc.

Section IV. Installation of Conductors

620.37. Wiring in Hoistways, Machine Rooms, Control Rooms, Machinery Spaces, and Control Spaces

620.37(A) Requires that all electric wiring, raceways, and cables within the designated areas be associated with some function directly associated with the elevator(s). This requirement prohibits running wiring that has nothing to do with the elevator(s) through elevator spaces. The intent is to discourage nonauthorized or unqualified persons from entering elevator spaces. The elevator hoistway is often seen as a convenient location to run other electrical wiring, telephone systems, data cables, etc. This creates a hazard for both those running this wiring as well as the users of the elevators.

620.37(B) If a lightning protection system grounding "down" conductor(s), located outside of the hoistway, is within a critical horizontal distance of the elevator rails, bonding of the rails to the lightning protection system grounding "down" conductor(s) is required by NFPA 780 to prevent a dangerous side flash between the lightning protection system grounding "down" conductor(s) and the elevator rails. A lightning strike on the building air terminal will be conducted through the lightning protection system grounding "down" conductor(s), and if the elevator rails are not at the same potential as the lightning protection system grounding "down" conductor(s), a side flash may occur. Equipment and wiring not associated with the elevator is prohibited from being installed in elevator machine rooms and hoistways. Only electrical equipment and wiring used directly in connection with the elevator may be installed inside the hoistway. (Also, see ASME A17.1/CSA B44, requirement 2.8.1.)

620.38. Electric Equipment in Garages and Similar Occupancies

Local code authorities have referenced this Section as a basis for requiring explosion-proof elevator equipment in garages used for parking or storage where no repair work is done. As indicated in Section 511.3(A), parking garages used expressly for parking or storage are not classified, and there is therefore no hazardous location involved.

Section V. Traveling Cables

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620.41. Suspension of Traveling Cables

See Diagram 2.26.4.1(j).

620.44. Installation of Traveling Cables

See Diagram 2.26.4.1(k).

Traveling cables that are suitably supported and protected from physical damage are permitted to be run without the use of a raceway when used anywhere inside the hoistway including on the elevator car, hoistway wall, counterweight, or controllers and machinery that are located inside the hoistway, provided the cables are in the original sheath.

They are also permitted to be run from inside the hoistway, to elevator controller enclosures and to elevator car and machine room, control room, machinery space, and control space connections that are located outside the hoistway for a distance not exceeding 1.8 m or 6 ft in length as measured from the first point of support on the elevator car or hoistway wall, or counterweight where applicable, provided the conductors are grouped together and taped or corded, or in the original sheath. The traveling cables are permitted to continue on to this equipment as fixed wiring.

Section VI.
Disconnecting Means and Control

See Diagram 2.26.4.1(j).

620.51. Disconnecting Means

The provision for locking or adding a lock to a disconnecting means must be installed on or at the switch or circuit breaker used as the disconnecting means and must remain in place with or without the lock installed.

620.51(A) Requirements are coordinated with Part IX of Article 430. See Diagrams 2.26.4.1(l) and 2.26.4.1(m). Passenger safety, comfort, and elevator maintenance is enhanced by separating the main power supply conductors from the car lighting, etc., supply conductors.

620.51(B) ASME A17.1/CSA B44, requirement 2.8.3.3 requires that if sprinklers are installed in hoistways, machine rooms, or machinery spaces, a means has to be provided to automatically disconnect the main line power supply to the affected elevator(s) prior to the application of water. Water on elevator electrical equipment can result in hazards such as uncontrolled car movement (wet machine brakes), and movement of elevator with open doors (water on safety circuits bypassing car and/or hoistway door interlocks). See Diagram 2.26.4.1(n).

620.51(C) Correlates requirements with definitions in 620-2 and provides for mechanic's safety when equipment is located in remote machinery spaces by requiring a disconnecting means to open all ungrounded main power supply conductors. See Diagrams 2.26.4.1(o) and 2.26.4.1(p).

620.51(D) Proper identification of the disconnecting means is required where the equipment for multiple units is located in the same machine room. See Diagram 2.26.4.1(q).

620.52. Power From More Than One Source

See Diagrams 2.26.4.1(r) and 2.26.4.1(s).

620.53. Car Light, Receptacle(s), and Ventilation Disconnecting Means

The disconnect is to assist elevator mechanics to safely troubleshoot elevator lighting and ventilation. Signs to identify the location of the supply side overcurrent protective device are to assist in troubleshooting in case of power loss.

620.54. Heating and Air Conditioning Disconnecting Means

See commentary on 620.54.

Section VII.
Overcurrent Protection

620.61. Overcurrent Protection

Operating devices, control, signaling, and power-limited circuit conductor overcurrent protection requirements are cited in the referenced Sections of Article 725.

Previously, sections of Article 725 were combined, simplified, and relocated to position the "installation" requirements before the "listing" requirements. The NEC® Code Making Panel responsible for Article 725 concluded that it is no longer practical to evaluate Class 2 and 3 equipment in the field. Both the testing and construction evaluation require special knowledge of product standards, materials, and procedures that are commonly available only through qualified testing laboratories. Based on this conclusion, the listing requirements for Class 2 and 3 power sources, including Tables 725-31(A) and (B) and Sections 725-1 to 725-36 in 1993 and older editions of the NEC® were moved to Chapter 9 to separate the installation requirements from the listing requirements so as to provide direction for testing laboratories properly equipped and qualified to evaluate these products. Definitions were also added (725-2) to better understand the Class 1, 2, and 3 circuits.

620.62. Selective Coordination

This is to assist elevator mechanics to troubleshoot and help locate supply side overcurrent protective devices in case of power loss. It also helps to isolate a fault in one elevator in a group from shutting down other elevators in the group due to group related overcurrent devices also operating. See Diagram 2.26.4.1(t).

Single elevator installations are exempted because they are typically located in low-rise structures and the electrical service is close to the elevator equipment and would not create a problem for elevator maintenance personnel in locating supply side overcurrent devices. Also, simplifies compliance by use of all available types of overcurrent devices.

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Section VIII.
Machine Rooms, Control Rooms, Machinery Spaces, and Control Spaces

620.71. Guarding Equipment

Requirements are stated for rooms and spaces for elevator equipment, with the key element that such rooms and spaces be secured against unauthorized access. 620.71(A) permits motor controllers to be located in a secure enclosure. 620.71(B) permits and recognizes various locations for driving machines, including locations in the hoistway. See ASME A17.1/CSA B44 for additional requirements.

Section IX.
Grounding

See Diagrams 2.26.4.1(u) and 2.26.4.1(v).

620.82. Electric Elevators

See Diagram 2.26.4.1(w).

620.85. Ground-Fault Circuit-Interrupter Protection for Personnel

To clarify that each receptacle is to be of the GFCI type, except in machine rooms and machinery spaces. Receptacles on the elevator car tops, pits, hoistways, and in escalator and moving walk wellways have to be of the GFCI type meaning that the reset button is integral with the receptacle itself. It is not in the best interest of safety to intro-duce an unnecessary action, such as climbing off the top of the elevator car and potentially falling, in order to reset the only device that provided protection in the first place. Receptacles in machine rooms and machinery spaces must have ground-fault circuit-interrupter protection (either at the overcurrent device or integral with the receptacle). The receptacle for the sump pump is exempted. See Diagrams 2.26.4.1(x) and 2.26.4.1(y).

Section X.
Emergency and Standby Power Systems

620.91. Emergency and Standby Power Systems

620.91(A) For a regenerative elevator motor drive system, some means are required to either absorb the regenerative power or prevent the elevator from overspeeding. This may be the power system itself, the emergency or standby power generator, if the prime mover is sufficiently large, or a separate load bank provided by the emergency or standby generator system. See Diagram 2.26.4.1(z).

620.91(B) Other building loads may be considered as an absorption means required in 620.91(A) as long as they are automatically connected to the emergency or standby power source (i.e., cannot be inadvertently omitted) and are large enough to absorb the regenerative energy without causing the elevator from attaining a speed equal to the governor tripping speed or a speed in excess of 125% of the elevator rated speed, whichever is the lesser.

620.91(C) The disconnecting means must disconnect the elevator from both the emergency or standby and the normal power source. This requires that the power transfer switch between the emergency or standby and the normal power systems, as well as the regenerative power absorption means is to be located on the supply side of the elevator disconnecting means (see 620.51). See Diagrams 2.26.4.1(aa) and 2.26.4.1(bb).

The requirements in the second paragraph of (C) were originally added to harmonize with the Canadian Electrical Code requirements in Section 38-091(3). The auxiliary contact prevents automatic operation of the elevator by the additional power source, where provided, when the disconnecting means is open.

Highlights of the New and Revised Requirements in the NEC® (NFPA 70-2020)

NOTE: The Author expresses his appreciation to Doug Henderson for his contributions to the NEC® highlights.

Chapter 2

Article 242 Overvoltage Protection

This revision relocated Articles 280 and 285 into a new Article 242 for clarity and usability. These requirements are more appropriately located immediately following Article 240 for overcurrent protection. The requirements in new 242.49 were modified to identify the types of grounding conductors referenced within this section. As noted in Table 242.3, this section applies to equipment addressed in Article 620.

Chapter 5

Article 505 Zone 0, 1, and 2 Locations

505.15 Wiring Methods.

(C)(2) Flexible Connections

This revision added the ability to use Type P or Type TC cables for flexible connections and mirrored the list style format used in 501.10(B)(2) for usability. Previous omissions from the table, such as Types TC-ER, TC-ER-HL, ITC-HL, and PLTC-ER, were all added to affirm that these fixed wiring methods, where appropriate, may terminate at equipment where flexibility is required. The previous exception for elevators was changed to a subrequirement to align with the NFPA style manual.

Chapter 6

Article 620 Elevators, Dumbwaiters, Escalators, Moving Walks, Platform Lifts, and Stairway Chairlifts

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620.2 Definitions.
Machinery Space (for Elevator, Dumbwaiter, Platform Lifts, and Stairway Chairlifts)

This revision was to add platform lifts and stairway chairlifts to this definition since they are also covered by Article 620. A note was added to clarify that the definitions included in this section only apply to Article 620.

620.6 Ground-Fault Circuit-Interrupter (GFCI) Protection for Personnel.

This revision clarifies permitted wiring methods for sump pumps used to protect equipment within the scope of Article 620. The text was revised to be clear that any receptacle in a pit must be GFCI protected. "Machinery space" was added because it was intended to be listed previously. This change aids in safety, installation, and enforcement. The language was moved under Part I because it is more appropriately located for ground fault protection.

Short-Circuit Current Rating.
(B) Installation.

This revision replaced the term "available short-circuit current" with the broader term "available fault current" to provide a higher level of clarity to users and to aid in achieving safety.

620.21 Wiring Methods.

This revision added requirements for physical protection of unused conductors and to aid in Code enforcement. An informational note was added to inform the user about the additional requirements in the building code for fire service access and occupant evacuation elevators. The term "cables" was added where appropriate for better clarity and usability. The term "energized circuit components and/or conductors" was replaced with the term "exposed live parts" in order to remove the ambiguity of "and/or." Other revisions were made to the lists in order to conform with the NEC Style Manual.

620.22 Branch Circuits for Car Lighting, Receptacle(s), Ventilation, Heating, and Air-Conditioning.
(A) Car Light Receptacles, Auxiliary Lighting, and Ventilation.

This revision made editorial changes to conform with the NEC Style Manual and clarified the intent of requiring overcurrent devices for equipment in this section to be accessible to qualified persons only.

620.25 Branch Circuits for Other Utilization Equipment.
(B) Overcurrent Devices.

This revision was an editorial change to align with language used in ASME A17.1/CSA B44 and definitions in this Article. This change is intended to aid in installation and enforcement by aligning with accepted industry terms.

620.51 Disconnecting Means.

This revision was an editorial change to clarify that multiple branch circuits are permitted by 620.22, 620.23, and 620.24.

(A) Type.

This revision requires that disconnecting means for equipment under the scope of Article 620 must not be lockable in the closed position to avoid possible injury to technicians or passengers.

(D) Identification and Signs.
(1) More Than One Driving Machine.
(2) Available Short-Circuit Current Field Marking.

This revision replaced the term "available short-circuit current" with the broader term "available fault current" to provide a higher level of clarity to users and to aid in achieving safety. It aligns with the change to 620.16(B).

(E) Surge Protection.

This revision expanded the surge protection requirements to cover all loads that impact life safety to ensure the reliability necessary for these critical loads. The addition of "listed" was to aid in enforcement by specifying that surge protection equipment, installed per Article 620.51, is required to be listed.

620.53 Car Light, Receptacle(s), and Ventilation Disconnecting Means.

This revision is to clarify Code requirements for location of disconnecting means and aid in installation and enforcement where there is no machine room or control room and the machine space or control space is not outside of the hoistway.

620.54 Heating and Air-Conditioning Disconnecting Means.

This revision is to clarify Code requirements for location of heating and air-conditioning disconnecting means and aid in installation and enforcement where there is no machine room or control room and the machine space or control space is not outside of the hoistway.

620.85 Ground-Fault Circuit-Interrupter Protection for Personnel.

This language was moved under Part I, Article 620.6, because it is more appropriately located for ground fault protection.

Highlights of the New and Revised Requirements in the CEC (CSA C22.1-21)

NOTE: The author expresses his appreciation to David McColl for the CEC highlights.

General

Changes that have been made between the 2018 edition and the 2021 edition are marked in the text of the Code by the delta (Δ) symbol in the margin.

Sections 0 to 16 and 26 are considered general Sections, and the other Sections supplement or amend the general Sections. Elevator and escalator provisions are included in

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Section 38. There were minimal changes impacting elevators and escalators in the 2021 edition.

Section 38

The following revisions were made to Section 38:

Rule 38-011. Deleted "or other types approved for the purpose" at the end of the rule.

Rule 38-021. Changed terminology to "insulated conductors and cables" and deleted the word "approved" throughout.

Rule 38-036. Changed terminology to "insulated conductors."

Rule 38-037. Changed terminology to "insulated conductors."

Rule 38-083. Changed terminology to "insulated conductors."

2.26.4.2 Electrical equipment has to be listed/certified and labeled/marked in accordance with requirements of the binational CSA-B44.1/ASME A17.5 standard. Wording in 2.26.4.2 was editorially revised in ASME A17.1-2007/CSA B44-07 to ensure consistency with the scope of CSA B44.1/ASME A17.5. It was further revised in ASME A17.1-2016/CSA B44-16. See Handbook commentary on 2.7.6.3.2.

Due to differences in application of industrial control equipment and elevator equipment, requirements of CSA B44.1/ASME A17.5 are not completely found in CSA C22.2 No. 14 and ANSI UL 508. Unlike industrial control equipment, which normally operates at continuous duty, low number of operations (about 3,000/yr), and at full load current, elevator control equipment typically operates at intermittent duty, high number of operations (about 500,000/yr), and at up to 200% to 250% of full load current in order to accelerate a mass. Even so, many of the requirements of CSA B44.1/ASME A17.5 were drawn from CSA C22.2 No. 14 and ANSI UL 508. Where differences existed between UL and CSA standards, the more stringent requirement was used. This is intended to minimize the risk of electricity as a source of electric shock and as a potential ignition source of fires.

Approval of equipment is the responsibility of an elevator and electrical inspection authority and many "approvals" are based on tests and listings of testing laboratories such as Underwriters Laboratories (UL), Canadian Standards Association (CSA), ETL Testing Laboratories (ETL), etc.

Also, see definitions for listed/certified and labeled/marked, which harmonize terms used in the United States and Canada.

A list of elevator and escalator electrical equipment that require listing, approval, or certification is provided below. Primarily, this list gives examples of what equipment is subject to CSA B44.1/ASME A17.5 certification. As a secondary function, this list also gives examples of what equipment may be listed/certified and labeled/marked to another acceptable standard, and what equipment is out of scope with respect to CSA B44.1/ASME A17.5.

When trying to determine which electrical equipment and devices must be labeled/marked for compliance with CSA B44.1/ASME A17.5, keep in mind the following guidelines:

(a) This list is to serve as a guideline and is not complete, as it cannot include devices that are new technology or those that have not been envisioned.

(b) All electrical equipment and devices must be listed/certified to at least one safety standard. For example, if a limit switch is marked/labeled as complying with an applicable UL or CSA standard, then it does not have to (but may) be labeled/marked as complying with CSA B44.1/ASME A17.5.

(c) Devices connected to extra-low-voltage Class 2 supply circuits are not within the scope of CSA B44.1/ASME A17.5. Note that exclusion is dependent on the power supply being both extra-low voltage (not more than 30 V rms or 42.4 V peak) and Class 2 (as defined by the applicable electrical code).

(d) An individual component or device is not required to be labeled/marked if it was certified as part of an assembly that is labeled/marked. Taken to its extreme this could mean that all the various control electrical devices could be included under one certification for the entire control system. In this case the certification documentation is the best method for determining which devices must be labeled/marked.

(e) A device can be labeled/marked by approved certifying organizations.

NOTE: Controllers, i.e., motion/motor/operation, are defined in Section 1.3 as follows:

(a) *controller, motion:* an operative unit comprising a device or group of devices for actuating the moving member.

(b) *controller, motor:* the operative units of a motion control system comprising the starter devices and power conversion equipment required to drive an electric motor.

(c) *controller, operation:* an operative unit comprising a device or group of devices for actuating the motion control.

Guidelines for Electrical Devices Requiring Labeling/Marking

(a) Motor Controllers and Motion Controllers

NOTE: This equipment will very likely (see exclusions) require CSA B44.1/ASME A17.5 certification and labeling.

(1) Starter/Control Panel for Door Motor or Machine Motor. This equipment may contain SCRs, IGBTs, transistors, diodes, transformers, contactors, resistors, capacitors, fuses, wiring, bus bars, printed circuit boards, etc. These components are certified to the requirements of pertinent standards or are specifically evaluated for the intended use and are not required to be labeled/marked as long as the assembly is certified and labeled/marked.

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(b) Operation Controllers

NOTE: This equipment will very likely (see exclusions) require CSA B44.1/ASME A17.5 certification and labeling.

(1) control systems
(2) dispatchers
(3) supervisory and management systems (i.e., group controller)
(4) motion controller

(c) Operating Devices

(1) car operating panel (COP)
(2) hall button/Firefighters' Service panel/box
(3) top-of-car inspection station
(4) hoistway access switch

(d) Other Electrical Equipment

NOTE: The Scope of CSA B44.1/ASME A17.5 also covers "all other electrical equipment not listed/certified and labeled/marked according to another product safety standard or code."

Key words in the Scoping requirement are "another product safety standard." As an example, if a certification of motors exists based on either UL 1004 or CAN/CSA-C22.2 No.100, the certification requirements of ASME A17.1/CSA B44 are met.

NOTES:

(1) Equipment such as the following must be certified to CSA B44.1/ASME A17.5 if not listed/certified and labeled/marked to another product safety standard. See also 1.4 in CSA B44.1/ASME A17.5.
(a) limit switches
(b) stop switches
(c) buffer switches
(d) brakes
(e) seismic switches
(f) electrical protective devices
(g) encoders
(h) position reference subsystems (tape reader, etc.)
(i) position switches
(j) hall lantern/position indicator panel/box
(k) motors
(l) motor-generator sets
(m) valves (CSA C22.2 No. 139)
(n) disconnects (NFPA 70 or CSA-C22.1)
(o) switches
(p) bells/buzzers
(q) intercoms
(r) card readers
(s) retiring cams
(t) receptacles (NFPA 70 or CSA-C22.1)
(u) traveling cables and junction boxes (NFPA 70 or CSA-C22.1)
(v) auxiliary lighting (CSA C22.2 No. 141)
(w) car call entry keyboard panels
(x) standby power panels
(y) lobby panels
(z) gate switches
(aa) hoistway or car door interlocks
(bb) combination hoistway door lock and contacts

(2) Door gate switches and interlocks require testing, certification, and marking as defined in 2.12.4 and 8.3.3 of ASME A17.1-2002 and CSA B44-00 Update 1-02.

Requirement 2.26.4.2 was revised in ASME A17.1-2022/CSA B44:22 and expanded to clarify what electrical equipment must be listed/certified and labeled/marked using CSA B44.1/ASME A17.5 as the certification standard. Expanding requirement 2.26.4.2 is intended to provide a more uniform understanding of the listing/certification requirement and reduce the likelihood that noncompliant devices will be used in low-voltage circuits that could affect the safety of an elevator system.

The previous requirement was sometimes misunderstood to mean that all electrical equipment must be listed/certified and labeled/marked using CSA B44.1/ASME A17.5. The second sentence of 2.26.4.2 in the 2019 Code was an attempt to help the reader understand when the design requirements of the CSA B44.1/ASME A17.5 Standard are applicable, but the Committee felt that additional clarification was needed.

The scope of CSA B44.1/ASME A17.5 indicates that the Standard applies to electrical equipment for elevators, escalators, moving walks, dumbwaiters, material lifts, and elevating devices for persons with physical disabilities. This electrical equipment includes

– motor controllers
– motion controllers
– operation controllers
– operating devices
– all other electrical equipment not listed/certified and labelled/marked according to another product safety standard or code

CSA B44.1/ASME A17.5 was never intended to be applied to devices for which component standards already exist, only for the specific elevator-type equipment enumerated above and to devices for which no safety standard currently exists. For this reason, CSA B44.1/ASME A17.5 does not include all necessary requirements for every type of component that exists.

Requirement 1.4 of CSA B44.1:19/ASME A17.5-2019 also includes a statement that the Standard does not apply to devices rated for connection to extra-low-voltage Class 2 supply circuits. This requirement has been misunderstood to mean that any component rated 30 V rms or less need not comply with CSA B44.1/ASME A17.5 (or any other standard); however, requirement 1.4 applies only to devices that are installed within extra-low-voltage Class 2 circuits. Class 2 circuits are very specifically defined in the Canadian and National Electrical Codes, and require very special installation considerations, including physical separation of Class 2 circuits from all other circuits. In addition, if a failure of a Class 2 circuit or a device in the circuit will introduce a life safety hazard (such as rendering an electrical protective device ineffective), it must be treated as a Class 1

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circuit (see CSA C22.1, Rule 16-010), and all of the requirements for Class 1 circuits are applicable, including the need for devices to be listed/certified.

This revision expanded requirement 2.26.4.2 to encompass all of these considerations in order to more clearly communicate the requirements for listing/certification of electrical equipment. The base requirement is that electrical equipment must be listed/certified and labeled/marked. The new requirements 2.26.4.2.1 through 2.26.4.2.3 clarify which devices must comply with CSA B44.1/ASME A17.5, which devices must comply with other approved component standards applicable to the country where the equipment is installed (e.g., Canada or the U.S.), and the criteria for where Class 2 circuit devices are not required to be listed/certified.

2.26.4.3 ASME A17.1-2000 and CSA B44-00 adopted the prior CSA B44 language in Clause 3.12.4.3, which consolidates the requirements for "electrical protective devices" under one requirement.

ASME A17.1-2007/CSA B44-07 adopted several additions and revisions within Section 2.26 related to electrical/electronic/programmable electronic system (E/E/PES), or commonly referred to as "PES." It is important to note that traditional methods of ASME A17.1/CSA B44 compliance were retained and that the programmable electronic system (PES) requirements were added to allow means of alternative compliance that provide equivalent safety. New supporting definitions and abbreviations derived from IEC 61508 were added in Section 1.3. They are relevant to an understanding of the text used in the Code requirements.

electrical/electronic/programmable electronic (E/E/PE) *:* based on electrical (E) and/or electronic (E) and/or programmable electronic (PE) technology.

NOTE: The term is intended to cover any and all devices or systems operating on electrical principles.

EXAMPLE: Electrical/electronic/programmable electronic devices include

(a) electromechanical devices (electrical)

(b) solid-state nonprogrammable electronic devices (electronic)

(c) electronic devices based on computer technology (programmable electronic)

electrical/electronic/programmable electronic system (E/E/PES) *:* system for control, protection, or monitoring based on one or more electrical/electronic/programmable electronic (E/E/PE) devices, including all elements of the system, such as power supplies, sensors, and other input devices; data highways and other communication paths; and actuators and other output devices.

mode of operation *:* way in which a safety-related system is intended to be used, with respect to the rate of demands made upon it, which may be either of the following:

low-demand mode: where the frequency of demands for operation made on an electrical safety function is no greater than one per year and no greater than twice the proof-test frequency.

high-demand or continuous mode: where the frequency of demands for operation made on a safety-related system is greater than one per year or greater than twice the proof-test frequency.

NOTE: High-demand or continuous mode covers those safety-related systems that implement continuous control to maintain functional safety.

proof-test *:* periodic test performed to detect failures in a safety-related system so that, if necessary, the system can be restored to an "as new" condition or as close as practical to this condition.

safety integrity level (SIL) *:* discrete level (one out of a possible four) for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/PE safety-related system, where safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest. Ref: IEC 61508-4.

General Information

PES devices and systems are typically one of the following types:

(a) solid-state nonprogrammable electronic devices (electronic)

(b) electronic devices based on computer technology (programmable electronic)

Electrical protective devices now have the option of meeting the traditional requirements of *positive actuation on opening, etc.* (2.26.4.3.1) or alternatively to be SIL rated and certified (2.26.4.3.2).

Requirement 2.26.4.3.2 allows electrical protective devices to alternatively be listed/certified and labeled/marked to a SIL rating in accordance with applicable requirements of IEC 61508-2 and IEC 61508-3 as long as the electrical protective device has a SIL rating equal to or greater than that shown in ASME A17.1/CSA B44, Table 2.26.4.3.2.

Table 2.26.4.3.2 was revised in ASME A17.1-2019/CSA B44:19 to use the new terms "closed detection means" and clarify the function of the devices.

Where necessary, to maintain integrity of a SIL rated E/E/PES and maintain fail-safe condition prior to a second fault that could lead to a dangerous condition, a manual reset is required to remove a SIL rated E/E/PES from the fail-safe condition.

Safety Integrity Level(s), SIL(s)

Safety integrity level (SIL) includes all causes of failures (both random hardware failures and systematic failures) that lead to an unsafe state. Examples include hardware failures, software-induced failures, and failures attributed to electrical interference.

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SILs are the foundation of implementing a PES device or system to meet the safety requirements of 2.26. There are four defined SIL levels, from 1 to 4, with 4 being the highest level, or that with the highest required "safety integrity." Another way to view SILs is that they represent the probability of failures per hour, which for each SIL level is a low number.

The starting point of understanding how SILs relate to ASME A17.1/CSA B44 is to review electrical protective devices defined in 2.26.2. SIL values for each electrical protective device have been added to ASME A17.1/CSA B44 and are summarized in Table 2.26.4.3.2. If an electrical protective device function is implemented via a PES device or system, then the PES-type electrical protective device must meet the required SIL level shown in Table 2.26.4.3.2. For each electrical protective device, the SIL has been specified to ensure reliability of an elevator safety system to be at least as good as it is today. This is achieved by targeting reliability of existing safety components that have withstood the test of time.

Six notes appended to Table 2.26.4.3.2 give a concise overview of the applicability of SIL ratings.

For the following three specific electrical protective devices, SIL rated devices are not permitted because it was determined through risk analysis that the highest possible SIL rating of 4 cannot fulfill these functions:

(a) *2.26.2.20* electric contacts for hinged car platform sills

(b) *2.26.2.31* car access panel locking device

(c) *2.26.2.32* hoistway access opening locking device

Another key point related to PES and SILs is that a safety system is periodically checked and repaired if necessary prior to an elevator being placed back into service. New requirements for verifying a PES device or system have been added in Sections 8.6, 8.10, and 8.11.

The term "proof-test" refers to periodic tests that must be performed to detect failures in a safety-related system.

SIL values for electrical protective devices specified in Table 2.26.4.3.2 are based on a proof-test frequency of no more than half the rate of demand on each safety function (electrical protective device). Inspection frequencies provided in Nonmandatory Appendix N serve as a reference to this proof-test interval and are addressed in the Maintenance Control Program. See Section 8.6.

Risk Analysis, ISO 14798, and IEC 61508

Procedures in these international standards were used to develop SIL values for each electrical protective device by applying a quantitative risk analysis methodology.

IEC 61508 and ISO 14798 have been added as reference documents in Section 9.1.

Third-Party Certification

PES requirements within Section 2.26 include the mandate that SIL rated devices or systems be "listed/certified," which means that the devices must be certified by an accredited certification organization. Clarifications for labeling and "marking" (e.g., a tag) for SIL rated devices were incorporated into ASME A17.1-2013/CSA B44-13 to identify such devices as being SIL rated and to direct elevator personnel to the Maintenance Control Program (MCP) for device information.

Requirement 2.26.4.3 and Table 2.26.4.3.2 were revised in ASME A17.1-2022/CSA B44:22 to provide requirements for the test enable device pertaining to electrical equipment and wiring. See Handbook commentary on 2.26.14.

2.26.4.3.1 This requirement was revised in ASME A17.1-2016/CSA B44-16 to clarify the meaning of "positively opened." This change also substantially harmonizes the requirement with EN 81.

Requirement 2.26.4.3.1 was revised in ASME A17.1-2022/CSA B44:22 to reference 2.26.2.38 to pick up the requirements for ladder electrical devices. See Handbook commentary on 2.2.4.2.

2.26.4.3.2 Requirement 2.26.4.3.2 was revised in ASME A17.1-2022/CSA B44:22 to pick up the SIL requirements for ladder electrical devices. See Handbook commentary on 2.2.4.2.

2.26.4.4 This requirement was originally written to address reported incidents of EMI causing an unsafe condition (e.g., car movement initiated by two-way radios and other forms of RF transmissions). The originally agreed-upon ASME A17.1/CSA B44 reference document for electromagnetic immunity was EN12016:1998 (European Standard on immunity for elevators, escalators, and passenger conveyors). This ISO standard specifies the following types of "threat" signals; their frequency ranges, if applicable; amplitudes or magnitudes; and appropriate test procedures by reference to other normative EN standards:

(a) electrostatic discharge

(b) radio frequency electromagnetic field

(c) fast transient, common mode

(d) voltage dips and transients for single-phase systems

ASME A17.1a-2008/CSA B44a-08 incorporated allowances to adjust the test values for voltage dips based on 60-Hz AC power-line frequency.

In ASME A17.1-2013/CSA B44-13, the referenced standard was revised to ISO 22200, with the stipulation that if control equipment were tested in accordance with EN 12016:1998 prior to 1 yr after the effective date of ASME A17.1-2013/CSA B44-13, then retesting to the ISO standard is not mandated since the revisions are not due to any known deficiencies with either current products or the original EN reference standard.

When control equipment is exposed to interference levels at the test values specified for "safety circuits" in ISO 22200, the interference cannot cause any of the conditions in 2.26.9.3.1(a) through 2.26.9.3.1(e), cause the car to move while on inspection operation, or render the

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traction-loss detection means ineffective. See Diagram 2.26.4.4.

It is important to note that 2.26.4.4 requires that control equipment be tested in accordance with interference levels at test values for safety circuits specified within ISO 22200. It is not intended that control equipment meet all of the requirements of ISO 22200.

Requirement 2.26.4.4 was revised in ASME A17.1-2019/CSA B44:19 to provide testing requirements at discrete frequencies throughout the ranges specified in ISO 22200:2009.

Warning sign requirements are given for the case where doors or suppression equipment must not be removed in order to meet the immunity requirements.

2.26.4.5 Requirement 2.26.4.5 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definition for "main line power."

2.26.5 System to Monitor and Prevent Automatic Operation of the Elevator With Faulty Door Contact Circuits

The requirement applies only to installations with power-operated car doors that are mechanically coupled with the landing doors. As is indicated in the heading for this subsection, clarification was made in ASME A17.1-2007/CSA B44-07 that this monitoring system is intended to prevent automatic operation and was not intended to prevent constant pressure operation.

The intent is to monitor the position of the car doors while the car is in the landing zone (see definition) in order to

(a) prevent automatic operation of the car (except when on leveling operation) if the car door is not closed with the car and/or landing contacts closed or open

(b) prevent power closing of doors during automatic operation if the car door is fully open and any of the following conditions exists:

(1) car door closed detection means is made (closed) or the car door interlock closed detection means and locked detection means are made (closed)

(2) landing door interlock closed detection means and locked detection means are made (closed)

(3) car closed detection means, or the car door interlock closed detection and locked detection means and the landing door interlock closed detection and locked detection means of the door coupled to the car door are made (closed) are made (closed)

(4) any of the circuits containing the closed or locked detection means are bypassed

Requirement 2.26.5 was revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means," more clearly define the requirements, and separate out the requirement for bypassed circuits.

Requirement 2.26.5 was revised in ASME A17.1-2022/CSA B44:22 and the requirements were moved to a new 2.26.5.1 to provide an exception to allow the door closed button to function on Phase II operation during a triggering of the door monitoring means in a situation where the hoistway door has become uncoupled from the car door, thus allowing the hoistway door to be closed while the car door remains open. This exception mitigates the hazard of stranding a firefighter at a fire floor by avoiding a door lock monitoring the fault condition and allowing closing of the car door with the constant pressure door closed button. The requirements were also editorially revised to use the term "door locked detection means."

2.26.5.2 Requirement 2.26.5.2 was added in ASME A17.1-2022/CSA B44:22 to provide a separate requirement addressing the monitoring of the position of the car door in the case of automatic car doors with manually operated swing hoistway doors, and to clarify that the monitoring is not required for the closed position of the swing hoistway door but for the retiring cam interlock device (see 2.12.2.5).

2.26.6 Phase Protection of Motors

If phase rotation is in the wrong direction, the motor rotation would be in the wrong direction and thus the elevator car or elevator door(s) would be traveling in an opposite direction, as indicated by the controller. This would allow the car to operate without protection of slowdowns and normal limits or could cause the door(s) to move in the wrong direction when a reopening device operates. The use of reverse-phase protection prevents the driving machine motor from being activated under these conditions.

This type of protection is required only on those drives where a phase reversal of the incoming alternating current power to the elevator could cause an unsafe condition.

2.26.7 Installation of Capacitors or Other Devices to Make Electrical Protective Devices Ineffective

In some circumstances, certain types of devices (e.g., capacitors) are wired in parallel with relay contacts, with the intent of extending relay contact life. Such devices could fail in a shorted mode, making electrical protective devices ineffective. The installation of capacitors or other devices, the operation or failure of which will cause an unsafe operation of the elevator, is prohibited. Therefore, no permanent device that will make the traction-loss detection means or any required electrical protective device ineffective shall be installed except as provided in the following:

(a) 2.7.6.5.2(h), Inspection and Test Panel

(b) 2.12.7.1, Hoistway Access Switches

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(c) 2.26.1.4.2(g), Top-of-Car Inspection Operation

(d) 2.26.1.5, Inspection Operation With Open Door Circuits

(e) 2.26.1.6, Operation in Leveling or Truck Zone

Requirement 2.26.7 was revised in ASME A17.1-2016/CSA B44-16 to eliminate the bypass of the in-car stop switch [2.27.3.1.6(c)] for freight elevators. For freight elevators, it is safer to leave the control to the operator. See Handbook commentary on 2.27.3.1.6.

Requirement 2.26.7 was revised in ASME A17.1-2022/CSA B44:22 to provide a more performance-based title and expand the requirements to allow hardware, software, and parameters to render electrical protective devices ineffective under the provisions of 2.26.14 test enable operation. The revisions also updated a reference and made editorial changes. See also Handbook commentary on 2.26.14.

2.26.8 Release and Application of Driving-Machine Brakes

Partially energizing the brake coil of a car at a floor level that is about to close its doors and start away from the floor does not violate the intent of this requirement. In fact, while the doors are closing, passengers may still be entering or leaving the car and thus may produce enough rope stretch to move the car away from the floor enough to activate releveling. The brake would then normally be fully energized and power applied to the elevator motor to bring the elevator back to floor level even though the doors would not be fully closed.

When the elevator is at the floor, the brake must be set. If loading or unloading causes the car-leveling device to be active, then the brake can be electrically released in accordance with 2.26.1.6. The brake cannot be connected across the armature as residual magnetism (voltage) remaining after the elevator has moved could hold the brake in the open position.

Two means are required to remove power from the brake. See Diagrams 2.26.8, 2.26.8.2, and 2.26.8.5.

2.26.8.2 ASME A17.1-2007/CSA B44-07 revised requirement to allow for the option of one of the means, in lieu of an electromechanical contactor, to be an E/E/PES with a SIL of no less than the highest SIL value of the applicable function as shown in Table 2.26.4.3.2 for the electrical protective devices involved. See Diagram 2.26.8.2.

Clarifications for labeling and "marking" (e.g., a tag) for SIL rated devices were added in ASME A17.1-2013/CSA B44-13 to identify such devices as being SIL rated and to direct elevator personnel to the Maintenance Control Program (MCP) for further information.

2.26.8.3 This requirement specifies the following conditions upon which the brake must set:

(a) upon releasing the car switch

(b) upon removing pressure from an operating device (e.g., inspection operation switch or hoistway access switch)

(c) at the conclusion of normal or terminal stopping in automatic operation

(d) if any electrical protective device is activated

(e) upon loss of power to the brake

(f) if the traction-loss detection means is actuated

2.26.8.5 See Diagram 2.26.8.5.

2.26.9 Control and Operating Circuits

2.26.9.1 The reason for this requirement is that springs in compression are less likely to fail than springs in tension.

2.26.9.2 This requirement can be traced back to the first edition (1921) of ASME A17.1. It was not until the third edition (1931) of ASME A17.1 that the restriction for interrupting power to the motor and brake "at the terminal" was added.

The circa-1931 committee left no known reason, except the recognized need for redundant safeguards at the terminal landing. The intent of 2.26.9.2 is that the contactors used to interrupt the power to the elevator driving-machine motor or brake at the terminal shall not be in the energized state. See Diagram 2.26.9.2.

2.26.9.3 Protection Against Failures. The safety principles of elevator control system have evolved since the days of Elisha Otis.

Elevator safety requires that the elevator control system be designed such that under any single hardware or software system failure as described in 2.26.9.3, the elevator

(a) continues its prescribed safe operation; or

(b) reverts to a more restrictive known safe operating state; or

(c) comes to a complete stop

However, 2.29.9.4 (redundancy checking) will prevent the elevator from restarting once stopped.

The nature of electrical equipment failures and the occurrence of accidental grounds on the safe operation of elevators were recognized in the very first edition of the Code, ASME A17.1-1921, and have evolved ever since.

The forerunner of the present-day language dates back to the ASA A17.1-1955 edition. It recognized the failure mechanism of magnetically operated switches, contactors, and relays to release in the intended manner, thereby implying that when ever such devices were used in controller design, redundancy (i.e., two-switch protection) was required to prevent the elevator from moving away from a floor with open car and hoistway landing doors because of this type of failure.

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Over the years, 2.26.9.3 was revised to include static control failures (ASME A17.1-1981), and in the ASME A17.1a-1988 Addenda, the requirement that the failures listed could not make the electrical protective devices ineffective was added.

With the ASME A17.1-2000 and CSA B44-00 editions, a number of new concepts were introduced: first, the concept of software system failures and the effect on elevator safety; and second, the concept of single failures and their effects on elevator safety when on hoistway access operation, inspection operation, door bypass operation, and leveling operation. See Diagrams 2.26.9.3.1(a) through 2.26.9.3.1(e).

Use of programmable electronics (software) is common in today's elevator control systems. The software may be involved directly or indirectly with elevator safety. Such failure must result in a "nondangerous" state of elevator operation as listed in 2.26.9.3.1(a) through 2.26.9.3.1(e).

ASME A17.1/CSA B44 also recognizes that the construction, installation, and maintenance of an elevator system must not compromise the basic design safety requirements in Sections 2.25 and 2.26.

ASME A17.1-2007/CSA B44-07 added the following wording in 2.26.9.3: "... or a failure of a software system in circuits not in conformance with 2.26.9.4(b)." Additions in 2.26.9.4(b) permitted a SIL rated software system.

ASME A17.1-2010/CSA B44-10: Requirement 2.26.9.3 added the title "Protection Against Failures" and moved the original requirement from 2.26.9.4(b), which is a method of compliance for protection against software system failures, into 2.26.9.3, which is a compilation of means to protect against failures. The result is the splitting of the previous 2.26.9.3 and 2.26.9.4(b) into two new 2.26.9.3 subsections, described as follows:

(a) Requirement 2.26.9.3.1 specifies the types of failures in the control and operating circuits that must be protected against.

Requirement 2.26.9.3.1 was revised in ASME A17.1-2019/CSA B44:19 to use the new term "closed detection means" and to include car door interlocks in the requirements.

(b) Requirement 2.26.9.3.2 specifies protection against failures, with the options of redundancy provided by a nonsoftware controlled means [2.26.9.3.2(a)], or compliance via SIL certification [2.26.9.3.2(b)].

The resulting reorganization of the requirements is that conditions for the design of circuits to comply with 2.26.9.3 [2.26.9.3.1] are now separated from the requirements that require checking of the functioning of circuits in 2.26.9.4. These are two separate and distinct requirements that are now organized more clearly.

Requirement 2.26.9.3.1(d) was revised in ASME A17.1-2022/CSA B44:22 to provide single failure protection of test enable operation to prevent operation other than from inspection operating devices or the test initiating means (see 2.26.14) and not permit power operation of the hoistway door and car door or gate. See also Handbook commentary on 2.26.14.

Requirement 2.26.9.3.1(f) was added in ASME A17.1-2022/CSA B44:22 to provide single failure protection to the means in 8.14.1(b) that will prevent changes to executable software or safety related parameters. See also Handbook commentary on Section 8.14.

2.26.9.4 This requirement requires automatic checking of methods to satisfy 2.26.9.3. It does not consider the possibility of a second failure occurring before the elevator comes to a stop.

"Checked prior to each start of the elevator from a landing" means checking for failures any time since the last start from a landing. See Diagrams 2.26.9.4(a) and 2.26.9.4(b).

Clarifications for labeling and "marking" (e.g., a tag) for assemblies containing SIL rated devices were added in ASME A17.1-2013/CSA B44-13 to identify such devices as being SIL rated and to direct the user to the Maintenance Control Program (MCP) for device information. A new requirement was added that circuits for SIL rated devices shall be identifiable on wiring diagrams with part identification, SIL, and certification identification information that shall be in accordance with the certifying organization's requirements.

2.26.9.5 The requirements cover both AC and DC drives (motor controller). Requires two means to remove power independently from the driving-machine motor. Since a single short circuit must not nullify safe operation of the brake, operation of the brake has to be made subject to an additional switch or certified E/E/PES device (the requirement was moved in ASME A17.1-2010/CSA B44-10 from 2.26.9.5 to 2.26.8.2), and provides protection in case the motor contactor welds closed when the elevator prepares to make a stop at a landing. See Handbook commentary on 2.26.8.

The motor current interrupting means has to be subject to car door and landing door safety contacts (i.e., electrical protective devices). For a reversal in direction (except direction reversals due to releveling), operation of initiating circuits (i.e., to permit elevator to run) is dependent on the prior drop out of the motor contactor if a contactor is utilized.

2.26.9.5.1 This requirement allows more than one contactor and less than one pole per power line to the motor. Otherwise, where an AC motor is used, compliance would require a four-pole contactor (a costly nonstandard industrial component) if one pole for the brake and one pole for each of the AC lines is used. Requirement 2.26.2 does not specify the number of lines to be opened in the requirement for the "removal of power" for nonstatic systems. NEC® Section 430.84 says that all conductors need not be opened. See Diagram 2.26.9.5.

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2.26.9.5.1(a) ASME A17.1-2007/CSA B44-07 added the option of dropping the contactor on each stop or, alternatively, not dropping the contactor if current through the driving-machine motor is verified to be virtually zero. If there is a change in elevator direction except in the case of releveling, the contactor must drop before the next start. This revision was added to harmonize with the EN 81 code.

2.26.9.5.1(b) ASME A17.1-2007/CSA B44-07 added the option of one of the means, in lieu of an electromechanical contactor, to be an E/E/PES with a SIL of no less than the highest SIL value of the applicable function as shown in Table 2.26.4.3.2 for electrical protective devices involved.

Clarifications for labeling and "marking" (e.g., a tag) for SIL rated devices were added in ASME A17.1-2013/CSA B44-13 to identify such devices as being SIL rated and to direct elevator personnel to the Maintenance Control Program (MCP) for device information.

2.26.9.5.2 This requirement is consistent with the requirements in 2.26.9.6.2 to ensure that the brake is applied while there is no drive torque applied to the motor. The requirement also permits use of an auxiliary means to open the brake circuit. This is analogous to "electrical protective devices" in a safety circuit operating relays, contactors, and/or devices, or controlling E/E/PES devices, which in turn prevent the brake from being released if the safety circuit is not closed. See also Diagram 2.26.9.5.

2.26.9.5.3 All required electrical protective devices and the traction-loss detection means shall control both means provided to remove power from the driving-machine motor. This requirement was added in ASME A17.1-2010/CSA B44-10.

2.26.9.5.4 This requirement was renumbered and rewritten in ASME A17.1-2007/CSA B44-07 to harmonize with EN 81 code, and to make clear that this requirement is still applicable where contactors are used.

2.26.9.6 The only difference from 2.26.9.5 is that instead of a motor contactor, VVVF drives can use an electromechanical relay to independently inhibit the flow of AC current through the inverter that connects the DC power source to the AC driving motor. A failure of the inverter power devices automatically applies DC to the AC motor and thereby provides a braking torque. In addition, speed governor overspeed switches (see Handbook commentary on 2.18.4) and the protective functions of 2.19.2 provide motion sensing to protect against the condition where the electromechanical relay closes, the brake lifts, and the inverter fails to conduct. For additional information, see Handbook commentary on 2.26.9.5 and Diagram 2.26.9.6.

In ASME A17.1-2007/CSA B44-07, the requirements were rewritten to harmonize with EN 81 code and allow for an option of one of the means, in lieu of an electromechanical relay, to be an E/E/PES with a SIL of no less than the highest SIL value of the applicable function as shown in Table 2.26.4.3.2 for the electrical protective devices involved.

Clarifications for labeling and "marking" (e.g., a tag) for SIL rated devices were added in ASME A17.1-2013/CSA B44-13 to identify such devices as being SIL rated and to direct the elevator personnel to the Maintenance Control Program (MCP) for device information.

2.26.9.6.3 All required electrical protective devices and the traction-loss detection means shall control both means provided to remove power from the driving-machine motor. This requirement was added in ASME A17.1-2010/CSA B44-10.

2.26.9.7 The magnetic properties of all electromagnetic apparatus have a certain amount of "memory." That is, after a magnetic field has been established in the iron of a generator, for instance, by passing current through its field windings, the removal of that current does not necessarily mean that the flux will drop to zero value immediately. This is expressed as residual magnetism.

The residual magnetism in the generator field, after removal of the excitation of the leveling field, will permit the series field windings to excite the generator and in turn develop some armature current. The armature current, in turn, will cause the elevator motor to move, particularly if the brake is not clamped tight. It is essential, therefore, to avoid this sequence by reversing the direction of the generator field and connecting it across the generator armature to buck the residual flux and kill its own generated voltage. Hence, the name "suicide." See Diagram 2.26.9.7.

2.26.9.8 See Diagrams 2.26.9.8(a) and 2.26.9.8(b).

2.26.10 Absorption of Regenerated Power

If the normal power source is incapable of absorbing the energy generated by an overhauling load, a separate means such as a resistor bank must be provided on the load side of each elevator power supply line disconnecting means to absorb the regenerated power. For an emergency power source, the requirements of 2.27.2 apply. See NEC®, Section 620.91. See also Diagram 2.26.10.

2.26.11 Car Platform to Hoistway Door Sills Vertical Distance

This requirement establishes leveling accuracy where the American National Standard for Accessible and Usable Buildings and Facilities (CABO/ANSI A117.1), the Americans With Disabilities Act Accessibility Guidelines (ADAAG), and the Americans With Disabilities Act/Architectural Barriers Act Accessibility Guidelines (ADA/ABA AG) are not applicable (e.g., Canada). It was added at the request of the Association of Canadian Chief Elevator

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Inspectors because they wanted a criterion for assessing leveling performance.

Requirement 2.26.11 was revised in ASME A17.1-2019/CSA B44:19 to add a missing reference to ADA/ABA AG.

Requirement 2.26.11 was revised in ASME A17.1-2022/CSA B44:22 to revise nomenclature for ICC/ANSI A117.1 so that the entire ASME A17.1/CSA B44 document reflects the accurate characters used by both the referenced standard and ASME A17.1/CSA B44, Section 9.1.

2.26.12 Symbols

The operating device symbols were developed to eliminate the language barrier and to assist the visually impaired. CABO/ANSI A117.1, ADAAG, ADA/ABA AG, and the Uniform Federal Accessibility Standard (UFAS) require the symbols to be adjacent and to the left of the controls on a contrasting color background. These standards also require that letters, numbers, and symbols be a minimum of 16 mm or $^{5}/_{8}$ in. high and raised or recessed 0.76 mm or 0.030 in.

In the early 1990s, National Elevator Industry, Inc. (*NEII*®) became aware that despite ASME A17.1 requirements for car control button symbols, further clarification was required. ASME A17.1 requirements allowed the designer too much leeway. Complaints were being raised by persons with visual impairments that the symbols in some cases were not clear when read tactily. *NEII*® formed a task group to work with the National Federation of the Blind. The findings of the task group were presented to the ASME A17 and ANSI A117 Committees. Both committees have adopted those findings. The identical requirements for control button identification now appear in ASME A17.1/CSA B44, ICC/ANSI A117.1-1998, and ADA/ABA AG.

The emergency stop switch symbol refers to the emergency stop switch marking only, and not the "STOP" and "RUN" position labeling required by 2.26.2.5(c).

Requirement 2.26.12 was revised in ASME A17.1-2019/CSA B44:19 to add a missing reference to ADA/ABA AG.

2.26.13 Remote Interaction Operation

NOTE: The author expresses his appreciation to Vince Robibero for his extensive contributions to the commentary for requirement 2.26.13.

Requirement 2.26.13, including subsections, was added in ASME A17.1-2022/CSA B44:22 to add requirements for remote interaction for electric and hydraulic elevators. Remote interaction operation (RIO) permits interaction between off-site systems with the automatic operation features of elevators connected to the internet. Cybersecurity requirements were added in Section 8.14 to protect elevator systems connected to the internet, including where RIO is involved. See also Handbook commentary on Section 8.14.

The requirements for RIO in 2.26.13 and 3.26.12 permit features and functions involving automatic operation to be invoked by signals exchanged between off-site systems and the elevator controllers of electric and hydraulic elevators within the limitations of the 2.26.13 and 3.26.12 sections of the Code.

The RIO Code requirements provide enhanced safety and user experiences with elevator systems. For example, remote systems can help building owners and managers secure building floors for events or for tenants, confirm an elevator is blocked at a floor, or park elevators on desired floors in preparation of VIP or other planned building traffic. RIO can also work together with remote monitoring supporting service personnel's troubleshooting and corrective actions.

The RIO requirements are permissive and therefore only apply where remote operation is provided on electric and hydraulic elevators. Requirement 3.26.12 refers to 2.26.13, therefore this commentary also applies to that requirement.

It is important to note that requirement 2.26.13 does not address remote monitoring. Remote monitoring, including status indication panel(s), is not an operation based on how ASME A7.1/CSA B44 applies the term "operation"; therefore it is not an RIO. The term "remote monitoring" is cited only in ASME A17.1/CSA B44 in the General Note of Nonmandatory Appendix N, Table N-1-1.

As noted previously, RIO permits interaction between off-site systems with the automatic operation features of elevators connected to the internet. Off-site systems that interact with on-site elevator controllers are subject to the requirements of RIO only when RIO is provided and enabled in an elevator.

On-site devices, such as smart mobile phones, that interact with the off-site systems are not applicable or subject to the requirements for RIO. On-site mobile devices that interact directly with elevator controllers are also not subject to the requirements of RIO. These interfaces are subject to all other existing requirements of the Code. See Diagram 2.26.13(a) for a visual representation.

Off-site systems may also perform other non-RIO actions, such as service diagnostics interactions with on-site elevator personnel. These actions are also not subject to the requirements of RIO. See Diagram 2.26.13(b) for a visual representation.

The "actions" permitted for RIO are outlined in requirement 2.26.13.2 and include

(a) registering car and hall calls to unsecured floors

(b) activating, deactivating, or setting the state of features, operations, or functions associated with automatic or group automatic operation

(c) removing the car from group automatic operation, except as limited by 2.26.13.3 and 2.26.13.4

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The actions in (a) through (c) are, however, restricted to the limitations specified in 2.26.13.3, 2.26.13.4, 2.26.13.5, 3.26.12.1, and 3.26.12.2. These requirements comprehensively cover all elevator operations RIO is not permitted to enable, disable, override, reset, or interfere with and all safety devices, functions, and means RIO is not permitted to interfere with, modify, reset, render ineffective, nor render inoperative. Features, functions, devices, and means not covered by these requirements are permitted to be modified, enabled, disabled, overridden, and reset by RIO. Changes to parameters that are not prohibited by the requirements are permitted by RIO. For example, changing parameters for the security for floors, door dwell time, and supervisory modes such as the Sabbath operation is permitted utilizing RIO.

Requirement 2.26.13.6 specifies that only elevator personnel and authorized personnel are permitted to utilize RIO. Elevator personnel under the definitions of the Code include "persons who have been trained in the construction, maintenance, repair, inspection, or testing of equipment." Authorized personnel under the definitions of the Code include "persons who have been instructed in the operation of the equipment and designated by the owner to use the equipment." Authorized persons can therefore be building tenants, employees, or anyone entering the building that has been given authorization by the owner to utilize RIO with appropriate instructions on that utilization.

On-site documentation is required to provide circuits relevant to RIO when it is provided [see requirement 8.6.1.2.2(a)] as well as procedures on how to disable RIO actions for elevator, authorized, and emergency personnel [see requirement 8.6.1.2.2(d)(4)].

When RIO is provided, requirement 2.26.13.1 requires signage that states "REMOTE INTERACTION OPERATION PROVIDED." The signage must be attached to the surface of the elevator controller or at an inspection and test panel to alert elevator personnel of the presence of RIO.

2.26.14 Test Enable Operation

Requirement 2.26.14, including subsections, was added in ASME A17.1-2022/CSA B44:22 to permit test enable operation utilizing the test enable device. The test enable operation allows electrical protective devices to be made ineffective for limited and general tests but only within specific control conditions. This new requirement expands the list of means currently in 2.26.7(a) through 2.26.7(e) to add test enable operation. Test enable operation is similar to the other means that are currently permitted to make electrical protective devices ineffective for maintenance, troubleshooting, inspection, and tests. Test enable operation is done in a safe-state operating mode and without the need to manage the use of wire jumpers that could be inadvertently left in place.

Test enable operation also allows electrical protective devices implemented with technology, such as SIL rated devices, to be made ineffective for test purposes. This is important because these devices cannot be simply bypassed with wire jumpers. The test enable operation cannot reset any electrical protective devices that require a manual reset and traction-loss detection means during a "LIMITED" or "GENERAL" test.

During a "LIMITED" or "GENERAL" test, traction-loss detection means and any electrical protective devices requiring a manual reset that were actuated during the test must remain actuated until manually reset.

The permissive requirements for test enable operation provide several safety benefits including

(a) Providing a single consistent visual location to identify that the controller is set up ("Armed") to have an electrical protective device made ineffective ("Jumped out") (see 2.26.14.1).

(b) Providing visual indicators at each inspection operating device to indicate TED has been activated [see 2.26.14.1.1(h)].

(c) Requiring the elevator to be in Inspection Operation when in the "GENERAL" position with any electrical protective device bypassed [see 2.26.14.1.1(g) and 2.26.14.5].

(d) Only allowing the electrical protective devices specified in 2.26.14.3.1 to be bypassed ensuring the elevator cannot be in normal operation. The requirements allow the bypass of those electrical protective devices for only a single test at a speed greater than inspection speed when TED is in the "LIMITED" position (see also 2.26.14.3.4 and 2.26.14.5).

(e) Requiring all electrical protective devices to become effective when TED is switched to the "OFF" position.

(f) Providing enhanced safety features that are not present with the use of jumpers. Jumpers are also used for troubleshooting, maintenance, repair, adjustments, rescue, testing, and inspection.

Test enable operation is enabled by a test enable device. One example of a test enable device is a physical toggle switch that provides a signal to the motion control to activate test enable operation

Requirements 2.26.14.1 and 2.26.14.2 provide requirements for the test enable device related to function, location, marking, security, and electrical equipment and wiring.

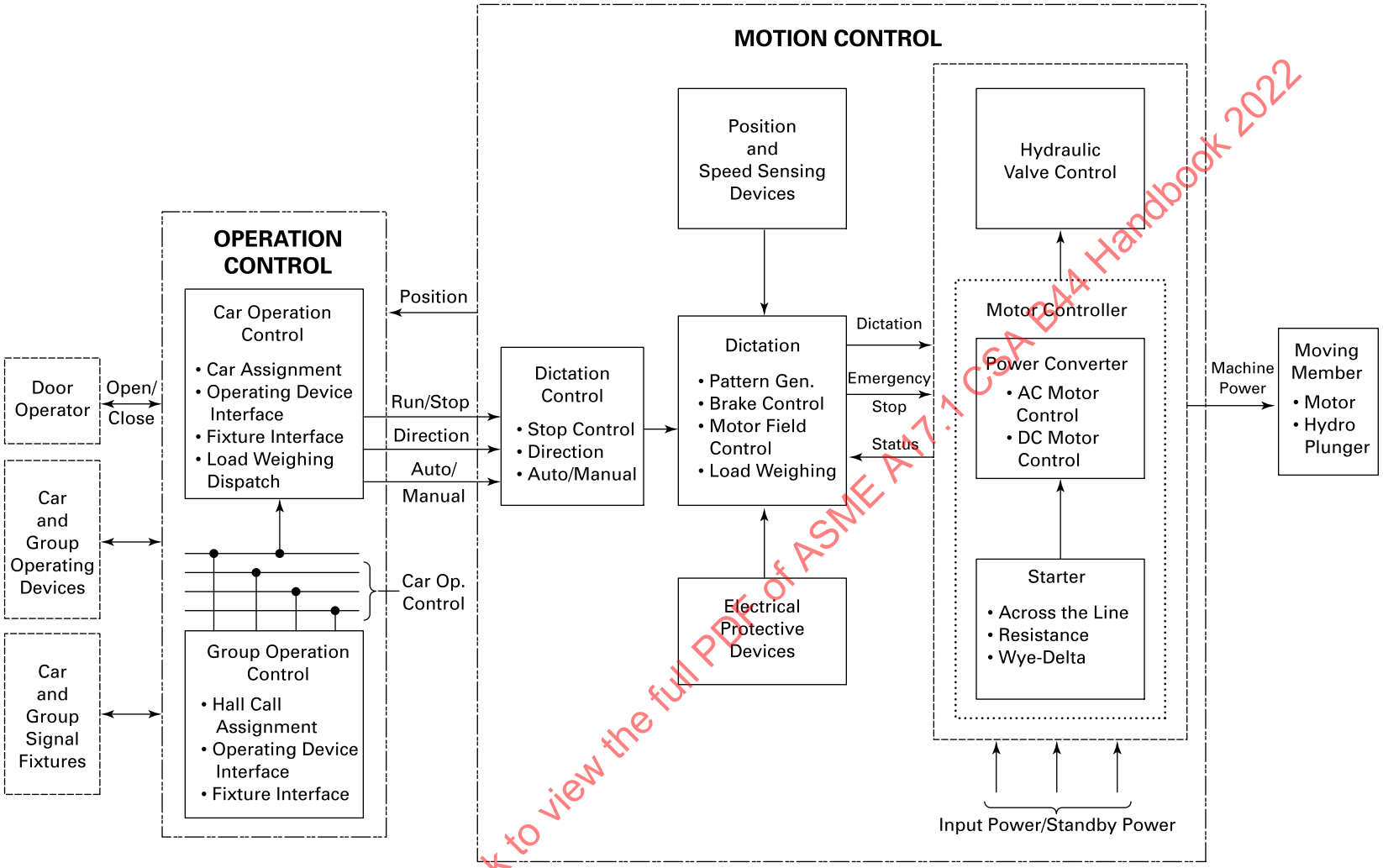
Requirements for the "LIMITED" test function, which is only for testing and inspection purposes, are provided in 2.26.14.3. Requirement 2.26.14.3 includes a requirement that the electrical protective devices are functional before the test is initiated and that all corrected actions are taken prior to manually resetting a safety device. Requirement 2.26.14.3 also includes requirements for how the operation must function during Phase I Emergency Recall or a seismic event.

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Requirements for the “GENERAL” test are provided in 2.26.14.4, including the scope, function, and limitations on which electrical protective devices can be bypassed. Requirement 2.26.14.5 includes conditions under which the test must be terminated, and 2.26.14.6 requires monitoring while in the test mode and that the car is only operated under constant pressure Inspection Operation. Requirement 2.26.14.7 defines the documentation that is required when test enable operation is provided and requires the test enable device to be identified on the wiring diagrams and in the on-site documentation.

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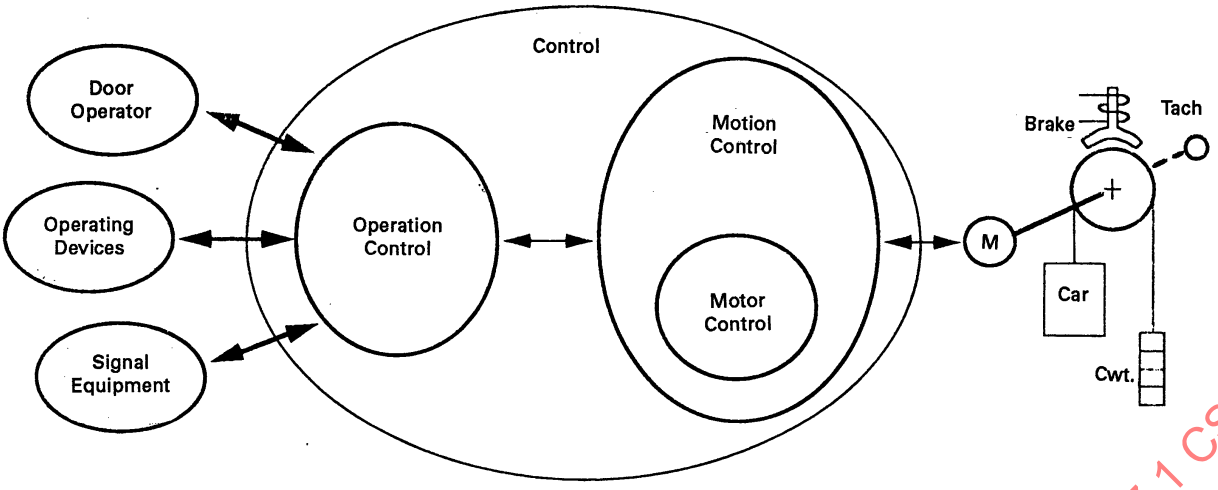
Diagram 2.26(a)
Operation Control and Motion Control



GENERAL NOTE: See Section 2.26 for Diagram legends.

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Diagram 2.26(b)
Definitions Control System



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Section 2.26 for Diagram legends.

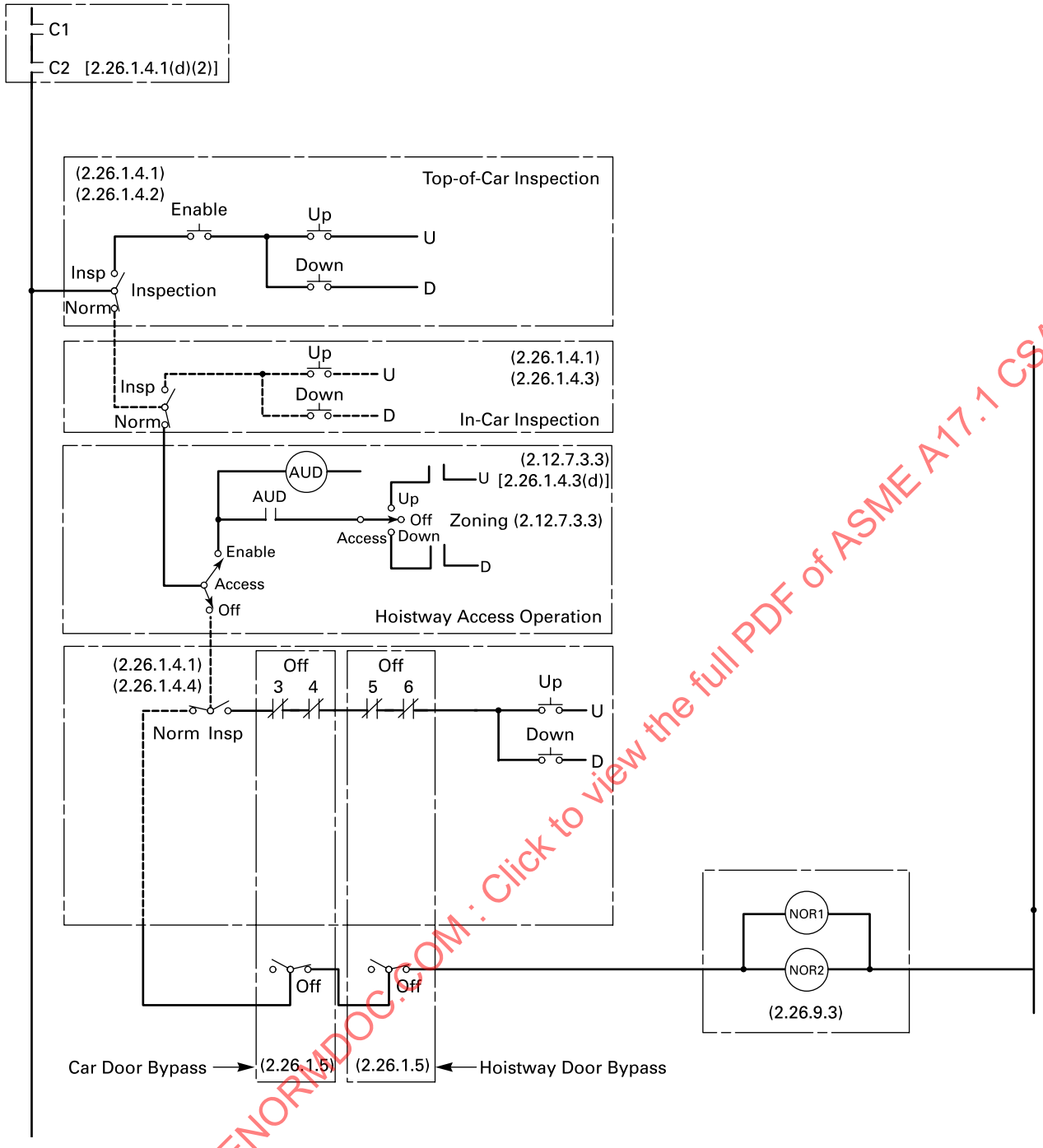
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Chart 2.26.1.4
Inspection Operation and Hoistway Access Switch Operation Hierarchy

											BYPASS Operation, 2.26.1.5		
Operation Modes Activated	**Top-of-Car, 2.26.1.4.2**	**In-Car, 2.26.1.4.3**	**Hoistway Access Operation, 2.12.7.3**	**Machine Room, 2.26.1.4.4**	**Control Room, 2.26.1.4.4**	**Machinery Space Outside Hoistway, 2.26.1.4.4**	**Control Space Outside Hoistway, 2.26.1.4.4**	**Landing, 2.26.1.4.4**	**Pit, 2.26.1.4.4**	**Working Platform, 2.26.1.4.4**	***Top-of-Car***	***In-Car***	**Operation Modes Activated**
Top-of-Car	**Top-of-Car**	*Top-of-Car*	*Top-of-Car*	*Top-of-Car*	*Top-of-Car*	*Top-of-Car*	*Top-of-Car*	*Top-of-Car*	No Operation	No Operation	*Top-of-Car*	*Top-of-Car*	**Top-of-Car**
In-Car	*Top-of-Car*	**In-Car**	*In-Car*	*In-Car*	*In-Car*	*In-Car*	*In-Car*	*In-Car*	No Operation	No Operation	*Top-of-Car*	*In Car*	**In-Car**
Hoistway Access	*Top-of-Car*	*In-Car*	**Hoistway Access**	*Hoistway Access*	*Hoistway Access*	*Hoistway Access*	*Hoistway Access*	*Hoistway Access*	No Operation	No Operation	*Top-of-Car*	*In-Car*	**Hoistway Access**
Machine Room	*Top-of-Car*	*In-Car*	*Hoistway Access*	**Machine Room**	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	*Top-of-Car*	*In-Car*	**Machine Room**
Control Room	*Top-of-Car*	*In-Car*	*Hoistway Access*	No Operation	**Control Room**	No Operation	No Operation	No Operation	No Operation	No Operation	*Top-of-Car*	*In-Car*	**Control Room**
Machinery Space Outside Hoistway	*Top-of-Car*	*In-Car*	*Hoistway Access*	No Operation	No Operation	**Machinery Space**	No Operation	No Operation	No Operation	No Operation	*Top-of-Car*	*In-Car*	**Machinery Space Outside Hoistway**
Control Space Outside Hoistway	*Top-of-Car*	*In-Car*	*Hoistway Access*	No Operation	No Operation	No Operation	**Control Space**	No Operation	No Operation	No Operation	*Top-of-Car*	*In-Car*	**Control Space Outside Hoistway**
Landing	*Top-of-Car*	*In-Car*	*Hoistway Access*	No Operation	No Operation	No Operation	No Operation	**Landing**	No Operation	No Operation	*Top-of-Car*	*In-Car*	**Landing**
Pit	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	***Pit***	No Operation	No Operation	No Operation	***Pit***
Working Platform	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	***Working Platform***	No Operation	No Operation	***Working Platform***

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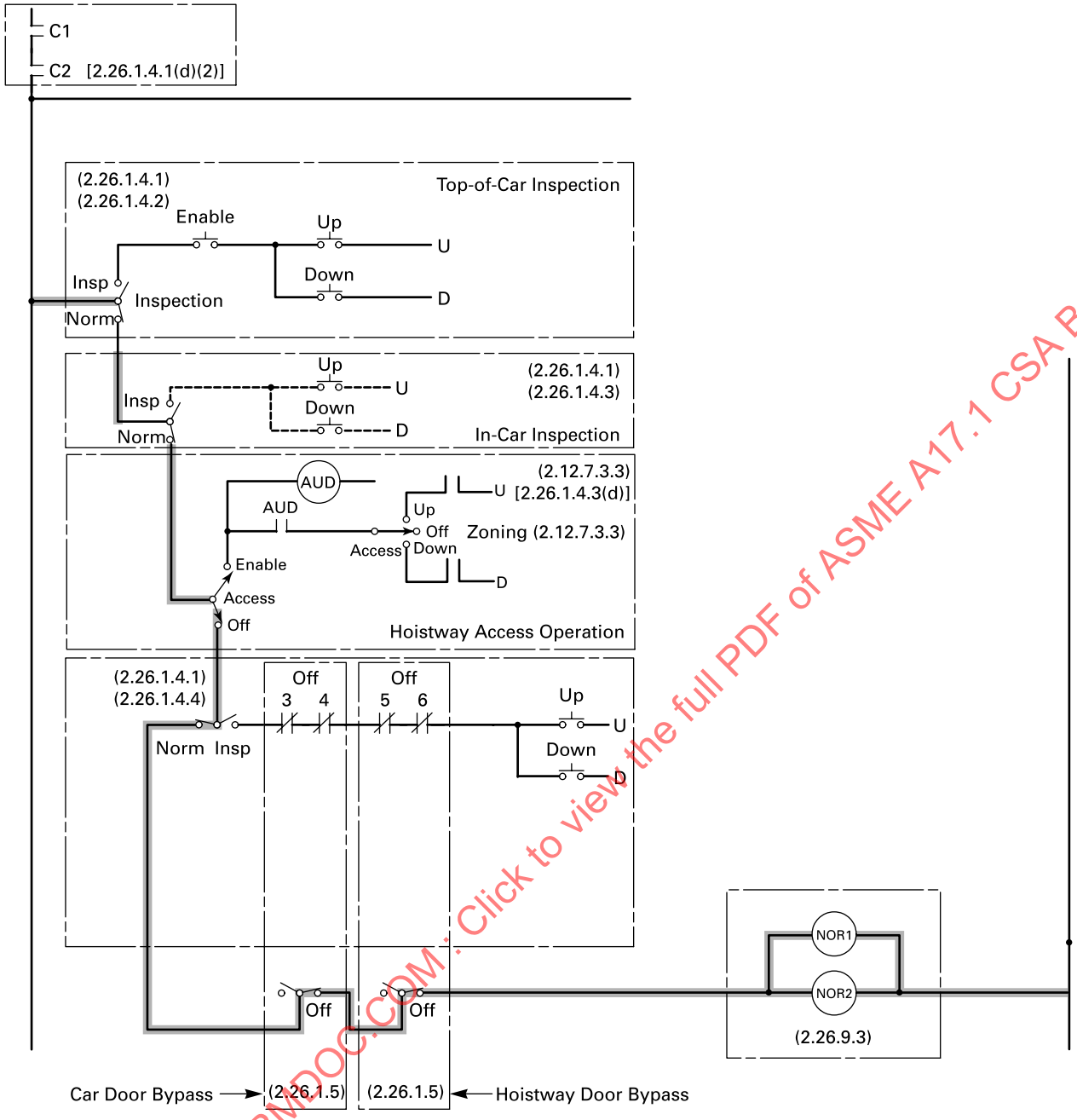
Diagram 2.26.1.4(a)
Inspection Operation



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.26 for Diagram legends.

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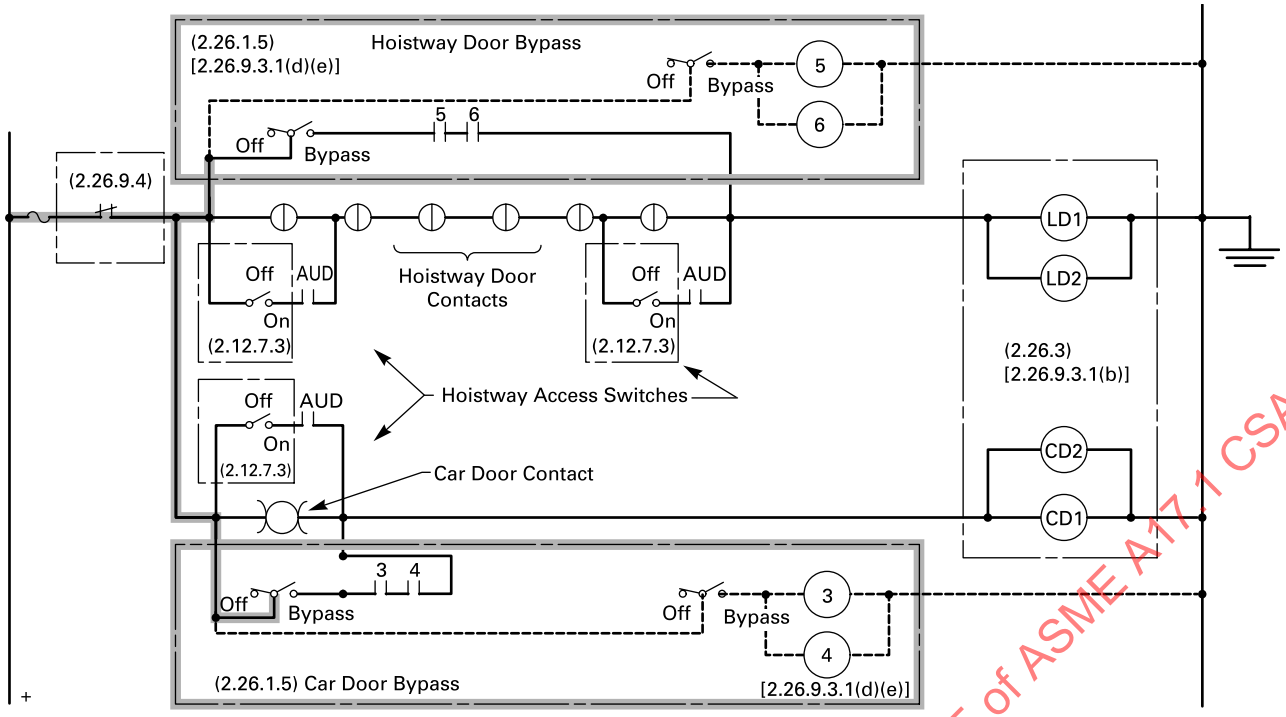
Diagram 2.26.1.4(b)
Inspection Operation and Protection Against Failure



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.26 for Diagram legends.

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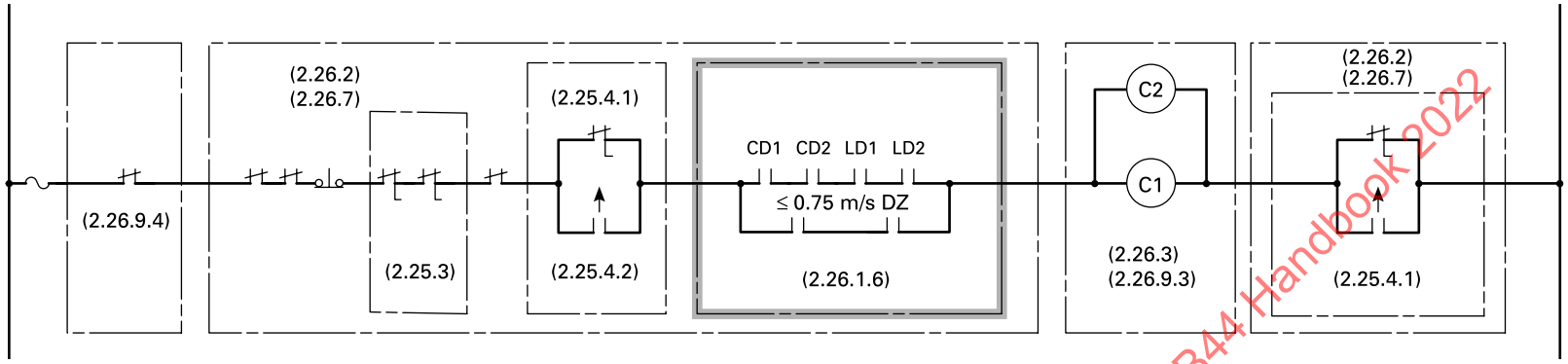
Diagram 2.26.1.5
Inspection Operation With Open Door Circuits and Protection Against Failures (2.26.9.3)



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.26 for Diagram legends.

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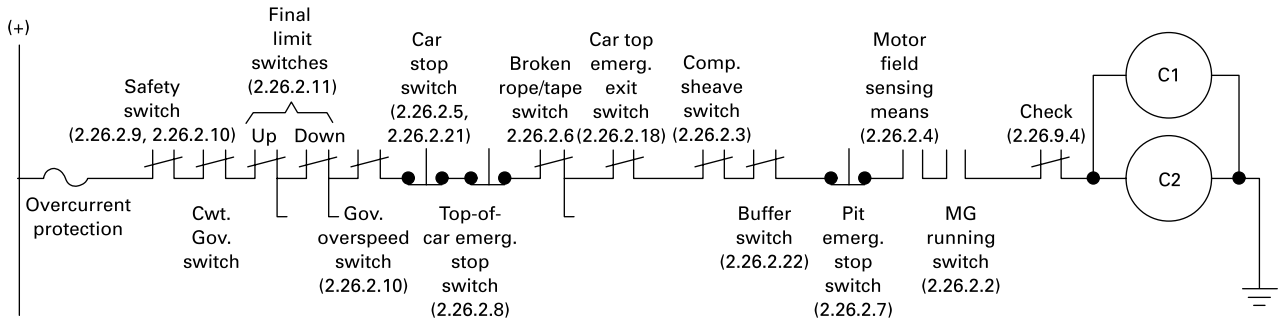
Diagram 2.26.1.6
Operation in Leveling Zone



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) Requirement 2.26.1.6.3 — leveling zone ± 450 mm (18 in.)
(c) Requirement 2.26.1.6.6 — ≤ 0.75 m/s (150 ft/min) max. and independent speed check for static control.
(d) Requirement 2.26.1.6.7 — inner door zone ± 75 mm (3 in.) for static control.
(e) See Handbook Section 2.26 for Diagram legends.

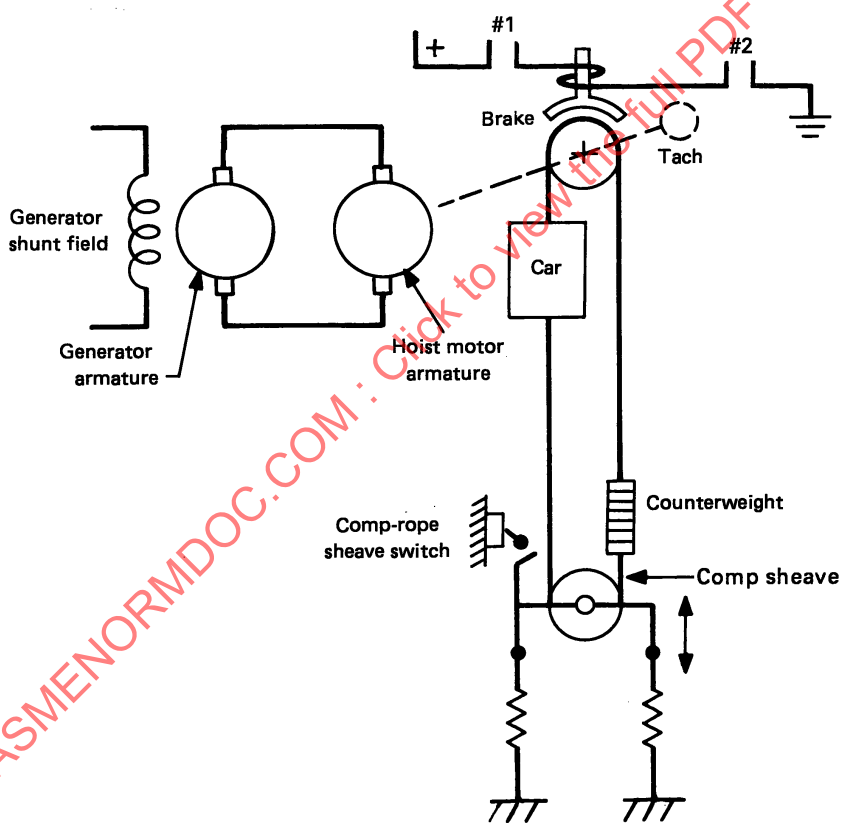
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Diagram 2.26.2
Typical Safety Circuit, Electrical Protective Devices Circuit



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) All electrical protective devices not included.
(c) See Handbook Section 2.26 for Diagram legends.

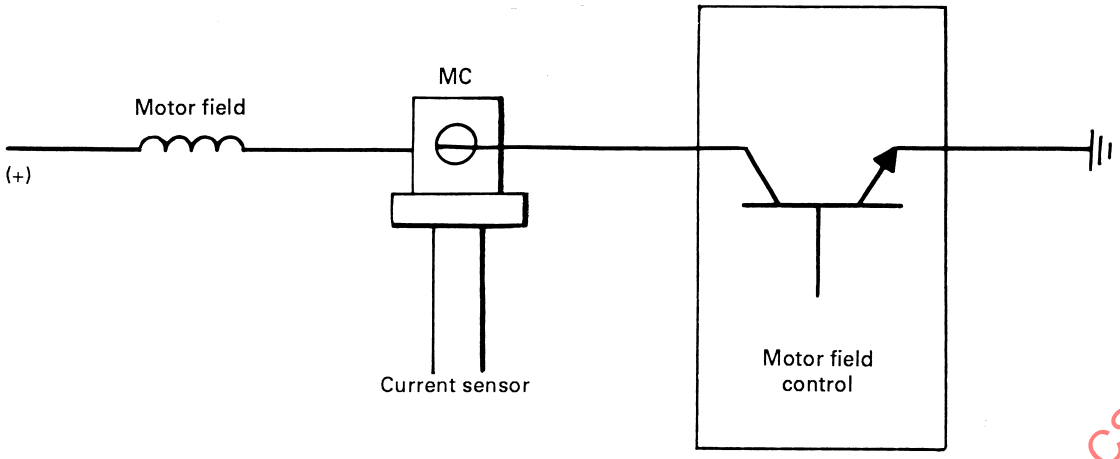
Diagram 2.26.2.3
Typical Compensating-Rope Sheave Switch Arrangement



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.26 for Diagram legends.

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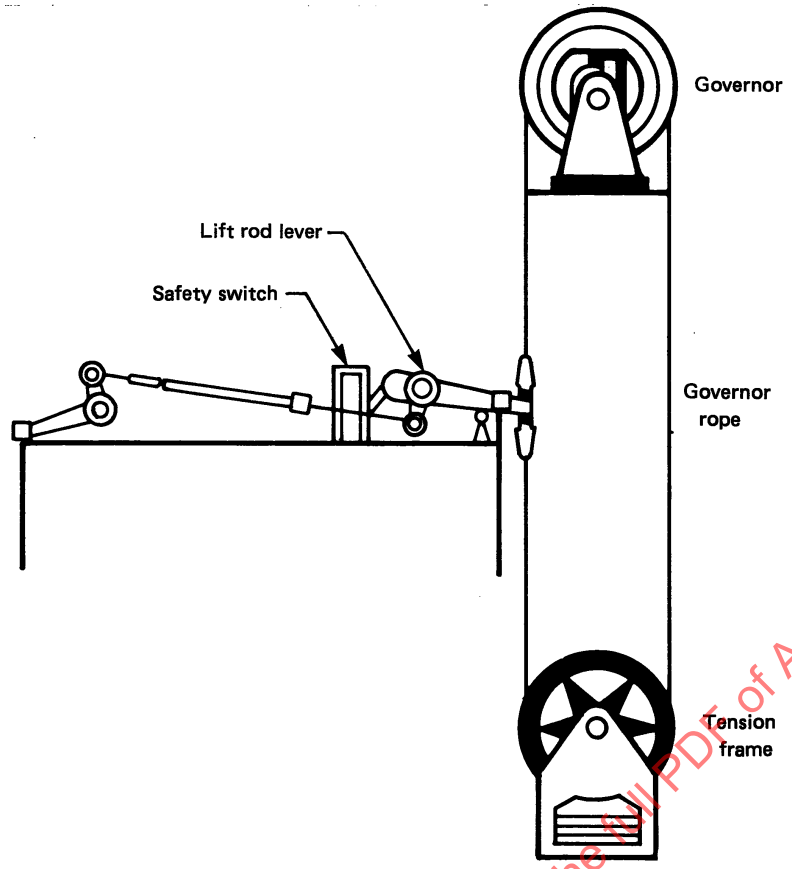
Diagram 2.26.2.4
Typical Motor Field Sensing Means Circuit



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

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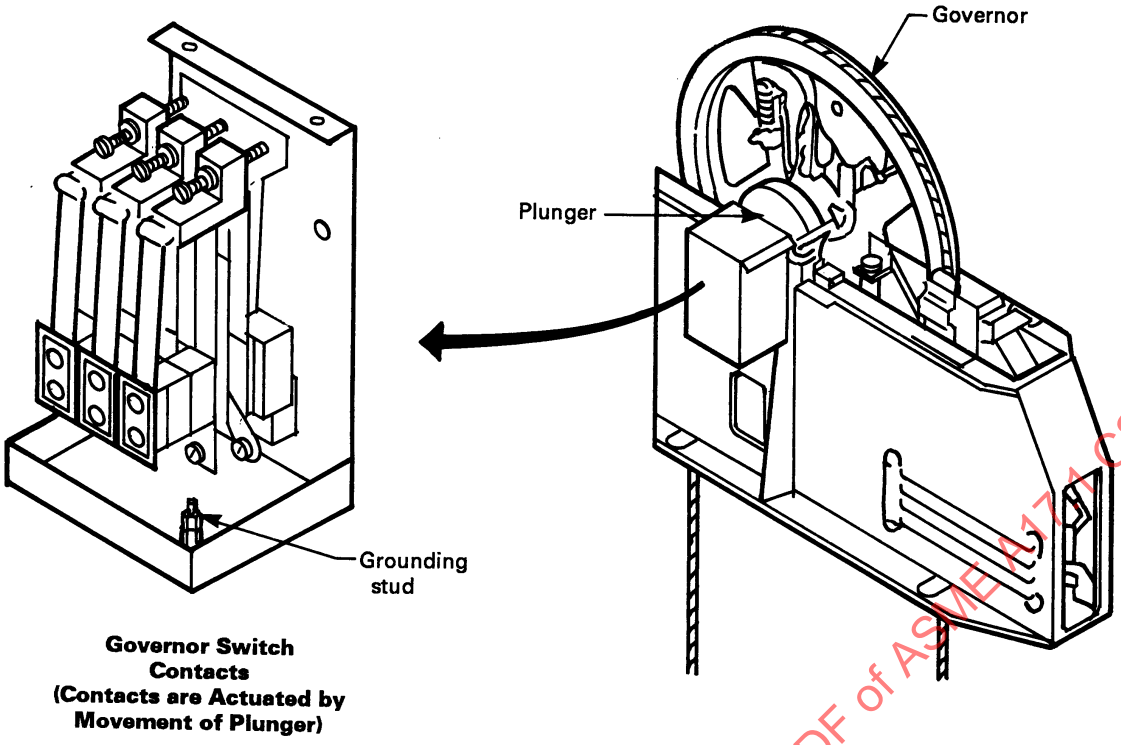
Diagram 2.26.2.9
Typical Car-Safety Mechanism Switch



GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

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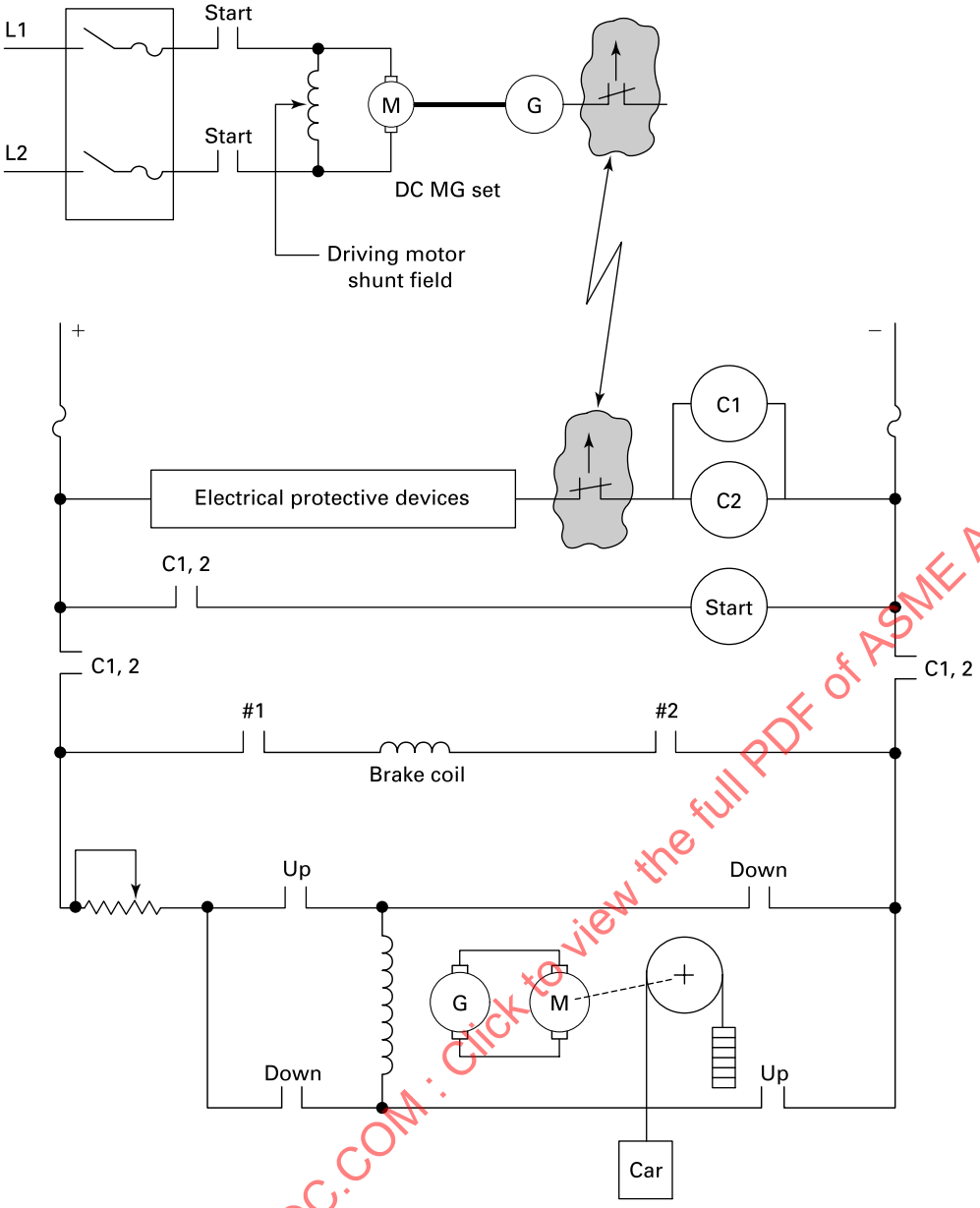
Diagram 2.26.2.10
Typical Speed Governor Overspeed Switch Arrangement



GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

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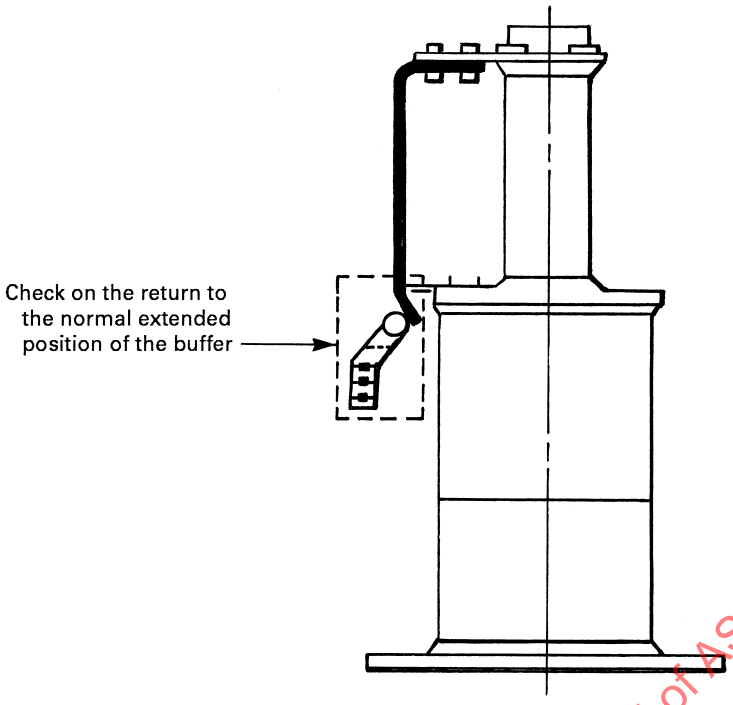
Diagram 2.26.2.19
Typical Motor-Generator Overspeed Switch



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.26 for Diagram legends.

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Diagram 2.26.2.22
Gas Spring-Return Oil Buffer Switch

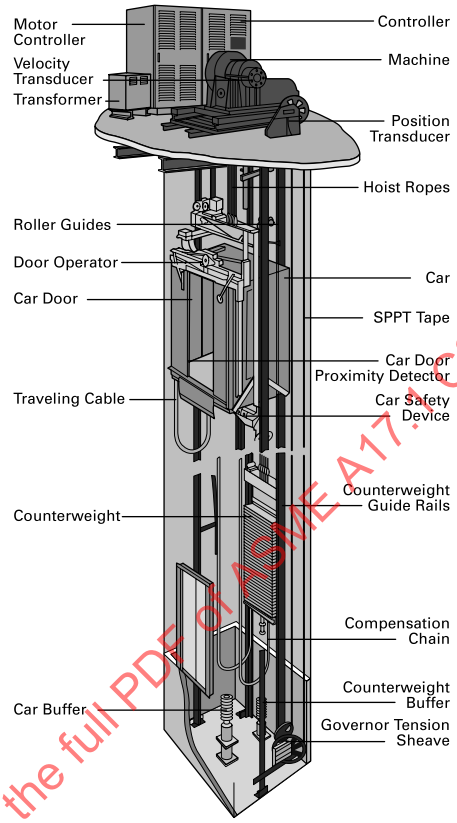


GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

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Diagram 2.26.4.1(a)
National Electrical Code® and Canadian Electrical Code Requirements

Section	NFPA 70-2017	CSA C22.1-18
Scope	620.1	38-001
Definitions	620.2	38-002
Voltage limitations	620.3	38-003
Live parts enclosed	620.4	38-004
Working clearances	620.5	38-005
Conductors	620.11-14	38-011-014
Motor controller rating	620.15	38-015
Wiring methods	620.21	38-021
Branch circuits	620.22-25	38-022-25
Installation of conductors	620.32-38	38-032-037
Traveling cables	620.41-44	38-041-044
Disconnecting means	620.51-55	38-051-055
Overcurrent protection	620.61-62	38-061-062
Guarding of equipment	620.71	38-071
Grounding/bonding	620.81-84	38-081-084
	Art. 250	Section 10
GFCI protection	620.85	38-085
Emergency and standby power systems	629.91, Art. 700	38-091



GENERAL NOTE: Courtesy of Joseph Busse, Andy Juhasz, and David McColl.

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Chart 2.26.4.1(b)
NEC® Section 620.3 — Voltage Limitations

Section	Type Circuits	Voltage (Max.)
(a) Power circuits	Motor controllers Driving-machine motors Machine brakes Motor-generator sets Door operator controller Door motors Internal to power conversion and functionally associated equipment including the interconnecting and wiring	600 >600
(b) Lighting circuits	All	Per Article 410
(c) Heating and air-conditioning circuits on the car	All	600

GENERAL NOTE:
(a) Courtesy of Joseph Busse and Andy Juhasz.
(b) 300 V max. between conductors unless permitted by (a), (b), and (c).

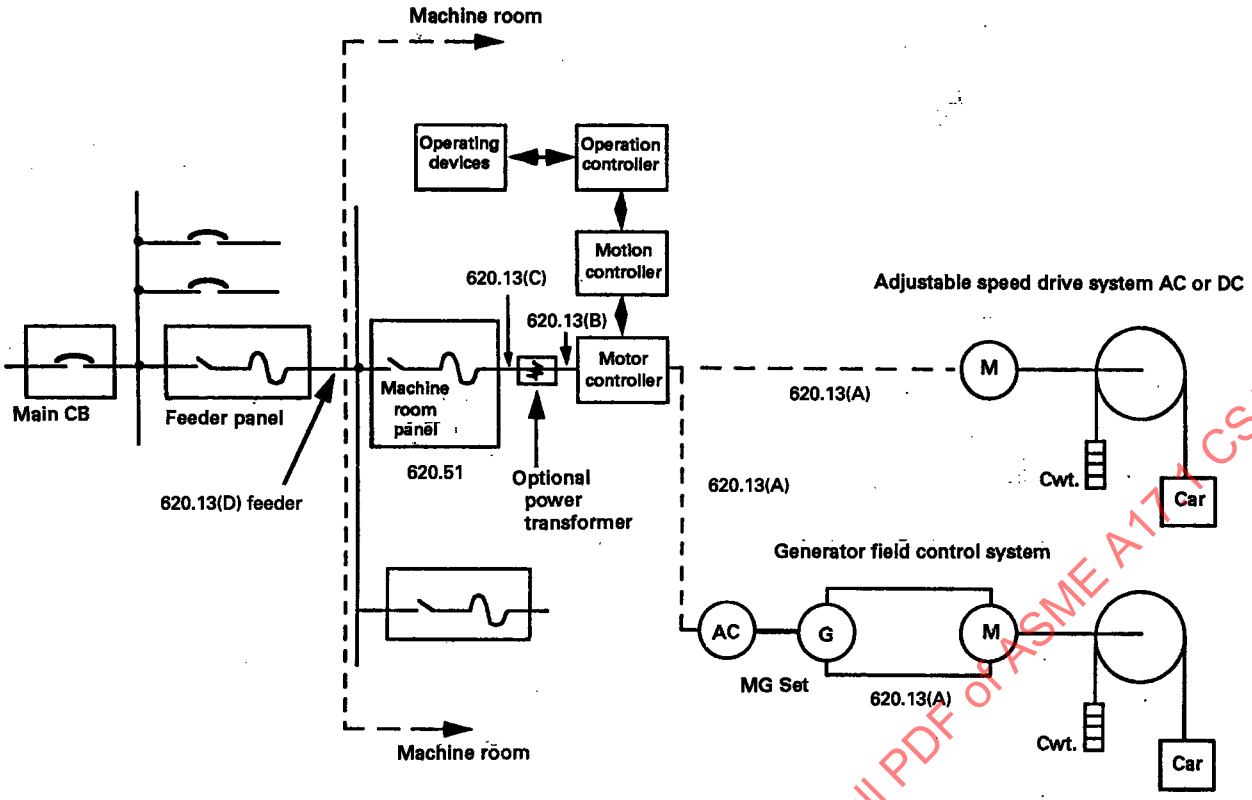
Chart 2.26.4.1(c)
NEC® Section 620.21(A)(B)(C) — Wiring Methods

Method	Article
Rigid metal conduit	344
Intermediate metal conduit	342
Electrical metallic tubing	358
Rigid nonmetallic conduit	
Rigid polyvinyl chloride conduit	352
Reinforced thermosetting resin conduit	355
Metal wireways	376
Nonmetallic wireways	378
Liquidtight flexible nonmetallic conduit (LFNC-B)	356
MC cable	330
MI cable	332
AC cable (BX)	320

GENERAL NOTE: Courtesy of Joseph Busse and Andy Juhasz.

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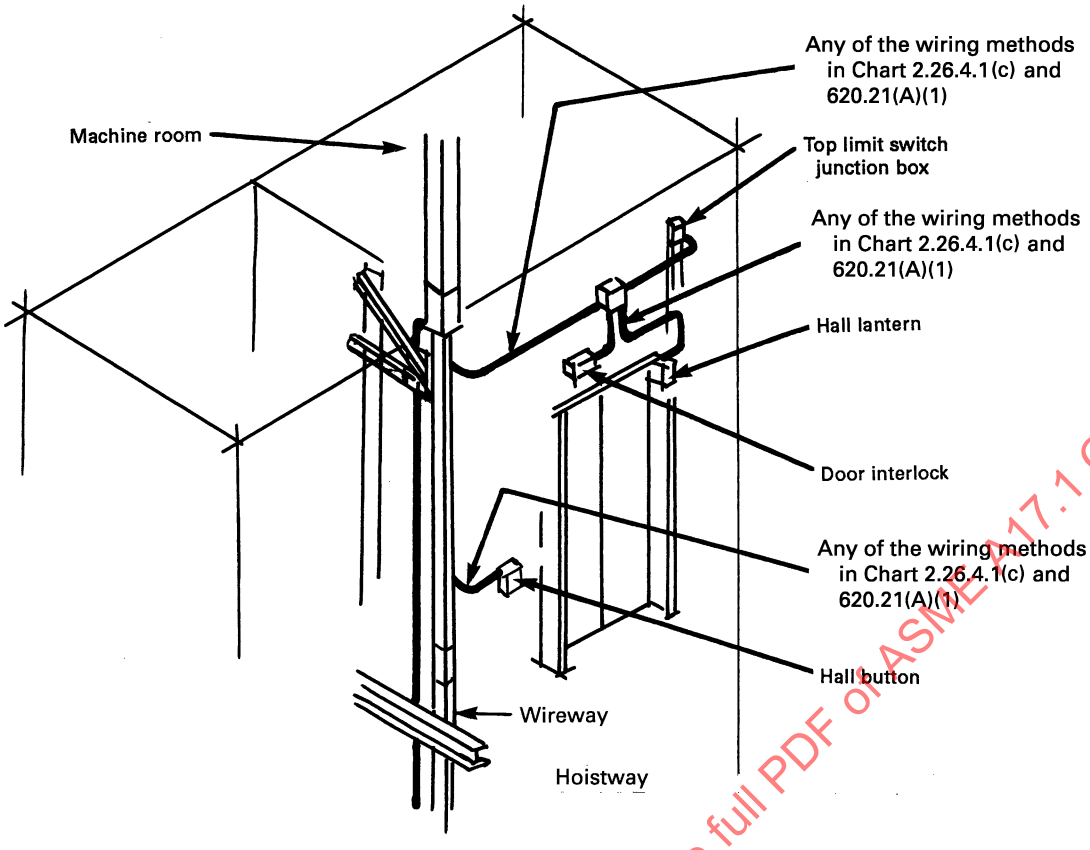
Diagram 2.26.4.1(d)
NEC® Section 620.13 — Feeder and Branch Circuit Conductors



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

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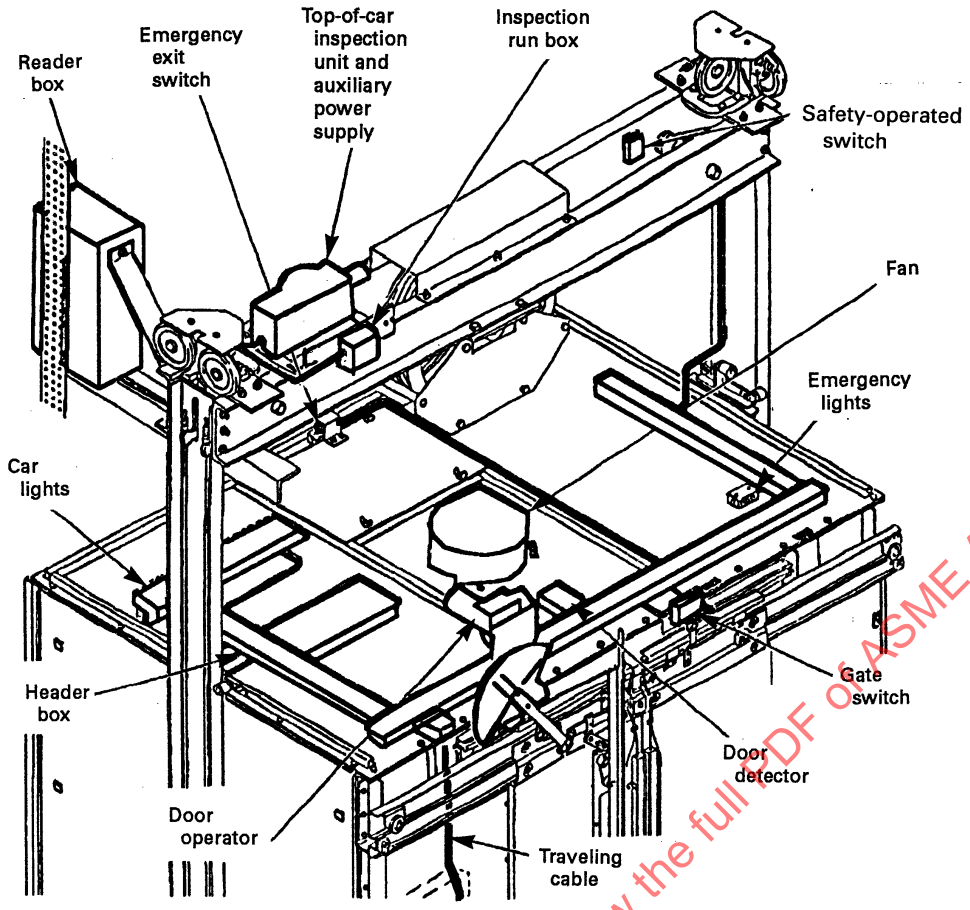
Diagram 2.26.4.1(e)
NEC® Section 620.21(A)(1) — Hoistway Wiring Methods



GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

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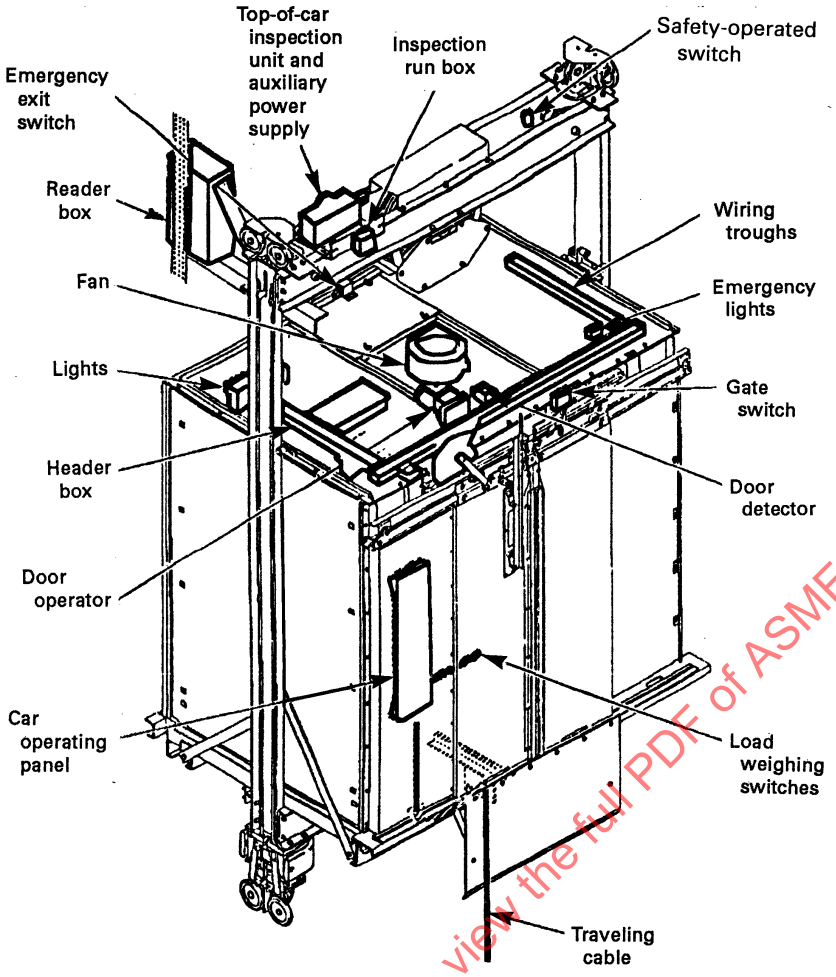
Diagram 2.26.4.1(f)
NEC® Section 620.21(A)(2) — Car Wiring Methods, Top of Car



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) Wiring — Any method in Chart 2.26.4.1(c) and NEC® Section 620.21(A)(2).

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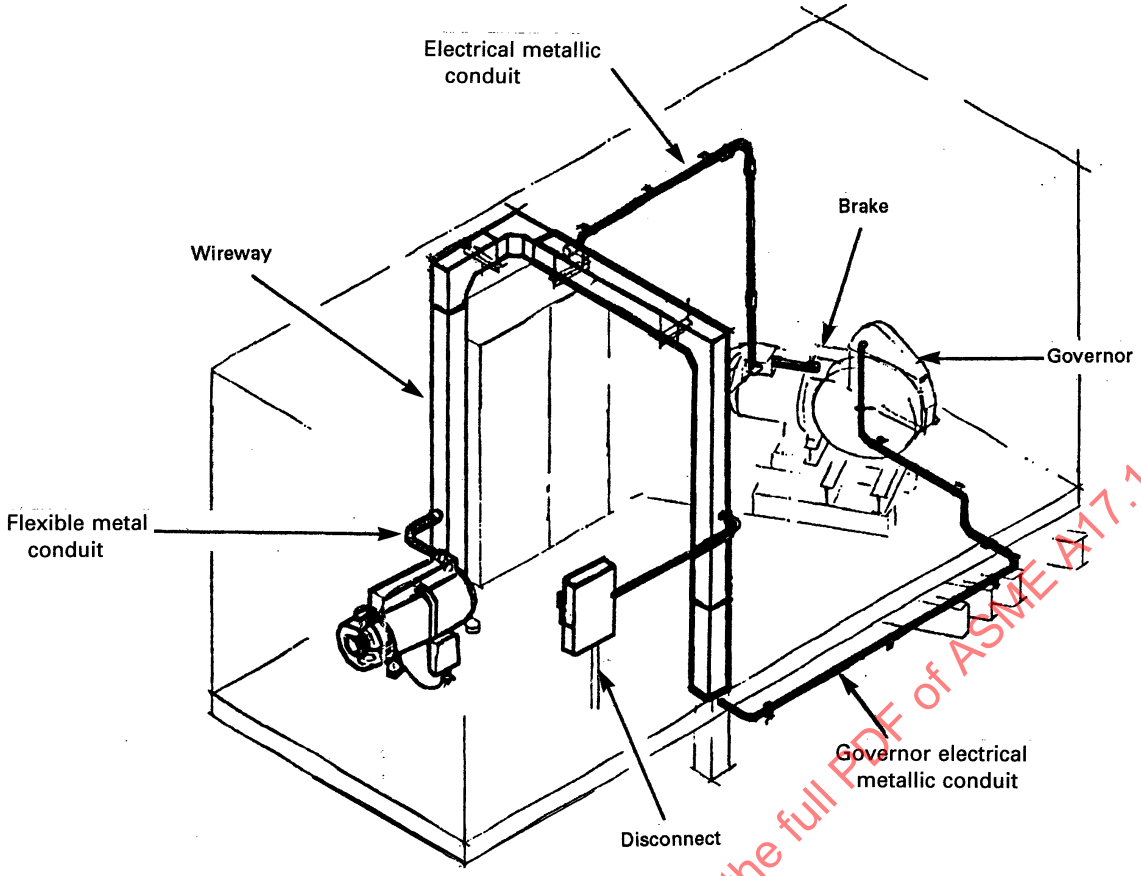
Diagram 2.26.4.1(g)
NEC® Section 620.21(A)(2) — Car Wiring Methods



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) Wiring — Any method in Chart 2.26.4.1(c) and NEC® Section 620.21(A)(2).

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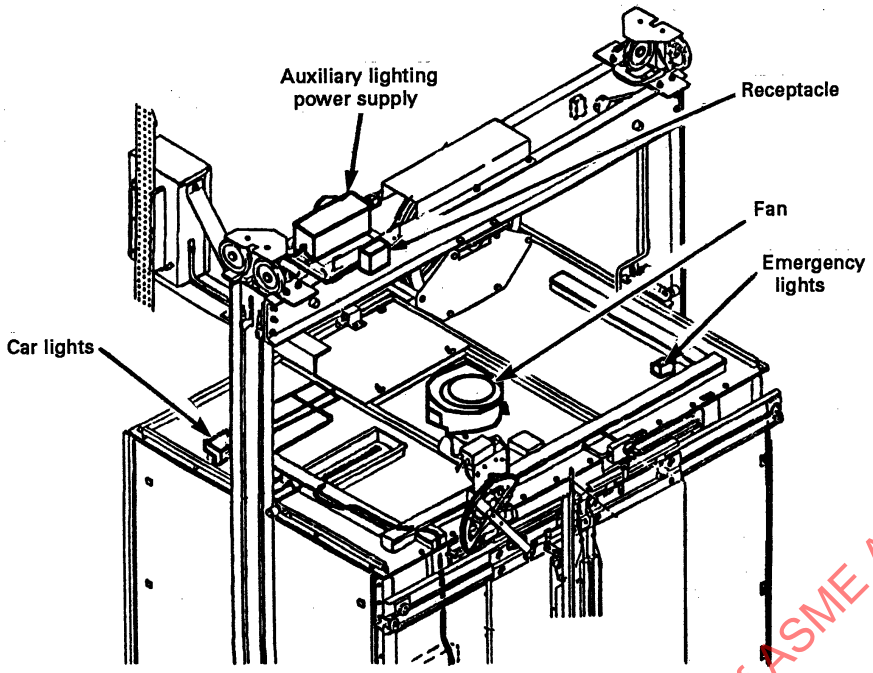
Diagram 2.26.4.1(h)
NEC® Section 620.21(A)(3) — Machine Room and Machinery Space Wiring Methods



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) Wiring — Any method in Chart 2.26.4.1(c) and NEC® Section 620.21(A)(2).

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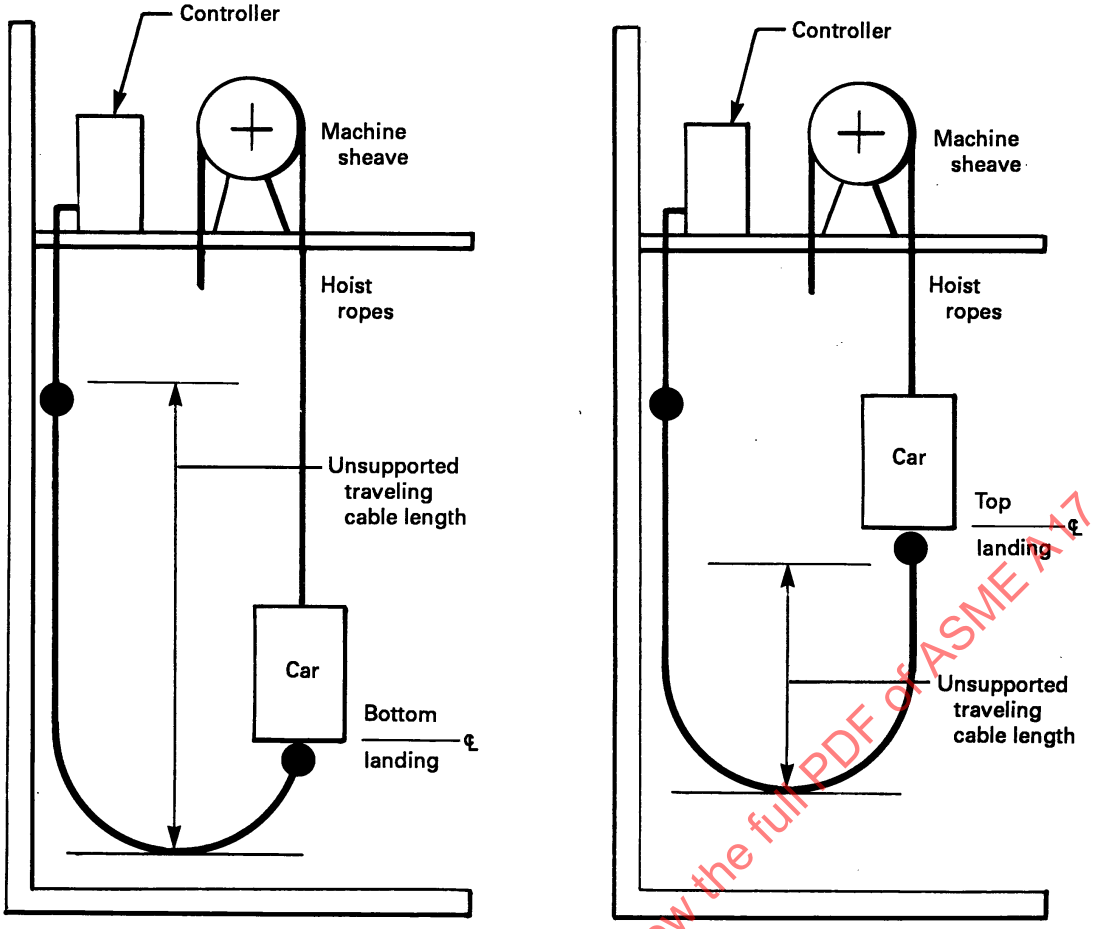
Diagram 2.26.4.1(i)
NEC® Section 620.22(A) — Branch Circuit for Car Lighting



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) Separate branch circuit on each elevator car to supply car lights, receptacle(s), auxiliary lighting power source, and ventilation.

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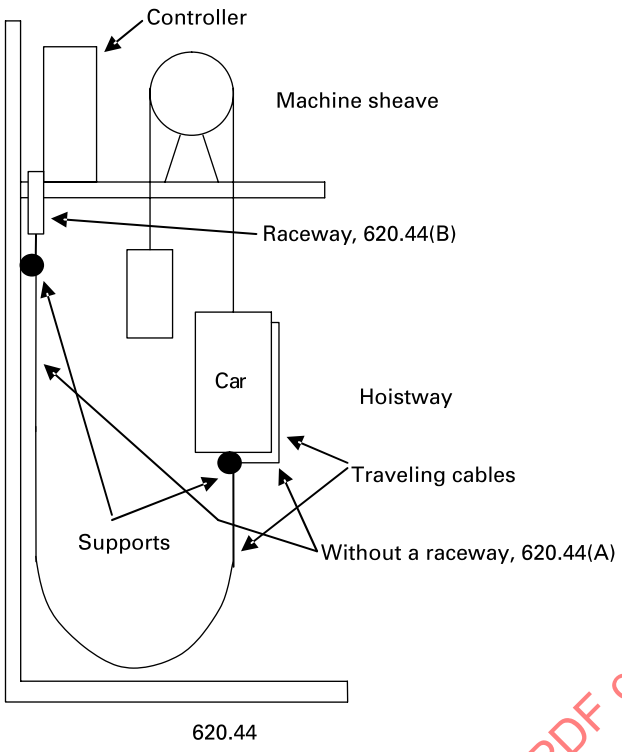
Diagram 2.26.4.1(j)
NEC® Section 620.41 — Unsupported Length of Traveling Cable



GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

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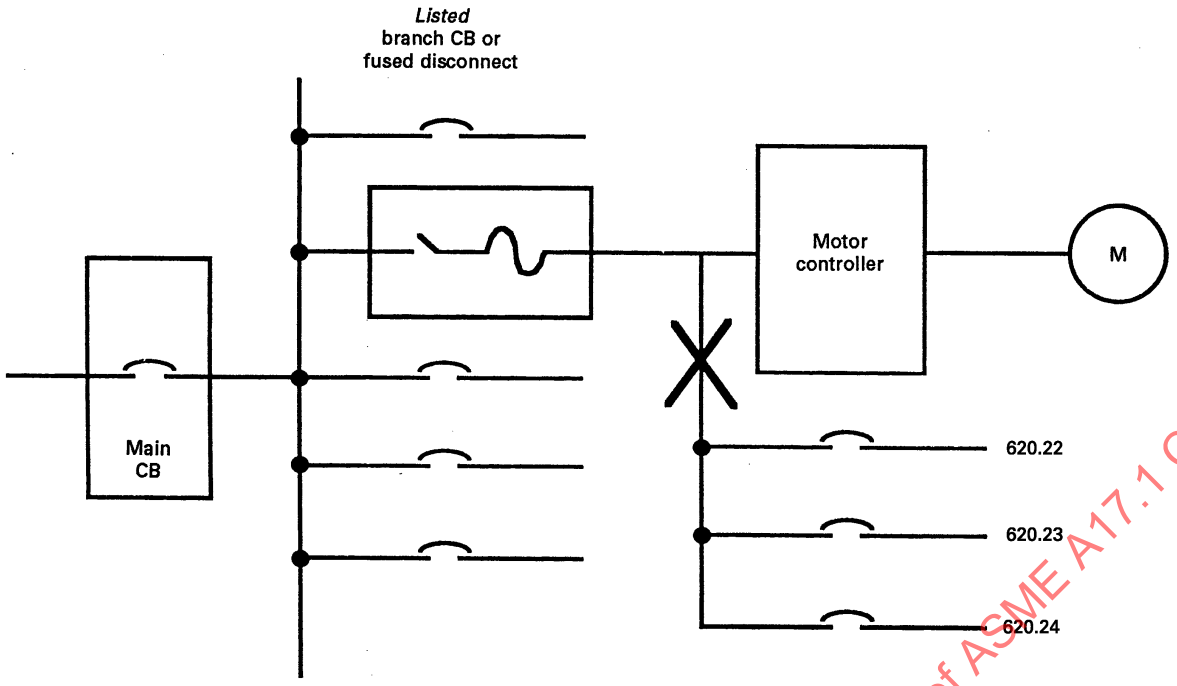
Diagram 2.26.4.1(k)
NEC® Section 620.44 — Installation of Traveling Cables



GENERAL NOTE: Courtesy of Joseph Busse and Andy Juhasz.

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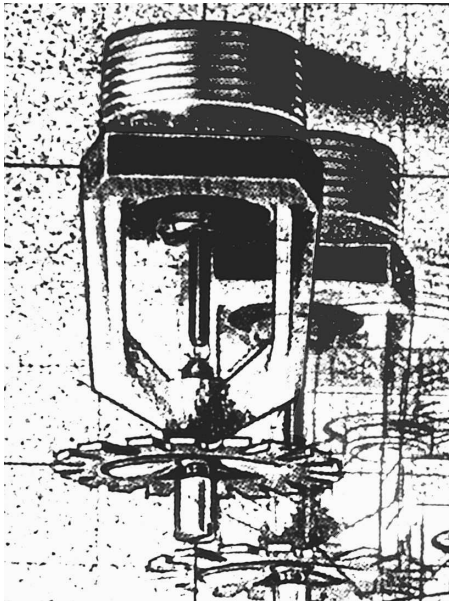
Diagram 2.26.4.1(l)
NEC® Section 620.51 — Disconnecting Means

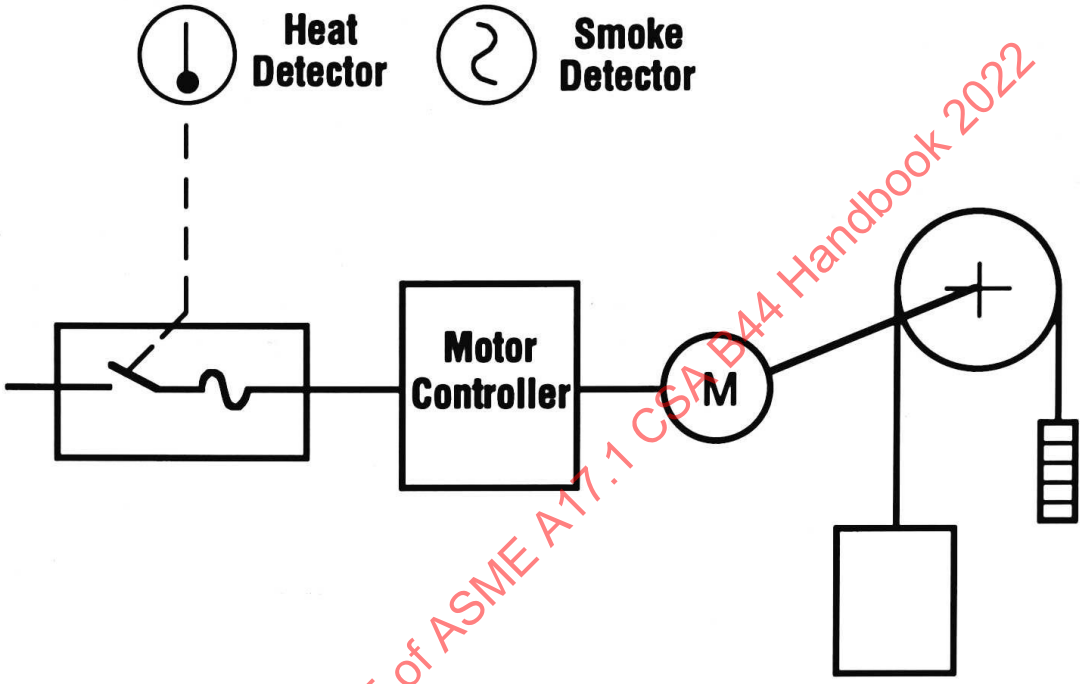


GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

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Diagram 2.26.4.1(m)
NEC® Section 620.51(B) — Operation Sprinklers



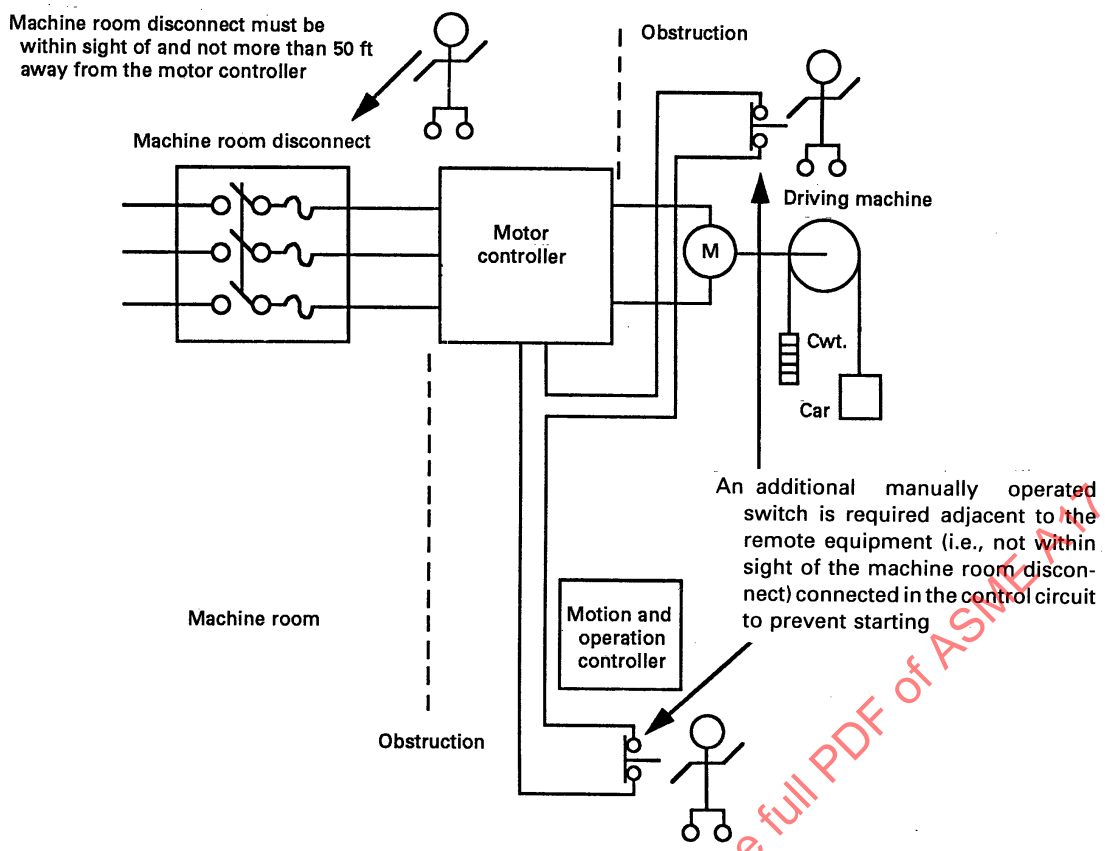


- Sprinklers in machine room, hoistways, machinery spaces

GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

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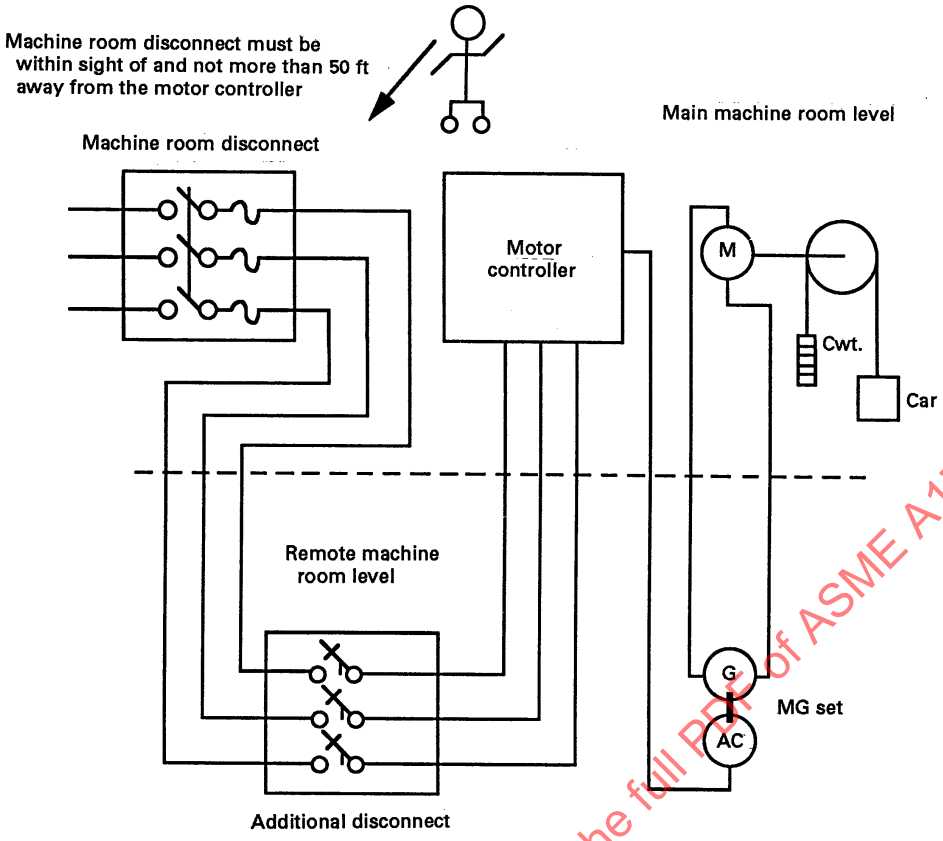
Diagram 2.26.4.1(n)
NEC® Section 620.51(C) — Disconnecting Means Location, Elevators Without Generator Field Control



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

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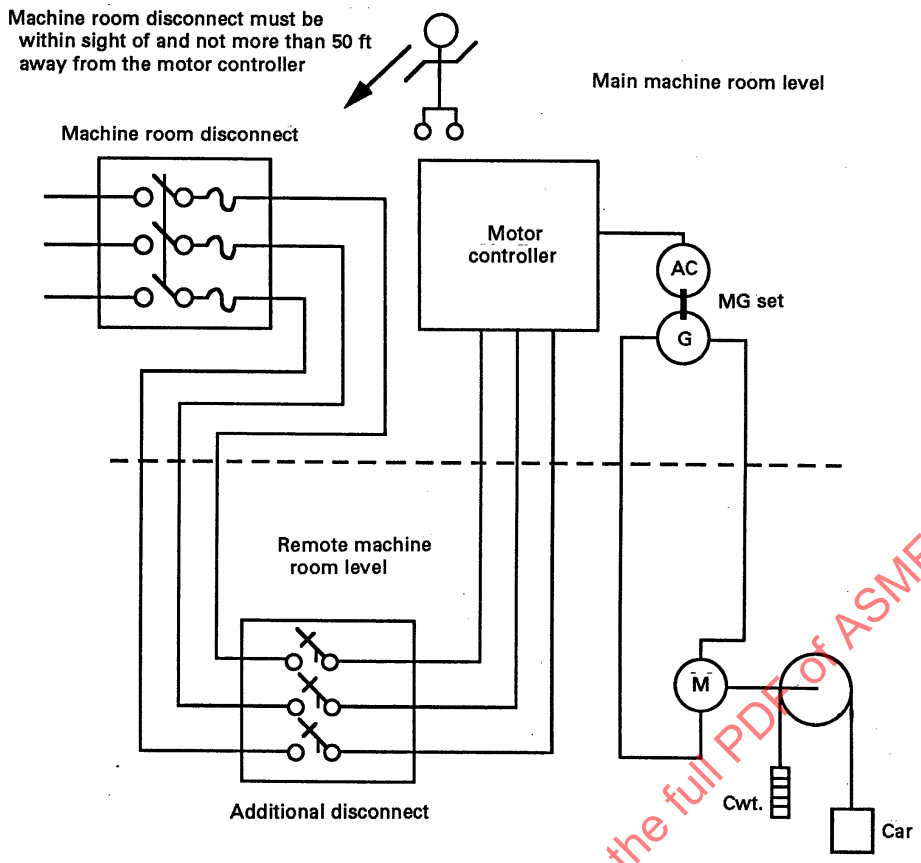
Diagram 2.26.4.1(o)
NEC® Section 620.51(C) — Disconnecting Means Location, Elevators With Generator Field Control, With Remote MG



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

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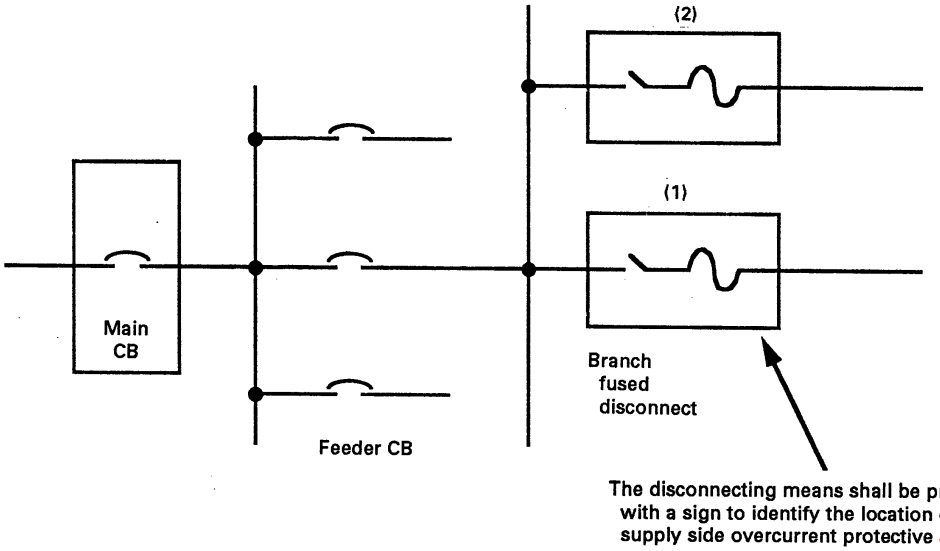
Diagram 2.26.4.1(p)
NEC® Section 620.51(C) — Disconnecting Means Location, Elevators With Generator Field Control, With Remote Driving Motor



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

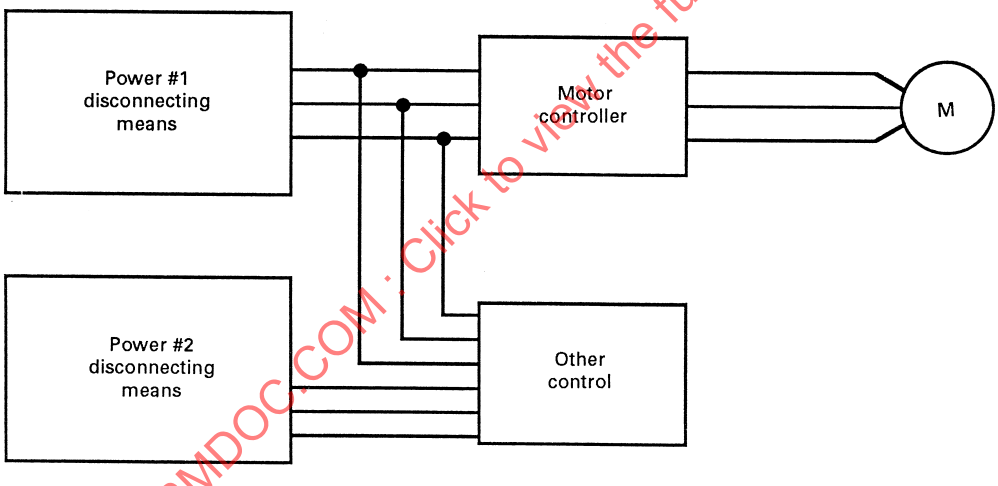
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Diagram 2.26.4.1(q)
NEC® Section 620.51(D) — Disconnecting Means Identification and Signs



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

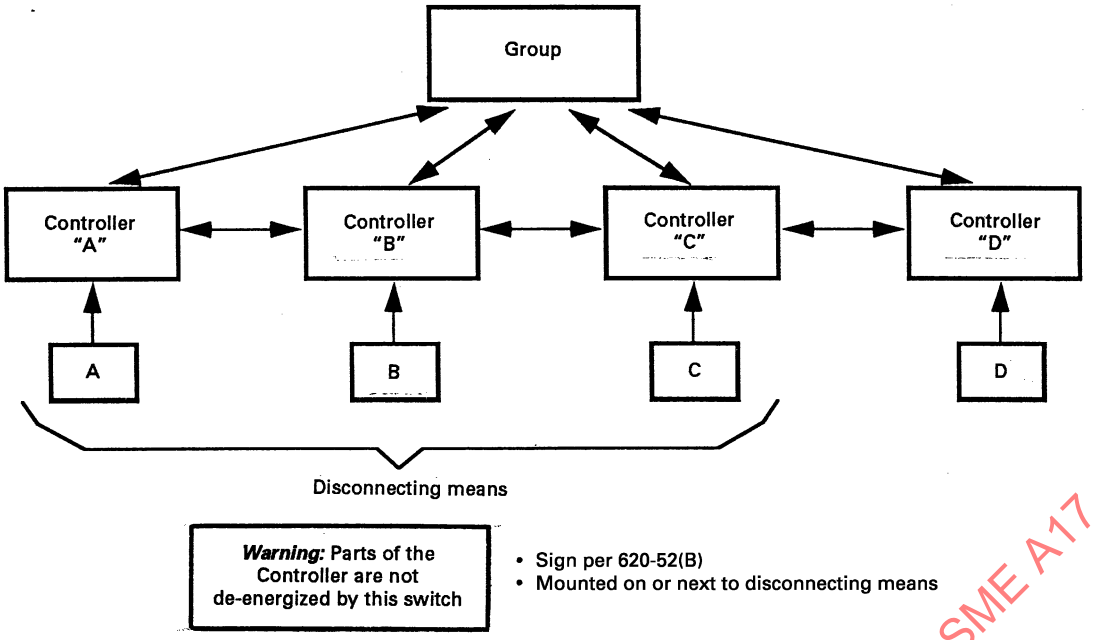
Diagram 2.26.4.1(r)
NEC® Section 620.52 — Power From More Than One Source Single- and Multi-Car Installations



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

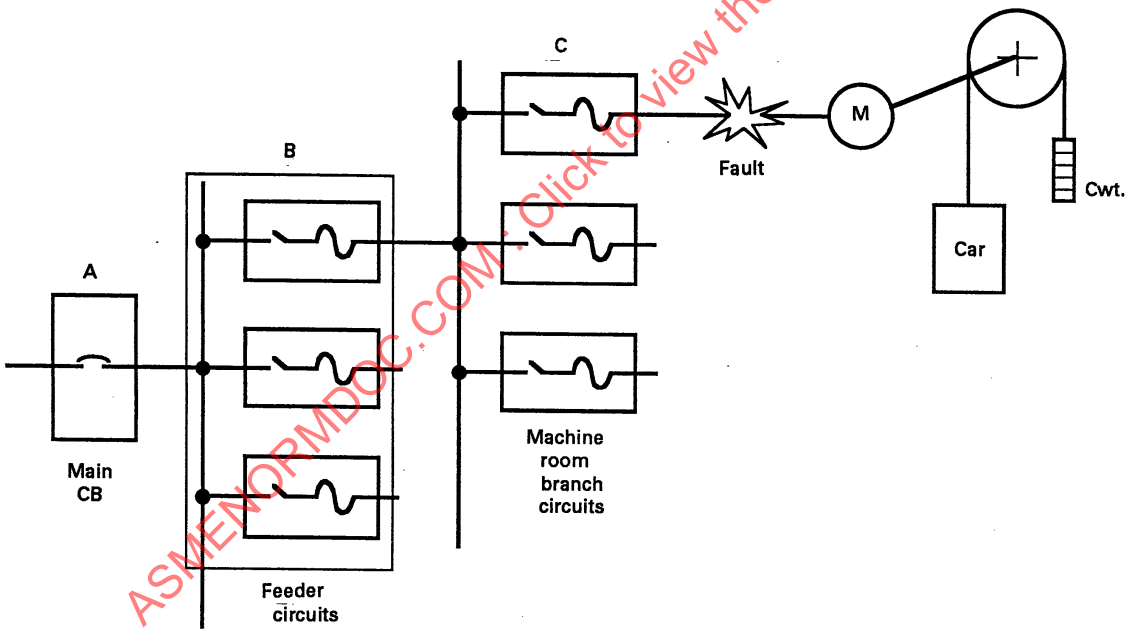
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Diagram 2.26.4.1(s)
NEC® Section 620.52 — Power From More Than One Source Interconnection Multi-Car Controllers



GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

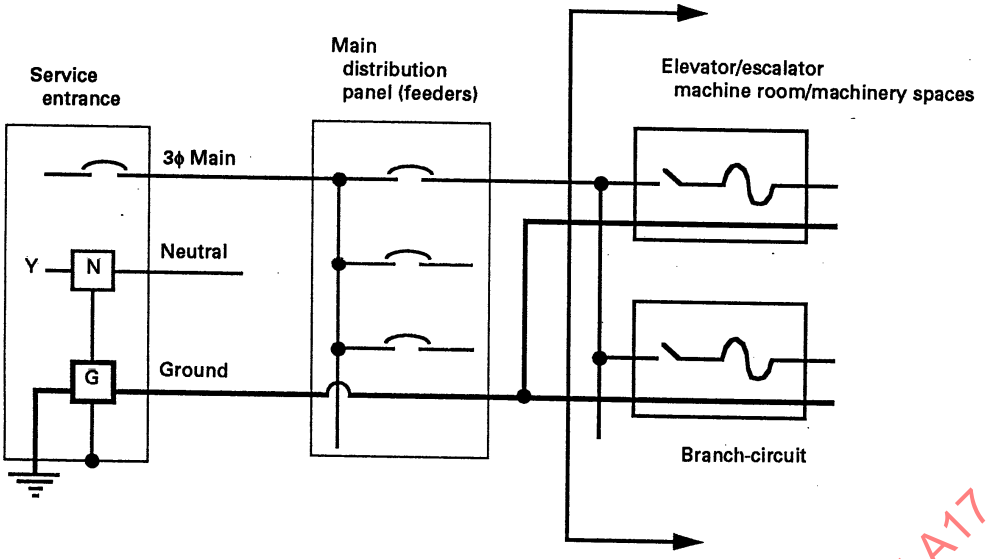
Diagram 2.26.4.1(t)
NEC® Section 620.62 — Selective Coordination



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

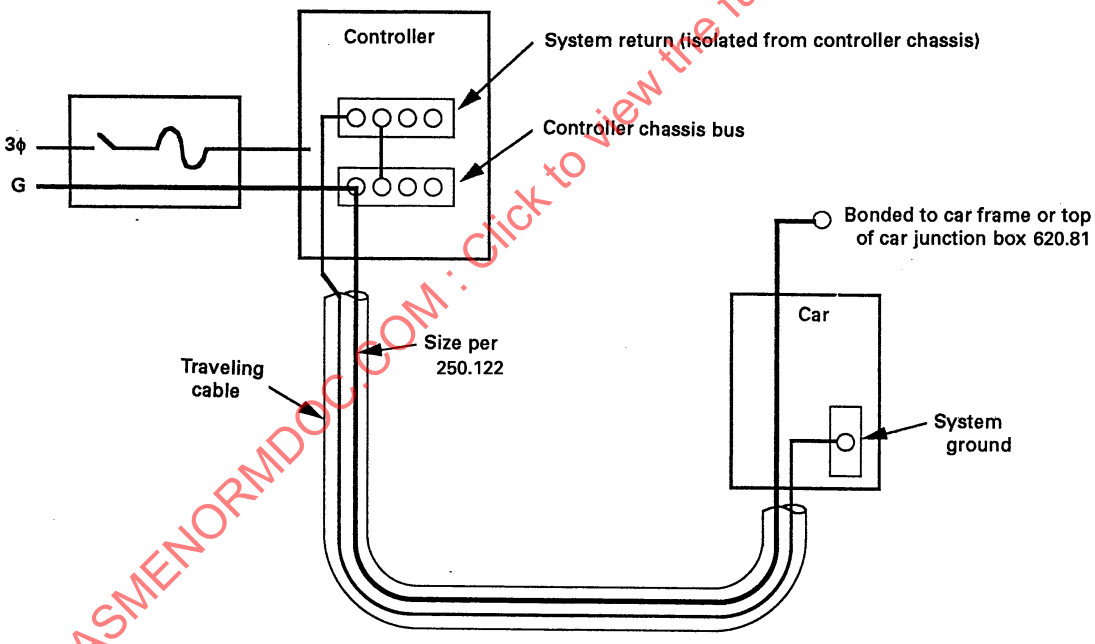
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Diagram 2.26.4.1(u)
NEC® Sections 620.81, 82, 83, and 84 — Grounding



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

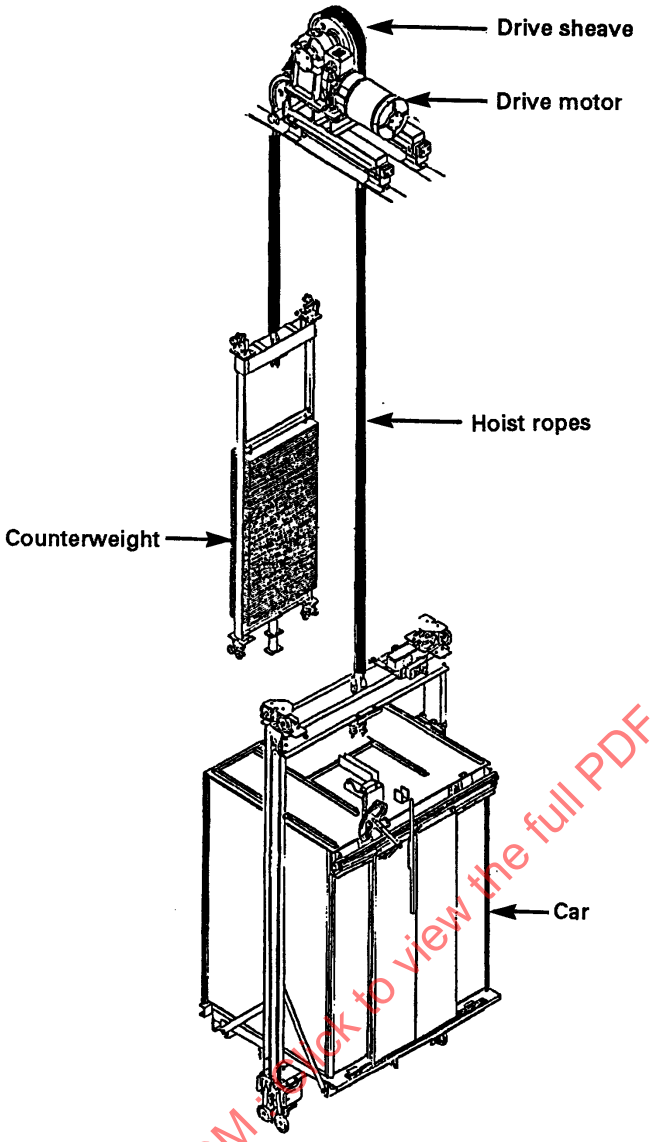
Diagram 2.26.4.1(v)
NEC® Sections 620.81, 82, 83, and 84 — Grounding



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

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Diagram 2.26.4.1(w)
NEC® Sections 250.58(B) and 250.136(B) — Metal Car Frames Equipment Considered Effectively Grounded

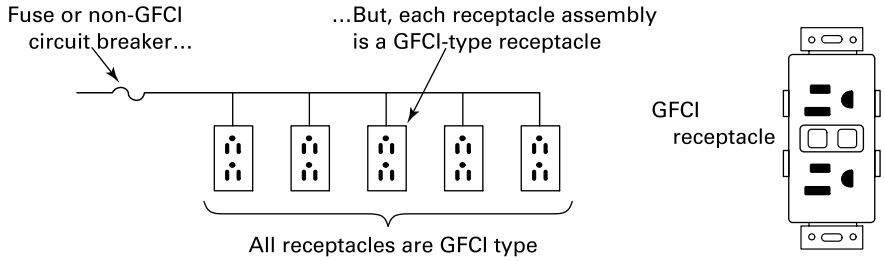


GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

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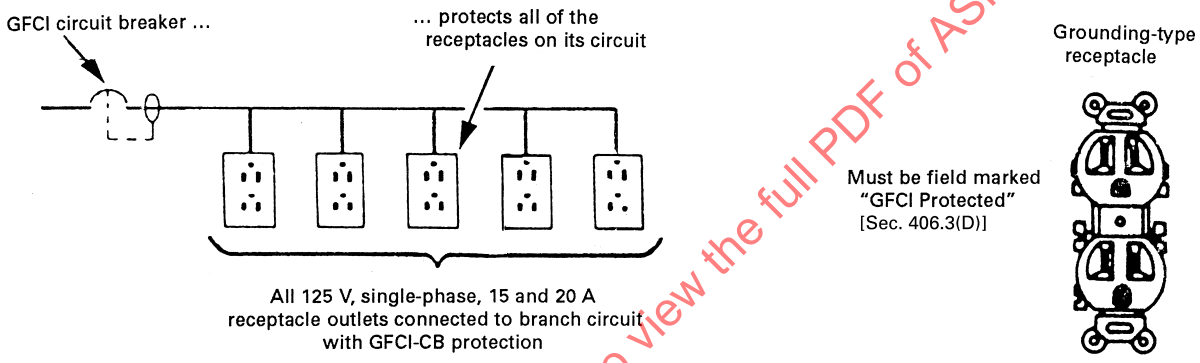
Diagram 2.26.4.1(x)
NEC® Section 620.85 — Ground Fault Circuit Interrupter Protection for Personnel

- Pits, elevator car tops, and escalator and moving walk wellways
- Each 125 V, single-phase, 15 and 20 A receptacle



GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

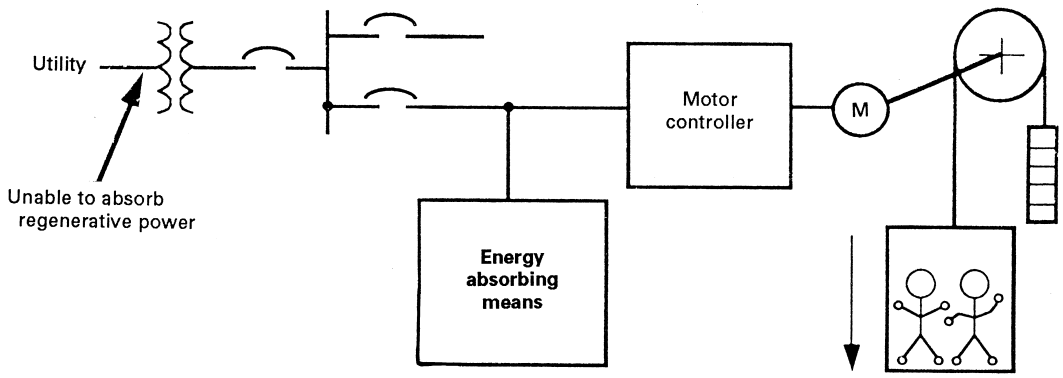
Diagram 2.26.4.1(y)
NEC®Section 620.85 — Ground Fault Circuit Interrupter Protection for Personnel in Machine Rooms and Machinery Spaces



GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

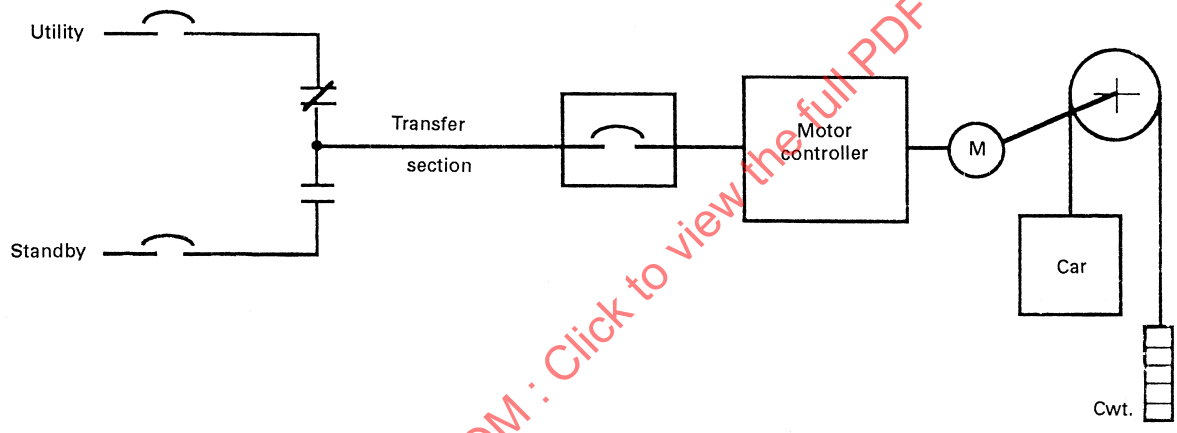
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Diagram 2.26.4.1(z)
NEC® Section 620.91(A), (B) — Emergency and Standby Power Systems Regenerative Power



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) For elevator systems that regenerate power back into the power source, which is unable to absorb the regenerative power under overhauling elevator load conditions, a means shall be provided to absorb this power.
(c) See Handbook Section 2.26 for Diagram legends.

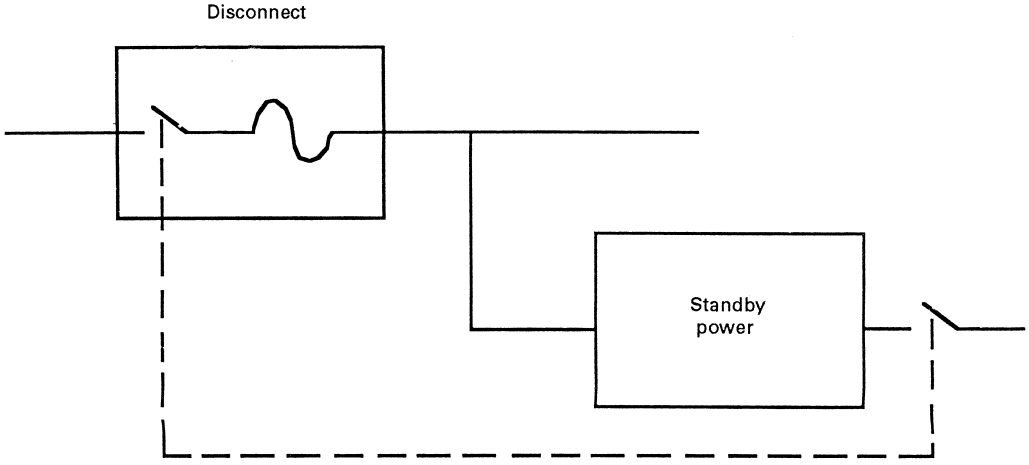
Diagram 2.26.4.1(aa)
NEC® Section 620.91(C) — Emergency and Standby Power Systems Disconnecting Means



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) The disconnecting means required by Section 620.51 shall disconnect the elevator from both the emergency or standby power system and the normal power system.
(c) See Handbook Section 2.26 for Diagram legends.

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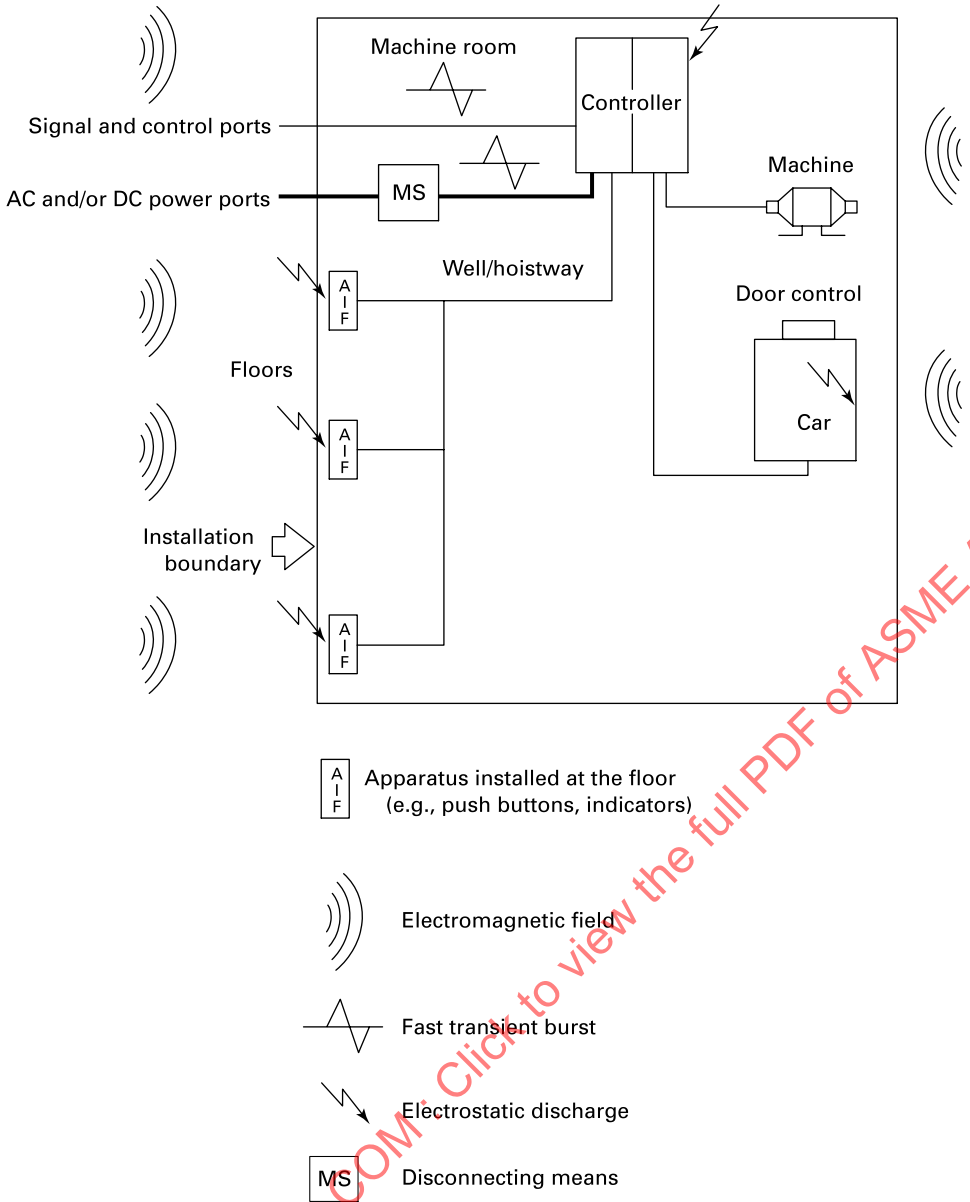
Diagram 2.26.4.1(bb)
NEC® Section 620.91(C) — Emergency and Standby Power Systems Disconnecting Means



GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

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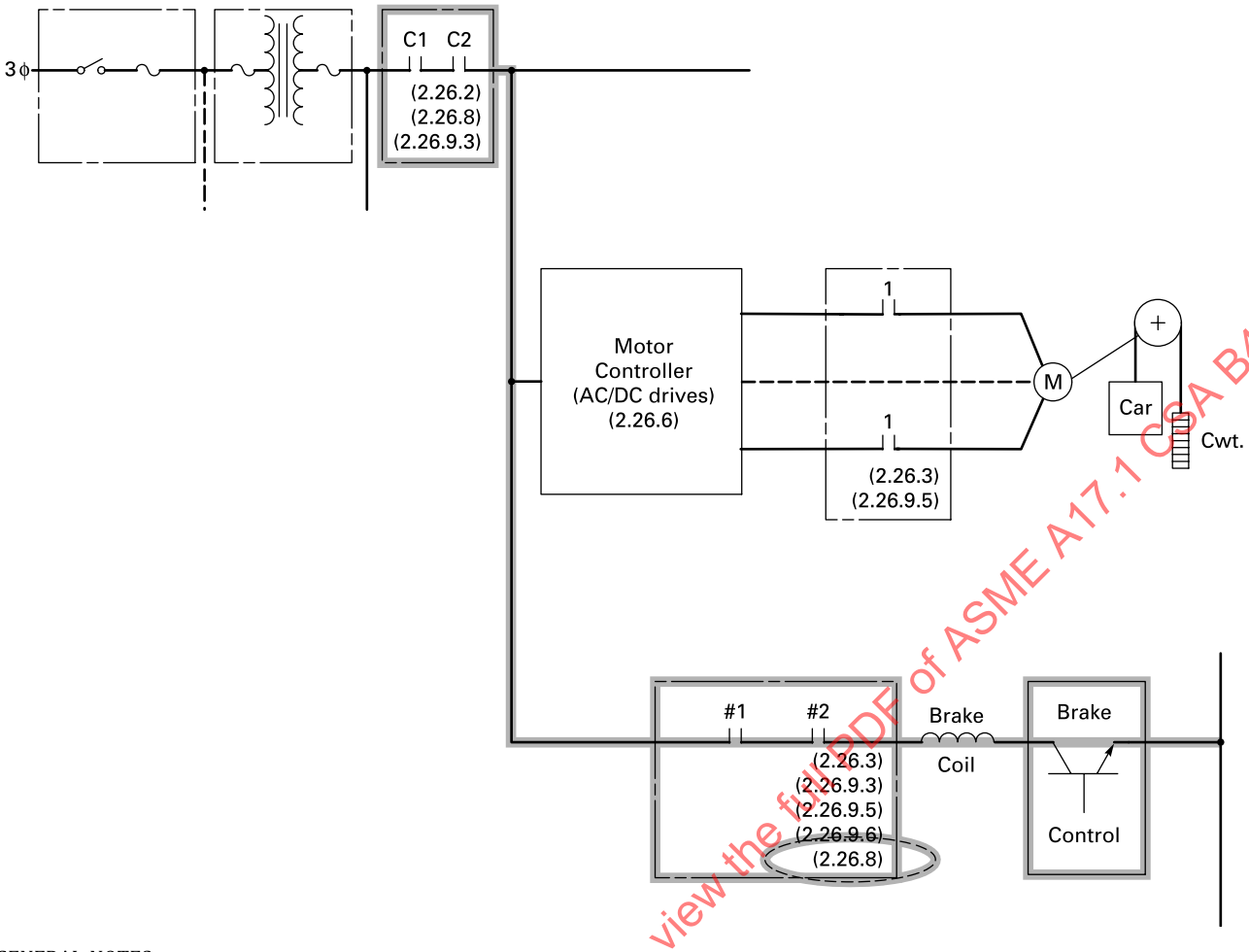
Diagram 2.26.4.4
Electrical Equipment and Wiring



GENERAL NOTE: Courtesy of Joseph Busse.

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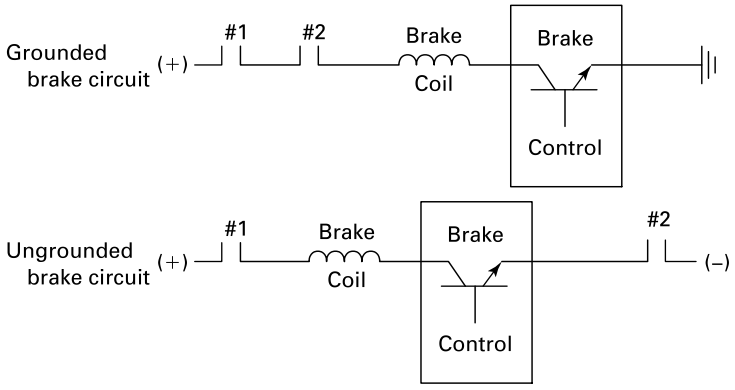
Diagram 2.26.8
Release and Application of Driving-Machine Brakes



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

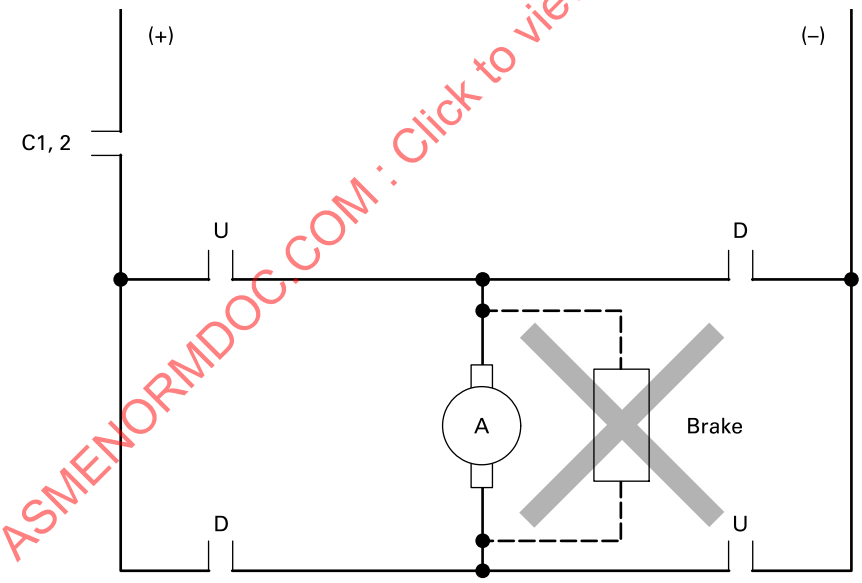
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Diagram 2.26.8.2
Release and Application of Driving-Machine Brakes



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

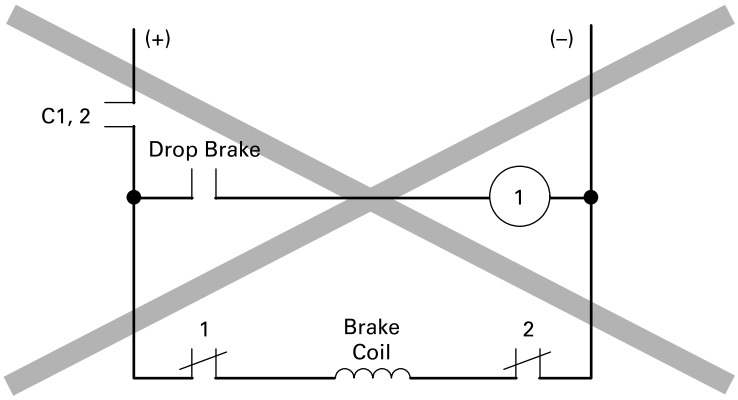
Diagram 2.26.8.5
Release and Application of Driving-Machine Brakes



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

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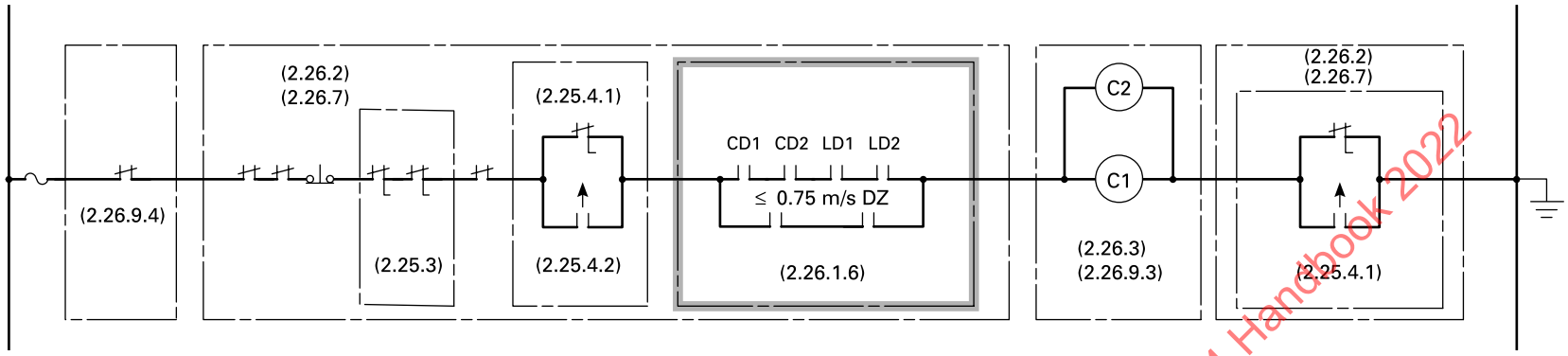
Diagram 2.26.9.2
Control and Operating Circuits



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co./Ralph Droste.
(b) See Handbook Section 2.26 for Diagram legends.

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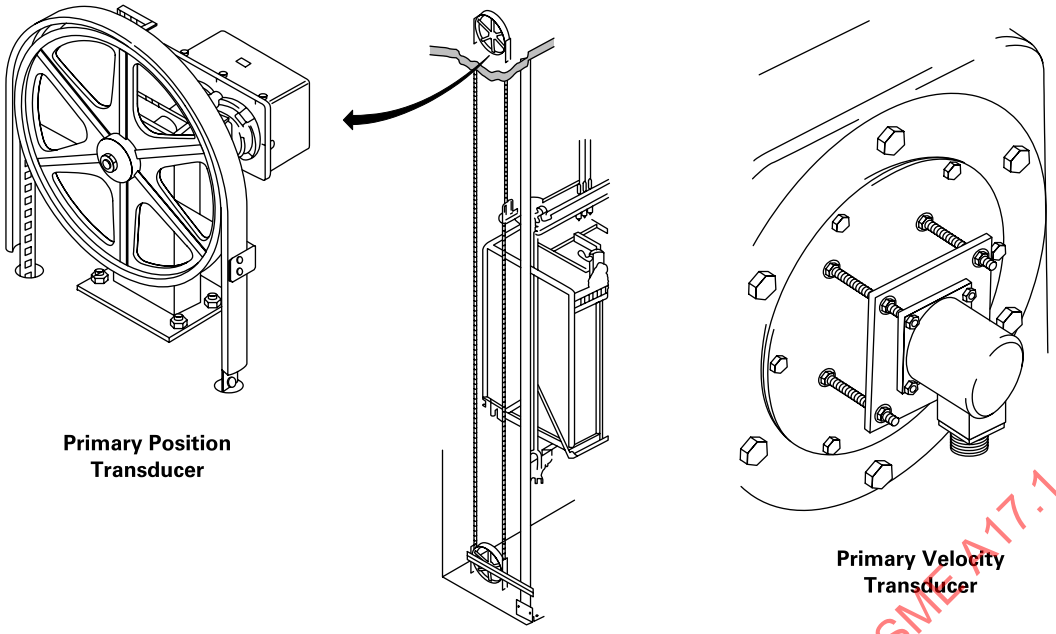
Diagram 2.26.9.3.1(a) and (b)
Protection Against Failures



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.26 for Diagram legends.

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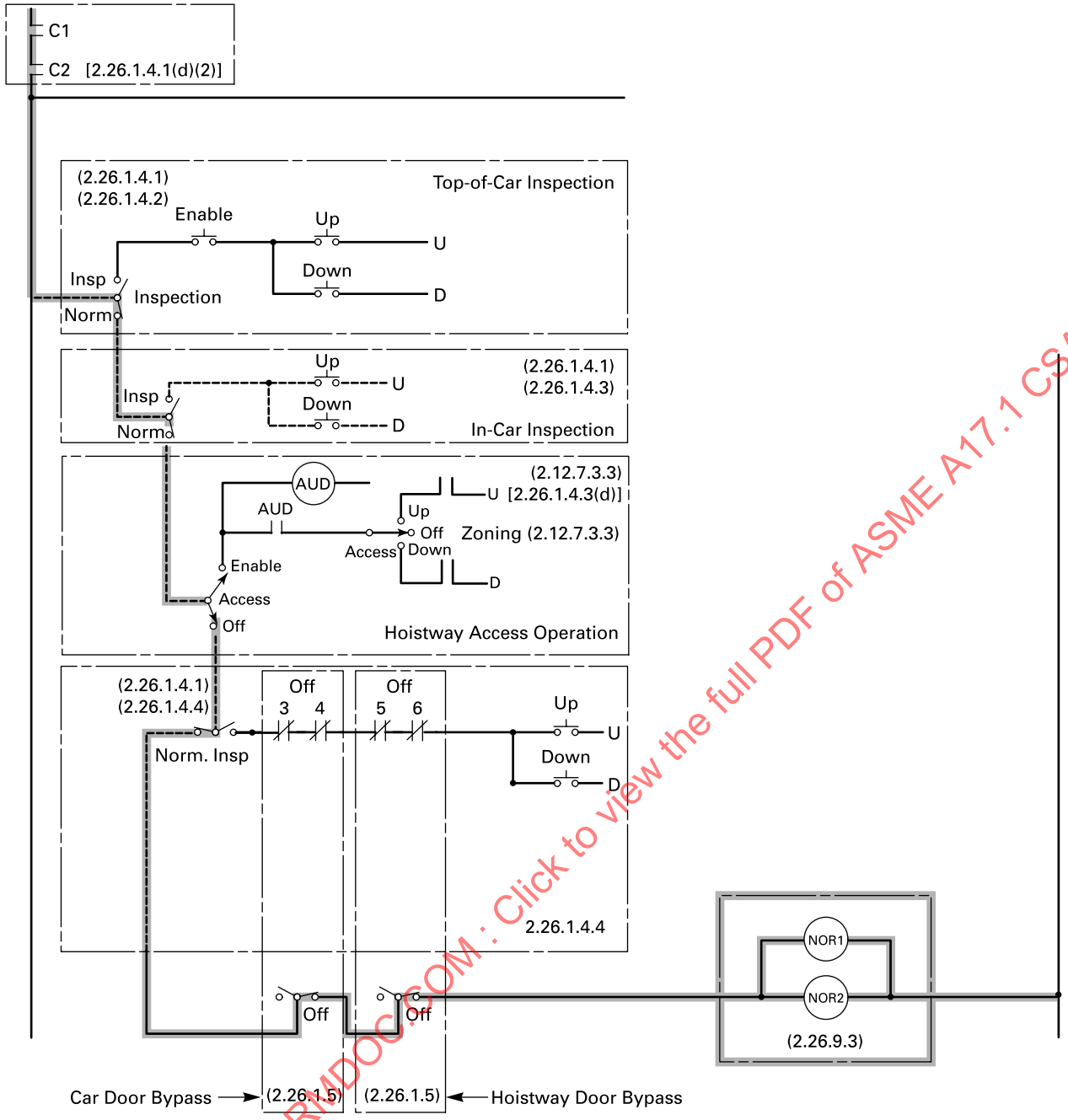
Diagram 2.26.9.3.1(c)
Protection Against Failures



GENERAL NOTE: Courtesy of Joseph Busse.

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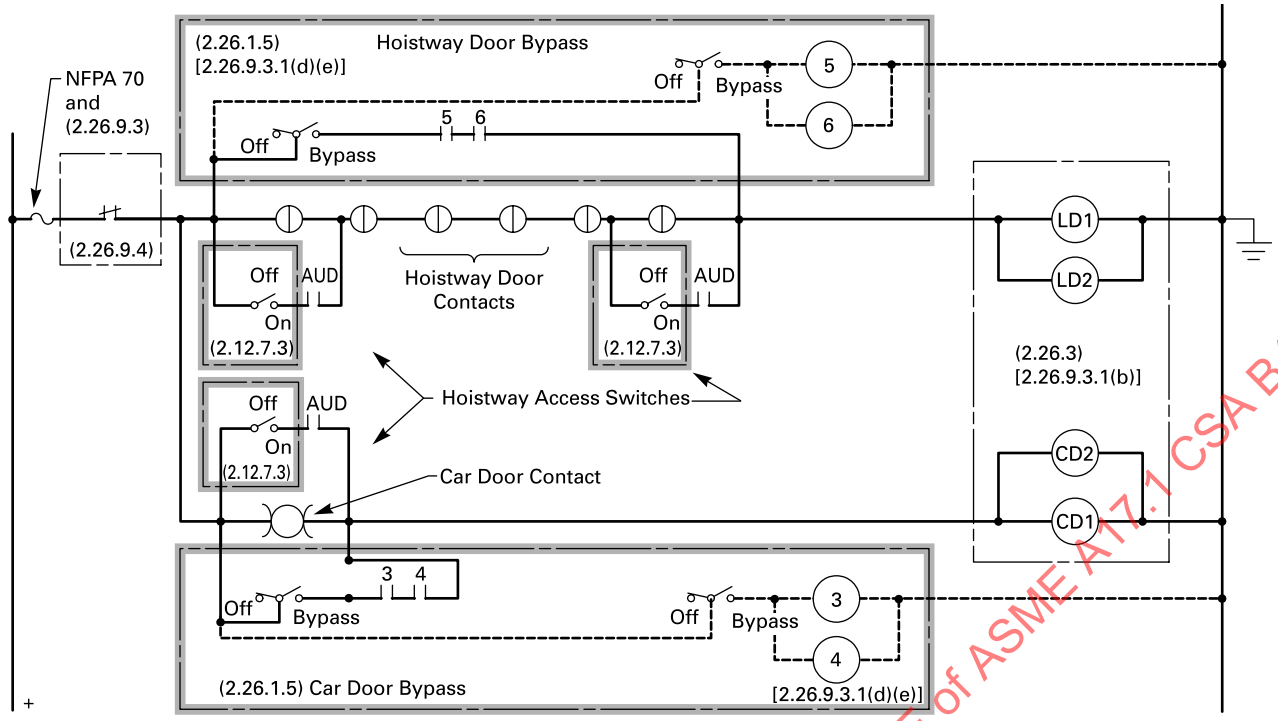
Diagram 2.26.9.3.1(d)
Protection Against Failures



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.26 for Diagram legends.

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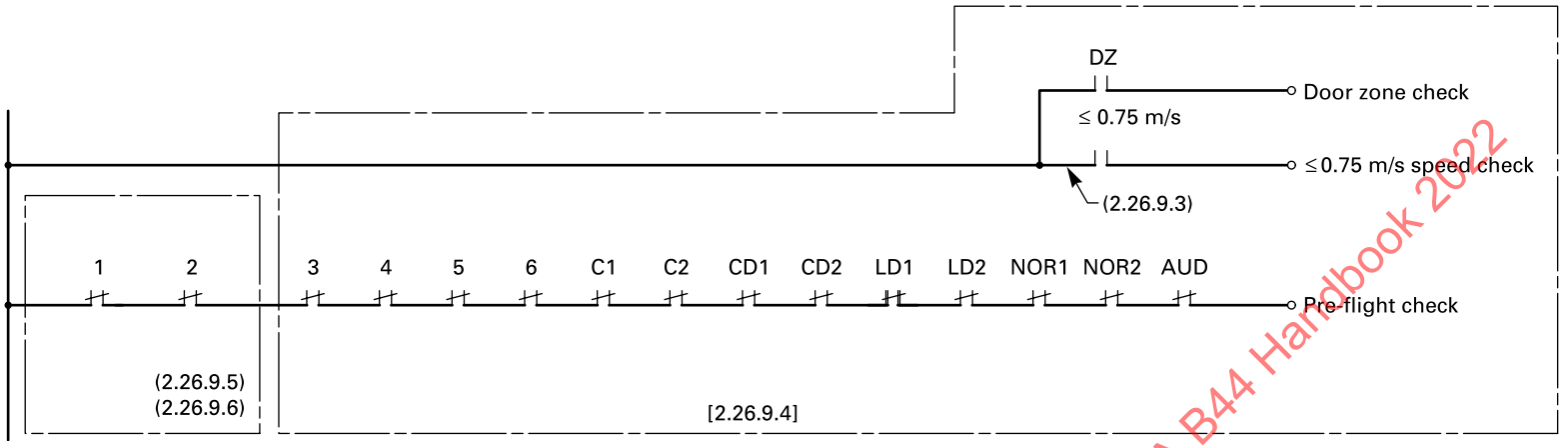
Diagram 2.26.9.3.1(e)
Protection Against Failures



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.26 for Diagram legends.

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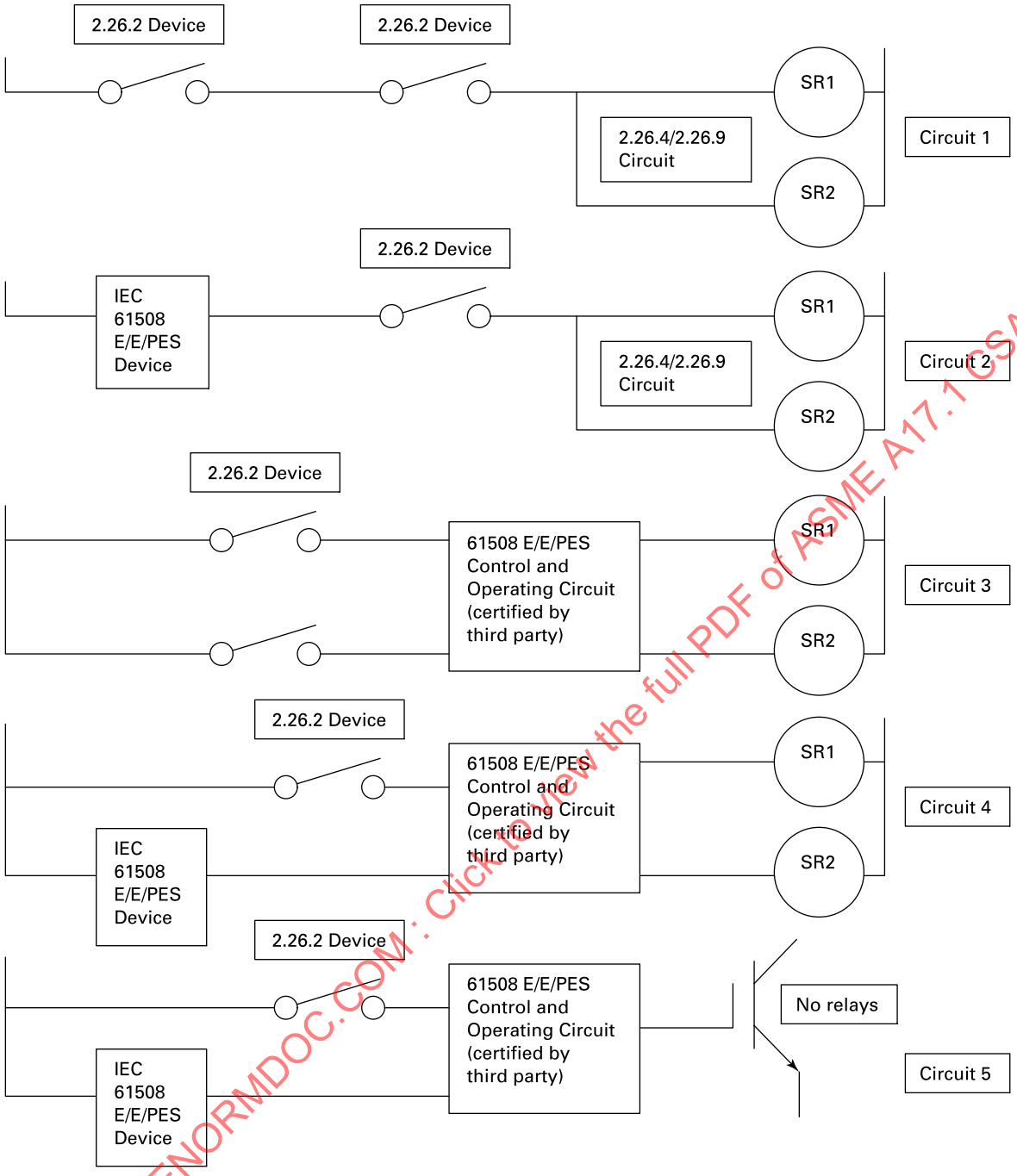
Diagram 2.26.9.4(a)
Protection Against Failures/Checking Prior to Starting



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.26 for Diagram legends.

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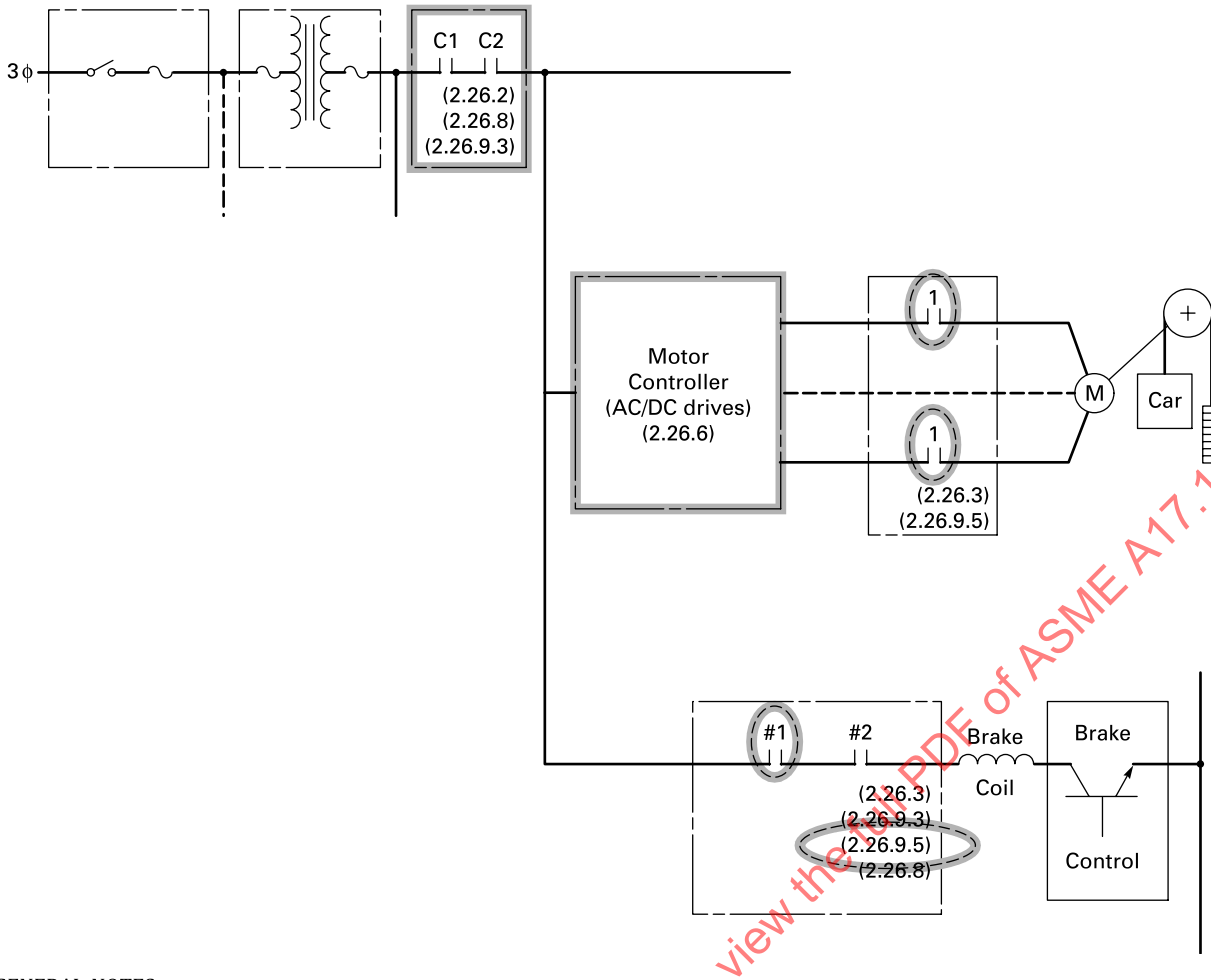
Diagram 2.26.9.4(b)
Examples of Control and Operating Circuits Consisting of Non-PES Devices and Control and Operating Circuits, and Combinations of Non-PES Devices and Circuits and IEC61508 E/E/PES Certified Devices and Circuits



GENERAL NOTES:
(a) Courtesy of John Weber.
(b) SR = safety relay.

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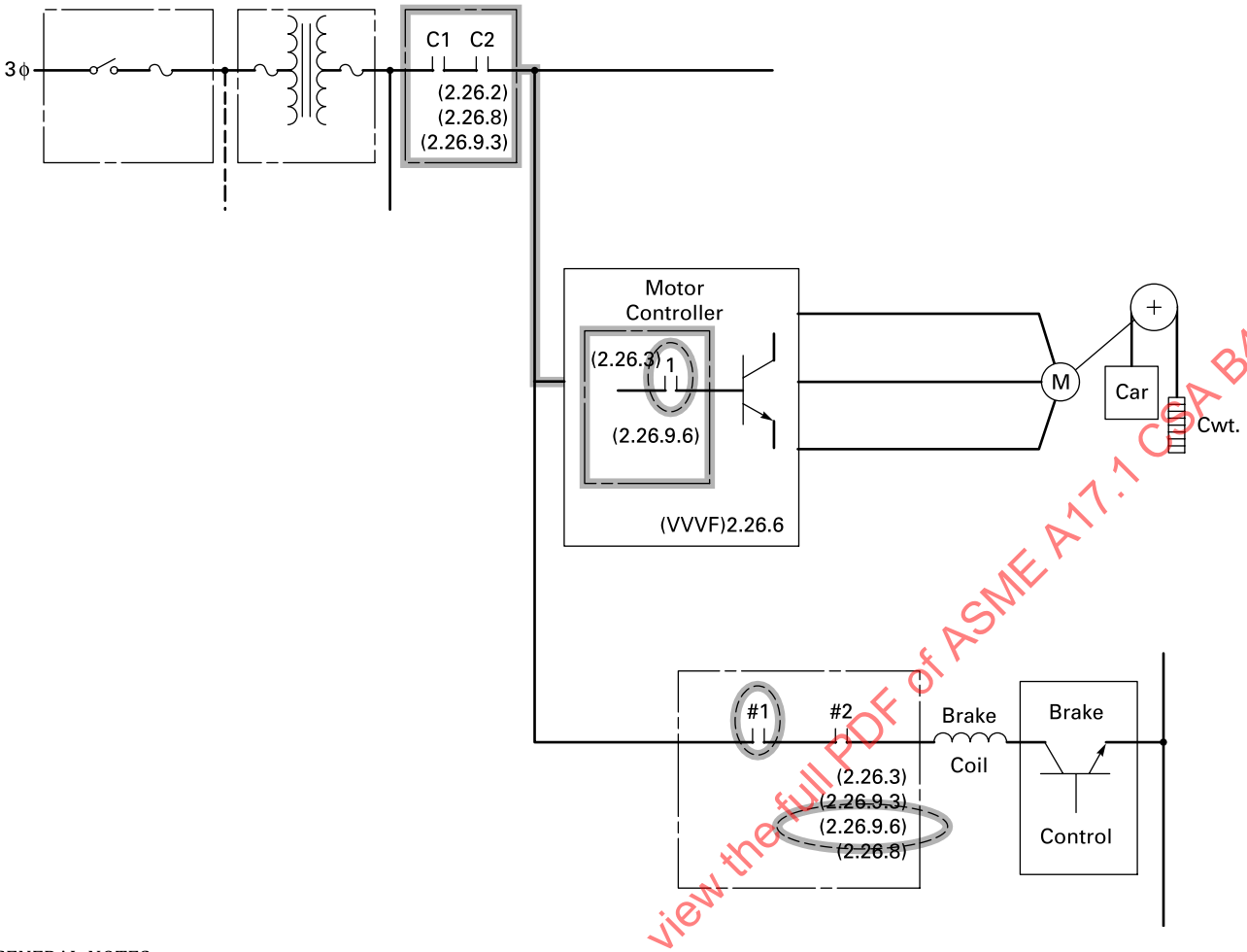
Diagram 2.26.9.5
AC/DC Drives



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.26 for Diagram legends.

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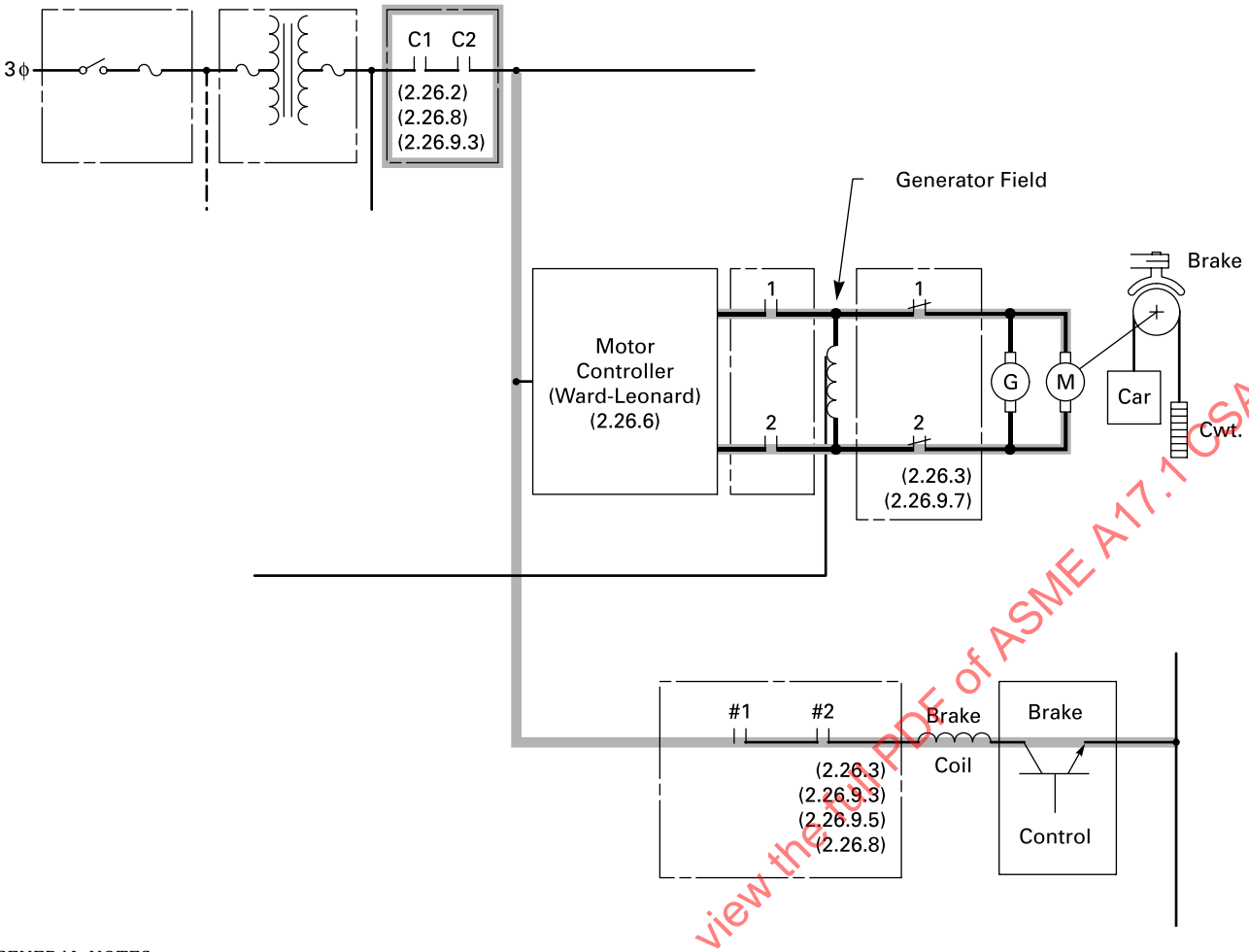
Diagram 2.26.9.6
VVVF Drives



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.26 for Diagram legends.

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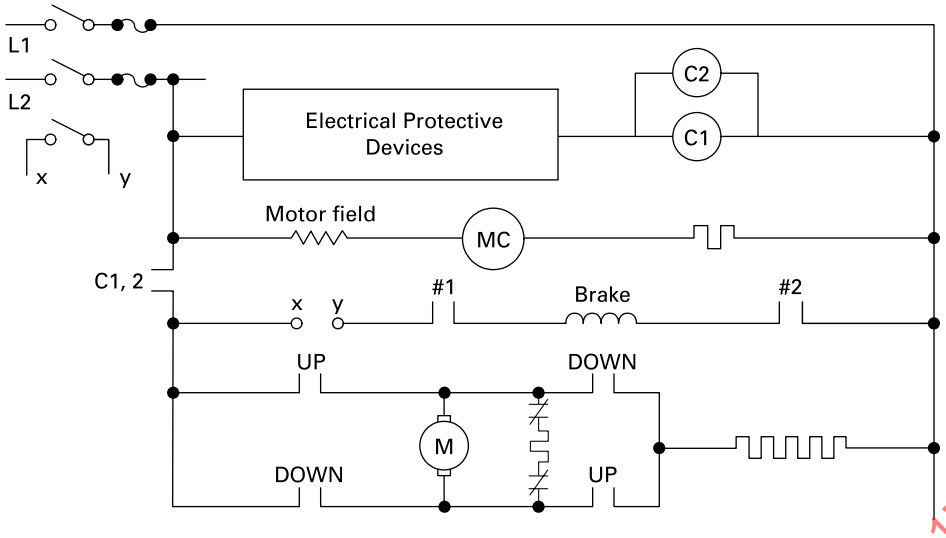
Diagram 2.26.9.7
Generator Field Control



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.26 for Diagram legends.

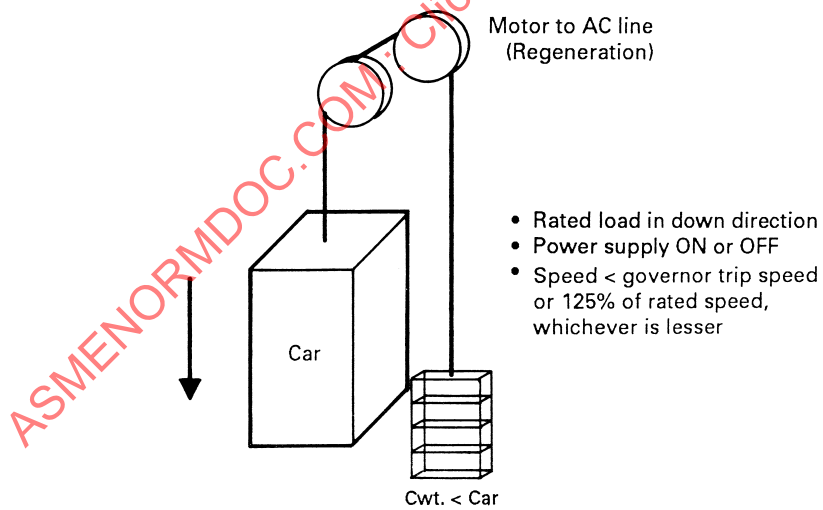
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Diagram 2.26.9.8(a)
Overspeed in Down Direction



GENERAL NOTES:
(a) Courtesy of Joseph Busse.
(b) See Handbook Section 2.26 for Diagram legends.

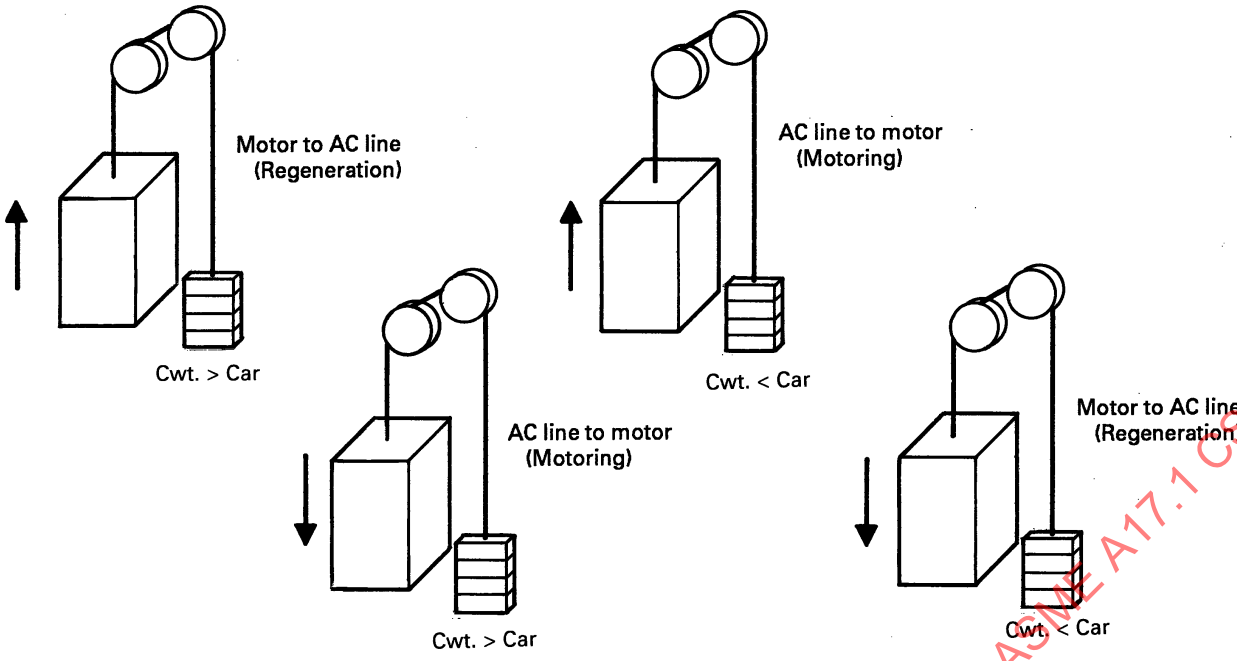
Diagram 2.26.9.8(b)
Typical Control and Operating Circuit for Controlling Overhauling Load in Down Direction



GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

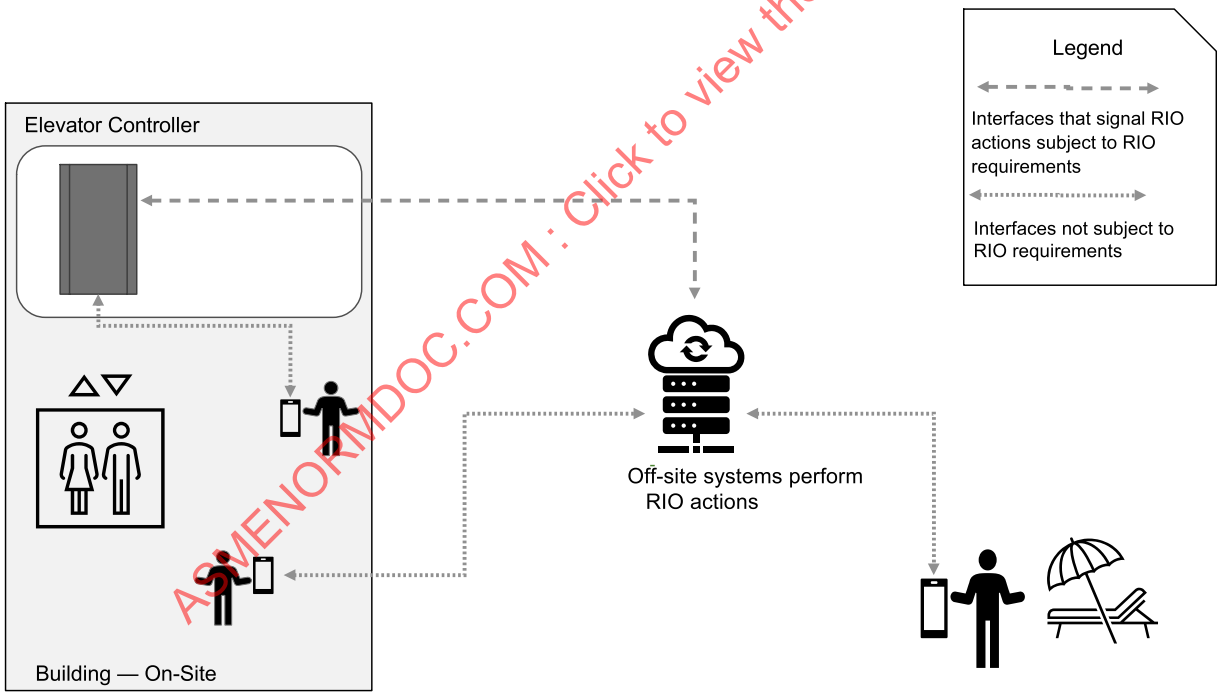
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Diagram 2.26.10
Regenerated Power



GENERAL NOTE: Courtesy of Otis Elevator Co./Ralph Droste.

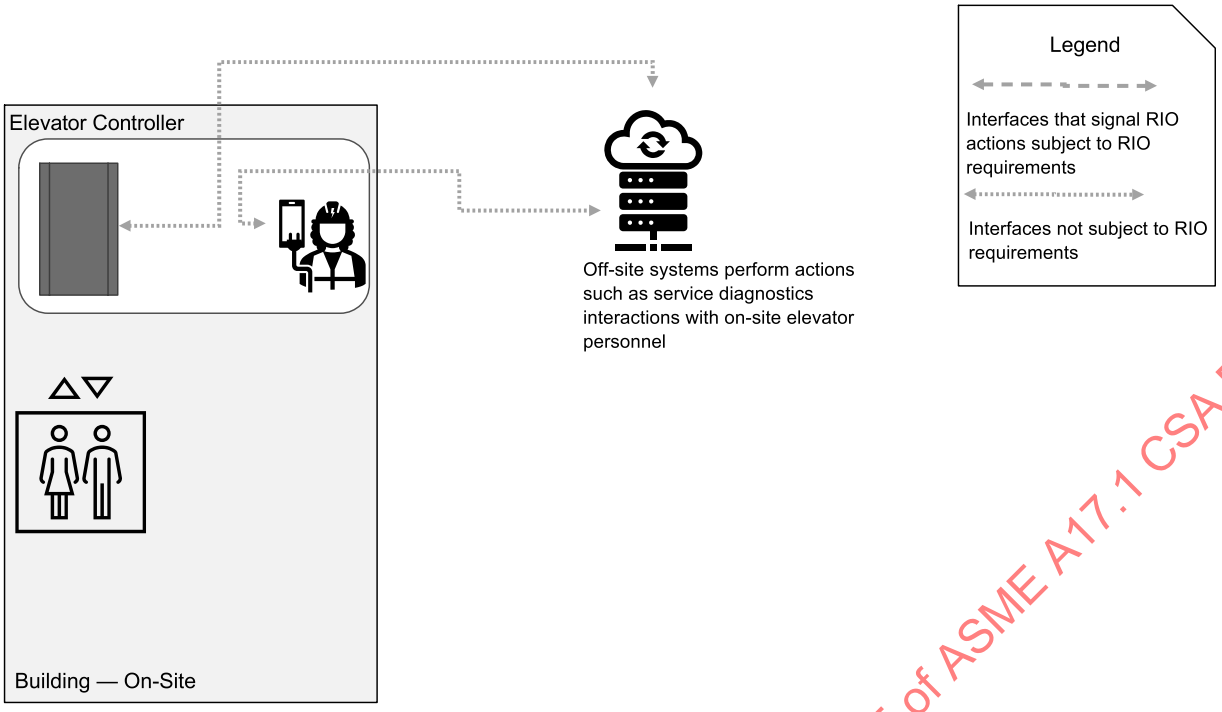
Diagram 2.26.13(a)
Example of Interfaces Applicable and Not Applicable to the RIO Requirements



GENERAL NOTE: Courtesy of Vincent Robibero.

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Diagram 2.26.13(b)
Example of Interfaces Not Applicable to the RIO Requirements



GENERAL NOTE: Courtesy of Vincent Robibero.

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SECTION 2.27
EMERGENCY OPERATION AND SIGNALING DEVICES

NOTE: The author expresses his appreciation to John Carlson for his extensive contributions to Section 2.27.

A note was added in ASME A17.1-2000 and CSA B44-00 to recognize that additional requirements may be found in the building codes. For example, IBC requires fire department communication system in high-rise buildings (IBC Section 907.2.13.2).

The note was revised in ASME A17.1-2019/CSA B44:19 to add a reference to the building code for Fire Service Access Elevators and Occupant Evacuation Operation.

Fire Service Access Elevators

Fire Service Access Elevators (FSAEs) have been in the International Building Code (IBC) since the 2009 edition. The IBC requires a minimum of two FSAEs (unless the building only has one elevator) for all buildings with an occupied floor more than 120 feet above the lowest level of fire department vehicle access. FSAEs must be a minimum of 3,500 lb capacity and be able to accommodate a standard size ambulance stretcher in the open position. The IBC has additional requirements for protection from water, hoistway and wiring fire-resistance ratings, and lobby enclosures. It also includes markings to identify the FSAE and lighting in the hoistway to aid firefighters for assessing the safety of using the elevator.

Similar elevator systems are specified in NFPA 101®, Life Safety Code® and NFPA 5000®, Building Construction and Safety Code®. Language is provided to reference ASME A17.1/CSA B44 for additional requirements.

Occupant Evacuation Elevators

Both the 2009 and 2012 editions of the International Building Code (IBC) contain provisions for Occupant Evacuation Elevators (OEE). The 2015 edition of the IBC includes language to harmonize OEE with ASME A17.1-2013/CSA B44-13, 2.27.11, Occupant Evacuation Operation (OEO). While never required by the Code, the provisions establish a standard design when an architect or engineer chooses to use elevators as a means to evacuate a building. Protection from water, hoistway and wiring fire-resistance ratings, and lobby enclosures are similar to those required for FSAEs, but all passenger elevators for general public use must meet the OEE requirements. The elevators will be available for occupant evacuation prior to Phase I Emergency Recall Operation and will be activated for this use by the operation of a supervised automatic sprinkler system, smoke detectors located in the building, or manual control.

Similar elevator systems are specified in NFPA 101®, Life Safety Code® and NFPA 5000®, Building Construction and Safety Code®. The 2015 editions of NFPA 101® and NFPA 5000® include language regarding Occupant Evacuation Elevators to make it consistent with ASME A17.1-2013/CSA B44-13, 2.27.11, Occupant Evacuation Operation.

See Charts 2.27(a) and 2.27(b).

2.27.1 Car Emergency Signaling Devices

ASME A17.1a-2002 and CSA B44-02 Update No. 1 made major revisions to car emergency signaling requirements. The Code requires a means for all passengers, both people with disabilities and those without, to communicate in an emergency. Requirements were prepared to address the following reported concerns:

(a) reports of passengers being trapped overnight, weekends, and holidays

(b) alarm bells being ignored

(c) alarm bells not working

(d) no one accepting responsibility or accountability for providing assistance

(e) deficiencies with new technology being used at this time

(f) needs of all elevator passengers

In addition to these requirements, building codes require that all elevators in high-rise buildings (see building code for definition) have a communication system from the elevator lobby, car, machine room, control room, machinery space, and control space outside the hoistway to the building's Fire Command Center (FCC) or, on jurisdictions enforcing NBCC, the Central Alarm and Control Facility (CACF).

2.27.1.1 Emergency Communications. Requirement 2.27.1.1 was revised in ASME A17.1-2019/CSA B44:19 to enhance the emergency communication system to better serve passengers who are unable to hear or are unable to verbally communicate effectively when trapped in the elevator. The 2018 edition of the International Building Code (IBC), Section 3001.2, added new requirements to mandate that the elevator emergency communication system be accessible to deaf, hard of hearing,, and speech impaired people; however, it did not include any detailed technical criteria. The revisions to Requirement 2.27.1.1 are to clarify the IBC-2018 use of video and enhanced communications for the deaf, hard of hearing, and speech impaired.

In developing the new requirements, the ASME Emergency Operations Committee set up a task group that included the proponent of the IBC change and other members representing the accessibility community. The requirements were developed for consistency with the guidelines in the Americans with Disabilities Act Title III, specifically the regulation for effective communication with deaf, hard of hearing,, and speech impaired people. The committee also considered advances in communication technology over the last decade that have made accessing video remotely or text messaging commonplace in everyday communication.

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It was also important to understand the intent and operation of the elevator emergency communication system in order to develop the new requirements. The primary purpose of the communications means is to allow a trapped passenger to call for help and reach someone trained to respond to the call for help. The call can be routed to a location within the building or to a call center staffed with personnel who are trained to handle the calls. Calls do not go directly to the 911 system. Passengers entrapped in a stalled elevator should remain calm and wait for help to arrive. Personnel handling the calls are trained to assess the situation and can contact emergency personnel if needed. For these reasons, the amount of communication needed is minimal and the new requirements reduce the need for audible communication with a trapped passenger. New communication components are also added to accommodate various passenger communication abilities. The term "two-way" was removed from the subsections and added to the base requirement because some communication components may not provide effective two-way communications for every passenger, as a passenger may only communicate verbally while others may only communicate visually.

2.27.1.1.1 In all buildings, a communications means is required that allows a trapped passenger to call for help and reach someone trained to respond to the call for help. Call routing may be different at different times of the day (for example, normal business hours versus nights and weekends), but a call for help should always reach a trained person, permitting action to be taken in a timely manner.

Requirement 2.27.1.1.1 was revised in ASME A17.1-2019/CSA B44:19 as part of the overall changes to the requirements for Emergency Communications. Previous Requirement 2.27.1.1.2(a) was combined with this requirement.

2.27.1.1.2 Requirements were added in ASME A17.1b-2009/CSA B44b-09 to clarify that if the location is not staffed at all times, the communications means needs to be forwarded to another location staffed by authorized personnel (see Section 1.3) to ensure a person in the car can always reach authorized personnel who can take appropriate action. Based on input from communications system suppliers, the response time is 45 s to allow adequate time to acknowledge the call and to prevent unnecessary forwarding.

Requirement 2.27.1.1.2 was revised in ASME A17.1-2019/CSA B44:19 as part of the overall changes to the requirements for Emergency Communications. The revision was to reformat the requirement because the previous 2.27.1.1.2(a) was combined with 2.27.1.1.1.

2.27.1.1.3 Requirement 2.27.1.1.3 was revised in ASME A17.1-2019/CSA B44:19 as part of the overall changes to the requirements for Emergency Communications. The revisions were to update the various subsections.

2.27.1.1.3(a) Requirements ensure there is no conflict with accessibility requirements (ICC/ANSI A117.1; ASME A17.1/CSA B44, Nonmandatory Appendix E; and ADA/ABA AG).

Requirement 2.27.1.1.3(a) was revised in ASME A17.1-2019/CSA B44:19 to add a missing reference to ADA/ABA AG.

Requirement 2.27.1.1.3(a) was revised in ASME A17.1-2022/CSA B44:22 to revise nomenclature for ICC/ANSI A117.1 so that the entire ASME A17.1/CSA B44 document reflects the accurate characters used by both the referenced standard and ASME A17.1/CSA B44, Section 9.1.

2.27.1.1.3(b) Provides a recognizable means accessible to the passenger to initiate a call for help and establish communications. Whatever the actual communications means (intercom, etc.), the phone symbol is widely recognized and has been used to mark the "HELP" button. To make the Code more readable, the button as of ASME A17.1-2010/CSA B44-10 is referred to directly as a "PHONE" button and replaces the reference to "HELP." Historically the alarm button has always been visible and thus the "PHONE" button must be visible.

Requirement 2.27.1.1.3(b) was revised in ASME A17.1-2019/CSA B44:19 to clarify the language as part of the overall changes to the requirements for emergency communications.

2.27.1.1.3(c) Provides an indication for hearing-impaired passengers that the call for help has been received and acknowledged by authorized personnel.

Requirement 2.27.1.1.3(c) was revised in ASME A17.1-2019/CSA B44:19 as part of the overall changes to the requirements for emergency communications. The revisions were to change "visual indication" to "message" to more accurately describe enhanced communications means and to add an allowance for the message to be extinguished if a new message needs to be displayed.

2.27.1.1.3(d) New Requirement 2.27.1.1.3(d) was added in ASME A17.1-2019/CSA B44:19 as part of the overall changes to the requirements for emergency communications. The new language requires a means to display messages on the same panel as the phone push button to provide for nonverbal communications between trapped passengers and authorized personnel.

2.27.1.1.3(e) New Requirement 2.27.1.1.3(e) was added in ASME A17.1-2019/CSA B44:19 as part of the overall changes to the requirements for emergency communications. The new language requires a means to display messages on the same panel as the phone push button to communicate to the trapped passengers that help is on the way.

Previous Requirement 2.27.1.1.3(e) was deleted in ASME A17.1-2019/CSA B44-19 as part of the overall changes to the requirements for emergency

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communications and because this requirement is now incorporated into the new Requirement 2.27.1.1.3(e).

2.27.1.1.3(f) Provides a means for authorized personnel to identify the location of the elevators independent of the passenger having to provide this information.

Requirement 2.27.1.1.3(f) was editorially renumbered and revised in ASME A17.1-2019/CSA B44:19 for consistency with the overall changes to the requirements for emergency communications.

2.27.1.1.3(g) The person who receives the call is in the best position to decide how long to continue the conversation. ASME A17.1-2013/CSA B44-13 added a timer feature to ensure elevator phones hang up upon completion of the call in those cases where the telephone network (public or building) does not provide disconnect signals. If a call is not properly disconnected, it will not be possible to place another call from inside the car or cars served by the phone line. Using voice notification enables any authorized personnel to properly respond to calls from any manufacturer's equipment.

Requirement 2.27.1.1.3(g) was editorially renumbered and revised in ASME A17.1-2019/CSA B44:19 for consistency with the overall changes to the requirements for emergency communications. The changes also clarified that the notification should come from the communication means.

2.27.1.1.3(h) Prohibits the use of handsets since they are easily subject to vandalism.

Requirement 2.27.1.1.3(h) was editorially renumbered and revised in ASME A17.1-2019/CSA B44:19 for consistency with the overall changes to the requirements for emergency communications.

2.27.1.1.3(i) The passenger needs help when a call is placed, not hours or days later when someone listens to voice mail.

Requirement 2.27.1.1.3(i) was editorially renumbered and revised in ASME A17.1-2019/CSA B44:19 for consistency with the overall changes to the requirements for emergency communications.

2.27.1.1.3(j) Requires operating instructions to be incorporated near the phone button.

Requirement 2.27.1.1.3(j) was editorially renumbered and revised in ASME A17.1-2019/CSA B44:19 for consistency with the overall changes to the requirements for emergency communications.

2.27.1.1.3(k) Requirement 2.27.1.1.3(k) was added in ASME A17.1-2019/CSA B44:19 as part of the overall changes to the requirements for emergency communications. It added a requirement for a means to observe the car interior to help authorized personnel determine if a passenger is trapped and assess if additional actions are required for a successful rescue, independent of the passenger's ability to audibly communicate.

Requirement 2.26.1.1.3 was revised in ASME A17.1-2022/CSA B44:22 to clarify that it is permitted to provide additional operating instructions if needed on or adjacent to the phone push button or as part of the new message display. Elevator passengers interact with the car operating panel and are familiar with its operation; therefore, it is self-evident to initiate a call for help by pressing the phone button. The phone symbol in Table 2.26.12.1 is the minimum essential instructional information required by the Code to operate the system.

The revisions also clarify that a phone push button is always required to be on the car station that contains the "FIRE OPERATION" key switch, so when the message display for passengers with hearing or speech impairments is not located on that car operating panel, a passenger with visual impairments can still be accommodated. The message display added in the 2019 edition was not intended to reduce the access to the emergency communication phone push button for a passenger with visual impairments who will try to locate a phone push button by touch on a car operating panel. The revisions also clarify that there was never a prohibition for providing multiple phone push buttons. All phone push buttons without a message display are required to have a visual indication to acknowledge communication is established. The message display location was incorporated into 2.27.1.1.3(c) to eliminate redundant language. A message display is not required to be on the same panel that contains the "FIRE OPERATION" key switch.

Additional requirements were added for the message display because these requirements were not addressed by the previous language or any reference standard. The added requirements for text size and font are based on proven accessibility requirements from the ADA/ABAAG and ICC/ANSI A117.1 for similar direct interactive systems such as automated teller machines and fare machines.

2.27.1.1.4 Provides arriving rescuers with the means to communicate with the passenger in high-rise buildings where direct voice communication may not be practical.

Requirement 2.27.1.1.4 was revised in ASME A17.1-2019/CSA B44:19 for consistency with the overall changes to the requirements for emergency communications.

2.27.1.1.4(a) Establishes a reasonable time frame in which communications are to be established. Requires the capability for two-way communication with a single car at a time.

Requirement 2.27.1.1.4(a) was revised in ASME A17.1-2019/CSA B44:19 for consistency with the overall changes to the requirements for emergency communications.

2.27.1.1.4(b) See Handbook commentary on 2.27.1.1.3(g).

Requirement 2.27.1.1.4(b) was editorially renumbered and revised in ASME A17.1-2019/CSA B44:19 for consistency with the overall changes to the requirements for emergency communications. The changes also clarified

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that the notification should come from the communication means.

2.27.1.1.4(c) Provides a visual indication to the passenger that communications have been established within the building.

Requirement 2.27.1.1.4(c) was revised in ASME A17.1-2019/CSA B44:19 as part of the overall changes to the requirements for emergency communications. The new language requires a means to display messages on the same panel as the phone pushbutton to communicate to the trapped passengers that help is on site and to add an allowance for the message to be extinguished if a new message needs to be displayed.

2.27.1.1.4(d) Provides authorized or "emergency" personnel with operating instructions.

2.27.1.1.4(e) New Requirement 2.27.1.1.4(e) was added in ASME A17.1-2019/CSA B44:19 as part of the overall changes to the requirements for emergency communications. The new language requires a means to display messages on the same panel as the phone push button to provide for nonverbal communications between trapped passengers and authorized personnel.

2.27.1.1.4(f) Requirement 2.27.1.1.4(f) was added in ASME A17.1-2019/CSA B44:19 as part of the overall changes to the requirements for emergency communications. It added a requirement for a means to observe the car interior to help authorized personnel determine if a passenger is trapped and assess if additional actions are required for a successful rescue, independent of the passenger's ability to audibly communicate.

2.27.1.1.4(g) Requirement 2.27.1.1.4(g) was added to provide consistency and security for the location for the communications means to aid emergency personnel upon arrival at an incident in high-rise buildings and where there is no fire command center or central alarm and control facility. The harmonization of ASME A17.1 and CSA B44 introduced the ability to communicate with trapped passengers from a location within the building accessible to emergency personnel. The technology changes to enhance communication with passengers who are deaf, hard of hearing, speech impaired, or vision impaired have highlighted the need to provide consistency and security for the location of the communication means.

Requirement 2.27.1.1.4 was revised in ASME A17.1-2022/CSA B44:22 to coordinate with the changes to the message revisions in 2.27.1.1.3. See also Handbook commentary on 2.27.1.1.3.

2.27.1.1.5 Provides an alternate power source if normal power fails. The visual signal is part of the emergency communications system and should have the same minimum time standard as the two-way communications means. Duration requirements for the audible signal was changed to 1 h as previously it was unintentionally included in the 4-h requirement.

Requirement 2.27.1.1.5 was revised in ASME A17.1-2019/CSA B44:19 as part of the overall changes to the requirements for emergency communications to clarify that the communication means must transfer to standby or emergency power and also to be consistent with the new definitions for auxiliary power supply and emergency or standby power.

2.27.1.1.6 This requirement was added in ASME A17.1b-2009/CSA B44b-09 along with 8.6.11.2 in order to increase the probability that trapped passengers can communicate with someone who can help. There have been reports of many installations where communications worked properly when installed but did not work a few years later. The most commonly cited reasons are disconnected phone lines and dialing plan changes (e.g., caller must now dial 1 and the area code, etc.), not equipment failure. Self-testing for the presence of voltage or dial tone, combined with periodic end-to-end testing should detect those problems.

The question is what to do when a problem is detected. In some buildings, entire groups of elevators share a single phone line. Taking elevators out of service due to a lack of dial tone would strand passengers, and was deemed too severe a response. If even a small percentage of passengers notice a lamp and buzzer in the lobby and complain to building management, the problem is likely to be corrected before a trapped passenger needs to call for help.

ASME A17.1-2013/CSA B44-13 clarified that the silencing of the audible signal must last a minimum of 12 h, to provide a meaningful period of quiet. Additionally, a nonfunctioning telephone line (or equivalent means) must be monitored at intervals of not more than 5 min until two-way communications is restored. The 5-min interval is required only while the telephone line (or equivalent means) is not functioning. The verification means would resort to its original monitoring interval once the telephone line operation is restored.

Requirement 2.27.1.1.6 was revised in ASME A17.1-2019/CSA B44:19 as part of the overall changes to the requirements for emergency communications and to clarify that automatic verification is limited to the audible communication because automatic verification of the video portion is not readily available with current technology. It was also revised to change to lower case font for the fire recall switch to follow the same style as the rest of A17.1/B44 when referencing these recall switches.

2.27.1.2 Emergency Stop Switch Audible Signal. This discourages the use of an emergency stop switch to hold a car at a floor, etc.

2.27.2 Emergency or Standby Power System

Requirement 2.27.2 was revised by ASME A17.1a-2008/CSA B44a-08 to

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(a) provide better description of the interaction between emergency power and fire service, making it clear that the cars should return to the designated level (normal service or fire service) unless the smoke detector at that floor has initiated fire service.

(b) define the behavior of the doors at the end of the recall; they should normally be left open to allow the firefighters to account for the location and occupancy of all cars.

(c) specify what happens to cars on the services excluded from automatic recall.

(d) treat standby and emergency power for elevators with Hospital Service the same as they are treated for Phase I.

(e) ensure that all cars get a chance to recall or move to a floor (inspection, Fire Phase II, etc.) before allowing manual selection, so that passengers can exit the car.

(f) rectify issues with the note in the prior requirement suggesting the switch be left in AUTO. This often was ignored and the switch was left in another position, and when the power failed, passengers in other cars would be trapped until an authorized person realized what was wrong. The note was also not enforceable and has been deleted. The new approach recalls the cars automatically no matter which position the switch is in.

(g) add an indicator to inform firefighters which cars are currently selected.

(h) prevent people from being trapped following a power interruption.

(i) activate the firefighter's light when the car is ready to run, so the firefighter knows that power has been restored to that car.

Cars requiring manual intervention to close the door will not be able to recall but will not create an entrapment and therefore are not addressed.

Emergency or standby power for an elevator is not required by ASME A17.1/CSA B44. If provided, then it must comply with 2.27.2. Building codes typically require standby power for at least one elevator able to travel to each floor in a high-rise building (see definition of building code in Section 1.3). This elevator does not have to stop at every floor, but every floor must be served by at least one elevator supplied with standby power. As an example, in a 20-story building elevator, group A serves floors 1 through 10 and elevator group B serves floors 1 and 11 through 20. Standby power would have to be supplied to one elevator in group A and one elevator in group B. If the same 20-story building had an elevator that served all floors 1 through 20, then standby power could be supplied to that elevator only.

Building codes in the United States address the need to provide accessible means of egress during a fire. Accessible means of egress include elevators, operating on Phase II Emergency Operation. When accessible means of egress include elevators, they shall be provided with standby power.

The National Electrical Code (NEC®) has requirements for both legally required standby power systems (Article 701) and optional standby power systems (Article 702). Legally required standby power systems provide electric power when normal power is interrupted to aid firefighting, rescue operations, control of health hazards, and similar operations. Optional standby power systems provide electric power when normal power is interrupted to eliminate physical discomfort, interruption of an industrial process, damage to equipment, or disruption of business.

Emergency power systems are those essential for safety to human life and must conform to requirements of NEC® Article 700. For additional information, see the NFPA 110 standard for emergency and standby power systems.

Legally required standby power systems have requirements that are very similar to emergency power systems. Upon loss of normal power, the legally required standby power system must be able to supply power within 60 s, whereas the emergency power system must be able to supply power within 10 s. Wiring for legally required standby power systems can be installed in the same raceway, cables, or boxes used for other general wiring. In contrast, emergency power system wiring must be entirely independent of all other wiring.

Elevators are normally connected to legally required standby power systems and not emergency power systems. Some hospital elevators are hooked into emergency power systems.

Requirement 2.27.2 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definitions for "normal building power" and "emergency or standby power" and to make editorial changes.

Requirement 2.27.2.1 facilitates availability of power for an elevator system. Power transfer and selection speeds up the evacuation process, minimizes entrapments, and allows use of an elevator by firefighters.

Requirements 2.27.2.1.1 and 2.27.2.2.1 were added in ASME A17.1-2022/CSA B44:22 to provide requirements for standby power when on Occupant Evacuation Operation, including when electrical power is restored. The requirements are similar to those in 2.27.3.4.

Requirement 2.27.2.3 recognizes that in today's buildings it is common to split a group of elevators between two different power feeders, so that sometimes half the cars are on normal power, and half are on emergency or standby power. In this case, the lamp should be illuminated.

ASME A17.1a-2008/CSA B44a-08 clarified the operation under emergency power and limited the use of the manual override. If the Note in the previous edition were ignored and power failed, passengers in nonselected cars would remain trapped. With this change, all cars have the chance to recall no matter

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how the switches are set. If firefighters are present and have activated firefighter emergency operation, they can use the manual override to preempt the recall sequence.

If the generator or alternate power supply is big enough to run all the cars, the cars can remain in normal service. However, if the generator can provide only enough power to run some of the cars at a time, requirement 2.27.2.4 defines how they take turns. Cars on normal operation recall to the ground floor and let passengers out. Cars with operators on them (including firefighters and elevator personnel) are given power for a period of time, during which the operator can move the car to whatever location he or she feels is best.

ASME A17.1-2016/CSA B44-16 revised 2.27.2.4.4 to provide the performance requirement of a minimum of 2 min for the in-car operator to move the car. The 20 s to 30 s previously allowed by the Code is adequate for cars on normal, automatic operation; however, when a car is on any nonautomatic or designated-attendant mode of operation, the in-car operator or elevator personnel may need more time to respond appropriately once power is transferred to that car.

In addition, firefighter operation was revised to split the automatic Phase I Emergency Recall Operation from the nonautomatic Phase II Emergency In-Car Operation. Requirement 2.27.2.4.4 now includes hoistway access operation, which had been inadvertently omitted from the list of operations that must be excluded when selecting the cars that will be automatically returned on emergency/standby power operation to the recall level in accordance with 2.27.2.4.4(a).

Once all the cars have recalled or had two chances to move, some cars remain parked while one or more cars (depending on the capability of the power supply) get full use of the power. They can then run in whatever mode is appropriate (Firefighters Emergency Operation, inspection, normal, etc.). For the initial automatic selection of cars to place in operation, priority will be given to cars on Hospital Emergency Operation followed by cars on Firefighters' Phase II Operation. This priority is only for the initial selection as a firefighter will manually select the cars to remain in operation.

Changing the car selected to recall or run, either by the automatic system or by the manual switch, must not cause an emergency stop; power will be transferred only after the elevator has stopped (at some floor if on automatic, possibly between floors if on inspection). Because of this delay, indicator lights are provided so the operator of the manual selection switches knows when his changes have taken effect. The operator also needs to know when cars are at the recall floor with doors open in order to make decisions about when to change the selection. Therefore, a lamp or display that indicates cars are at the recall floor with doors open must also be provided. If the doors close or the car leaves the floor, the indicator should show that change. A requirement was added in ASME A17.1-2013/CSA B44-13 to clarify that even a single elevator shall be provided with emergency power indicators.

Requirement 2.27.2.4 was revised in ASME A17.1-2019/CSA B44:19 to clarify that selection of an elevator to operate on emergency power shall be secured by the Firefighter key. The term "selection means" allows alternate methods in conjunction with the Firefighter key. These changes are in response to newer elevator specifications that call for unsecured selection buttons (e.g., strip switches). The new language allows marking on a display to indicate the selected elevator and to indicate automatic selection mode. In addition, Requirement 2.27.2.4.5 was revised to change to lowercase font for the fire recall switch since it is not specifically addressing the lettering associated with the fire recall switch.

Requirement 2.27.2.4.4 was revised in ASME A17.1-2022/CSA B44:22 to ensure the emergency power recall level is above the safe minimum elevation during a flood event as part of the Flood Detection Operation. See Handbook commentary on 2.27.13.

Requirements 2.27.2.4.4 and 2.27.2.4.5 were revised in ASME A17.1-2022/CSA B44:22 to clarify that the minimum number of elevators designated for occupant evacuation must continue to run simultaneously on Occupant Evacuation Operation (OEO), without interruption. Each elevator with OEO is supplied by both normal building power and Type 60, Class 2, Level 1 backup power. That means that the transfer switch will not be without power for more than 60 s, the elevator must operate for a minimum of 2 hr at rated load, and the elevator has enhanced reliability and features. Additional occupant evacuation elevators beyond those required by the building code are not required to continue to operate on OEO, but must comply with the requirements in 2.27.2.4.4(a) and 2.27.2.4.5.

Requirement 2.27.2.4.4 was also revised in ASME A17.1-2022/CSA B44:22 to clarify that Firefighters' Emergency Operation and OEO are not in conflict with test enable operation. See also Handbook commentary on 2.26.14.

Requirement 2.27.2.5 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definitions for "emergency or standby power" and "main line power" and to provide some additional editorial clean up.

See also the commentary on 2.26.10 and Section 620.91 of the National Electrical Code®.

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2.27.3 Firefighters' Emergency Operations: Automatic Elevators

In 2008, the National Fire Protection Association reported 1,451,500 fires resulting in 2,900 fire deaths in the United States and $12.4 billion in damages. The last available set of figures showing a comparison between the United States and Canada is from 2002. Combined figures covering office buildings, hotels, apartment buildings, and hospitals are 7,300 reported structure fires with 15 civilian deaths, 300 civilian injuries, and $26 million dollars in direct property damage. If extrapolated to all property uses, these figures suggest a total of 10,200 high-rise fires in 2002, civilian deaths of approximately 28, injuries of 350, and direct property damage at $143 million. The total building fire incidents in the United States were 1,734,500 with 6,196 deaths not including those lost on September 11, 2001, in the World Trade Center attack. In Canada, the comparative figures available for 2001 were 55,300 fire incidents, resulting in 337 deaths. An equally important set of figures is the total number of injuries in both the United States (21,100) and Canada (1,754). Only through an examination of the data does a true picture of the fire problem that we are facing today emerge. Between both countries, it is estimated that in the past 25 yr, there have been thousands of new high-rise buildings built.

The building codes define a high-rise building as a building more than 23 m or 75 ft in height measured from the lowest level of fire department vehicle access to the highest occupiable floor. For a short period after the events of September 11, 2001, there was a period of indecision about the potential future of high-rise construction around the world. All one has to do is look at the skyline in any major city in North America to recognize that high-rise buildings are still being constructed. In the past, office occupancies had been classified as a low-risk fire hazard. This was true in older, compartmentalized high-rise buildings, with no multifloor HVAC systems, and office furnishings made of wood or metal. However, the modern high-rise building is different. Fire and smoke spreading to other floors of the structure (e.g., World Trade Center attack of 2001, Chicago Cook County Building fire in 2003) are the true nightmare facing the firefighting forces of both countries. A factor in this fire problem is the furnishings. The vast majority of today's building interiors use various forms of plastic. Firefighters commonly refer to plastic as frozen gasoline. As plastic is heated from exposure to fire, it goes through a decomposition process that emits toxic, disabling gases (e.g., hydrogen chloride) and flammable hydrocarbon gases, which rapidly spread and cause immediate propagation of the fire across large areas. The smoke from these products of combustion is dense and black, causing trapped occupants to have little or no visibility, encounter choking smoke, and face heat of temperatures well above what a human being can endure.

Today's high-rise buildings present new and different problems to fire suppression personnel and techniques. The cause of fires in high-rise buildings and the materials used in them, including furniture and fixtures, are not any different from those used in conventional low-rise structures. However, if a fire breaks out in the top story of a high-rise, the fire service must transport their firefighters and equipment to the upper floors via elevators operating on Phase II Firefighters' In-Car Operation. In some fires, firefighters had to use stairs to reach the fire floor. Keep in mind that firefighters wearing all of their protective gear weigh an additional 29.5 kg or 65 lb. Firefighters also carry long lengths of hose and attachments weighing an additional 22.6 kg or 50 lb to 29.5 kg or 65 lb. Using the stairs to gain access to upper floors in a high-rise structure is the last resort. However, firefighters will use stairs where there is no other choice, as was the case during the World Trade Center attacks on September 11, 2001. After reaching the fire floor, the firefighters will be subjected to high heat (temperatures above 93°C or 200°F). Their protective clothing will provide only a limited amount of protection, taking into account the "preheating" of the gear, depending on the amount of heat exposure, etc. Elevators must be a reliable tool to be used by the firefighters in the performance of their duties.

A firefighting commander prefers a fire that is located on the top floor of a building over a fire on a lower floor. Why? Because the life hazard is on the fire floor (top floor), where only the roof and the sky are being exposed. In contrast, a fire on the 10th floor of a 34-story building has a life hazard on all floors above the fire as well as on the fire floor, requiring additional staffing to accomplish the tasks of search, rescue, and fire extinguishment. Recent improvements to the National Fire Incident Reporting System (NFIRS) now allow the exact floor of fire origin to be indicated, revealing the fact that in high-rise fires reported, the fire floor was typically on floor 6 or below. Usually the lower floors of any high-rise building contain the service areas, such as maintenance, heating, coffee shops, restaurants, cleaners, and other support functions, with the resulting fires. Many fires do start on higher floors, but on average, they start on floor 6 or below.

Firefighters have immediate concerns relating to smoke and heat spread, stack effect, and uncontrolled evacuation of building occupants down the same stairways that firefighters are trying to use to move up to locate, surround, and extinguish the fire. A few points to keep in mind: first, at the Meridian Plaza fire in Philadelphia, there was a total failure of all building systems early in the fire; and second, the first World Trade Center explosion and resulting fire were below grade, and it took 11 h to complete the evacuation. The events of September 11, 2001, provided terrible

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reminders of the life hazard that we all must face during a fire in a high-rise building.

Let's review some of the reasons that led to the Code requirements for Firefighters' Emergency Operation. Elevators are unsafe in a fire because

(a) a person may push a corridor button and have to wait for an elevator that may never respond; valuable time to escape is lost.

(b) elevators respond to car and corridor calls; one of these may be at the fire floor.

(c) elevators cannot start until the car and hoistway doors are closed. This could lead to overcrowding of an elevator and the blockage of the doors, and thus prevent closing.

(d) power failure during a fire can happen at any time and thus lead to passenger entrapment.

(e) fatal delivery of the elevator to the fire floor, which can be caused by any of the following:

(1) An elevator passenger may press the car button for the fire floor.

(2) One or both of the corridor call buttons may be pushed on the fire floor.

(3) Heat may melt or deform the corridor push button or its wiring at the fire floor.

(4) Normal functioning of the elevator, such as high or low reversal, may occur at the fire floor.

(5) Heat from the fire or loss of air-conditioning in the machinery space, machine room, control space, or control room may have a detrimental effect on solid-state control equipment, resulting in erratic elevator operation.

ASME A17.1/CSA B44 recognized all of these conditions and has reacted by mandating Phase I Emergency Recall Operation. The building code also requires a sign in elevator lobbies to advise building occupants not to use elevators in a fire. See Handbook commentary on 2.27.9.

Firefighters' Emergency Operation (FEO) is also known as Firefighters' Service or special emergency service [SES]. The ASME A17 and CSA B44 Committees have strived to standardize the operation to eliminate variations amongst different elevator equipment that may confuse firefighters during an emergency. The automatic or manual return of elevators to the designated level (see Section 1.3 for definition) is referred to as Phase I Emergency Recall Operation. Phase II Emergency In-Car Operation refers to provisions allowing emergency personnel to operate the elevator from within the car.

The requirements for Firefighters' Emergency Operation are detailed in the flowcharts shown in Diagrams 2.27.3(b)(1) through 2.27.3(b)(18). Due to the complexity of system design, it is not practical to diagram every path, but these diagrams are intended to provide key operational aspects.

NOTE: Diagram 2.27.3(b)(1) shows the logic needed inside the fire alarm panel to generate the three signals for the elevator system.

Diagram 2.27.3(b)(2) shows the initiation of fire service for a car on Inspection.

Diagram 2.27.3(b)(3) shows the initiation of fire service for a car on Hospital Service.

Diagrams 2.27.3(b)(4) and 2.27.3(b)(5) show the initiation of fire service for a car on Designated Attendant Service.

Diagrams 2.27.3(b)(6) through 2.27.3(b)(8) show the Phase I recall.

Diagrams 2.27.3(b)(9) shows the car at the lobby after Phase I recall.

Diagrams 2.27.3(b)(10) through 2.27.3(b)(13) show Phase II operation.

Diagrams 2.27.3(b)(14) and 2.27.3(b)(15) show the car going off of Phase II operation.

Diagrams 2.27.3(b)(16) through 2.27.3(b)(18) show recovery from a power failure.

Requirement 2.27.3 was revised in ASME A17.1-2022/CSA B44:22 to ensure that the alternate recall level is above the safe minimum elevation or at the highest available landing during a flood event and to use the alternate recall level during a flood event. See also Handbook commentary on 2.27.13.

2.27.3.1 Phase I Emergency Recall Operation. ASME A17.1b-1989 through ASME A17.1b-1992 required Phase I for an elevator with a rise of 7.62 m or 25 ft or more. Under earlier editions of the Code, an elevator could have nearly 15.24 m or 50 ft of rise (just less than 7.62 m or 25 ft above and below the designated landing) and still not have been required to have Phase I and Phase II operation. The term "designated level" (see Section 1.3) refers to the main floor or other level identified by the building code or fire authority that best serves the needs of emergency personnel for firefighting and rescue purposes. The term "alternate level" (see Section 1.3) refers to the second best floor level, which will be used by the elevators when the designated landing is unavailable. The term "recall level" (see Section 1.3) refers to whichever level (designated or alternate) is in use at a particular moment in a particular fire. These requirements apply for all automatic elevators except when the hoistway or a portion thereof is not required to be constructed of fire-resistive construction (2.1.1.1), the rise does not exceed 2 000 mm or 80 in., and the hoistway does not penetrate a floor. An example of this would be an elevator that travels only from one level in a lobby to a second level in the same lobby and does not penetrate a fire barrier. This arrangement can be seen in department stores or malls.

A three-position key-operated switch must be provided in the designated level lobby for each single elevator or for a group of elevators. The location of the three-position Phase I Emergency Recall switch has been standardized so that the switch will be located where all of the elevators

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are within sight and readily accessible. The key is to be removable only in the "ON" and "OFF" positions. The specified key positions standardize around a clockwise rotation to reach the "ON" position similar to the requirements for the Phase II Emergency In-Car Operation switch. Prior to ASME A17.1-2000 and CSA B44-00, the three-position Phase I key switch included the "BYPASS" position in jurisdictions not enforcing NBCC. Bypass allowed building or emergency personnel to return elevators to normal service without clearing an activated (alarmed) fire alarm initiating device (e.g., smoke detector) because early smoke detector systems were prone to false alarms. However, the entire automatic Phase I Emergency Recall system would be disabled when the key was in the "BYPASS" position. The fire alarm initiating devices that are used today are far superior to the ones that were first used. Today's systems can be monitored, maintained, and cleared from the fire alarm control panel, making BYPASS unnecessary.

Requirement 2.27.3.1.1(c) was revised in ASME A17.1-2022/CSA B44:22 to specify an acceptable range for the height of the "FIRE RECALL" switch above the finished floor to be readily accessible to firefighters. The height range is based on the established heights for the phone jack in NFPA 72.

Requirement 2.27.3.1.2 allows a second switch that must be labeled. The requirement was revised in ASME A17.1-2019/CSA B44:19 to require that additional information accompany the switch to identify which elevators it controls and recognize that the local authority may determine the location of the switch. In addition, 2.27.3.1.2, 2.27.3.1.4, and 2.27.3.1.6 were revised to change to lowercase font for the fire recall switch since it is not specifically addressing the lettering associated with the fire recall switch.

Beginning with ASME A17.1-1996, the expertise of NFPA 72® was recognized as the proper authority to determine the number, type, and location of fire alarm initiating devices in a building. In continuing with this transition, in ASME A17.1-2000 and CSA B44-00 the "BYPASS" position was replaced with the "RESET" position on the three-position Phase I Emergency Recall Operation switch. The "RESET" feature will be utilized by emergency personnel (see Section 1.3) to reset the elevators, returning them to normal service, after Phase I Emergency Recall Operation has been activated. If the fire alarm initiating device has not been cleared before using the "RESET" feature, then the Phase I Emergency Recall Operation will continue in effect until the device has been replaced, repaired, or bypassed by the fire alarm system. The Phase I switch shall be labeled "FIRE RECALL" and its positions marked as "RESET," "OFF," and "ON" (in that order), with the "OFF" position as the center position. An additional key-operated "FIRE RECALL" switch, with two positions, marked "OFF" and "ON" (in that order), is permitted only at the building fire control station. Keys shall be removable in the "OFF" and "ON" positions only. The switches cannot be spring loaded.

During Phase I operation, the elevator is not available to the general public as elevator use may be hazardous during a fire emergency. When an elevator is out of service during a fire, the public is unable to use it as a means of exiting from the building. Depending on the building fire plan, occupants will be directed either to the stairwells or places of refuge or to be active participants in the emergency plan developed for their safety by the building owners/operators.

Earlier editions of ASME A17.1/CSA B44 addressed only automatic door operations. The 1981 and later editions of ASME A17.1 cover operation of vertically sliding doors, doors controlled by constant pressure buttons, and manual doors. The only time an automatic elevator will not return upon activation of Phase I is when that car is at a landing with its door(s) open and the in-car stop switch, emergency stop switch (in-car, top-of-car, pit, etc.), or some other electrical protective device is activated.

Requirement 2.27.3.1.6(c) was revised in ASME A17.1-2016/CSA B44-16 to prohibit anyone from making the in-car stop switch or in-car emergency stop switch ineffective.

The in-car stop switch is accessible only to elevator personnel. It is either located behind a Group 1 locked panel or operated by a Group 1 key. If a mechanic actuates the in-car stop switch, it must be assumed there is a valid reason to stop the car immediately. In this case, the power should be removed from the driving-machine motor and brake, as intended.

The emergency stop switch on freight elevators is required to ensure that the elevator operator can safely manage the movement of freight. This switch is an electrical protective device required to be readily accessible, red, and conspicuously marked, thereby allowing quick actuation by the operator. If the operator actuates the emergency stop switch, it must be assumed there is a valid reason to stop the car immediately. Any car movement can result in the need for the operator to stop the car immediately; therefore, this electrical protective device should remain functional during all car movement. Misuse of the emergency stop switch during Phase I Emergency Recall can be quickly assessed by the firefighters via the emergency communication means of 2.27.1.1.4, which requires direct communication between emergency personnel and the elevator operator in the car. The analysis shows that the benefits of having an operational electrical protective device outweigh the concerns for ensuring the car recall during Phase I operation.

For passenger safety, 2.27.3.1.6(e) requires elevators doors to close at a slower speed when a door reopening device is rendered inoperative. Mechanically actuated door reopening devices are not sensitive to smoke or flame and can remain operative. Flame is the glowing,

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gaseous, visible part of a fire. Smoke or flame can register a signal, whereas a direct flame fire will destroy. Unless the fire was inside the car, the cars should have responded to the recall level well in advance of fire directly impinging on the hoistway door reversal device. The reference to 2.13.5 recognizes "nudging" and, therefore, it is not unsafe to disconnect mechanically actuated door reopening devices.

Requirements 2.27.3.1.6(f) and 2.27.3.1.6(g) allow full control of those doors that may have to be closed from the corridor. Also, the automatic closing of vertical slide doors requires an active "OPEN" or "STOP" button on the corridor. An active corridor "DOOR OPEN" button allows the user to open a closed hoistway door to access a car with a manual gate that is in an open position. A firefighter may need the "DOOR OPEN" button to open the door to see if anyone is in the car.

Operating hall position indicators [2.27.3.1.6(f)] may convey a message that the elevators may be used, leading occupants to wait for them instead of evacuating via stairs. Only where elevator location is important to firefighters, such as the designated level and the building fire control station, may hall position indicators remain in operation. Car position indicators are always required by the firefighters utilizing the elevators, thus these devices are to remain operative.

As the car will not be called to the fire floor, and the recall level elevator landing is free of smoke, it is safe to keep the doors open. Arriving firefighting forces will be able to immediately determine if all cars have answered the recall and passengers are not trapped in cars within the hoistway. If the Incident Commander (IC) of the firefighting forces cannot account for and verify where the elevators are, then firefighters will have to be diverted from other critical duties of rescue and suppression to search for and establish control over those elevators and their occupants.

The visible and audible signals [2.27.3.1.6(h)] alert passengers in an automatically operated elevator of the emergency and can minimize any apprehension that the passengers may have while the elevator is returning to the main floor. In an attendant-operated elevator, this signal alerts the attendant of the emergency and signals them to return immediately to the designated level. When on inspection operation, the inspector or maintenance personnel are also alerted to the emergency by this signal.

Requirement 2.27.3.1.6(j) recognized that if the smoke detector at the designated level is activated, turning only the additional Phase I switch to the "ON" position will not override the fire alarm initiating device sending the car to the alternate level. Where an additional "FIRE RECALL" switch is provided, both "FIRE RECALL" switches must be in the "ON" position to recall the elevator to the designated level if the elevator was recalled to the alternate level (2.27.3.2.4). This is because the additional switch may be at a location where the condition of the designated level lobby cannot be determined. This also prevents a melted Phase I switch from recalling the cars from the alternate to the designated level.

To remove the elevators from Phase I, the "FIRE RECALL" switch shall first be rotated to the "RESET" position, and then to the "OFF" position. If a second recall switch is provided, it must be in the "OFF" position to remove the elevator from Phase I Emergency Recall Operation. Means used to remove elevators from normal operation, other than as specified in this Code, shall not prevent Phase I Emergency Recall Operation. This requirement gives firefighters priority over elevator use by service personnel, movers, security lock-out, etc. This feature was included at the request of the fire service community, who often arrived after normal business hours at a fire only to find that most of the elevators were not accessible for their use.

On the other hand, changes in ASME A17.1-2007/CSA B44-07 recognized that cars shut down for safety reasons in accordance with other related conditions (such as an earthquake or flood) should not respond to Firefighters' Emergency Operation. The Code as of the ASME A17.1-2007/CSA B44-07 edition also recognized the existence of battery-operated devices used to move an elevator during a power failure. Without knowing where the fire is, these devices can move the elevator to let the passengers out as soon as possible, while the fire is still in its early stages, so they can exit the building. The ASME A17.1b-2009/CSA B44b-09 Addenda recognized that some systems contain batteries for purposes other than moving the car (for example, to retain information in computer memory) and clarified that this requirement does not apply to those systems.

2.27.3.1.6

2.27.3.1.6(a) This requirement was revised in ASME A17.1-2013/CSA B44-13 to clarify that any door (side, rear, etc.) that does not have an associated "FIRE RECALL" switch is not to be automatically opened when the car returns to the designated level.

Because the prior language addressed only when the door open button(s) are to be rendered inoperative, additional language was needed to clarify that the door open button(s) for doors that do not have an associated "FIRE RECALL" switch are required to be operative when the car is at the designated level. The requirement provides a maximum time that a door can be held open by a door open button associated with an entrance other than the door serving the lobby at the designated level. A 15-s maximum is a consensus value chosen by the Committee as a door stand-open time, and it is consistent with similar situations for hydraulic elevators [see 3.27.1(d)] and for traction elevators with alternate source of power [see 2.27.3.1.6(n)(3)].

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2.27.3.1.6(d) This requirement was revised in ASME A17.1-2016/CSA B44-16 to include Phase I Emergency Recall initiated when the doors are in the closed position. The phrasing specific to doors in the closed position had been inadvertently omitted from previous editions.

2.27.3.1.6(h) This requirement was revised in ASME A17.1-2019/CSA B44:19 to clarify the requirements for the audio and visual signals and to clarify the operation of the audio signal when the door is closed.

2.27.3.1.6(j) This requirement was revised in ASME A17.1-2019/CSA B44:19 to clarify the requirements and allow the group fire recall switch to remove individual cars from fire service when placed on fire service by the car fire recall switch, provided the switches are in the "OFF" position. The revisions also changed to lowercase font for the fire recall switch, since it is not specifically addressing the lettering associated with the fire recall switch, and relocated the note with the first use of the term "fire command center" from after 2.27.3.1.2 to after 2.27.3.1.6(n)(5), where the term first appears in 2.27.3.1.6(f)(2). In addition, revisions were made to clarify the existing requirement regarding the interaction between the "FIRE RECALL" switch(es) and the automatic fire alarm initiation devices that may initiate recall to the alternate level before either "FIRE RECALL" switch has been manually actuated.

Requirement 2.27.3.1.6 was revised in ASME A17.1-2022/CSA B44:22 to clarify that the prescribed operation is initiated when the fire recall switch is placed in the "ON" position. The operation does not take place only while the switch is maintained in the "ON" position. Requirement 2.27.3.1.6(n) was also revised to be consistent with the new definitions for "normal building power" and "emergency or standby power."

2.27.3.2 Phase I Emergency Recall Operation by Fire Alarm Initiating Device. An initiation device is defined by NFPA 72® as a system component that originates transmission of a change-of-state condition, such as in a smoke detector, etc.

2.27.3.2.1 NFPA 72®, National Fire Alarm and Signaling Code Handbook, specifies the type and installation of automatic initiating devices. Members of the National Fire Alarm and Signaling Code, NFPA *72*® Committee have the expertise to determine when fire conditions require automatic elevator recall. See Chart 2.27.3.2.1(a) for excerpts from the NFPA 72®, *National Fire Alarm and Signaling Code Handbook*. Beginning with ASME A17.1b-1997, a fire alarm initiating device (FAID) must be provided at all floors. ASME A17.1/CSA B44 recognizes that devices other than smoke detectors may be more appropriate under some conditions. Those conditions are specified within NFPA *72*. See Chart 2.27.3.2.1(b). ASME A17.1-2013/CSA B44-13 clarified that only FAIDs located in the elevator group's lobbies shall recall the elevators associated with those lobbies; FAIDs located in other elevator lobbies do not. In ASME A17.1-2016/CSA B44-16, a note was added to clarify the existing requirement for FAIDs in the hoistway. Because of new technology, the elevator motor controller or driving machine can be located in elevator hoistways, and in such cases, FAIDs would be required in the hoistway.

Requirement 2.27.3.2.1 was revised in ASME A17.1-2022/CSA B44:22 to only require FAIDs in the hoistway if sprinklers are installed more than 24 in. (600 mm) above the pit floor and to eliminate the requirement for an FAID in the pit on all elevators. NFPA 13 requires sprinklers in the pit to be located no more than 24 in. (600 mm) above the pit floor. If the sprinklers required by NFPA 13 actuate, they do not cause an unsafe elevator operation and Phase I Emergency Recall Operation is not needed; therefore, the FAID is not necessary.

Requirement 2.27.3.2.1(c) was revised in ASME A17.1-2022/CSA B44:22 to address the scenario where a hoistway smoke detector is required to activate the smoke relief equipment (see NFPA 72) on smoke detection to vent the hoistway and to activate Phase I recall.

2.27.3.2.2 To harmonize with the requirements in NBCC, the term "smoke detector" substitutes for "fire alarm initiating device," and "elevator lobby" for "elevator landing."

The FAIDs that are located in a machine room or machinery space are intended to detect when the elevator equipment is on fire and initiate Phase 1 Emergency Recall Operation for all elevators that share the machine room. As MRL elevators have become popular, there are now systems with the motor, drive, and control in places other than a traditional machine room. The locations that contain the control system or electrical devices but that do not contain the electrical driving machine (motor) or motor controller (drive) do not need FAIDs because such devices are typically low energy and therefore cannot start a significant building fire. However, there is enough energy available in the motor and drive that the Code requires a FAID be located with them, wherever they are.

Manual pull stations are never used to initiate Fire Service because they do not provide any information about the location of the fire. Occupants often move a significant distance toward an exit before pulling a manual alarm. The FAIDs in the elevator lobbies, etc., indicate when the elevator is threatened. ASME A17.1-2013/CSA B44-13 clarified that only FAIDs located in the elevator lobbies shall recall the associated elevators. In ASME A17.1-2016/CSA B44-16, a note was added to 2.27.3.2.2 to clarify the existing requirement for FAIDs in the hoistway. Because of new technology, elevator machinery and elevator control spaces can now be located in elevator hoistways, and in such cases, FAIDs would be required in the hoistway.

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Requirement 2.27.3.2.2 was revised in ASME A17.1-2022/CSA B44:22 to only require FAIDs in the hoistway if sprinklers are installed more than 24 in. (600 mm) above the pit floor and to eliminate the requirement for an FAID in the pit on all elevators. NFPA 13 requires sprinklers in the pit to be located no more than 24 in. (600 mm) above the pit floor. If the sprinklers required by NFPA 13 actuate, they do not cause an unsafe elevator operation and Phase I Emergency Recall Operation is not needed; therefore, the FAID is not necessary.

2.27.3.2.3 This requirement was revised in ASME A17.1-2019/CSA B44:19 to clarify that an active FAID in one elevator group's lobby shall recall only elevators associated with that lobby and not recall elevators that service the floor by a separate elevator lobby.

2.27.3.2.4 The following is the basis for alternate floor recall. It is not preordained that the designated level has the lowest fuel load of any other floor in the buildings. This may be the case in some major high-rise office buildings, but it certainly is not applicable to many other buildings, such as apartments, hotels, showrooms, or buildings with elaborate reception areas. However, even if it were a fact, a firebomb can suddenly provide an enormous fuel load on an otherwise fire-resistant floor.

Most buildings have elevators without an express zone, so the next floor above the ground floor is often used. However, it may be safer to park elevators away from any potential fire floor.

When elevators are returned to an alternate level, firefighters have not lost control. They can go to the alternate level and confirm that all cars are present, indicating that no one is trapped between floors. Normally they will not use the elevators on Phase II from the alternate level, since the fire is below them, but they have that option if the situation requires. If conditions dictate that the designated level is safe, firefighters can call the elevators to the designated level by turning the required three-position keyed switch to the "ON" position. The key switch overrides alternate floor recall operation and returns all elevators to the designated level, even though the elevators may be parked at a floor above an express zone. ASME A17.1a-2005 and CSA B44-04 Update 1-05 made a change so that once this happens, the designated level remains the recall level, even if the key switch is reset.

Typically, the designated level is also the location of the Fire Command Center (FCC) or, on jurisdictions enforcing NBCC, the Central Alarm and Control Facility (CACF). It would be difficult to effectively utilize a designated-level FCC or CACF if the designated level is engulfed in a rapidly spreading fire such as the one that destroyed the main floor of the MGM Hotel. Elevators that are returned to, or parked at, the main floor are of no value if the result is loss of life.

While sprinklers will reduce the probability of a large fire, smoke in dangerous quantities may be produced. Sprinkler manufacturers argue for the effectiveness of sprinklers in stopping fire in a large number of buildings, but as smoke control advocates note, it is smoke and not the flames themselves that causes the majority of fire deaths. Smoke control advocates believe that sprinklers allow too much smoke to develop before sprinklers activate.

Use of smoke detectors for the recall function has also been questioned because of the possibility that smoke may be present on floors above and/or below the fire floor. The Code has addressed this in 2.27.3.2.5 by indicating that the first smoke detector activation determines the recall level (see Section 1.3). It is highly improbable that smoke detectors on floors other than the fire floor would activate beforehand.

As a corollary to smoke detectors required to initiate elevator recall, others argue that the water flow switch associated with the on-floor sprinkler system is more positive. Smoke detectors can initiate elevator recall when the smoke reaches the elevators and threatens passengers, but smoke or water flow in a remote part of the building should not trigger a recall.

Requirement 2.27.3.2.4 was revised in ASME A17.1-2019/CSA B44:19 to clarify the references to 2.27.3.1.6 that need to be modified for alternate level and to clarify when recall to an alternate level is in effect.

2.27.3.2.5 This requirement states that the elevator needs to respond only to the first alarm initiating device activated. It is assumed that the smoke detector at the fire floor will be the first one that is activated. Subsequent alarms would most likely occur due to smoke migration and would not affect the choice of the recall floor. Revisions made in ASME A17.1a-2005 and CSA B44-04 Update 1-05 clarified the cars should never move to the alternate floor after being recalled to the designated level.

Connecting smoke detectors to the elevator system appropriately positions the elevators while the fire department is still on the way. This feature prevents building occupants from being delivered to a fire floor and permits the firefighters to quickly assess if all elevators have been recalled. Detectors at the designated level prevent the passengers from being delivered to a fire at that floor. The detectors no longer serve a purpose for the elevators once the passengers are out and the firefighters have arrived. The detectors are still useful for tracking smoke spread at the fire alarm panel. Once the firefighters decide it is safe to return the cars to the designated level, there is no reason to return the cars to the alternate again.

Requirement 2.27.3.2.5 was revised in ASME A17.1-2019/CSA B44:19 to change to lowercase font for the fire recall switch to follow the same style as the rest of A17.1/B44 when referencing these recall switches.

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2.27.3.2.6 If the FAID that initiated Phase I Emergency Recall Operation is in a location or space containing the elevator driving machine or motor controller, or in the hoistway, then the elevator equipment is likely the source of the fire, since very little is permitted to be stored in these areas. The in-car lamp is flashed to warn firefighters before they use the elevator on Phase II Emergency In-Car Operation that the fire likely originated in a location of high-energy elevator equipment and the elevator should not be used. Elevators that are in the same group but do not share the same hoistway, driving machine, or motor controller can still be used; therefore, these elevators will not flash the in-car lamp. Requirements were added to ASME A17.1-2013/CSA B44-13 to clarify that only FAIDs in the location(s) containimg the driving machine and/or motor controller shall cause the in-car lamp to flash.

In many cases, smoke spreads to areas that are remote from the fire; the elevator hoistway may even act as a chimney and draw smoke to itself. Even before this smoke enters the hoistway and subsequently activates the hoistway FAID, it would likely cause an elevator lobby FAID to activate and initiate Phase I Emergency Recall Operation. The Code does not want to discourage firefighters from using the elevators and potentially delay access to the fire due to smoke spread, so the in-car lamp does not flash on subsequent FAID activations.

In ASME A17.1a-2008/CSA B44a-08, a reference to heat detectors was deleted. This reference was first added as a clerical error. There was no technical change intended in either adding or removing it.

Requirement 2.27.3.2.6 was revised in ASME A17.1-2022/CSA B44:22 to require the visual signal to remain intermittent and not change to continuous illumination until the "FIRE RECALL" switch is turned to reset. The intent of the flashing indicator is to let the firefighters know that the Phase I recall was initiated from a location with elevator equipment and that the elevator equipment may be compromised.

2.27.3.2.7 Requirements were added in ASME A17.1-2013/CSA B44-13 to specify that a listed relay or listed appliance that complies with NFPA *72* (6.16.2.2) shall interface with fire alarm systems in jurisdictions not enforcing the NBCC as fire alarm company employees are not allowed to enter dangerous areas, e.g., any room or space requiring Group 1 Security (see Handbook commentary on 8.1.2).

2.27.3.3 Phase II Emergency In-Car Operation. Beginning with the 1981 edition of ASME A17.1, Phase II operation is required whenever Phase I operation is provided. Previously the requirement was predicated on the needs of emergency personnel. The current requirement takes into account the need of firefighters during an emergency, including evacuating people with disabilities. In a fire, even a firefighter can be considered disabled, especially when near exhaustion or if his/her compressed air supply is gone. Further, people without disabilities can become disabled from smoke, from walking up or down steps, or from shock. Therefore, when you hear that provisions must be made for people with disabilities during a fire, expand your overall picture, because even normally ambulatory persons can suddenly become nonambulatory.

Phase II firefighters' operation is for firefighters. Some of the input received from firefighters is as follows:

Firefighters need the elevator for their use. The Fire Services have long complained of elevators not being available to them upon arrival at the fire building. Elevators operating on Phase II are "firefighters' tools," and firefighters want the maximum number of elevators available. Firefighters will take command during a fire, and they will determine whether and how many elevators are to be used. Firefighters are willing to accept the risks that are associated with running elevators during a fire. It is standard operating procedure for the firefighters to use the elevators not only to carry equipment for firefighting or evacuation purposes, but also to disperse fire personnel to non-fire-involved floors. The presence of a firefighter reduces occupant fears, and firefighters can direct occupant movement strategy since they are in constant communication with the fire command post.

Many firefighters stated that there are times when they cannot afford the luxury of using personnel to operate an elevator on a return trip to the main floor. They requested placing the Phase II switch in the elevator to the "OFF" position to automatically cause the elevator to return to the main floor for use by later-arriving firefighters. However, Standard Operating Guidelines (SOG) dictate that whenever staffing does permit, a firefighter with a radio should be dedicated as the "taxi" operator of any car being placed onto Phase II operation. That firefighter would be responsible for the shuttling of firefighters and their equipment to the discharge floor, usually a minimum of two stories below the fire floor. This would be their task until relieved by another fire-fighter assigned that position. There also is a requirement that when the car is on Phase II operation, turning the switch in the car to the "HOLD" position at a floor will permit the firefighter to remove the key, and leave the car without the danger of an unauthorized person taking the car to another floor.

The ASME A17 Code Committee was aware of the need to evacuate people with disabilities during a fire. ASME A17.1a-1992 and later editions require firefighters' service on all elevators. Building codes; NFPA 101®, Life Safety Code®; American with Disabilities Act Accessibility Guidelines (ADAAG); and Americans With Disabilities Act/Architectural Barriers Act Accessibility Guidelines (ADA/ABA AG) envision the use of elevators operating on Phase II as a principal means of evacuating people with disabilities during a fire. Phase II is a major step forward by providing firefighters with the necessary

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tools to accomplish this task. However, the elevator industry must continue its research and development into making the elevator reliable for evacuation during a fire. See Handbook commentary on Occupant Evacuation Operation in 2.27.11.

Firefighters need access to all floors that the elevator serves, so security systems, etc., must be overridden. ASME A17.1-2007/CSA B44-07 recognized that modern elevators do not always have traditional car call buttons, provided they give firefighters access without causing unnecessary delay and/or confusion.

ASME A17.1-2004 and CSA B44-04 incorporated a number of new requirements. The FIRE OPERATION switch (2.27.3.3), the CALL CANCEL button [2.27.3.3.1 (h)], the stop switch [2.27.3.3.1(m)], the door open button(s), the door close button(s), the additional visual signal (2.27.3.3.8), and the operating instructions shown in Figure 2.27.7.2 are required to be grouped together at the top of a main car operating panel behind a locked cover. This panel came about for a number of reasons. To eliminate confusion, firefighters wanted all of the components that they would be using in one area.

A STOP switch, which will be accessible only to the firefighters, is required in the fire operation panel. Since this STOP switch is intended for emergency use if the elevator misbehaves, there should be no way for the control system to disable it, and it must be easy to activate while wearing firefighting gloves. Therefore, "pull to stop" switches and rotary switches, etc., are not acceptable. The firefighter operation panel cover must be operable by the same key that operates the FIRE OPERATION switch. The cover shall be permitted to open automatically when the car is on Phase I Emergency Recall Operation and at the recall level. When closed, the cover shall be self-locking. Where rear doors are provided, buttons for both the front and rear doors are required to be provided in the firefighters' operation panel. The door open and close buttons for the rear entrance must be labeled "REAR OPEN" and "REAR CLOSE" or "SIDE OPEN" and "SIDE CLOSE" as appropriate. While the firefighters will primarily use the door open and close buttons behind this panel, any other door open or close buttons that are provided in the car must be operational. All door buttons must be operative when the elevator is stopped within an unlocking zone.

All buttons and switches must be readily accessible, located not more than 1220 mm or 48 in. and not less than 1830 mm or 72 in. above the floor, and shall be arranged as shown in Figure 2.27.3.3.7. Requirement 2.26.12 does not apply to these buttons and switches. These controls are not required to comply with ADA/ABA AG, ICC/ANSI A117.1, or ASME A17.1/CSA B44, Nonmandatory Appendix E, because they are provided for use by firefighters — not the occupants of the building. Thus, ASME A17.1/CSA B44 specifies minimum sizes to ensure that a firefighter wearing gloves can operate them. The front of the cover must contain the words "FIRE-FIGHTERS' OPERATION" in red letters at least 10 mm or 0.4 in. high.

The intent has always been that a firefighter standing at the car operating panel would have full control of the car on Phase II operation and have access to all the necessary buttons and switches. ASME A17.1-2010/CSA B44-10 made it clear that all required buttons have to be located in the fire operation panel and has standardized the location of the firefighters' operation panel. In addition, when the panel is in the open position, the view of the instructions and access to the buttons or switches cannot be restricted. As noted, there is need for the firefighter to have access to all the landings served by the car. As of ASME A17.1-2010/CSA B44-10, the Code clarified that "all landings" means both front and rear entrances. For example, an elevator may serve 10 front and 5 rear openings, thus access is required for all landings including the door operating buttons.

The key-operated switch is called the "FIRE OPERATION" switch, labeled "OFF," "HOLD," and "ON," in that order. It shall be rotated clockwise, to go from "OFF" to "HOLD" to "ON." The key shall be removable only in the "OFF" and "HOLD" position, and it shall not change the mode of operation within Phase II Emergency In-Car Operation until the car is at a landing with its doors in the normal open position. Preventing the key from being removed from the fire operation switch when in the "ON" position reduces the potential of leaving a car stranded after a fire emergency. It also reduces the possibility of unauthorized personnel entering an empty car and taking it to another floor, as it is unlikely a firefighter would not remove their fire operations key when exiting a car.

Firefighters may reverse the elevator direction at the next available landing by turning Phase II switch to "OFF" (2.27.3.3.4). The car shall remain on Phase II operation and, without going through a door open and close sequence, will return to the designated level. This provides the firefighter with a means of aborting an upward flight when conditions warrant their return to a known safe floor — the one at which they started.

Means used to remove elevators from normal operation, other than as specified in this Code, shall not prevent Phase II Emergency In-Car Operation. Appropriate requirements for cars with more than one entrance are established by 2.27.3.3.1(d). Requirement 2.27.3.3.1(e) recognizes that reopening large vertically sliding doors with continuous-pressure closing is impractical and may introduce a delay factor impeding safety. Requirement 2.27.3.3.1(g) recognizes that door reopening devices are not necessary since constant-pressure operation is required.

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At the request of firefighters, 2.27.3.3.2 was revised in ASME A17.1-2007/CSA B44-07 to address elevators with power-operated or manually operated doors.

For standardization, 2.27.3.3.3 and 2.27.3.3.4 define Phase II operation in the "OFF" position and the car is not at the recall level. Turning the key "OFF" returns the car to the floor where the firefighter started.

Requirement 2.27.3.3.4 was revised in ASME A17.1-2007/CSA B44-07 to clarify elevator operation when the Phase II switch is placed in the "OFF" position. If Phase I is activated by the fire alarm initiating device at the designated level, the car will return to the alternate level unless it has been overridden by the Phase I switch.

The requirements 2.27.3.3.1, 2.27.3.3.2, and 2.27.3.3.4 were revised in ASME A17.1-2013/CSA B44-13 to address when alternate sources of power (auxiliary power) are used and the elevator may soon be unavailable. When this condition is detected, the in-car lamp will flash to notify firefighters.

2.27.3.3.1 Requirement 2.27.3.3.1(c) was revised in ASME A17.1-2016/CSA B44-16 to reference 2.12.1 so that users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

Requirement 2.27.3.3.1 was revised in ASME A17.1-2022/CSA B44:22 to add the reference for Flood Detection Operation. See Handbook commentary on 2.27.13.

Requirement 2.27.3.3.1(n) was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definitions for "normal building power" and "emergency or standby power."

2.27.3.3.2 Requirement 2.27.3.3.2 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definitions for "normal building power" and "emergency or standby power."

2.27.3.3.4 Requirement 2.27.3.3.4 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definitions for "normal building power," "emergency or standby power," and "auxiliary power," and for editorial corrections.

2.27.3.3.5 Prior Code editions required the car to return to the designated level when the Phase II key was turned to "OFF," because firefighters normally use the Phase I switch to move the car from the alternate floor to the designated floor when arriving at the building, as this is the egress floor where they are entering the building. If there was an active fire in the designated floor lobby preventing the use of the Phase I switch, then firefighters would not use the elevator. If firefighters did use the elevator in this scenario, they would be exposed in a car when the fire breaches the hoistway door. Prior Code editions were based on this basic understanding of how firefighters evaluate when to use an elevator.

The change in ASME A17.1-2022/CSA B44:22 to specify that the car exits Phase II at the recall level instead of the designated level was to help prevent confusion when checking fire service operation of this unusual scenario from the alternate floor. This change eliminates any confusion of the operation as the car will return and then exit Phase II automatically at the recall level without any further action to move the car to the alternate floor and open the doors. Once the elevator exits Phase II, the elevator will then revert to Phase I or the previous automatic operation.

2.27.3.3.6 Water from automatic sprinklers and/or fire department hose streams may cause an accidental ground or short circuit in elevator electrical equipment that is located on the landing side of the hoistway enclosure. Equipment such as hall lanterns and corridor call buttons must not shut down a car operating on Phase II.

A machine-room-less elevator with a controller cabinet located on the landing side of the hoistway, and/or wiring located on the landing side of the hoistway must be protected from water, but not protected from heat or fire. Wiring on the landing side of the hoistway enclosure must be protected from grounds or shorts if they could result in the disabling of Phase II Emergency In-Car Operation as a result of exposure to water. Heat and fire are not addressed by this requirement; only water is addressed.

2.27.3.3.7 This requirement was revised in ASME A17.1-2016/CSA B44-16 to specify the location of the phone jack when it is provided as part of the fire department communication system.

Requirement 2.27.3.3.7 was revised in ASME A17.1-2019/CSA B44:19 to clarify that the floor selection means is permitted to be behind a locked cover and to change to lower case font for the fire recall switch to follow the same style as the rest of A17.1/B44 when referencing these recall switches.

2.27.3.3.8 This requirement was editorially revised in ASME A17.1-2016/CSA B44-16 to clarify that the additional visual signal required for Phase II operation will have the same operation as the visual signal required by 2.27.3.1.6(h).

2.27.3.3.9 Requirement 2.27.3.3.9 was added in ASME A17.1-2022/CSA B44:22 to provide an exception to allow the door close button to function on Phase II operation during a false triggering of the door monitoring means such as where the hoistway door has become uncoupled from the car door allowing the hoistway door to remain closed while the car door remains open. This protects from stranding a firefighter at a floor by allowing the car door to be closed with the constant pressure door close button and the continued operation on Phase II. See Handbook commentary on 2.26.5.

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2.27.3.4 Interruption of Power. This requirement clarifies that during power interruption, Phase I or Phase II must remain in effect upon restoration of power. The elevator must be designed to recover from the power failure without further endangering the firefighters or other passengers. Firefighters normally use elevators to move between the recall floor and a staging floor typically two floors below the fire. Firefighters typically do not move the elevator past the fire floor. If the elevator control system needs to move the car to reestablish its position, movement should occur only when the firefighters are ready, and not take the car past the fire floor. There is no need to remember exactly what part of Phase I or Phase II was happening before the power was lost. The power outage could have been 5 s or 5 h, and the situation may have changed. On power up, the system just looks at the current state of the key switches and at the position of the doors to decide what to do, since this indicates the most recent request from the firefighter.

Requirement 2.27.3.4 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definitions for "normal building power" and "emergency or standby power."

Requirement 2.27.3.4(c) was revised in ASME A17.1-2022/CSA B44:22 to update the requirements for the door operation under Phase II Emergency In-Car Operation. For the car doors to remain open when power is removed requires the mechanical resistance of the door operator and/or car doors to overcome the closing force of the mechanical door closers used to comply with requirement 2.11.3.1. Modern door operators are designed for minimal wear and therefore provide little mechanical resistive force. The door closers can, in certain cases, mechanically close both the car and hoistway doors when power is removed. The change fully reopens doors to restore control of the car to the firefighter should this occur and clarifies that once the car recovers on "HOLD" operation it shall conform to the requirements of 2.27.3.3.2.

2.27.3.5 Multicompartment Elevators. Prior to ASME A17.1-2007/CSA B44-07, designers developed operational steps for double-deck elevators on Phase II. This led to some complex processes that differed from building to building. To provide consistency for firefighters, the Code defines a method allowing a firefighter in the upper deck to verify that lower deck is vacant and to control the doors on the lower deck. To respect the privacy of passengers in nonemergency situations, the viewing means is disabled during normal operation.

Requirement 2.27.3.5.1 was revised in ASME A17.1-2019/CSA B44:19 to change to lowercase font for the fire recall switch to follow the same style as the rest of A17.1/B44 when referencing these recall switches.

2.27.4 Firefighters' Emergency Operation: Nonautomatic Elevators

This requirement establishes the operation requirements of elevators that are not covered by 2.27.3. A standard sign alerts the operator as to which floor the elevator should be returned. See Handbook commentary on 2.27.3. ASME A17.1-2013/CSA B44-13 deleted the Canadian exceptions and harmonized requirements for all elevators to have automatic recall. Prior editions of ASME A17.1/CSA B44 unintentionally overlooked nonautomatic elevators.

Requirement 2.27.4.1 allows a second switch that must be labeled. The requirement was revised in ASME A17.1-2019/CSA B44:19 to require that additional information accompany the switch to identify which elevators it controls and recognize that the local authority may determine the location of the switch. In addition, Requirements 2.27.4.1 and 2.27.4.2 were revised to change to lowercase font for the fire recall switch since it is not specifically addressing the lettering associated with the fire recall switch.

Requirement 2.27.4.2 was revised in ASME A17.1-2022/CSA B44:22 to require the visual signal to remain intermittent and not change to continuous illumination until the "FIRE RECALL" switch is turned to reset. The intent of the flashing indicator is to let the firefighters know that the Phase I recall was initiated from a location with elevator equipment and that further evaluation is required to determine if the elevator equipment may be compromised.

2.27.5 Firefighters' Emergency Operation: Automatic Elevators With Designated Attendant Operation

A "designated attendant" (see Section 1.3) is where the elevator is controlled solely by authorized personnel (see Section 1.3) such as attendant service, independent service, hospital service, and similar operations.

A car could be left at the fire floor, exposing the hoistway to fire, when it could be recalled. The delay gives ample warning prior to recall. ASME A17.1-2007/CSA B44-07 eliminated the time delay if the car was parked at the recall level, since an arriving firefighter could ride the car up into the building thinking that the elevator was operating on Phase II, and then be put in danger when the doors open automatically.

Operators of cars on attendant service must be notified that there is a fire emergency in the building and given the opportunity to take appropriate action based on their training.

"Hospital service" (see Section 1.3) is a special case of operation by a designated attendant (see Section 1.3) used only for medical emergencies. Hospital service elevators are used for transporting critical patients — not food or laundry. Bringing a patient to the lobby instead of an

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operating room, etc., could be life threatening. Firefighters can use another elevator until the car is released from hospital service. The Code beginning with ASME A17.1a-2005/CSA B44-04 Update 1-05 allows the operator to temporarily silence the audible signal, since noise may inhibit patient care.

Requirement 2.27.5.3 was revised in ASME A17.1-2019/CSA B44:19 to change to lower case font for the fire recall switch to follow the same style as the rest of A17.1/B44 when referencing these recall switches.

2.27.6 Firefighters' Emergency Operation, Occupant Evacuation Operation: Inspection Operation

This requirement recognizes that taking the elevator control away from elevator personnel may be hazardous. This requirement provides for notification of an emergency in the building. The requirement specifies that the signal must be audible where the inspection operation is active, but it is not required to be physically in that location.

Requirement 2.27.6 was revised in ASME A17.1-2019/CSA B44:19 to change to lower case font for the fire recall switch to follow the same style as the rest of A17.1/B44 when referencing these recall switches.

Requirement 2.27.6 was revised in ASME A17.1-2022/CSA B44:22 to clarify that Firefighters' Emergency Operation and Occupant Evacuation Operation are not in conflict with test enable operation. See Handbook commentary on 2.26.14. It was also revised to coordinate with changes to 2.27.13 to ensure the audible signal is actuated during Flood Detection Operation.

2.27.7 Firefighters' Emergency Operation: Operating Procedures

Operating procedures must be incorporated with or be adjacent to the Phase I and Phase II key-operated switches. This ensures that, during an emergency, emergency personnel have quick access to the procedures. Since firefighters' service is now standardized, the Code specifies signs with simple and clear wording that explain the operation of the elevators. Signs must not deviate from the required text in ASME A17.1/CSA B44. However, the requirement allows the instructions to be modified for manual doors. An explanation of the "RESET" position is not necessary on the Phase I sign because this is a building function, not a firefighters' operation.

Requirement 2.27.7.1 was revised in ASME A17.1-2019/CSA B44:19 to clarify that the instruction signage applies only to the group fire recall "red" switch (see 2.27.3.1.1(b)) and the instruction signage will not apply to the OEO per car fire recall "yellow" switch (see 2.27.11.1.2(b)). The instruction signage for the "red" group fire recall switch is more than sufficient for a trained fire fighter to understand the use and operation of the "yellow" car fire recall switch(es) in a single elevator or a single group of elevators or multiple group of elevators operating on OEO. In addition, the requirement included a change to lower case font for the fire recall switch to follow the same style as the rest of A17.1/B44 when referencing these recall switches.

Requirement 2.27.7.4 recognizes a requirement in NBCC.

Requirement 2.27.7.4 was relocated to 2.27.10.2 in ASME A17.1-2019/CSA B44:19 to locate with similar requirements for "Firefighters' Elevator" required by the NBCC.

2.27.8 Switch Keys

ASME A17.1-2007/CSA B44-07 incorporated a requirement for a single specific key coded "FEO-K1" to be used on all elevators to eliminate the confusion and delay that occurs when hunting for keys during a response to an emergency. It was subsequently discovered that bitting codes can be interpreted in different ways by different lock manufacturers, resulting in non-interoperable keys and locks; additional details have been added to the key description to achieve the original goal of a single standard key. To ensure uniformity in the FEO-K1 key due to different key-cutting conventions, ASME A17.1-2013/CSA B44-13 included cutting information. Some jurisdictions may adopt their own standard key to accomplish the same goal. Distribution of a uniform key should be controlled through laws and training to prevent abuse. Building personnel are allowed to use the key to perform required monthly tests of fire service but not for any other purpose.

The required switch keys for Phase I and Phase II operation must be the same to ensure a speedy response to the emergency situation. A key is required for all Phase I and Phase II key switches to allow for simultaneous operation of all key switches.

A Note is included to suggest that local jurisdictions may legislate uniform keyed lockbox requirements to ensure the availability of emergency keys when building personnel are not available. It is not within the jurisdiction of ASME A17.1/CSA B44 to mandate a uniform keyed lockbox.

2.27.9 Elevator Corridor Call Station Pictograph

If the building code requires a sign but does not specify its appearance, then the sign in ASME A17.1/CSA B44, Fig. 2.27.9 must be used. Previously, designers were free to provide any sign, resulting in inconsistency and possible confusion.Requirements were added to ASME A17.1-2010/CSA B44-10 to allow the circles to be filled with the same color as the background material, since many signs are engraved in a metal plate without loss of readability. It also improved the dimensioning of the sign, making it clear that the background material can continue beyond the sign to any size desired.

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Figure 2.27.9 was revised in ASME A17.1-2019/CSA B44:19 to correct an error in the pictograph from the previous edition.

2.27.10 Elevator(s) for Use by Firefighters

Requirements 2.27.10 and 2.27.10.1 were added in ASME A17.1-2019/CSA B44:19 to address Fire Service Access Elevators, which are required by the International Building Code and NFPA 5000® in buildings with an occupied floor more than 120 feet (37 m) above the lowest level of fire department vehicle access. See also Handbook commentary on Section 2.27.

Previous Requirement 2.27.7.4 was relocated to new Requirement 2.27.10.2 in ASME A17.1-2019/CSA B44:19 to locate with similar requirements.

Requirement 2.27.10 was revised in ASME A17.1-2022/CSA B44:22 to prohibit any class of freight elevators and all hydraulic elevators from serving as Fire Service Access Elevators (FSAEs) to prevent conflicts with other codes. NFPA 13 requires sprinklers in freight elevator hoistways and in hydraulic machine rooms. The building codes prohibit sprinklers in the hoistway or machine room of FSAEs.

Requirement 2.27.10.1 was revised in ASME A17.1-2022/CSA B44:22 to coordinate with the addition of 2.1.7, which requires full hoistway lighting. The requirement to turn on the hoistway lighting is included in 2.1.7.1.3. See Handbook commentary on 2.1.7. Requirement 2.27.10.1 was also modified to provide guidance for identifying Fire Service Access Elevators.

2.27.11 Occupant Evacuation Operation

When a fire occurs in a high-rise building, Firefighters' Emergency Operation (FEO) operates as it has for years. If the fire/smoke is remote from elevators, the elevators can safely be used to supplement stairs for building evacuation. With this added capacity, building occupants most directly threatened by the fire, including those unable to use the stairs, can be safely out of the building by the time firefighters arrive. This allows firefighters to focus attention on fighting the fire. Occupant Evacuation Operation (OEO) is not required by ASME A17.1/CSA B44 but, if provided, must comply with these requirements.

ASME A17.1-2013/CSA B44-13 was the first edition to include OEO requirements. The operation is for the elevators to be a shuttle between the five floors closest to the fire (e.g., fire floor, two floors above, and two floors below) and the elevator discharge level (typically the ground floor), thereby preventing occupant travel to or from any other floor when a FAID is activated. Signs and voice announcements on all floors will inform occupants about the emergency and whether or not the elevators are available for their use.

If the fire is remote from the elevators and the fire alarm system has not recalled the cars, the arriving firefighters can do what they have always done: turn a switch [in the lobby, or in the Fire Command Center (FCC) or, in jurisdictions enforcing NBCC, the Central Alarm and Control Facility (CACF)] and recall all the cars to the lobby, and then use as many cars as they want on Phase II. However, OEO provides the firefighters with another option as well. If they see that evacuation is progressing but is not complete, they can choose to recall only the cars they plan to use on Phase II, leaving the rest in evacuation mode. This is done using a "per car" Phase I recall switch located next to each car. As needs grow, firefighters can capture more cars by turning additional "per car" recall switches at any time, or turning the "group" switch if they require all cars.

Requirement 2.27.11 was revised in ASME A17.1-2019/CSA B44:19 to clarify the relationship between Occupant Evacuation Operation (OEO) as specified in A17.1/B44 and Occupant Evacuation Elevators (OEE) as defined by the building codes. The revisions also removed any implied operational requirements from the base paragraph since they are addressed in the following requirements and added a note to clarify the terms used when destination-oriented control systems are used for OEO. Several of the OEO requirements were updated for clarity and enhancements based on the experience gained from some of the early OEO installations.

Human Factors Research

Like the use of any technological system, the safe and effective use of elevators during emergencies will be partially dependent on correct assumptions on occupant behavior during the emergency. Applying OEO consideration of the different aspects of occupant behavior will be important to the use of the elevator system.

Occupant behavior assumptions identified when developing these requirements included the following:

(a) floor wardens: personnel will carry out their responsibilities correctly

(b) occupant training: personnel will

(1) attend initial training sessions

(2) attend ongoing training

(c) occupants and lobby signage/voice notification (SVN): personnel will

(1) take time to observe the SVN

(2) understand SVN symbols and language

(3) follow SVN instructions

(4) have a workable sense of acceptable wait times in the elevator lobby

(5) make the correct decisions regarding using elevators or the stairs

(6) go to the stairway in an orderly manner once a decision is made to leave the elevator lobby

(d) occupants and elevators: system design and training on use of the two-way communication system will ensure correct use.

(e) occupants — general

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(1) occupants will accurately gauge their ability to take the stairs.

(2) occupants will provide correct assistance to others who cannot use the stairs.

(3) visitors will follow the lead of trained occupants.

Issues involving fire wardens, signage/voice notification system, and in-car communication system are those with the greatest potential impact in the event the assumptions made prove incorrect.

While some occupant behavior issues can be addressed through building policy (e.g., mandatory training for new and existing occupant employees), others need investigation to validate the assumptions. Investigation can take the form of elevator component mock-up or observations in buildings where similar systems are currently in use.

Research on aspects of occupant behavior is needed to enable emergency-use elevator systems to be put in place with the greatest degree of confidence regarding their safe and effective application. To the extent that research confirms working hypotheses, it will be easier to design elevator evacuation systems that perform effectively.

Elevator evacuation systems should not be designed to require 100% human reliability, just as systems should not be designed to depend solely on the reliability of any single hardware feature. To the extent that research does not support these assumptions, systems should be designed to improve human performance, and to use redundancy and other measures to compensate for inherent limits in human reliability.

A hazard analysis was made that shows the use of elevators by occupants during a building evacuation starting prior to Phase I Emergency Recall Operation provides a reasonable degree of safety for the occupants when the provisions of ASME A17.1/CSA B44 are met, but unacceptable hazards remain if any of them are omitted.

2.27.11.1 Phase I Emergency Recall Operation with OEO. Firefighters normally do not use all elevators. This allows the option of using as many as necessary while simultaneously allowing the rest to continue evacuating occupants from the building. In some cases, firefighters will still want to recall an entire group of elevators without having to turn numerous keys, so the current group recall switch is retained. Note that Section 2.29 requires car identification to be marked at the designated level and on the car operating panel. Each must be labeled in case they are mounted one above the other between two cars.

There is a lamp by every "FIRE RECALL" switch. When the group goes on fire service, they all illuminate. When only a single car is placed on fire service, only the lamp for that car should illuminate. This makes it easy for a firefighter standing in the lobby to quickly determine car status.

"Designated level" is the same as "elevator discharge level" since in most buildings the ground floor is both the level of exit discharge (terminology per IBC and NFPA 101®) and the designated level. Some buildings, particularly those on hills or attached to large complexes, may have them on different floors. If OEO is to be used, they must be the same floor to allow firefighters to observe and manage operations.

Requirement 2.27.11.1, including the subsections, was revised in ASME A17.1-2019/CSA B44:19 to clarify that Firef ighters' Emergency Operation (FEO) is impacted by the addition of OEO to an elevator even if the OEO is not active at the time the FEO is in use. Several of the subsections were updated to change to lower case font for the fire recall switch to follow the same style as the rest of A17.1/B44 when referencing these recall switches.

Requirements 2.27.11.1.1 and 2.27.11.1.2 were revised to clarify that they only apply to groups of two or more elevators and to clarify the requirements. When groups are provided, the labels for the three-position switch in the lobby and the two-position switch need to be modified to indicate that they are for group fire recall. An additional, three-position switch is also required for each elevator in the group to allow for individual car fire recall and to include labeling to identify the car it controls. The additional switches must be located at the elevator discharge level.

Requirement 2.27.11.1.3 was modified to clarify that the use of the car fire recall switch initiates Phase I and overrides OEO as long as Phase I remains in effect.

Requirement 2.27.11.1.4 was updated to directly reference the requirement for the illuminated visual signal rather than duplicating the language.

Requirement 2.27.11.1.5 was modified to clarify operation of an individual elevator when it is removed from Phase I operation. If the remaining cars in the group are operating under OEO, the individual car also returns to OEO operation after it is removed from Phase I.

Requirement 2.27.11.1.6 was updated for simplicity and to clarify that the group fire recall switch cannot override the individual car fire recall switch when in the "ON" position. It also provides requirements to allow the group fire recall switch to reset all cars in the group under the correct conditions. A Note was added to provide clarification of the group fire recall switch "RESET" operation.

A new requirement, 2.27.11.1.8, was added to use the variable message display to alert users when an elevator is not available for evacuation because FEO is in effect.

2.27.11.2 OEO Lobby Signage. Occupants need information to help them decide whether to wait for elevator service or take the stairs. By positioning signage at reasonable height, visibility will be available to most people, even in a crowded lobby. Those who don't or can't see signage can be informed by others.

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Requirement 2.27.11.2 was reformatted and revised in ASME A17.1-2019/CSA B44:19 for clarity. The revisions clarify that the variable message sign is also required for a single elevator that is not part of a group and to allow other messaging and a power indicator to identify when a variable message sign is active for consistency with other emergency communication systems that permit dual usage of signage. The revisions also require that the variable message sign must display a message when OEO is terminated.

NOTE: Actual wording and symbols to be used must be determined based on further human factor studies.

Requirement 2.27.11.2.2 was revised in ASME A17.1-2022/CSA B44:22 to revise nomenclature for ICC/ANSI A117.1 so that the entire ASME A17.1/CSA B44 document reflects the accurate characters used by both the referenced standard and ASME A17.1/CSA B44, Section 9.1.

2.27.11.3 Requirement 2.27.11.3 was deleted in ASME A17.1-2019/CSA B44:19. For Occupant Evacuation Elevators, per the building code, the elevator lobbies are protected spaces that are pressurized, while the egress landing is likely an open lobby. After a FEO Phase I recall, the elevator hoistway doors in the protected lobbies are closed mitigating any smoke leakage into the pressurized lobbies from a lower pressure hoistway. This eliminates the need to close the doors at the Recall Level (egress landing) after a Phase I recall.

2.27.11.4 When hoistway doors are closed, firefighters cannot determine car location without a position indicator.

Requirement 2.27.11.4 was revised in ASME A17.1-2019/CSA B44:19 to remove the requirement for position indicators for OEO since the doors are not required to be closed (see modification to 2.27.11.3), but if provided, the indicators are required to remain operative similar to position indicators during FEO. [See 2.27.3.1.6(f)3(-b).] An operational position indicator could aid firefighters in selecting an elevator for individual fire recall during OEO.

2.27.11.5 Fire Alarm System Interface. OEO can be used for fires that do not affect the elevator system. If smoke is detected in an elevator lobby, hoistway, or machine room, associated elevators recall on Phase I Emergency Recall Operation. Generally, a fire starts on a single floor; in high-rise buildings particularly, only that floor and adjoining floors are evacuated. Occupants on other floors remain in place. In the event smoke or fire spreads to another floor (even if it skips floors), all floors in between must be evacuated. If the fire is on the ground floor, a trained person must decide if there is a safe path from the elevators to an exit. Zoned evacuation plans in high-rise construction typically require evacuation of at least the floor with an active fire alarm initiating device (FAID) and the adjacent floor above and the adjacent floor below. OEO evacuates two floors above the active FAID in recognition of the potential for upward smoke spread, particularly through convenience stairs or other floor penetrations. OEO also evacuates two floors below the FAID in recognition of fire service standard practice of staging response operation two floors below the fire as specified in ASME A17.4. The fire alarm system is assigned the responsibility of adding two floors above and below the fire floor to the evacuation zone, as well as filling in the floors between separated alarms to be consistent with the next rule, and to simplify the interface when a fire zone spans between two groups of elevators. Methodology for the fire alarm system to indicate to the elevator system the floors to be evacuated is left for resolution between fire alarm system and elevator manufacturers. Parallel wiring and serial communication are both acceptable.

The decision to evacuate a building due to fire growth (or other threat) must be made by a responsible individual, not by an automated system. Additional information can be found in NFPA 72®-2019, National Fire Alarm and Signaling Code Handbook.

Requirement 2.27.11.5.1 was revised in ASME A17.1-2019/CSA B44:19 to clarify that the discharge level is not to be included in the contiguous block of floors to be evacuated by the elevators. The signage indicates that passengers should not use elevators and car calls for other floors are disabled. The requirement was also reformatted for clarity and to remove language that is already addressed in the signal interface requirements of NFPA 72®. In addition, the revisions clarify that the expansion of the zone is due to additional alarms and only includes alarms in this group's discharge level. A requirement was added to provide status to the fire alarm system.

The Note for Requirement 2.27.11.5.1 was revised in ASME A17.1-2019/CSA B44:19 to clarify the term "active alarm" as it is used within the OEO requirements and to eliminate confusion with the initiating devices of 2.27.3.2. Since the code is performance-oriented, the objective for evacuation is stated without prescriptive interface requirements; therefore, the elevator system and fire alarm system installers need to coordinate their systems. An identical note appears in NFPA 72®, Appendix A.

Requirement 2.27.11.5.2 was revised in ASME A17.1-2019/CSA B44-19 to remove a requirement that is already addressed in NFPA 72® and add a Note (2.27.11.5.2) to provide guidance on where to find the location of the total building activation means.

2.27.11.6 Any system needs to keep occupants informed of current status, consistent with voice announcements, so occupants can make decisions whether to wait for an elevator or take stairs to egress. Format, resolution, message accuracy, and time estimates remain unspecified pending results of human

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factor studies to determine what information is most effective and, at the same time, feasible.

Requirement 2.27.11.6 was revised in ASME A17.1-2019/CSA B44:19 to clarify that the OEO requirements in this section apply to all elevators that serve floors in the evacuation zone, whether they are single elevators or in a group.

2.27.11.6.1 Requirement 2.27.11.6.1 was revised in ASME A17.1-2019/CSA B44:19 to use the term "elevator evacuation zone" to describe the block of floors to evacuate for consistency with revisions to 2.27.11.5 and to clarify the requirements for the estimated time display of the discharge level message sign . It is not possible to display the estimated time for the next car to arrive until the landing call has been placed because the car will not travel to the landing until there is demand. In some instances, elevators may not be available for use on OEO because they are being used for fire service or may be out of service, so the display needs to alert occupants to use the stairs. Additional revisions were made to clarify that the message must indicate when the estimated time is less than 1 min, and that the message is only based on elevators within a particular group. to clarify what message shall be displayed on each floor (discharge, evacuation, or other), and to distinguish the difference between "not available" and "out of service." References were added to the notes and examples were deleted to ensure that no modes of operation would be excluded. Also, updated terms for consistency as well as distinguish between building occupants and elevator passengers.

Requirement 2.27.11.6.1 was revised in ASME A17.1-2022/CSA B44:22 to update the example text in the Note. The updated example is more instructive to the occupants of the building, and once the button is pressed the appropriate ETA will also be displayed. The ETA is based on the current demand and can be used by occupants to assist in making a decision on whether to wait for the elevator or take the stairs.

2.27.11.6.2 Signals instruct passengers to exit quickly so that cars can return as expeditiously as possible to evacuation floor(s).

Requirement 2.27.11.6.2 was revised in ASME A17.1-2019/CSA B44:19 to clarify that the text height requirement only applies to the variable message sign and to update terms for consistency with other requirements in 2.27.11. A note was also added to provide example text for situations where the car stopped at either discharge or non-discharge levels.

2.27.11.6.3 Any hall call signal from an affected floor is an indication that someone is present and needs to be evacuated. Therefore, a car will be dispatched and person(s) taken to the elevator discharge level. For total building evacuation, occupants on the fire floor and adjacent floors are in the greatest danger and should receive service. Higher floors are next in priority to minimize time for total building evacuation, since occupants of those floors would have the longest stair evacuation time. As priorities change and new hall call signals are received, elevator cars should never be used to carry occupants to higher floors. Once an elevator stops and passengers enter, car travel should be only in the down direction. For buildings with unique layouts/populations, AHJs might approve alternative priority schemes.

Requirement 2.27.11.6.3 was reformatted and revised in ASME A17.1-2019/CSA B44:19 to for clarity and consistency. The revisions also allowed the use of performance-based dispatching (versus top down only) to maximize evacuation efficiency and added an exception if evacuations are occurring in conjunction with a seismic event. The previous Requirement 2.27.11.6.4 to override building security systems that limit service to some floors during OEO operation was incorporated into this requirement. Additional changes were made to clarify that travel direction is limited only with passengers and that answering additional landing call while passengers are in the car is permitted.

Requirement 2.27.11.6.2 was revised in ASME A17.1-2022/CSA B44:22 to revise nomenclature for ICC/ANSI A117.1 so that the entire ASME A17.1/CSA B44 document reflects the accurate characters used by both the referenced standard and ASME A17.1/CSA B44, Section 9.1.

2.27.11.6.4 The previous Requirement 2.27.11.6.4 was incorporated into Requirements 2.27.11.6.3 and 2.27.11.6.7 in ASME A17.1-2019/CSA B44:19.

2.27.11.6.5 After the first group is evacuated, the elevators will go back to the fire floor or to the other floors being evacuated based on entered hall calls. Note that landing calls at any of the affected floors will end this "parked with doors closed" period.

Requirement 2.27.11.6.5 was revised in ASME A17.1-2019/CSA B44:19 to clarify the operation of the elevator car when OEO is initiated and there are no active car calls. When no calls are active and the elevator is at a landing it is required to travel to and park within the evacuation zone with the doors closed. If the car is traveling away from the evacuation zone and no calls are active it is required to reverse direction and return to the evacuation zone and park with the doors closed. In both scenarios the door open button must remain operational.

2.27.11.6.6 While people might have been headed for non-fire-involved floors, they are still safer outside the building because the fire could grow. Firefighters' have stated that the fewer people in the building, the better.

Requirement 2.27.11.6.6 was revised in ASME A17.1-2019/CSA B44:19 to clarify the operation of the elevator car when OEO is initiated and there is an active car call. When OEO is initiated with an active car call and the car traveling away from the discharge level, it is required to reverse direction and return to the discharge level. After opening and closing the doors to allow passengers to exit, the elevator shall travel to the evacuation zone to respond

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to calls or park within the zone with the doors closed and the door open button operational.

2.27.11.6.7 Traditional dispatch systems will send only a single car at a time to answer a hall call, which will slow the evacuation process. This requirement brings more than one car at a time to the floor if there are calls indicating people are waiting. Destination systems will routinely send multiple cars if enough calls are entered to indicate demand exceeds single-call capacity.

Requirement 2.27.11.6.7 was revised in ASME A17.1-2019/CSA B44:19 to update terms for consistency with other sections of 2.27.11 and to clarify that pushing the landing control at a floor in the evacuation zone should not prevent a loaded car from departing the floor. For modern dispatching algorithms, call allocation to cars is optimized based on many variables, and there is no need to specify how to allocate new call demand or when to dispatch additional cars to a floor. The revisions also allow new technology to be used for allocating elevator service to a landing based on the number of people waiting at the landing.

2.27.11.6.8 For evacuation to proceed quickly, cars should be well loaded, without delay caused by overloading and then unloading. Closing doors will limit some of the debate about whether or not one more person can squeeze in. The trigger point for closing the doors is provided as a maximum amount to give flexibility to manufacturers due to inaccuracies of typical load-measuring devices and to suit building conditions.

Requirement 2.27.11.6.8 was revised in ASME A17.1-2019/CSA B44:19 to update the terms for consistency with other changes and to provide a range of 60% to 80% of capacity to prevent overloading the elevator. At 100% capacity, doors are prevented from closing and voice notification is provided to prevent overloading the elevator. The door stalling sentence was deleted because the reduced kinetic energy requirements (nudging) are covered in 2.13.4.2.1. Additional requirements were added to clarify for when the audible signal is to actuate (i.e., nudging). A note was also added to provide sample text for when an elevator is overloaded during OEO operation.

2.27.11.6.9 Standard emergency evacuation strategies are for people in the rest of the building to stay where they are until the firefighters evaluate the situation. Firefighters can still initiate total building evacuation if warranted.

Requirement 2.27.11.6.9 was revised in ASME A17.1-2019/CSA B44:19 to update the terms for consistency with other changes and to clarify the parking requirements. The parking floor was changed to a floor within the zone because all elevator lobbies are safe as no FAID has initiated Fire Phase I Recall. This allows for better positioning of parked cars, if possible, based on additional building population information.

2.27.11.6.10 Smoke detection in an elevator lobby, machine room, or hoistway shuts down OEO.

Requirement 2.27.11.6.9 was revised in ASME A17.1-2019/CSA B44:19 to clarify that the requirements for termination of OEO apply to the group or to a single elevator that is not in a group.

2.27.12 Emergency Responder Radio Coverage Equipment Inside Cars

Section 2.27.12, including subsections 2.27.12.1 and 2.27.12.2, was added in ASME A17.1-2022/CSA B44:22 to provide general requirements and limitations for components of emergency responder radio coverage (ERRC) systems that can be installed on the elevator car enclosure. See also Handbook commentary on 2.8.7.

Requirement 2.27.12.3 was added in ASME A17.1-2022/CSA B44:22 to provide specific requirements and restrictions for ERRC antennas when installed in the elevator car. See also Handbook commentary on 2.8.7.

Requirement 2.27.12.4 was added in ASME A17.1-2022/CSA B44:22 to provide specific requirements and restrictions for ERRC repeater units when installed in the elevator car. See also Handbook commentary on 2.8.7.

Requirement 2.27.12.5 was added in ASME A17.1-2022/CSA B44:22 to allow authorized personnel to access ERRC equipment under prescribed conditions. See also Handbook commentary on 2.8.7.

2.27.13 Flood Detection Operation

Section 2.27.13, including subsections 2.27.13.1 through 2.27.13.4, was added in ASME A17.1-2022/CSA B44:22 to provide a flood detection means and Flood Detection Operation to meet the requirements of ASCE/SEI 24. Allowing an elevator car or other equipment to descend into flood waters can endanger passengers and damage equipment.

The requirements ensure that the cars recall to a level above the minimum safe elevation determined by ASCE/SEI 24 or the highest available landing. For jurisdictions not enforcing the NBCC, the alternate level is used for proper interaction with Firefighters' Emergency Operation. The system is required to cancel any landing or car calls that could cause the elevator car or the counterweight to descend below the designated flood elevation. Audible and visual signals are required inside the car and at inspection operating stations to alert passengers and elevator personnel during a flood event. Flood Detection Operation must remain active until it is manually reset by elevator personnel.

The added requirements also ensure that the Flood Detection Operation interacts properly with Inspection Operation, Hoistway Access Operation, Earthquake Emergency Operation, and Occupant Evacuation Operation and does not allow the car or other equipment to descend below the designated flood elevation.

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Chart 2.27(a)
Excerpts From NFPA 72®-2022 Handbook: Fire Service Access Elevators

21.5* Fire Service Access Elevators.

Where one or more elevators are specifically designated and marked as fire service access elevators, temperature and presence of smoke in elevator lobbies, machine rooms, control rooms, machinery spaces, or control spaces shall be continuously monitored and displayed on a building fire alarm system annunciator(s), or other annunciator(s) as approved by the authority having jurisdiction.

Section 21.5 was rewritten in a previous edition of the Code to include and simplify the requirements that had previously been in multiple subsections.

In a typical building with more than one story or in a high rise with many stories, tenants, occupants, and visitors use elevators daily. In the elevator lobby, one pushes a call button, the elevator arrives and its doors open; upon entering the elevator, one pushes the appropriate floor indicator button, which causes the doors to close and the elevator to begin its travel and ultimately arrive at the requested floor. Use in this manner becomes the norm and the expectation.

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Chart 2.27(a)
Excerpts From NFPA 72®-2019 Handbook: Fire Service Access Elevators (Cont'd)

NFPA 72 addresses how elevator use changes in a fire emergency. Ordinarily, Elevator Phase I Emergency Recall Operation is in place as required by ASME A17.1/CSA B44. A series of smoke detectors monitor specific areas related to elevators to ensure these areas remain tenable during a fire event. Smoke detectors monitor the elevator lobby on each floor of the building covered by the elevator, the elevator machine room controlling that elevator(s), and the elevator hoistway. There could be a number of elevators serving the same elevator lobby. This group of elevators would have common lobby detection and a common elevator machine room. If another automatic detector in the building not associated with elevator recall should activate, the elevators would continue to operate normally to move people from floor to floor in the building. An alarm from one of these other devices normally will cause a voice communication message to be delivered on various floors of the building advising persons not to use the elevators but to use the exit stairs.

At the point in the fire event when smoke is detected in an elevator lobby, elevator machine room controlling that elevator(s), or elevator hoistway, that elevator or group of elevators serving the same lobby will be "captured" and immediately dispatched to the designated level. The designated level is established previously by the fire department as the most logical level where emergency responders will typically arrive in the emergency based on factors such as building use and access by emergency vehicles. (See the FAQ following 21.3.14 to see how the designated and alternate levels are determined.) Captured elevators will immediately travel to the designated level and remain there with their doors open.

Arriving emergency responders can use a FEO-K1 key and override the captured elevator(s) and continue to use it (them) to shuttle fire fighters and equipment to fire-safe floors below the emergency level. Note that there are inherent risks associated with this use. The fire department will determine the point at which elevators need to be abandoned and will cease use if the emergency continues to escalate.

FSAEs are being incorporated as part of many new building designs. *NFPA 5000®*, *Building Construction and Safety Code®*, requires that buildings with an occupied floor higher than 120 ft (36.6 m) above the lowest level of fire department vehicle access must have at least two FSAEs. There are many requirements for the design, installation, and marking of the FSAE system. These include the following:

- Minimum 3500 lb (1590 kg) capacity
- Service to every floor in the building
- Direct access from FSAE lobby to an exit stair enclosure
- Smoke barrier having a minimum 1-hour fire resistance rating
- Lobby door assemblies having not less than a 3/4-hour fire protection rating
- Each exit stair having direct access to the FSAE lobby to have standpipe hose connection
- Elevator system monitoring
- Both normal power and Type 60/Class 2/Level 1 standby power
- 1-hour fire resistance rating for protection of wiring or cables
- No sprinklers whatsoever in the elevator machine rooms and machinery spaces
- FSAE symbol for identification and an approved method to prevent water from infiltrating the hoistway enclosure

Because FSAEs have all these requirements, they are more robust than traditional elevator systems. The design enables the elevator system to be usable for longer than a traditional elevator in a fire emergency, and it enables greater fire fighter use for staging to fight the fire and enable increased assisted evacuation for persons who cannot easily self-evacuate. In some installations, FSAEs are in reserve and used exclusively for emergency responders.

NFPA *101®*, *Life Safety Code®*, requires special structures and high-rise buildings to be provided with an emergency command center (i.e., fire command center). Among other things, the emergency command center is required to contain the voice fire alarm system panels and controls, fire department

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Chart 2.27(a)
Excerpts From NFPA 72®-2019 Handbook: Fire Service Access Elevators (Cont'd)

two-way telephone communication service panels and controls (where required), elevator floor location and operation annunciators, elevator fire recall switch in accordance with ASME A17.1/CSA B44, and an elevator emergency power selector switch(es) where provided in accordance with ASME A17.1/CSA B44.

The status of all elevators must be provided, but this information is not required to be monitored or displayed by the fire alarm system.

A.21.5 The continuous monitoring of smoke and temperature is to allow the responding fire fighters to know when the tenability conditions at the floor elevator lobbies are changing. This can be accomplished at a minimum by monitoring elevator lobbies, machine rooms, control rooms, machinery spaces, or control spaces smoke detector(s) for the presence of smoke and a minimum of three ranges of temperature in the elevator lobbies, machine rooms, machinery spaces, or control rooms that provide full bodily access for fire fighters, as follows:

(1) Normal ≤90°F (32°C)
(2) Monitoring (supervisory) between 90°F (32°C) and 135°F (57°C)
(3) Unsafe (alarm) above 135°F (57°C)

Indications at the fire alarm control unit would typically be as follows:
For smoke:

(1) No indication for normal
(2) Red/alarm messaging or unsafe

For heat:

(1) Green (no indication on fire alarm control unit) for a normal range
(2) Amber/yellow/supervisory messaging for monitor range
(3) Red/alarm messaging for unsafe

Note 1: Temperature monitoring should not be required in areas or locations not accessible to fire fighters, such as elevator control spaces and elevator machinery spaces located inside the elevator hoistway.
Note 2: If fire service access elevators or occupant evacuation elevators are provided in buildings not provided with a fire command center or emergency command center, such as low-rise buildings, the required annunciator(s) should be installed in another approved location as determined by the authority having jurisdiction.

In most cases, a separate annunciator would be recommended to provide an overall status of the elevator lobbies, machine rooms, or control rooms that provide full bodily access for fire fighters in the building.

The lowest temperature defined in Table 17.6.2.1, Temperature Classification and Color Code for Heat-Sensing Fire Detectors, is 100°F (38°C), so a thermostat or other approved heat sensor(s) should be used to monitor temperatures less than 100°F (38°C).

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Chart 2.27(b)
Excerpts From NFPA 72®-2022: Occupant Evacuation Elevators

21.6* Occupant Evacuation Elevators (OEE).

This section pertains to OEEs, which enter occupant evacuation operation (OEO) during a fire event. In buildings with traditional elevator systems, elevators typically recall upon activation of an elevator lobby detector, machine room detector, or elevator hoistway detector. The activation of an automatic detector in a typical high-rise building normally will cause a voice communication message to be delivered on various floors of the building advising persons to use the exit stairs instead of the elevators.

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Chart 2.27(b)
Excerpts From NFPA 72®-2022: Occupant Evacuation Elevators (Cont'd)

Elevators designated as OEEs are more robust than traditional elevator systems. Most current building codes allow OEEs, but only when many conditions have been satisfied (refer to Section 7.15 of NFPA *101*).

OEO functions before Elevator Phase I Emergency Recall Operation. OEEs enable occupants to continue to use elevators during a fire event until Elevator Phase I Emergency Recall Operation occurs, which is activated by a smoke detector in an elevator lobby, in the elevator machine room controlling that elevator(s), or in the elevator hoistway. Where Elevator Phase I Emergency Recall Operation occurs, elevators are captured and dispatched to the designated level where they remain with their doors open.

For traditional and OEE systems, every elevator lobby/landing is provided with an appropriate call button(s). A tenant, occupant, or visitor in an elevator lobby/landing will push an elevator call button. The elevator arrives, the doors open, the person steps into the elevator and depresses the floor button to which they wish to travel. The doors close and the elevator begins its travel and ultimately arrives at the requested floor.

For the traditional elevator system, if smoke is detected in an elevator lobby, elevator machine room controlling that elevator, or elevator hoistway, that elevator or group of elevators serving the same lobby/landing will be captured and dispatched immediately to the designated level. An alarm from one of these devices normally will cause a voice communication message to be delivered on various floors of the building advising persons to use the exit stairs instead of the elevators.

For OEEs, if smoke is detected in an elevator lobby, elevator machine room controlling that elevator, or elevator hoistway, that elevator or group of elevators in the same lobby will be captured and dispatched to the designated level.

If smoke is detected by activation of other automatic detectors in the building (i.e., detectors that do not initiate Elevator Phase I Emergency Recall Operation), elevator use continues in OEO mode. OEO is a complicated combination of fire alarm and elevator system actions and interactions. Both systems work together in OEO mode to provide prioritized evacuation of occupants from the fire floor and surrounding floors. Due to the history of prohibiting elevator use during a fire event, the fire alarm and elevator systems are required to provide coordinated, clear, and frequent communication to building occupants with up-to-date and accurate information regarding whether they should evacuate and whether they should use the stairs or the elevators.

Section 21.6 prescribes the fire alarm system interface requirements with the elevator system and the information provided to the occupants concerning the availability of the elevator(s) during the fire emergency. The interface requirements for such elevators are outlined in Section 2.27 of ASME A17.1/CSA B44.

Section 7.15 of NFPA *101* outlines requirements "where passenger elevators for general public use are permitted to be used for occupant evacuation prior to Phase 1 Emergency Recall Operation." This section of NFPA *101* covers requirements for the following:

- Emergency action plan
- Signage
- Monitoring and display of conditions necessary for the safe operation of the elevator at the building emergency command center
- Status indicators in elevator lobbies
- Fire detection, alarm, and communications system
- Sprinkler system
- Construction/protection for the elevator cars, hoistways, machine rooms, and electrical power and control wiring

Additionally, there are specific requirements for elevator lobby size.

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Chart 2.27(b)
Excerpts From NFPA 72®-2022: Occupant Evacuation Elevators (Cont'd)

NFPA *101* does not permit sprinklers to be installed in elevator machine/control rooms or machinery/control spaces and at the top of elevator hoistways for OEEs. Sprinklers, if installed in the hoistway, are permitted to be installed only if they are located 24 in. (610 mm) or less above the pit floor. Additionally, shunt trip breakers are not permitted to be installed on OEEs. Annex material for Section 7.15 of NFPA *101* explains that the exclusion of a shunt trip breaker is not in violation of the power shutdown requirements of ASME A17.1/CSA B44 because sprinklers are not permitted to be installed in elevator machine/control rooms, machinery/control space rooms, or at the top of elevator hoistways, and that sprinklers in the hoistway cannot be more than 24 in. (610 mm) above the pit floor. ASME A17.1/CSA B44 does not include similar language prohibiting elevator power shutdown for OEO elevators.

The following excerpt from NFPA *101* specifies the fire detection, alarm, and communications requirements that apply when elevators for occupant-controlled evacuation are used:

NFPA *101* (2021)

7.15.4 Fire Detection, Alarm, and Communication.

7.15.4.1 The building shall be protected throughout by an approved fire alarm system in accordance with Section 9.6.

7.15.4.2* The fire alarm system shall include an emergency voice/alarm communication system in accordance with *NFPA 72* with the ability to provide voice directions on a selective basis to any building floor.

A.7.15.4.2 The emergency voice/alarm communication system with the ability to provide voice directions on a selective basis to any building floor might be used to instruct occupants of the fire floor who are able to use stairs to relocate to a floor level below. The selective voice notification feature might be used to provide occupants of a given elevator lobby with a status report or supplemental instructions.

7.15.4.3* The emergency voice/alarm communication system shall be arranged so that intelligible voice instructions are audible in the elevator lobbies under conditions where the elevator lobby doors are in the closed position.

A.7.15.4.3 An audible notification appliance will need to be positioned in the elevator lobby in order to meet the requirement of 7.15.3.4. The continued use of the occupant evacuation elevator system is predicated on elevator lobby doors that are closed to keep smoke from reaching the elevator lobby smoke detector that is arranged to initiate the Phase I emergency recall operation.

7.15.4.4 Two-way Communication System. A two-way communication system shall be provided in each occupant evacuation elevator lobby for initiating communication with the fire command center or an alternative location approved by the fire department.

7.15.4.4.1 Design and Installation. The two-way communication system shall include audible and visible signals and shall be designed and installed in accordance with the requirements of ICC A117.1, *Accessible and Usable Buildings and Facilities.*

7.15.4.4.2 Instructions.

7.15.4.4.2.1 Instructions for the use of the two-way communication system, along with the location of the station, shall be permanently located adjacent to each station.

7.15.4.4.2.2 Signage for instructions shall comply with the requirements of ICC A117.1, *Accessible and Usable Buildings and Facilities*, for visual characters.

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Chart 2.27(b)
Excerpts From NFPA 72®-2022: Occupant Evacuation Elevators (Cont'd)

A.21.6 Refer to the applicable building code for application requirements and definitions related to occupant evacuation elevators (OEE). OEE are not required by code, and they will be provided for a relatively limited number of buildings, mainly office use high-rise buildings over 420 ft (128 m) in lieu of a required additional stairway as a building code exception. They could also be provided on a voluntary basis in other buildings due to ADA or mobility of occupants concerns. It is highly recommended that those involved with design and installation of these systems become familiar with available information such as ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, Section 2.27, regarding occupant evacuation operation (OEO) and its nonmandatory Appendix V, "Building Features for Occupant Evacuation Operation." It will be imperative that a great amount of coordination and performance-based design be done between elevator and fire alarm system designers, installation contractors, and the authority having jurisdiction.

Figure A.21.6 demonstrates the basics of OEO. This is a simplified flowchart and is not intended to show all required inputs, outputs, or interfaces. This figure demonstrates some functions that are dictated by ASME A17.1/CSA B44 for reference only. Inclusion of elevator system operations in this figure is not intended to suggest that the fire alarm system is responsible for the feature.

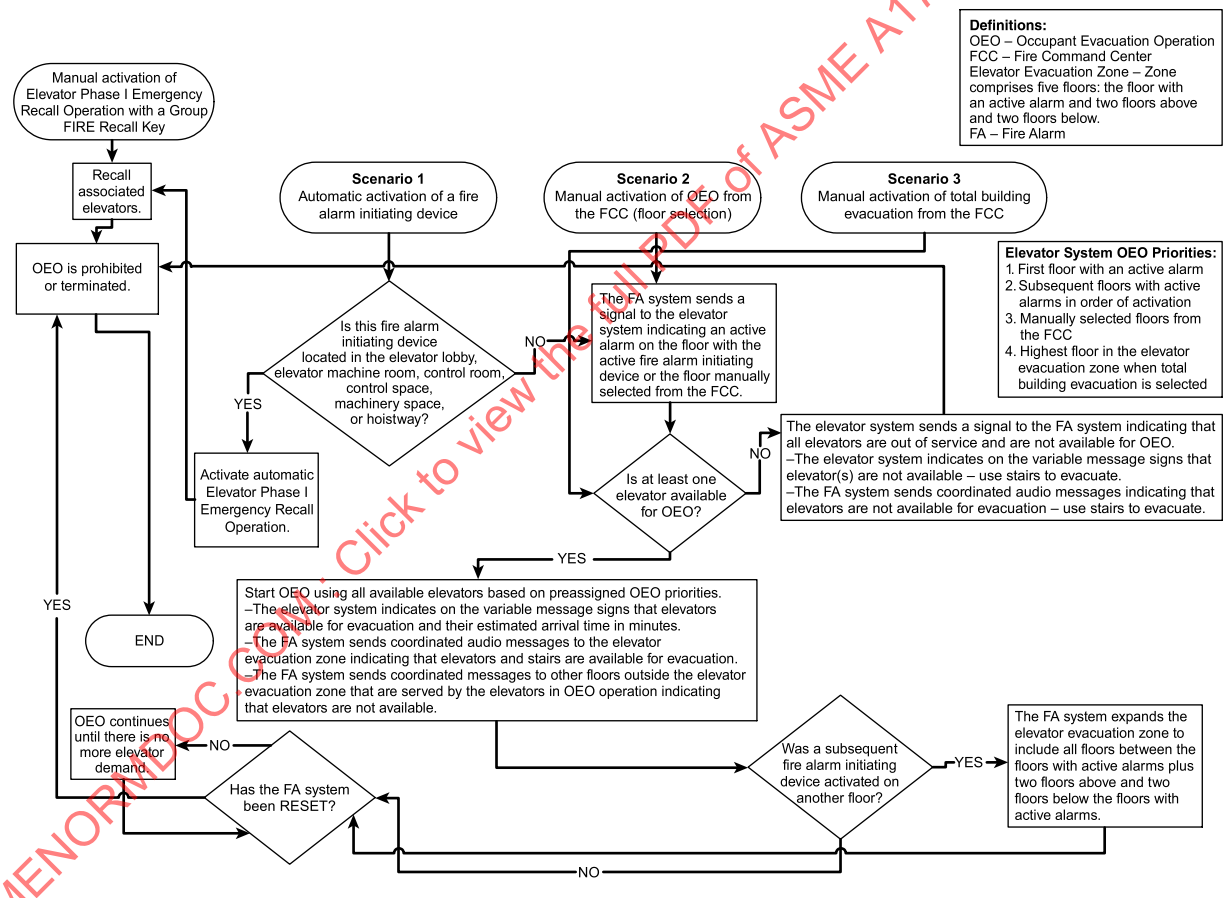


FIGURE A.21.6 *Simplified Occupant Evacuation Operation (OEO) (Elevator system interface with the building fire alarm system based on ASME A17.1/CSA B44, Section 2.27.11, and NFPA 72, Section 21.6).*

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Chart 2.27(b)
Excerpts From NFPA 72®-2022: Occupant Evacuation Elevators (Cont'd)

21.6.1 Elevator Status. Where elevators are to be used for occupant self-evacuation during fires and non-fire emergencies, they shall comply with Sections 21.5 and 21.6.

21.6.2 Occupant Evacuation Operation (OEO). Outputs from the fire alarm system to the elevator system shall be provided to implement elevator occupant evacuation operation in accordance with Section 2.27 of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, as required in 21.6.2.1 through 21.6.2.5.

If smoke is detected by activation of other automatic detectors in the building (i.e., detectors that do not initiate Elevator Phase I Emergency Recall Operation), elevator use continues in OEO mode.

OEO is activated by signals from the fire alarm system to the elevator system. The floors for evacuation are contiguous floors and consist of the actual floor of alarm, two floors below the floor of alarm, and two floors above the floor of alarm. The fire alarm system normally will cause a voice communication message to be delivered to these five contiguous floors with a message that elevators and stairs are available for evacuation.

As part of the elevator system, a scrolling message sign provided in each elevator lobby of the five contiguous floors will indicate that the elevators are available for evacuation and the estimated time duration in minutes for the next elevator car to arrive. The sign in each elevator lobby of the five contiguous floors will display, "Elevators and stairs available for evacuation. Next car in about X minutes." The sign in each elevator lobby of all other floors will display, "Elevators temporarily dedicated to other floors." The sign in the designated elevator lobby will display, "Elevators dedicated to evacuation. Do not enter elevator."

While in OEO mode, the elevators will stop only at the designated level and the five contiguous floors identified by the fire alarm system to the elevator system. An occupant depressing a call button on any floor other than the five contiguous floors will be ignored. If the active alarm is on the elevator discharge level, automatic initiation of OEO is not possible.

When the fire alarm system and elevator system activate OEO mode, any car that is occupied, whether it is moving up or down, will proceed to the designated level to discharge its passengers. The doors will close and the elevator will ignore all call buttons, responding only to call buttons of the contiguous five floors. In this manner, the elevator will proceed to one of the contiguous floors as announced by the message sign that displays the estimated time duration in minutes to arrival. If a call button is not depressed at one of the five contiguous floors, the elevator will park at one of these floors with its doors closed until a call is registered.

While in OEO mode, the elevators will shuttle passengers between the five contiguous floors and the designated level only. All other floor call buttons will be ignored. The scrolling message sign in all other floor elevator lobbies will display, "Elevators temporarily dedicated to other floors." When all occupants have been shuttled to the designated level determined by a 60-second period of call button inactivity from the five contiguous floors, the elevator system will park one car at the lowest of the five contiguous floors with its doors closed, ready to respond to another call button from one of the five contiguous floors, while all other elevators will park at the designated level with their doors open.

At any time during the event, if another alarm is received at the fire alarm system due to another automatic detector in the building (i.e., a detector that does not initiate Elevator Phase I Emergency Recall Operation), the fire alarm system will expand the continuous block of floors from the five floors to the new activated device plus two floors above or below as appropriate. (See 21.6.2.3.4.) OEO will continue including the new contiguous block. A revision to 21.6.2.4.4 in the 2022 edition more clearly permits, as an alternative to 21.6.2.3.4, the authority having jurisdiction to add a single floor to an OEO group.

If Elevator Phase I Emergency Recall Operation is initiated at any time during OEO by a lobby smoke detector, a detector in the elevator machine room controlling that elevator(s), or a detector in the elevator hoistway, OEO ceases. The elevators are captured and dispacted to the designated level where they remain with doors open.

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Chart 2.27(b)
Excerpts From NFPA 72®-2022: Occupant Evacuation Elevators (Cont'd)

21.6.2.1 Applicability. OEO shall only be initiated upon an automatic or manual signal from the fire alarm system to the elevator system.

This clarifies that the fire alarm system is responsible for causing the elevator system to enter OEO mode.

21.6.2.1.1* OEO shall apply separately to each individual elevator and to elevators having *group automatic operation* or designated as an *elevator group* or *group of elevators.*

A.21.6.2.1.1 The term *group automatic operation* is defined in ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*. Other terms such as *elevator group* or *group of elevators* are used in Section 26.6 to refer to those elevators sharing a common landing call operation. For instance, if an elevator landing call is registered on a particular floor, any elevator that could respond to that call would be considered in that elevator group. Elevators in an *elevator group* typically share a lobby, hoistway, and/or machine/control room or control space.

It is critical for the purpose of OEO (and all elevator emergency control function interfaces) to identify each elevator group and design the fire alarm system interface accordingly. In tall buildings where OEEs would typically be specified, it is common for elevator groups to be offset, requiring occupant transfer from one group to another to traverse the entire height of the building in an elevator.

21.6.2.1.2* OEO shall function per 21.6.2.1.1 only prior to Elevator Phase I Emergency Recall Operation.

A.21.6.2.1.2 When OEO is actuated either manually or automatically, it is applicable to all elevators serving the floors of the elevator evacuation zone. However, when a single elevator or elevator group is placed on manual Elevator Phase I Emergency Recall Operation, OEO continues to operate for the other elevator groups serving the elevator evacuation zone. Similarly, when a fire alarm initiating device(s) described in 21.3.14.1 and 21.3.14.2 is actuated, Elevator Phase I Emergency Recall Operation will cause recall only to the elevator group and not to all elevators in the elevator evacuation zone not associated with that group of recalled elevators. See also 21.6.2.8.

This section reiterates that elevator recall cancels OEO for the affected elevator group. Note that elevator recall only affects the designated group. Depending on the elevator group arrangement, this can result in complicated messaging on floors served by multiple elevator groups.

21.6.2.2 Partial Building Evacuation. Where an elevator or group of elevators is designated for use by occupants for self-evacuation, the provisions of 21.6.2.3 through 21.6.2.6 shall apply for partial building evacuation.

Δ **21.6.2.3 Initiation.** OEO shall be initiated by either manual means from the Fire Command Center or Emergency Command Center in accordance with 21.6.2.4 or by actuation of an automatic fire alarm initiating device in accordance with 21.6.2.3.1.

21.6.2.3.1* An active automatic fire alarm initiating device that does not initiate Elevator Phase I Emergency Recall Operation shall cause the fire alarm system to provide a signal to the elevator system indicating the floor of an active alarm, except as prohibited by 21.6.2.3.6.

A.21.6.2.3.1 This signal to the elevator system is caused by the activation of a fire alarm initiating device other than that which is described in 21.3.14.1 and 21.3.14.2.

21.6.2.3.2* The floors to be evacuated shall be a contiguous block of floors designated as "the elevator evacuation zone" consisting of at least the floor with an active alarm, two floors above the floor with the active alarm, and two floors below the floor with the active alarm.

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Chart 2.27(b)
Excerpts From NFPA 72®-2022: Occupant Evacuation Elevators (Cont'd)

A.21.6.2.3.2 The elevator evacuation zone would typically be the floor of an active alarm plus two floors above and two floors below the floor with the active alarm for a total of five floors or as otherwise determined by the authority having jurisdiction.

21.6.2.3.3* When the floor designated as the elevator discharge level falls within the elevator evacuation zone, it is not to be evacuated by the elevator(s), and the fire alarm system shall initiate a voice message to instruct the occupants on that level to exit the building.

A.21.6.2.3.3 The elevator discharge level is considered the same level as the designated level of elevator recall for an individual elevator or a group of elevators. More than a single elevator discharge level can exist in a building

Messaging to occupants on the designated level must be carefully considered when an elevator group designated level is at a level other than the level of exit discharge.

21.6.2.3.4 If activation of an automatic fire alarm initiating device that does not initiate Elevator Phase I Emergency Recall Operation occurs on an additional floor(s), including the elevator discharge level at any time while OEO is in effect, the elevator evacuation zone shall be expanded to include all floors with an active alarm, all floors between the highest and lowest floor with an active alarm, plus two floors above the highest floor with an active alarm and two floors below the lowest floor with an active alarm.

21.6.2.3.5 If the first active alarm is on the elevator discharge level, automatic initiation of OEO shall not be permitted for all elevators having that same elevator discharge level.

21.6.2.3.6* When the first active alarm is on an elevator discharge level, the fire alarm system shall not send a signal to the elevator system for that alarm or any other active alarm that does not initiate Elevator Phase I Emergency Recall Operation for that group of elevators.

A.21.6.2.3.6 If there are different elevator discharge levels in the building, then separate signals from the fire alarm system should be sent to each elevator group serving the active alarm floors to allow for OEO operation of those elevators when the alarm is not at the elevator discharge level. The fire alarm system should not send signal(s) to the elevator system to initiate OEO for a group of elevators when the first active alarm is at the discharge level for that group. Subsequent active alarms at any levels should not cause the fire alarm system to send signal(s) to the elevator system to initiate OEO for that group of elevators. When the first active alarm is not on the discharge level, the fire alarm system should send signals to the elevator system to initiate OEO for that group of elevators and all subsequent active alarms, including at the elevator discharge level.

21.6.2.4* Manual Floor Selection.

A.21.6.2.4 The manual selection means such as a switch or a push button for each floor is intended in lieu of automatic initiating devices that could be impaired or out of service and would otherwise have actuated to provide automatic initiation in accordance with 21.6.2.3. Manual fire alarm boxes are not included because they are typically actuated at locations remote from the fire. The manual selection means could also serve to evacuate the building or portions of the building for non-fire-related emergencies. The manual selection means is required to provide a maintained nonlatching output(s) from the fire alarm system to the elevator system to prevent the need for fire alarm system reset upon a wrong or unwanted manual selection of a floor(s).

Authorized or emergency personnel are permitted to use a manual initiation means to initiate OEO. The manual means would need to stipulate the floor selected as the alarm floor; the programming would then create the five contiguous floors as the floor of alarm, two floors above, and two floors below, or by a single floor as permitted by 21.6.2.4.4.

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Chart 2.27(b)
Excerpts From NFPA 72®-2022: Occupant Evacuation Elevators (Cont'd)

21.6.2.4.1 A means shall be furnished at the Fire Command Center or the Emergency Command Center to provide for the manual selection of each floor in the building.

21.6.2.4.2 The manual floor selection shall be actuated only by authorized or emergency personnel.

21.6.2.4.3 When OEO is not yet in effect and a manual floor selection is made to initiate OEO, a signal shall be sent to the elevator system simulating an active alarm for that floor.

21.6.2.4.4 When OEO is in effect and a manual floor selection is made, the elevator evacuation zone shall be permitted by the authority having jurisdiction to be expanded as described in 21.6.2.3.4 or by adding that floor to the evacuation zone.

Paragraph 21.6.2.4.4 was revised for the 2022 edition that provided clearer, more permissive language that the authority having jurisdiction is permitted to use 21.6.2.3.4 or 21.6.2.4.4 when expanding the floors included in OEO.

21.6.2.4.5 Each manual selection means shall have the capability to cancel a manually actuated output signal.

21.6.2.5* Fire Alarm Output Signals to Elevator System.

A.21.6.2.5 The fire alarm system uses the floor identification to automatically establish an elevator evacuation zone for voice messaging purposes. The elevator system also uses the floor identification to determine the contiguous block of floors to be evacuated (elevator evacuation zone, see A.21.6.2.3.2). The elevator evacuation zone is updated to reflect changing conditions as indicated by the output signal(s). This information is sent to the elevator system and also used for occupant notification. The output signals from the fire alarm system can be in the form of contact closures or serial communications or other approved means. Coordination needs to be provided between the fire alarm system installer, the elevator system installer, and the authority having jurisdiction.

21.6.2.5.1 Output from the fire alarm system to the elevator system shall identify each floor with an actuated automatic fire alarm initiating device.

21.6.2.5.2 Output from the fire alarm system to the elevator system shall include the following:

(1) Floor(s) with any actuated fire alarm initiating device(s)
(2) Floor(s) selected by manual means from the Fire Command Center or the Emergency Command Center

Δ **21.6.2.5.3** The identified floor(s) and all other associated floors comprising the elevator evacuation zone shall be displayed on the building fire alarm system annunciator or on a listed non-fire alarm system annunciator or other annunciator as approved by the authority having jurisdiction.

N **21.6.2.5.4** The annunciator referenced in 21.6.2.5.3 shall be located at the Fire Command Center or Emergency Command Center.

The 2022 edition of the Code expanded the existing requirements related to the display of floors comprising the elevator evacuation zone. In 21.6.2.5.3, in addition to the identified floor(s) in OEO, all other associated floors that might be a part of the OEO must also be indicated on the annunciation equipment. In 21.6.2.5.4, which is new for 2022, the floors must be displayed on an annunciator that is located either in the fire command center or in the emergency command center. It is at these two locations

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Chart 2.27(b)
Excerpts From NFPA 72®-2022: Occupant Evacuation Elevators (Cont'd)

that fire command personnel would be operating during an emergency incident. Decisions related to evacuation would be made by command personnel, and their knowledge of the availability of elevators operating in OEO may affect their evacuation orders.

21.6.2.6* Occupant Notification. The in-building emergency voice/alarm communications system shall transmit messages coordinated with the elevator system's variable message signs in all elevator lobbies.

A.21.6.2.6 Prerecorded automatic voice messages provided by the in-building fire emergency voice/alarm communications system need to be coordinated with the variable message signs provided separately by the elevator system to all affected elevator lobbies and floors served by the elevator(s) operating in OEO so that occupants will understand what to expect and how to react. Additional visual information will be provided in each affected elevator lobby by the elevator system to further inform occupants of the status of the elevators. Refer also to 24.3.6 and associated Annex A material (Messages for One-Way Emergency Communications Systems) for additional information. It is important to note that all elevator lobbies served by elevator(s) operating in OEO, both within the elevator evacuation zone and on other floors outside that zone, will be considered as affected lobbies, and they will be provided with variable messages controlled by the elevator system. The fire alarm system will not provide automatic voice messages in the affected elevator lobbies, but rather it will provide automatic messages to all floors having those affected lobbies via audible appliances located outside those lobbies. The messages provided by the fire alarm system and the elevator system on the affected floors and lobbies must be coordinated so as not to conflict with each other. It is especially important to address additional automatic or manual alarm actuation(s) and the impact on expanding the elevator evacuation zone and the corresponding voice messaging that has to adjust to the change. Table A.21.6.2.6 gives sample voice message content to be added to normal messaging (to be coordinated with the variable message display provided by the elevator contractor). Voice messaging is permitted to all other floor(s) in the building not in the elevator evacuation zone and not served by elevator(s) performing OEO in accordance with the facility emergency response plan approved by the authority having jurisdiction. For further information on voice messaging strategies refer to NIST Technical Note 1779, *General Guidance on Emergency Communication Strategies for Buildings* and *FPRF Elevator Messaging Strategies*.

TABLE A.21.6.2.6 *Sample Voice Message Content*

Condition	*Sample Voice Message*
Specific block of floors being evacuated	"Elevators and stairs are available for evacuation."
Floors not in the elevator evacuation zone within an elevator group performing OEO	"Elevators are not available; they are temporarily dedicated to other floors."
On the discharge level	"Elevators are dedicated to evacuation. Do not enter elevator."
If some elevators have been recalled but other elevator(s) are still available	"Elevators and stairs are available for evacuation."
If all elevators serving a floor or elevator evacuation zone are recalled	"Elevators are out of service. Use stairs to evacuate."

21.6.2.6.1 Automatic voice evacuation messages shall be transmitted to the elevator evacuation zone floors to indicate the need to evacuate and that elevator service is available.

21.6.2.6.2 Automatic voice messages shall be transmitted to the floors that are not in the elevator evacuation zone and are served by the group, to inform occupants that elevator service is not available.

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Chart 2.27(b)
Excerpts From NFPA 72®-2022: Occupant Evacuation Elevators (Cont'd)

Automatic voice messages are required to be sent to every floor served by the affected elevator group to ensure that all occupants who may call an elevator are provided accurate and proactive communication in a fire event where their elevators are not available for use.

21.6.2.6.3* Automatic voice messages shall be transmitted to the floors in the elevator evacuation zone when no elevators serving that elevator evacuation zone are available.

A.21.6.2.6.3 This new message will require a signal(s) from the elevator system to the fire alarm system. This signal(s) will indicate to the fire alarm system that all elevators serving an elevator evacuation zone are not available due to Elevator Phase I Emergency Recall Operation or due to other elevator condition(s) such as inspection, operation, and malfunction.

21.6.2.6.4* Where required by other governing laws, codes, or standards, the emergency voice/alarm communications system's loudspeaker(s) located in each OEE lobby shall be connected to a separate notification zone for manual paging only.

A.21.6.2.6.4 The emergency voice/alarm communications system's loudspeaker(s) located in each OEE lobby are not permitted to transmit automatic voice messages since they could interrupt occupants using the required OEE elevator lobby two-way communication system. Therefore, manual paging zones are required for those loudspeakers by applicable building code(s). The specific zone selection will be performed from a fire alarm system paging panel located in the Fire Command Center. Since a very large number of individual paging zones could be required, it is permitted to group all OEE lobbies' loudspeakers per floor or vertically per elevator group as a single paging zone. The OEE lobby paging zone will be dedicated to loudspeakers that only serve OEE lobbies and will be separate from all other loudspeakers outside of an OEE lobby.

Given the variable nature of partial evacuation scenarios in a tall building, it is important that emergency responders are able to communicate with occupants in key areas. This section requires coordination of the manual paging zones with the authority having jurisdiction to ensure alignment with their response plan and the building emergency plan.

21.6.2.6.4.1 Individual paging zones per each OEE lobby on each floor or a grouped paging zone for all OEE lobbies on a floor shall be permitted if approved.

21.6.2.6.4.2 A vertical paging zone for each elevator group shall be permitted if approved.

21.6.2.6.5 Visual notification appliances (strobes) shall comply with 24.5.17.3(1), 24.5.17.3(2), and 24.5.17.3(3).

21.6.2.7 Total Evacuation. A means to initiate total building evacuation labeled "ELEVATOR TOTAL BUILDING EVACUATION" shall be provided at the Fire Command Center or at the Emergency Command Center.

This provides a simple method for emergency responders to expand the OEO evacuation zone to include all floors served by all elevator groups.

21.6.2.7.1 When the total building evacuation means is actuated, the fire alarm system shall provide a signal to the elevator system indicating that all floors in the building are to be evacuated.

21.6.2.7.2 When the total building evacuation means is actuated, the in-building fire emergency voice/alarm communications system shall transmit an evacuation message throughout the building.

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Chart 2.27(b)
Excerpts From NFPA 72®-2022: Occupant Evacuation Elevators (Cont'd)

21.6.2.8* Suspension of OEO for an Individual Elevator or Group of Elevators. When OEO has been suspended, the in-building fire emergency voice/alarm communications system shall transmit messages coordinated with the elevator system's variable message signs in compliance with 21.6.2.6.

A.21.6.2.8 Suspension of OEO can occur when an individual elevator or group of elevators is recalled by fire fighters using key operated switch(es). It is important to recognize that OEO continues operation using the available elevator(s). The affected elevator(s) will return to OEO operation when fire fighters' emergency operation has been reset.

21.6.2.9* Partial Termination of OEO.

A.21.6.2.9 Partial termination can occur when a particular group of elevators has been taken out of service because they have been recalled under automatic Elevator Phase I Emergency Recall Operation, but other elevator(s) in the elevator evacuation zone are still available for evacuation.

21.6.2.9.1 OEO shall be terminated for a specific group of elevator(s) when the signal(s) provided in 21.3.14.1 and 21.3.14.2 associated with this group of elevator(s) has initiated Elevator Phase I Emergency Recall Operation for this group of elevator(s).

21.6.2.9.2 When OEO has been partially terminated, the in-building fire emergency voice/alarm communications system shall transmit messages coordinated with the elevator system's variable message signs in compliance with 21.6.2.6.

21.6.2.10* Total Termination of OEO. OEO shall be terminated for all elevators in the building upon reset of the fire alarm system.

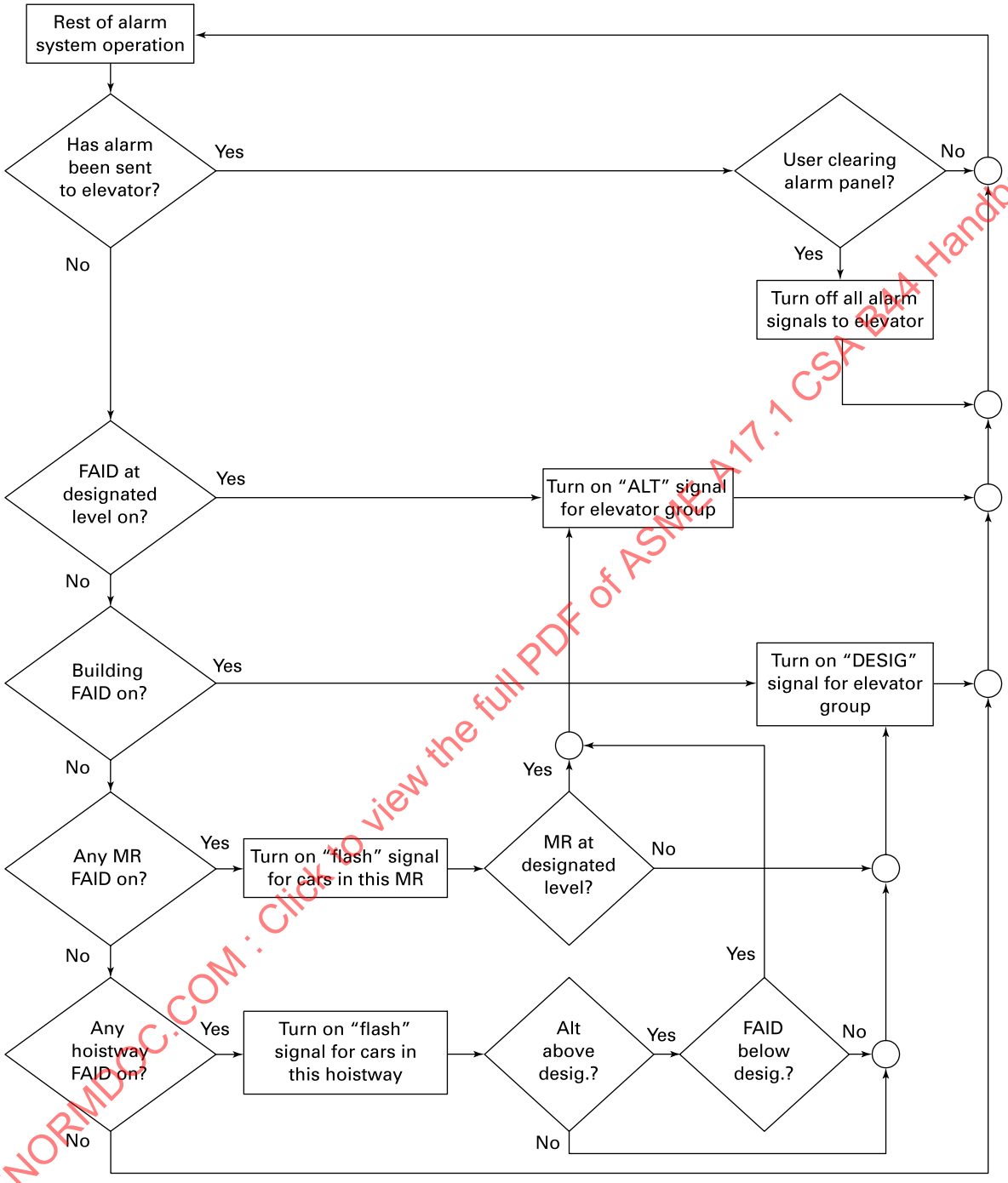
A.21.6.2.10 OEO will not actuate if no elevators are available. There are several instances where signals must be received from the elevator system. One of these is when the Elevator Phase I Emergency Recall key switch is used to manually initiate recall for all elevators. Another situation requiring a signal from the elevator system is when the elevator system cannot provide the intended operation. In this case the fire alarm system needs to know so it does not provide incorrect messaging to a floor(s). See also A.21.6.2.6.3.

For the fire alarm system to reset, all alarm signals must be cleared. This prevents termination interruption of OEO until emergency responders and system technicians verify that the building has been fully evacuated and/or the emergency event has ended.

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Diagram 2.27.3(b)(1)
Fire Alarm System Logic to Generate Elevator Input Signals

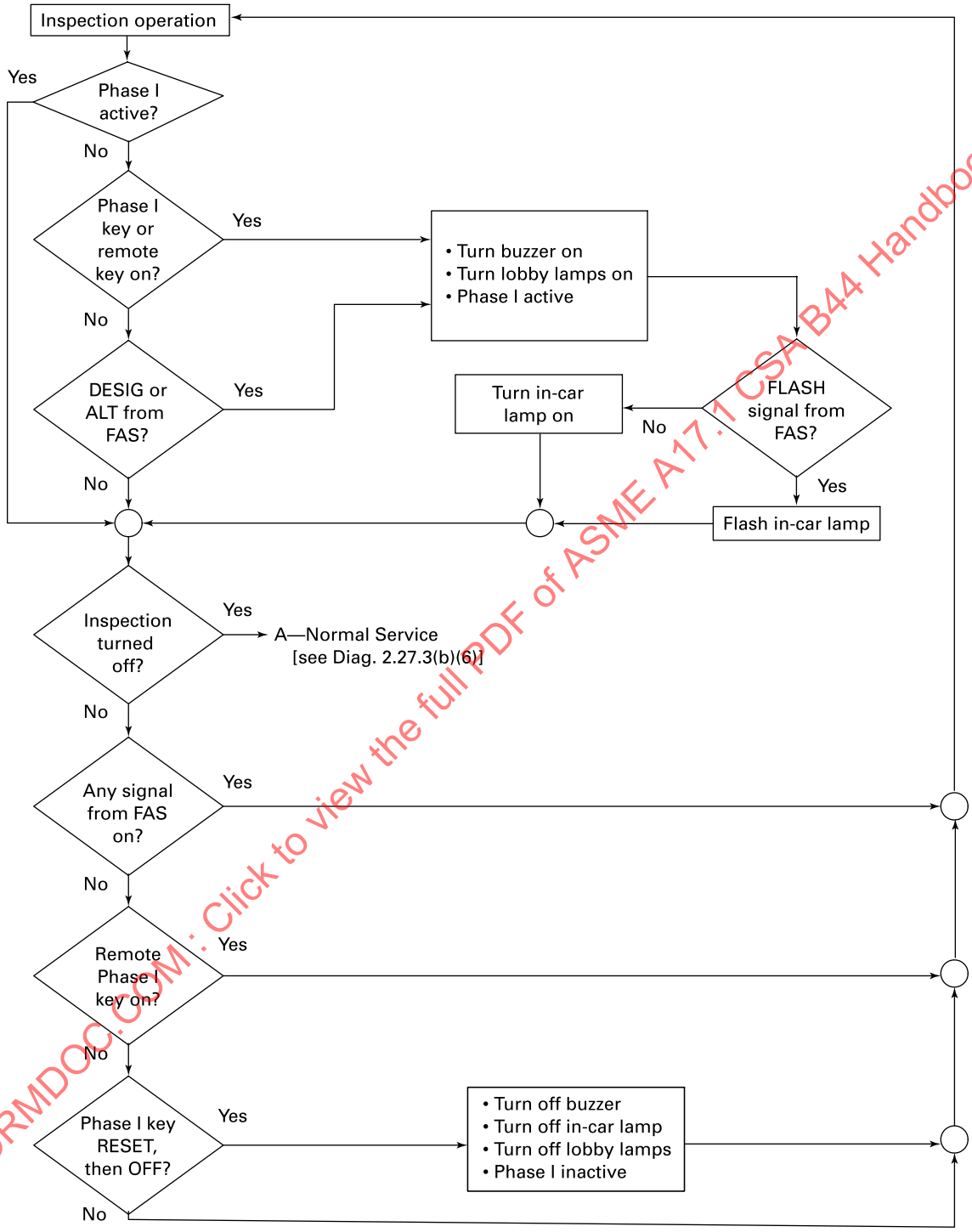


WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) FAID = fire alarm initiating device. MR = machine room.
(c) Interface consists of one signal per group to command a designated level recall, one per group to command an alternate level recall, and several signals (min. = 1, max. = # of cars) to a hoistway or MR detector is active. The number depends on how many cars share motor rooms and how many share hoistways.

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Diagram 2.27.3(b)(2)
Fire Service Phase I Recall When on Inspection Service Operation



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GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) FAS = fire alarm system. If there is no remote Phase I switch, assume it is OFF.

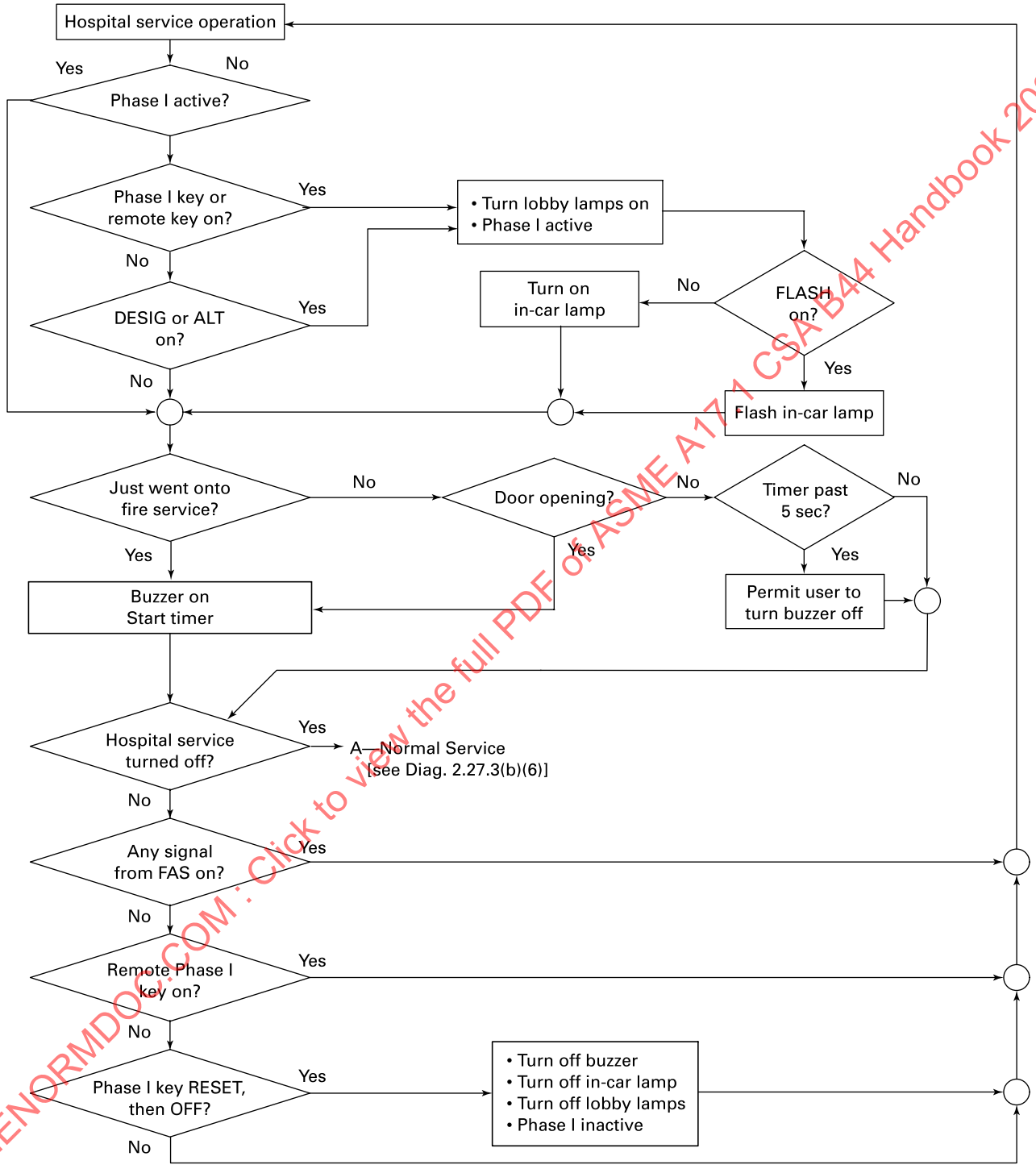
Diagram 2.27.3(b)(2)
Fire Service Phase I Recall When on Inspection Service Operation (Cont'd)

GENERAL NOTES (Cont'd)

(c) Generally single-letter references (e.g., A, B, C) are related to Phase I operation and double-letter references (e.g., BB, CC, GG) are related to Phase II operation.

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Diagram 2.27.3(b)(3)
Fire Service Phase I Recall When on Hospital Service Operation

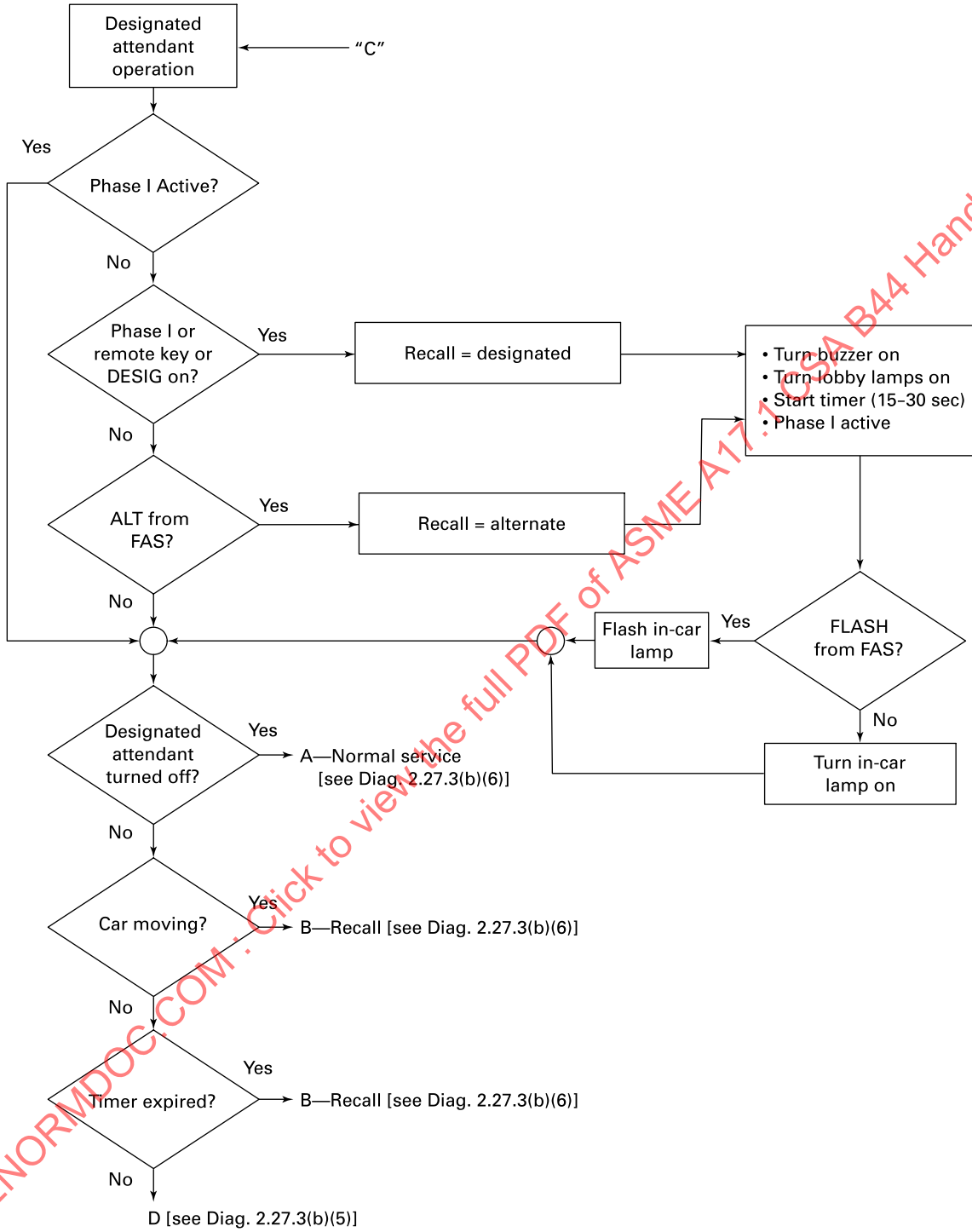


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GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) FAS = fire alarm system. If there is no remote Phase I switch, assume it is OFF.
(c) Generally single-letter references (e.g., A, B, C) are related to Phase I operation and double-letter references (e.g., BB, CC, GG) are related to Phase II operation.

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Diagram 2.27.3(b)(4)
Fire Service Phase I Recall When on Designated Attendant Operation

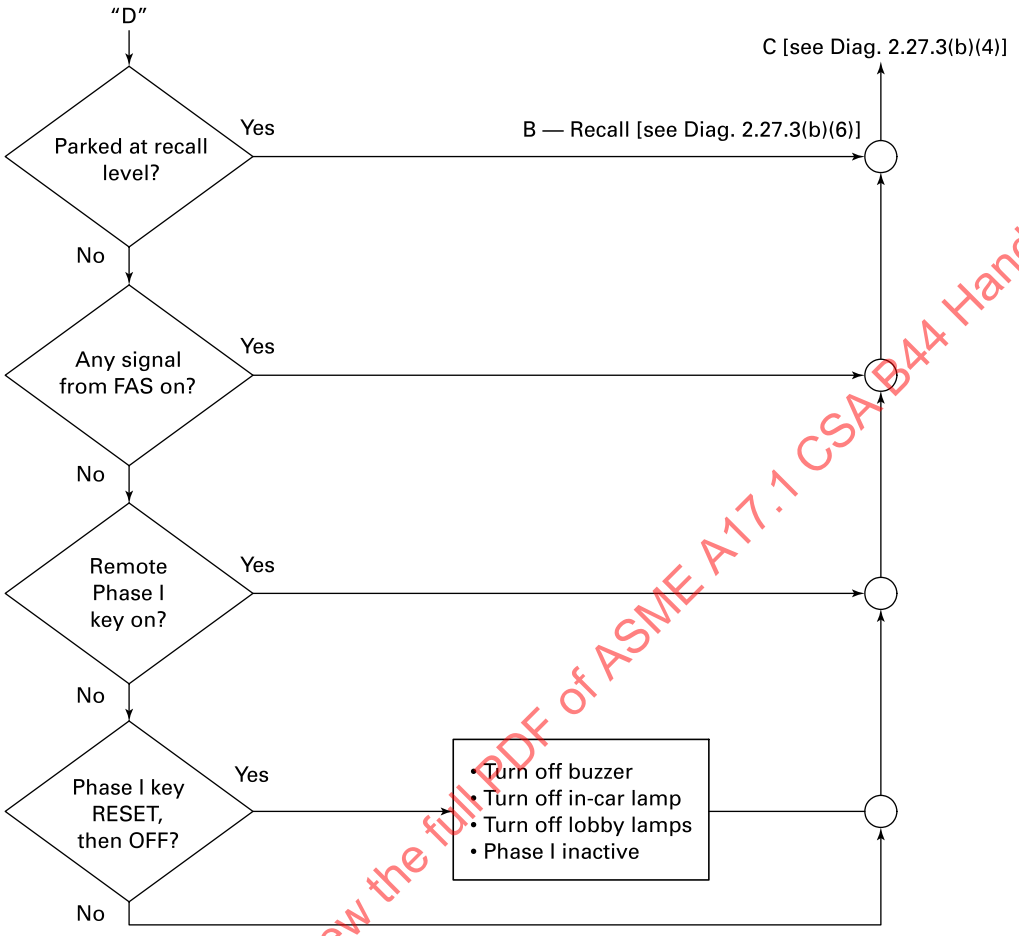


WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) FAS = fire alarm system. If there is no remote Phase I switch, assume it is OFF.
(c) Generally single-letter references (e.g., A, B, C) are related to Phase I operation and double-letter references (e.g., BB, CC, GG) are related to Phase II operation.

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Diagram 2.27.3(b)(5)
Fire Service Phase I Recall When on Designated Attendant Operation

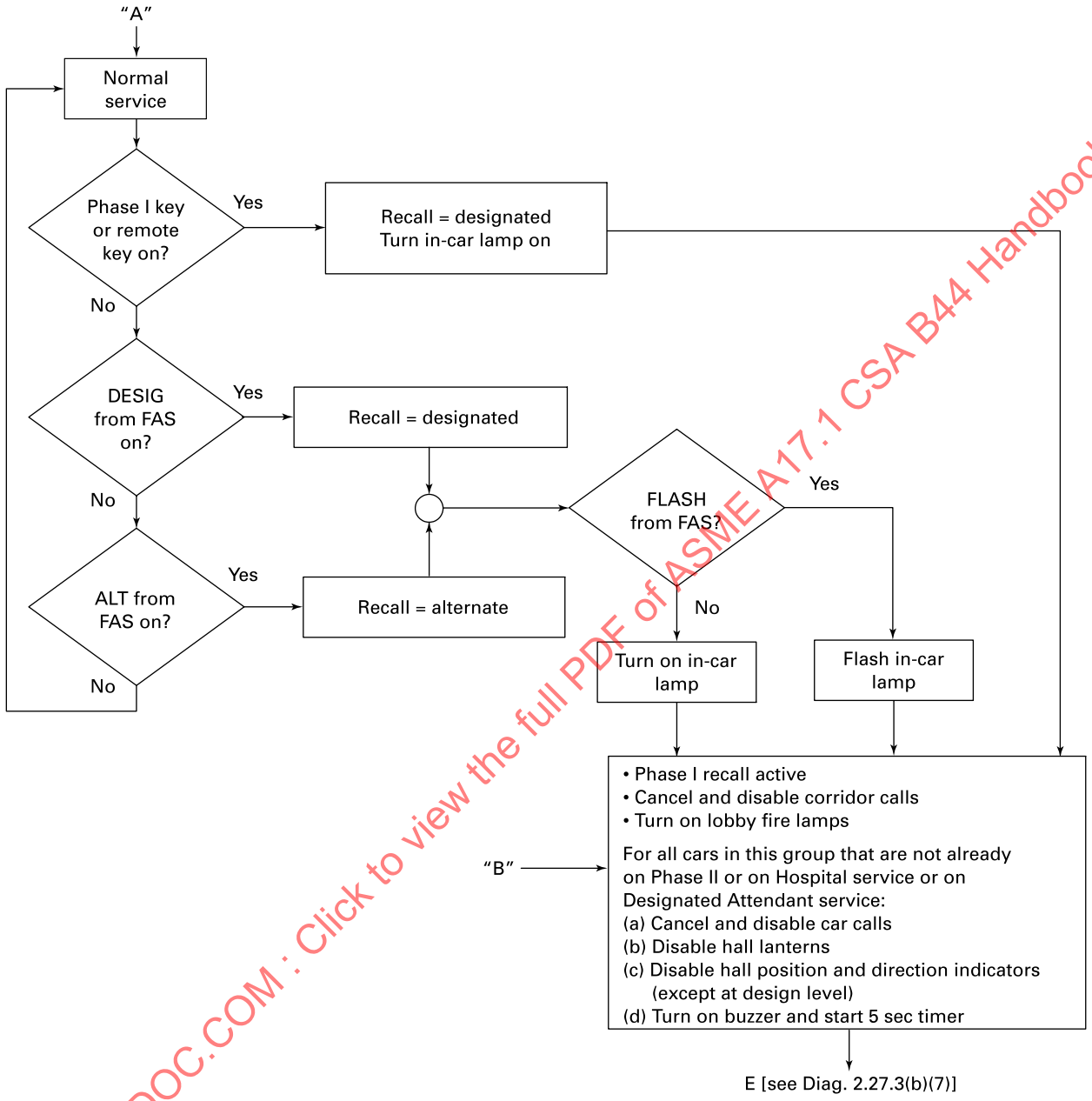


WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) Anytime "FLASH" signal comes from FAS, change in-car lamp to flashing. FAS = fire alarm system. If there is no remote Phase I switch, assume it is OFF.
(c) Generally single-letter references (e.g., A, B, C) are related to Phase I operation and double-letter references (e.g., BB, CC, GG) are related to Phase II operation.

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Diagram 2.27.3(b)(6)
Fire Service Phase I Recall When on Normal Operation

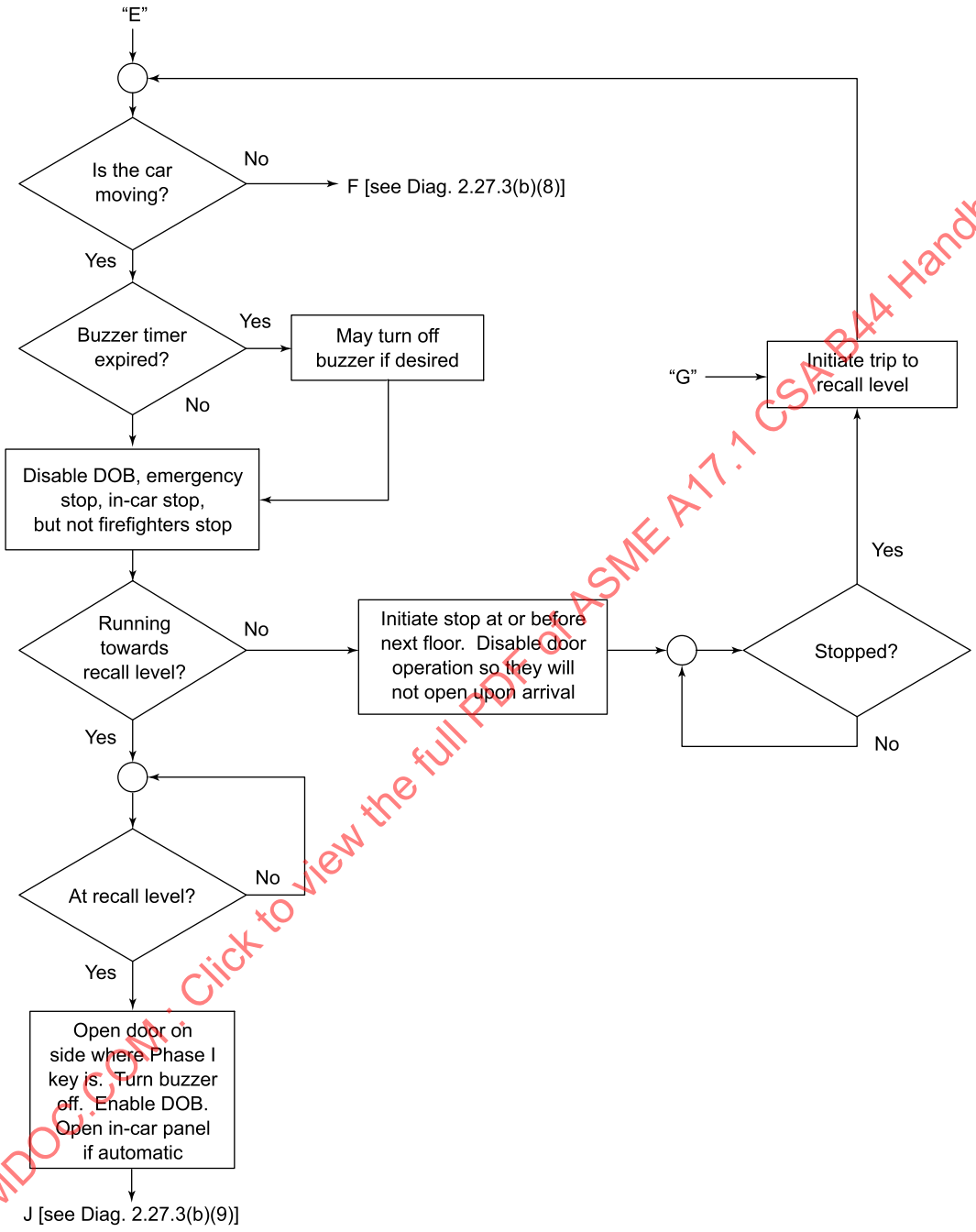


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GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) FAS = fire alarm system. If there is no remote Phase I switch, assume it is OFF.
(c) Generally single-letter references (e.g., A, B, C) are related to Phase I operation and double-letter references (e.g., BB, CC, GG) are related to Phase II operation.

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Diagram 2.27.3(b)(7)
Fire Service Phase I Recall When on Normal Operation

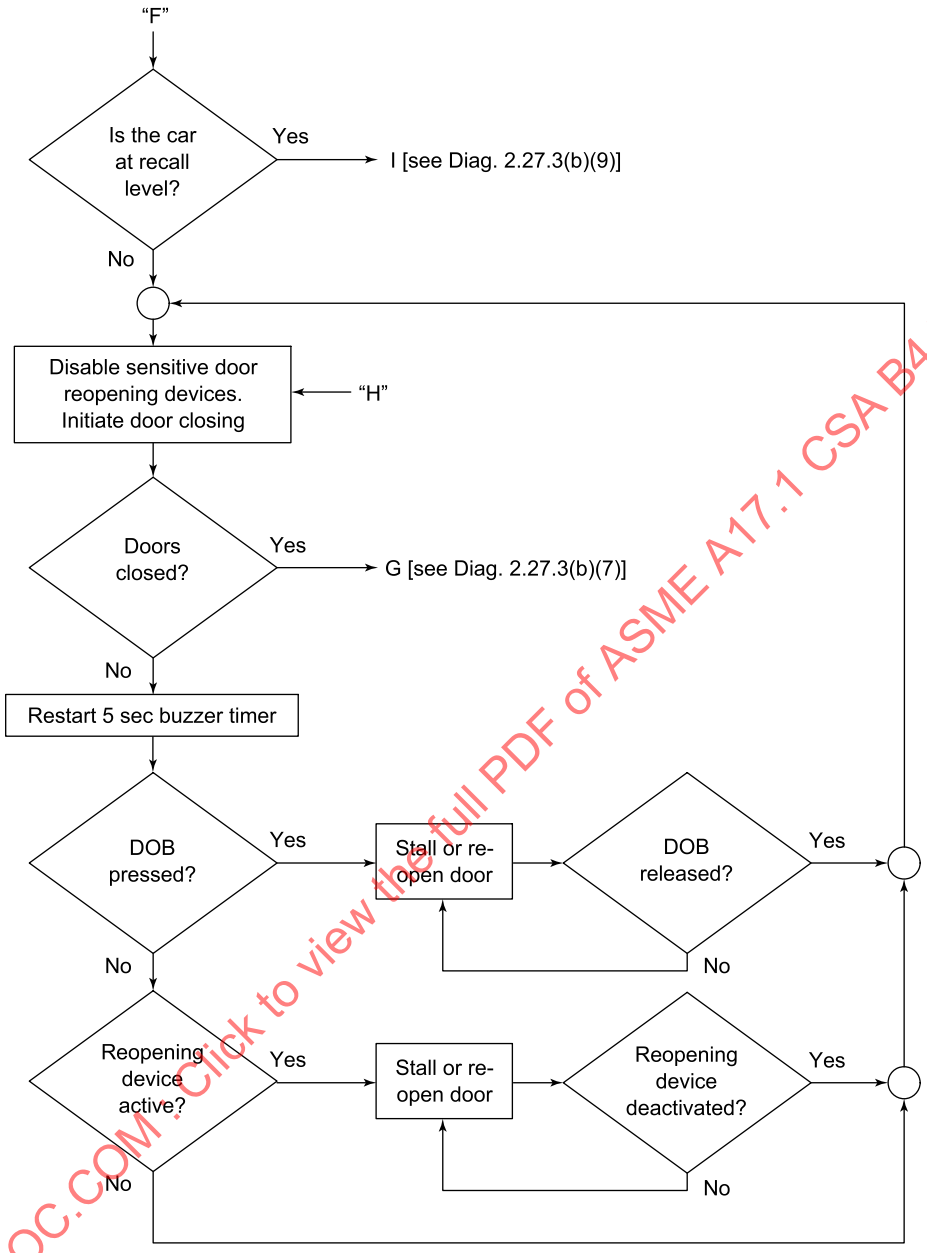


WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) DOB = "DOOR OPEN" button.
(c) Generally single-letter references (e.g., A, B, C) are related to Phase I operation and double-letter references (e.g., BB, CC, GG) are related to Phase II operation.

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Diagram 2.27.3(b)(8)
Fire Service Phase I Recall When on Normal Operation

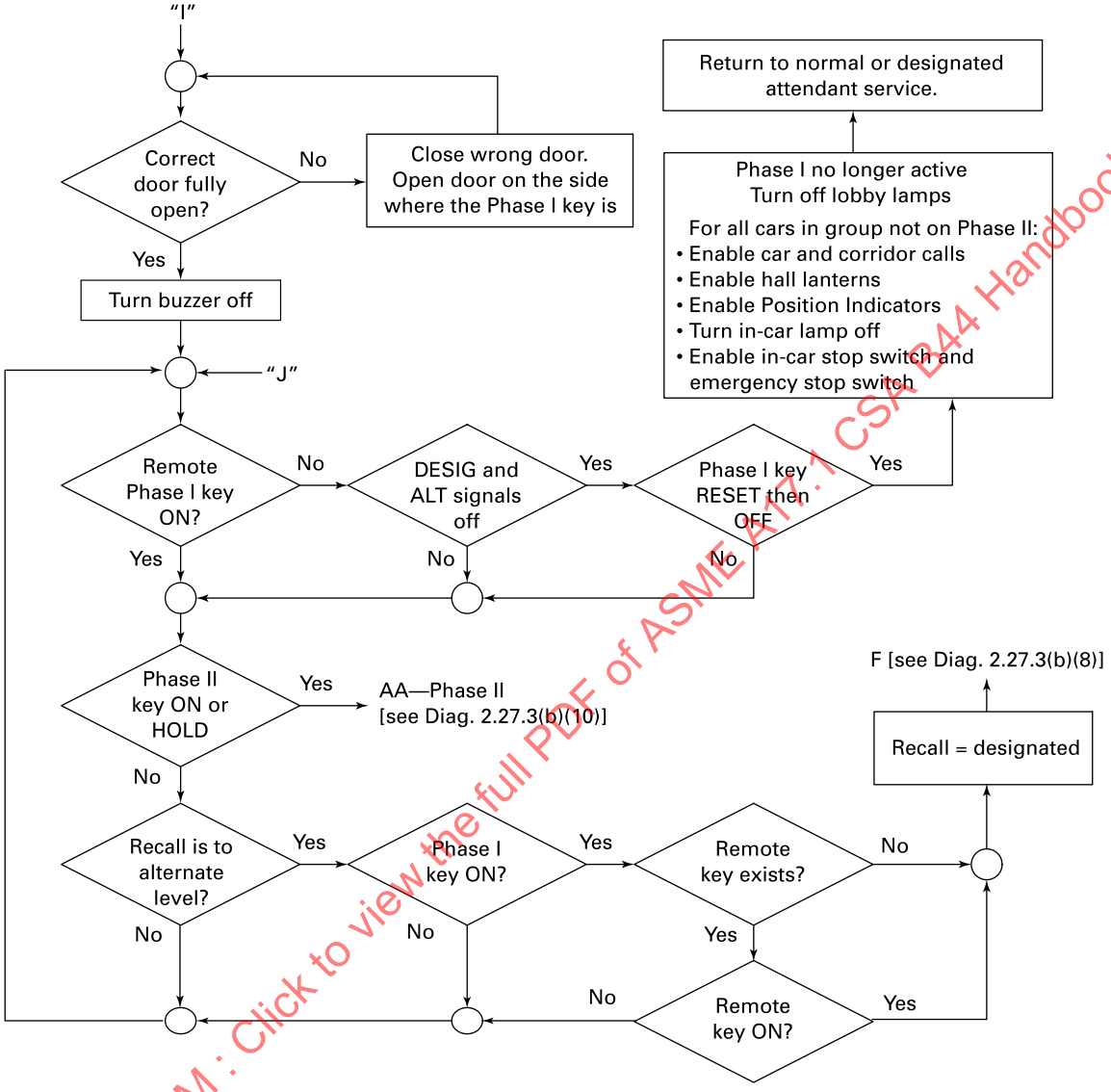


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Diagram 2.27.3(b)(9)
Fire Service Phase I Recall When on Normal Operation

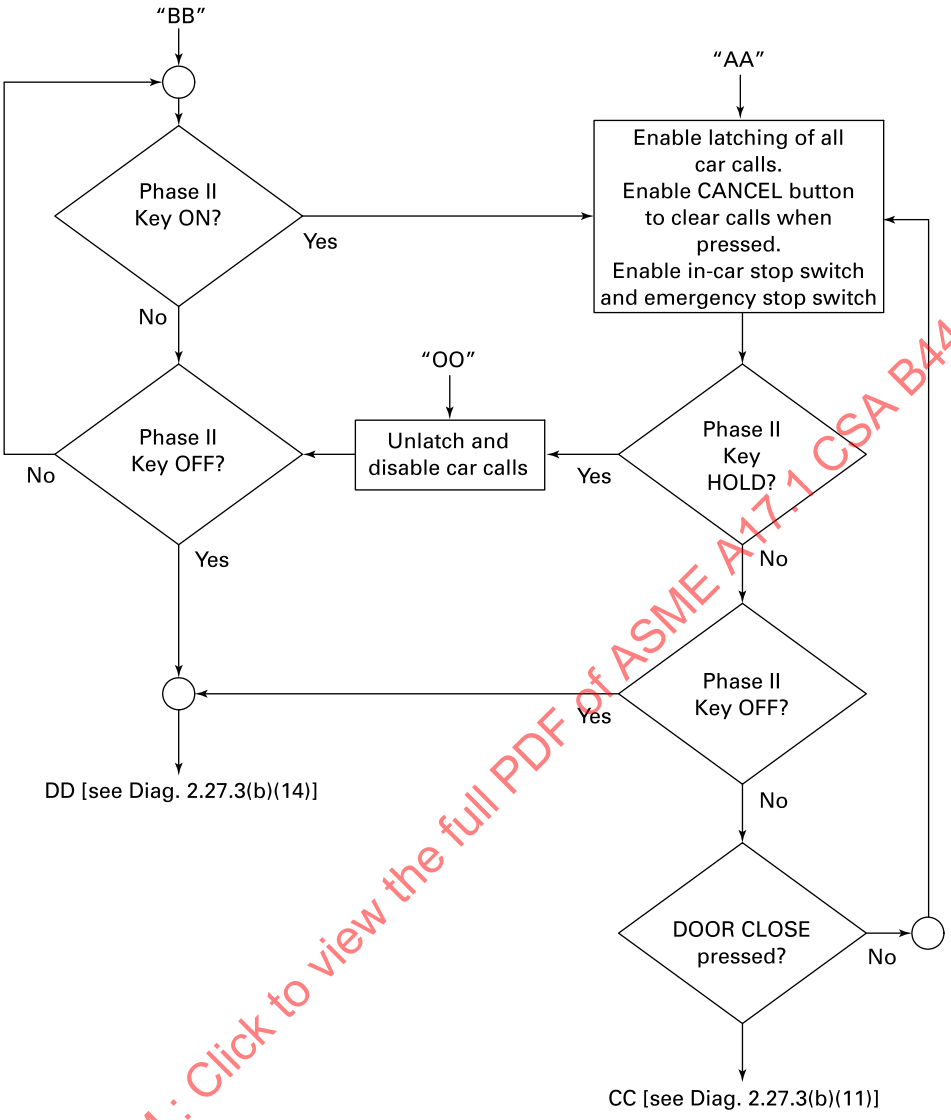


WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) DOB = "DOOR OPEN" button.
(c) Generally single-letter references (e.g., A, B, C) are related to Phase I operation and double-letter references (e.g., BB, CC, GG) are related to Phase II operation.

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Diagram 2.27.3(b)(10)
Phase II "HOLD," Phase II "ON," Parked With Doors Open

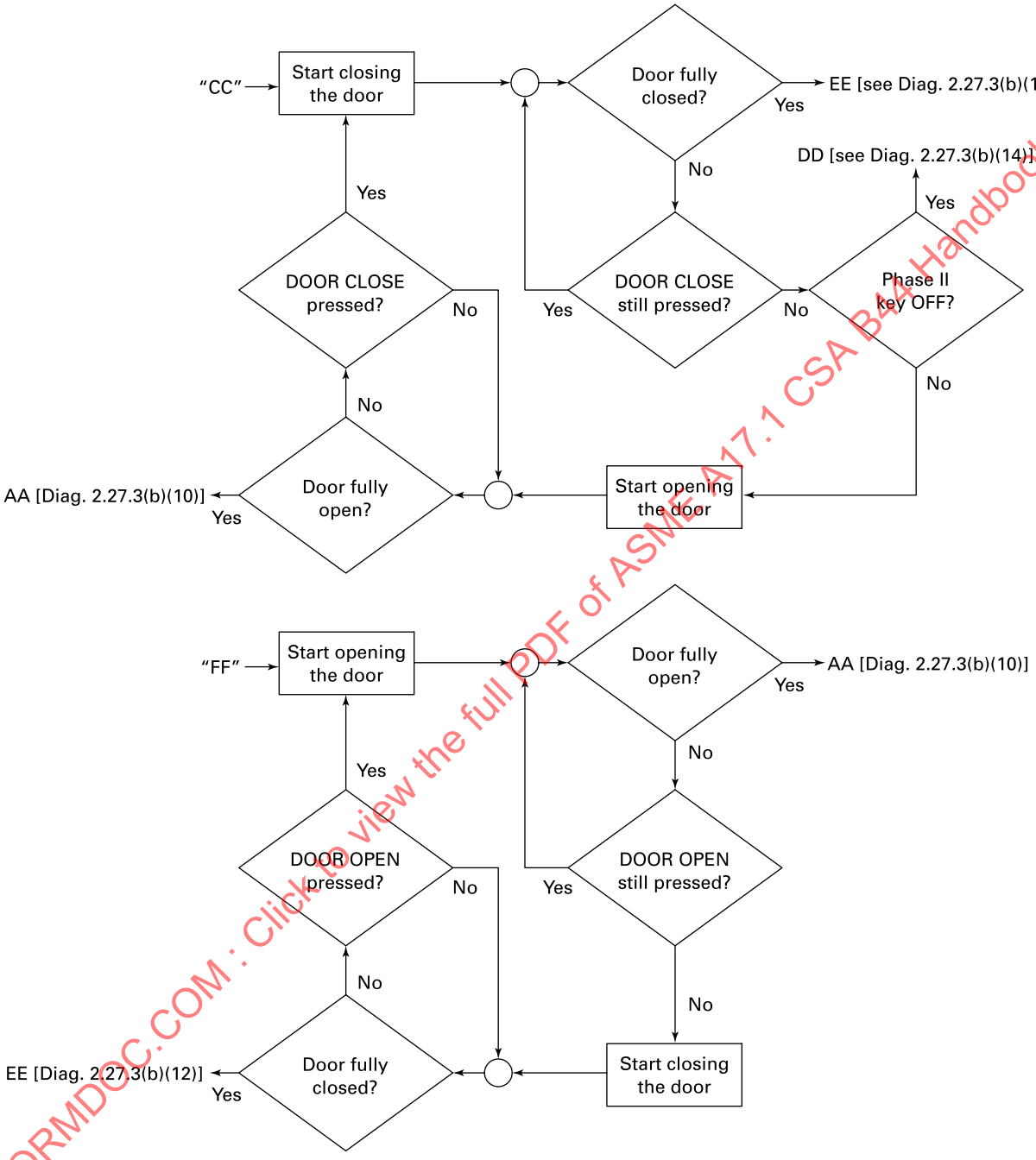


WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) Generally single-letter references (e.g., A, B, C) are related to Phase I operation and double-letter references (e.g., BB, CC, GG) are related to Phase II operation.

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Diagram 2.27.3(b)(11)
Phase II "ON," Opening and Closing the Doors

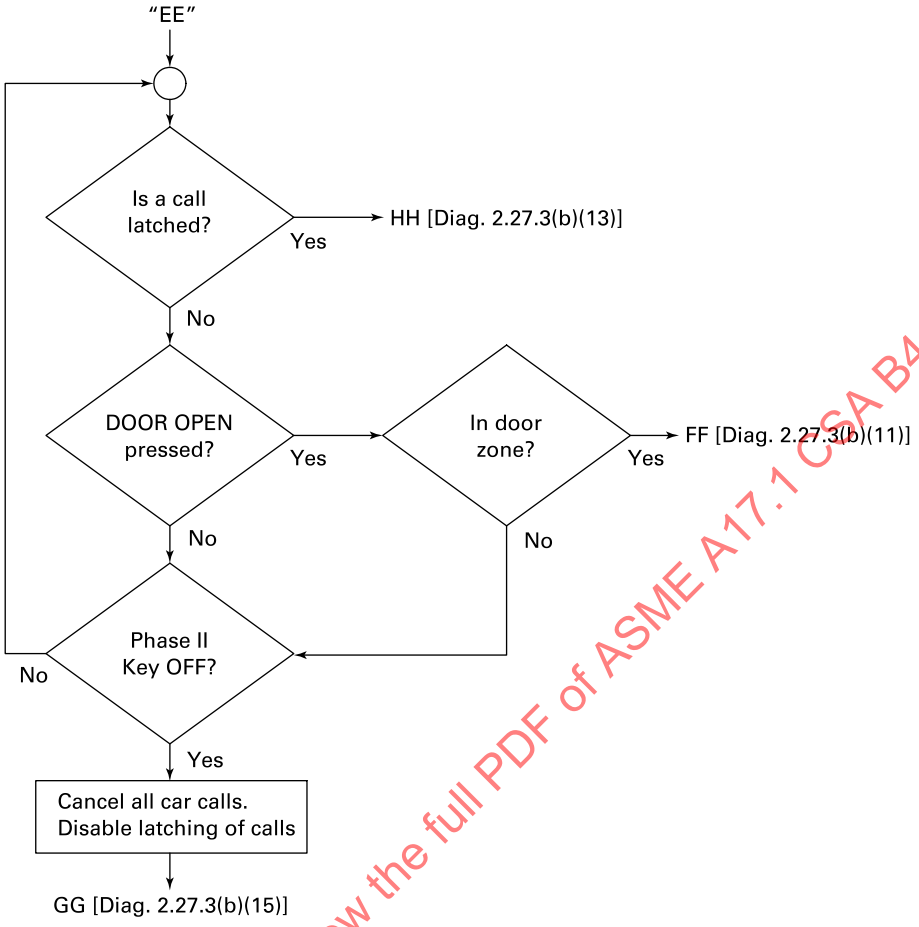


WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) Generally single-letter references (e.g., A, B, C) are related to Phase I operation and double-letter references (e.g., BB, CC, GG) are related to Phase II operation.

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Diagram 2.27.3(b)(12)
Phase II "ON," Parked With Doors Closed

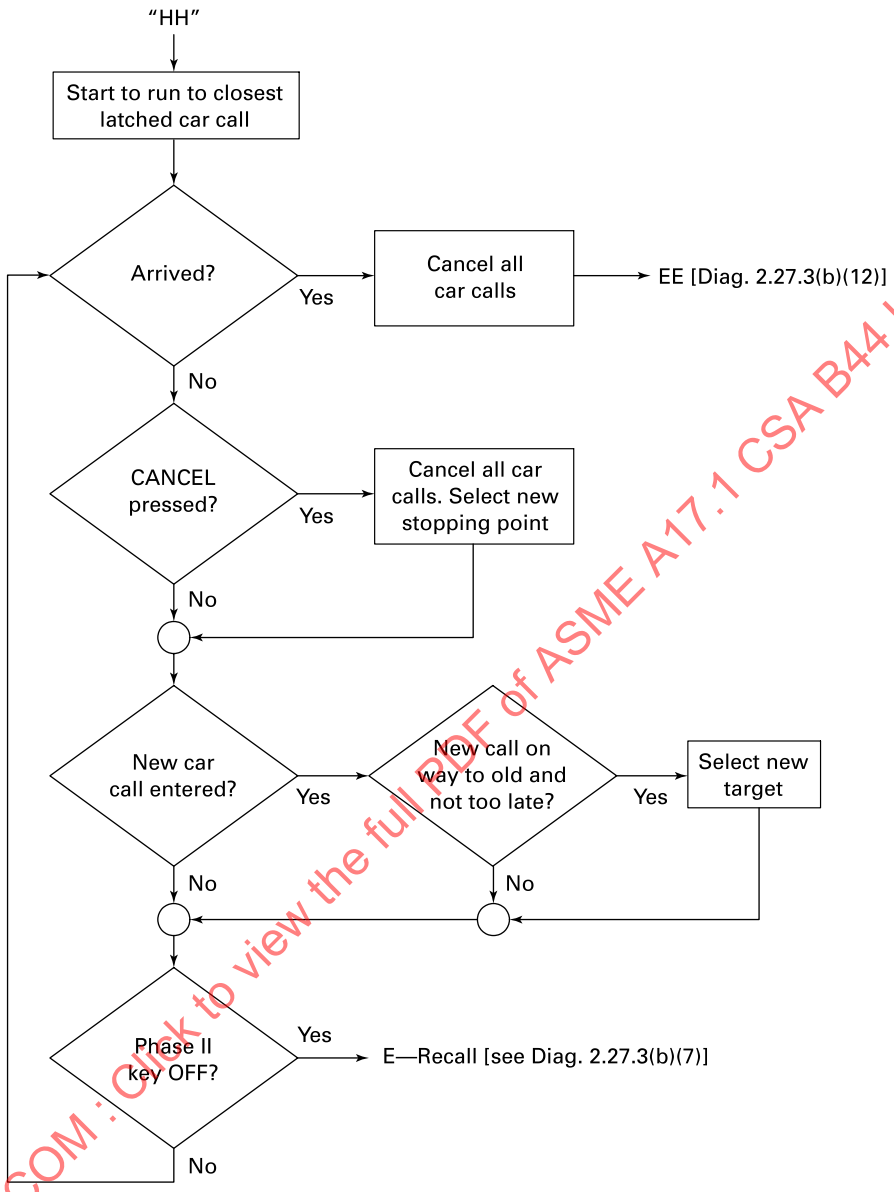


WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) Generally single-letter references (e.g., A, B, C) are related to Phase I operation and double-letter references (e.g., BB, CC, GG) are related to Phase II operation.

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Diagram 2.27.3(b)(13)
Running on Phase II

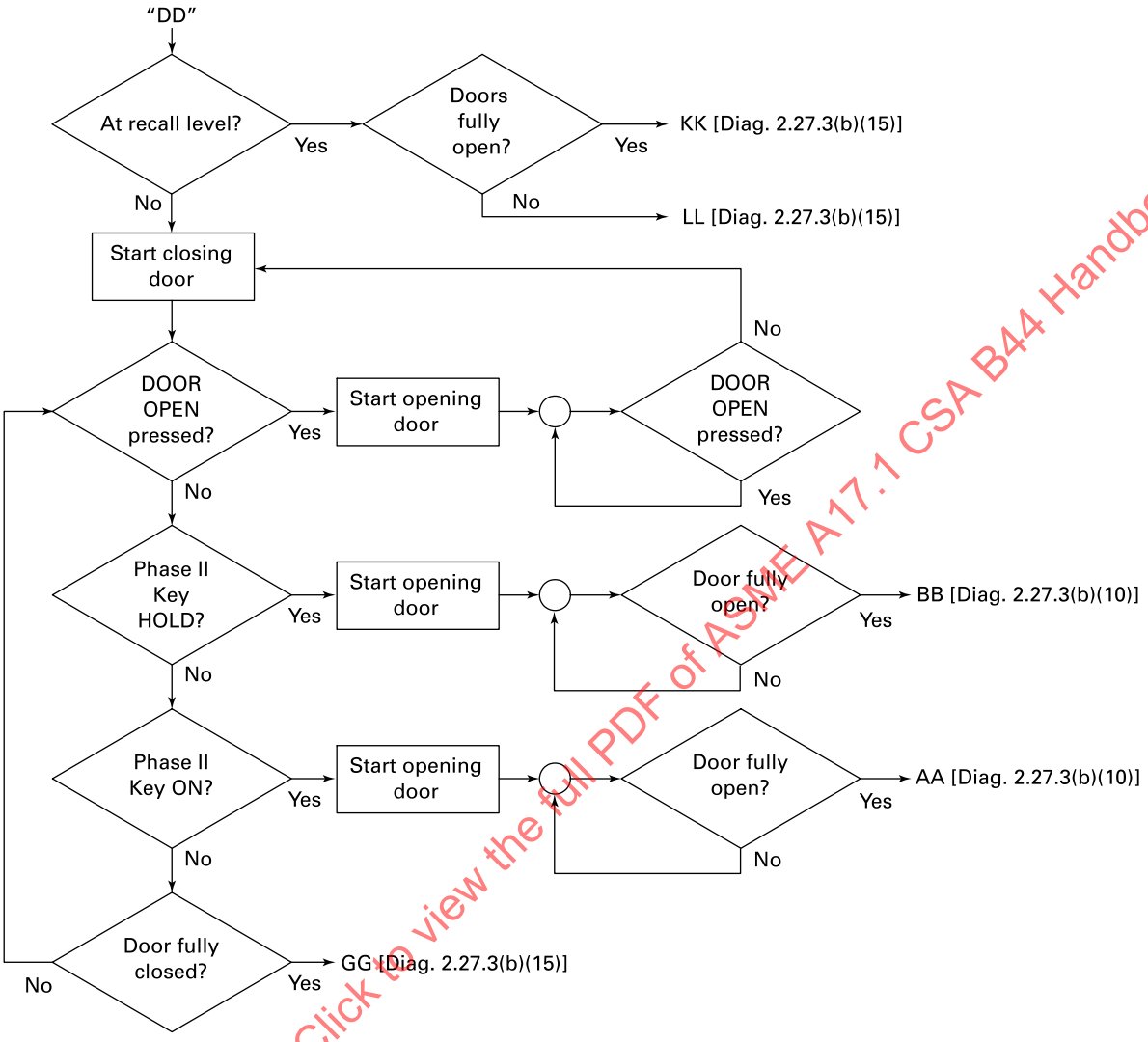


WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) Generally single-letter references (e.g., A, B, C) are related to Phase I operation and double-letter references (e.g., BB, CC, GG) are related to Phase II operation.

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Diagram 2.27.3(b)(14)
Going Off Phase II, Closing the Doors

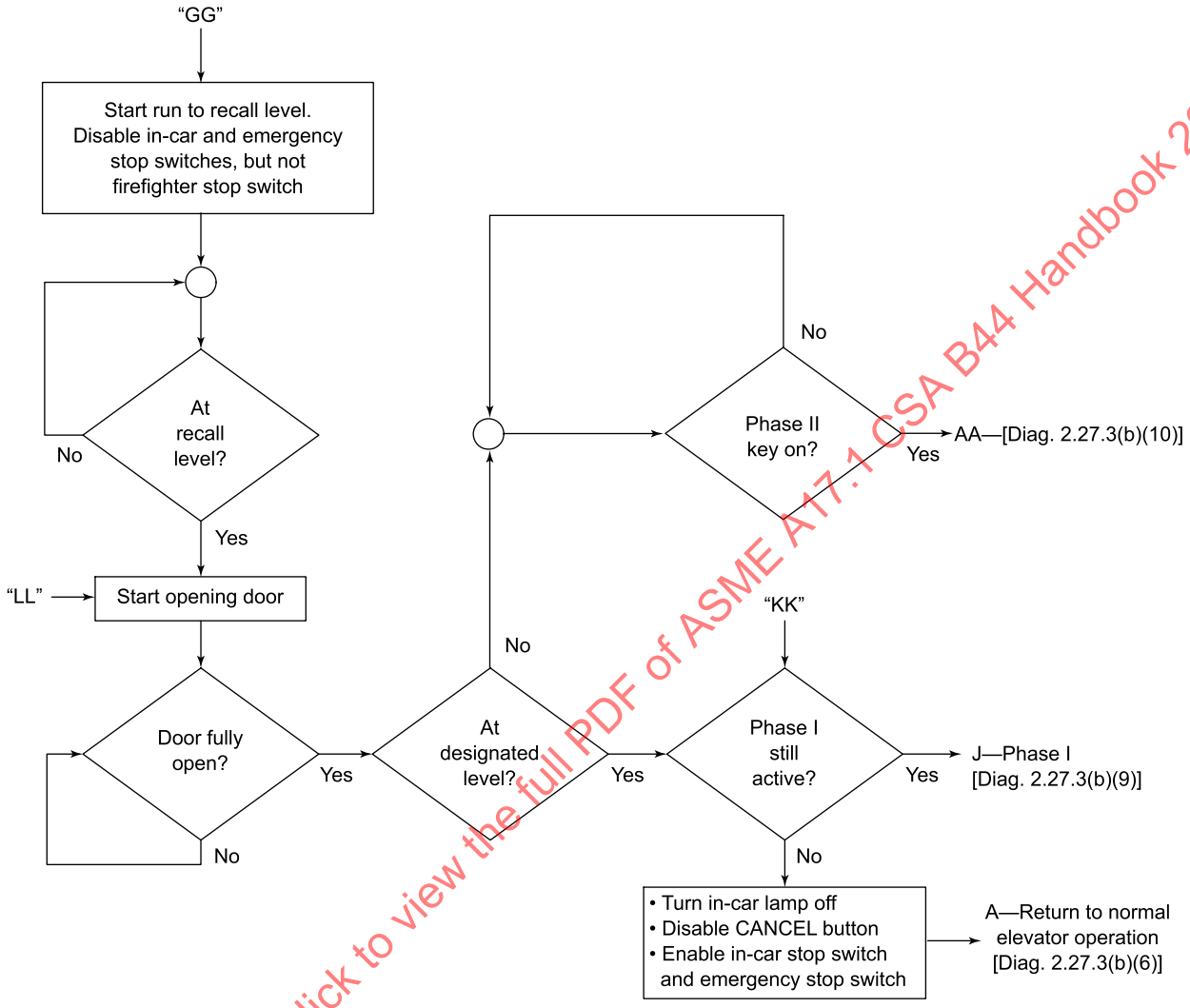


WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) Generally single-letter references (e.g., A, B, C) are related to Phase I operation and double-letter references (e.g., BB, CC, GG) are related to Phase II operation.

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Diagram 2.27.3(b)(15)
Going Off Phase II

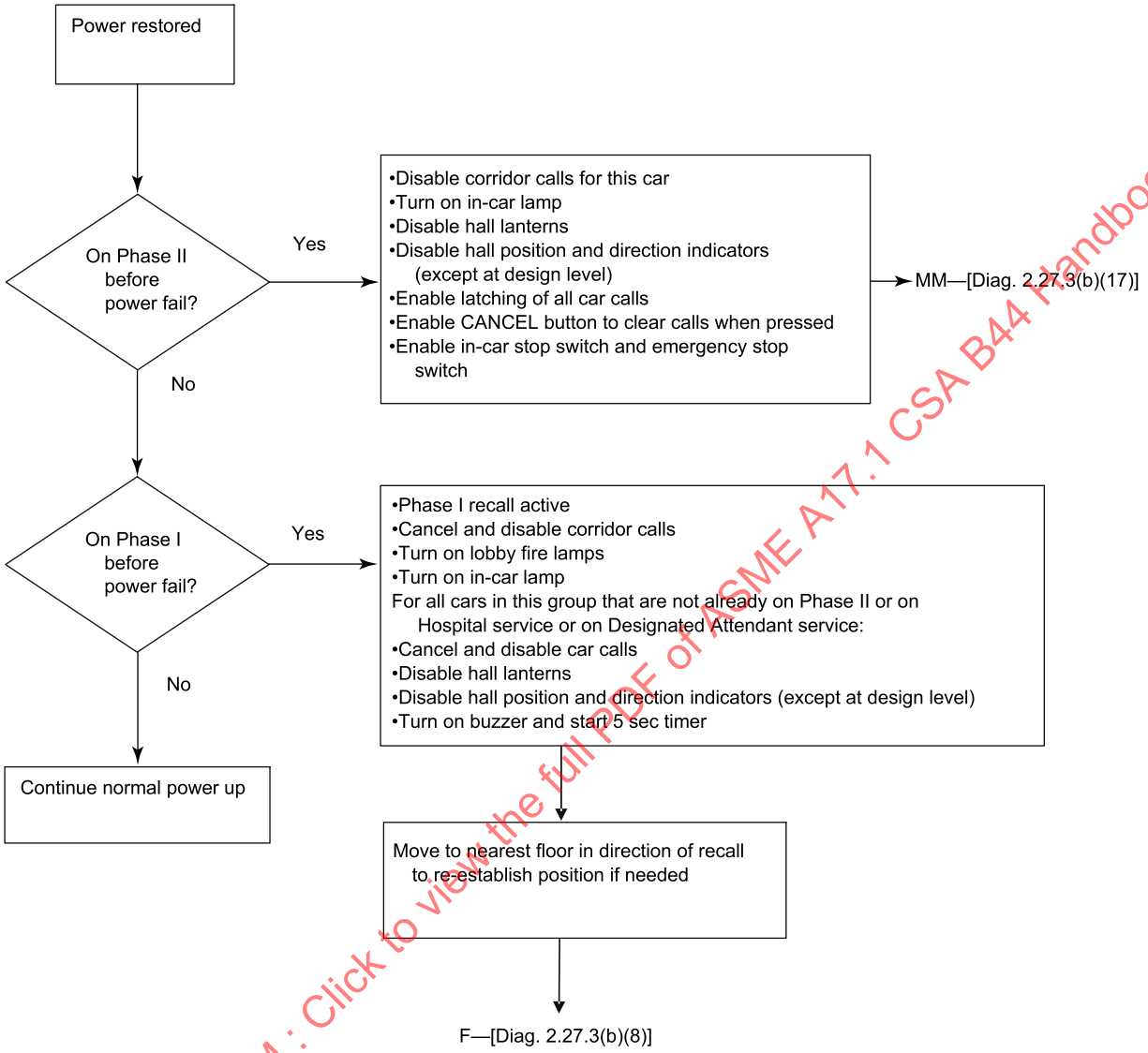


WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTES:
(a) Courtesy of Matt Martin.
(b) Generally single-letter references (e.g., A, B, C) are related to Phase I operation and double-letter references (e.g., BB, CC, GG) are related to Phase II operation.

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Diagram 2.27.3(b)(16)
Recovery From Power Failure

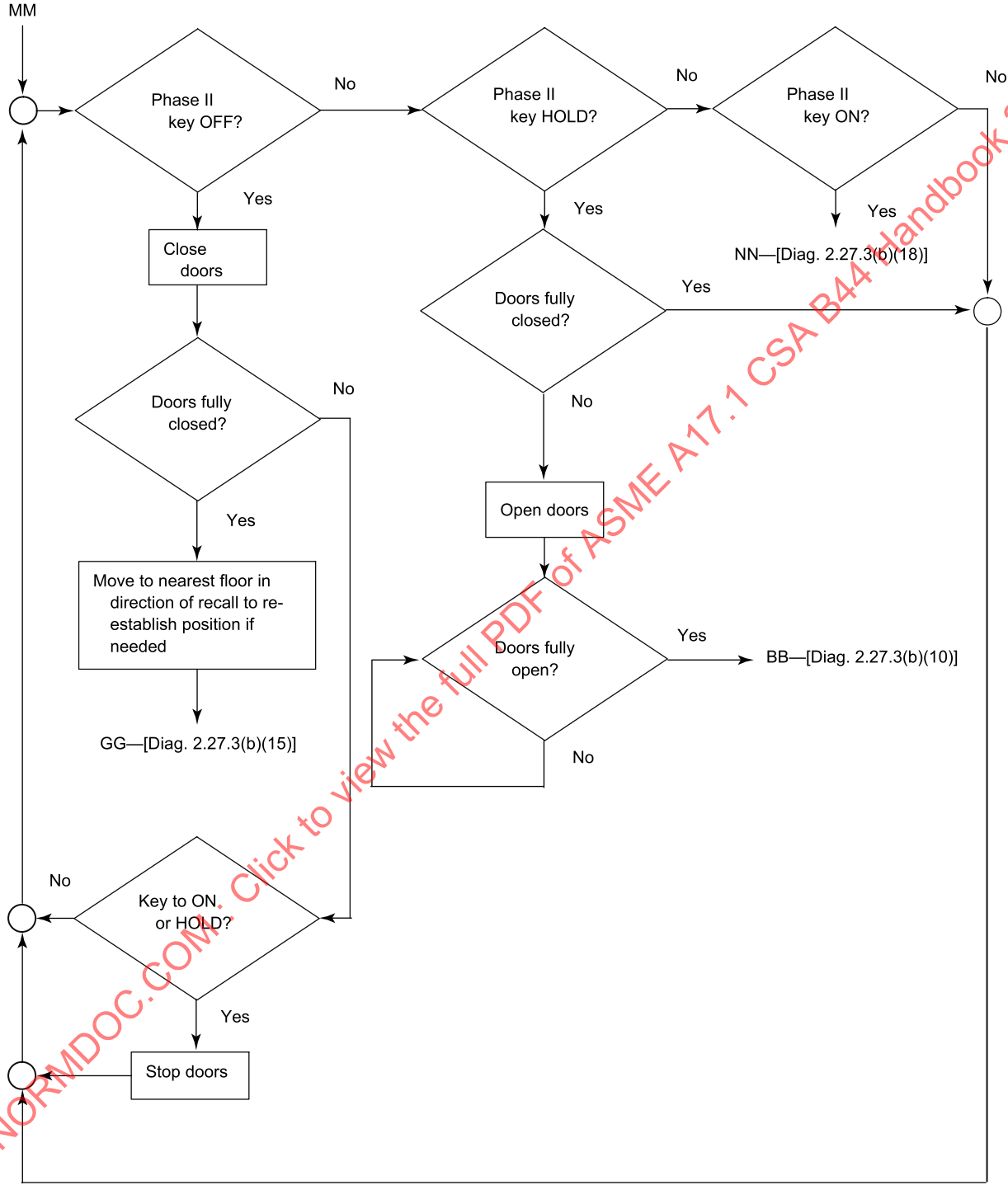


WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTE: Courtesy of Matt Martin.

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Diagram 2.27.3(b)(17)
Recovery From Power Failure

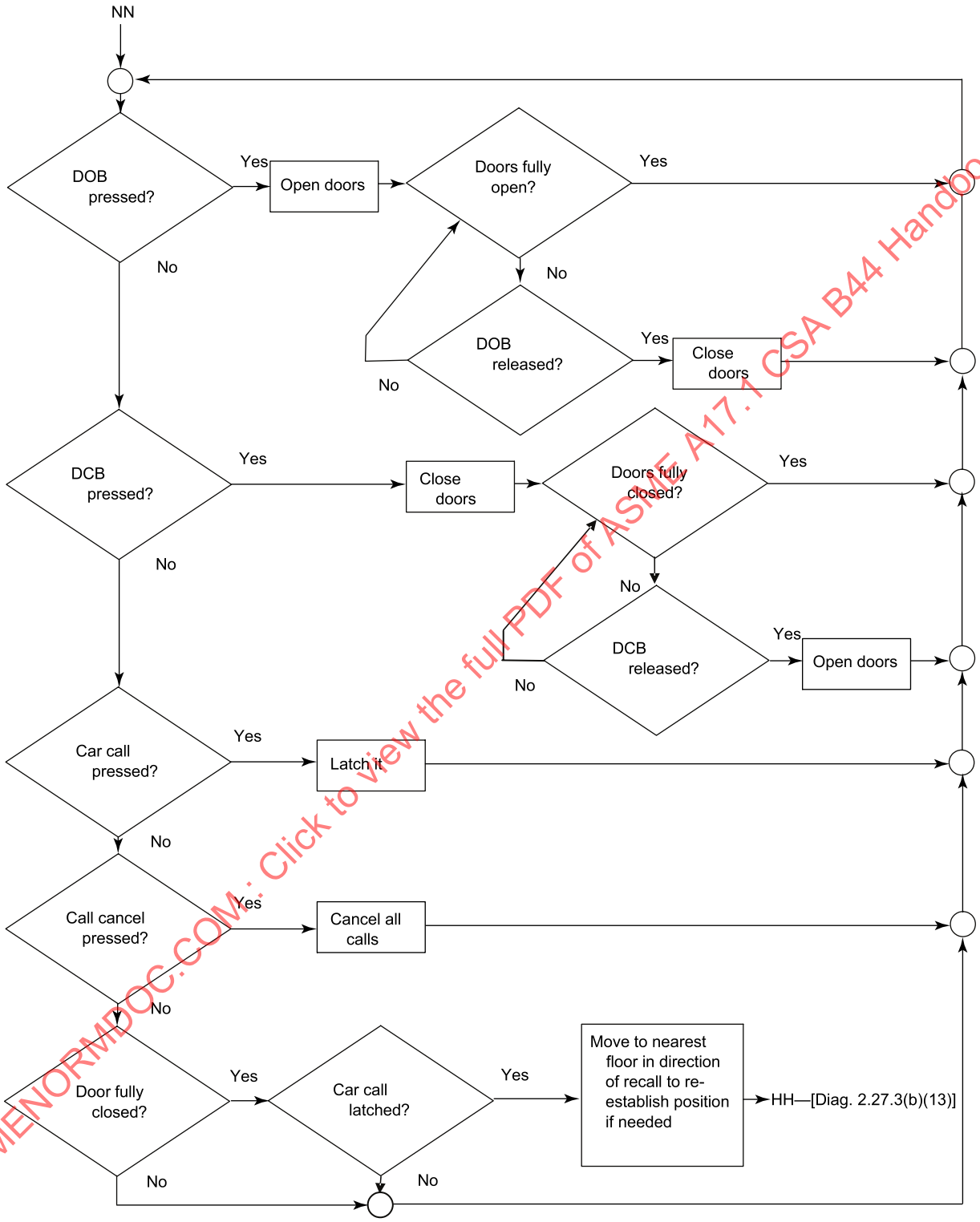


WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTE: Courtesy of Matt Martin.

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Diagram 2.27.3(b)(18)
Recovery From Power Failure



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WARNING: Diagram may not show every logic path required by ASME A17.1/CSA B44. Some logic paths may not be required by ASME A17.1/CSA B44 but are shown for completeness.

GENERAL NOTE: Courtesy of Matt Martin.

Chart 2.27.3.2.1(a)
Excerpts From NFPA 72®-2022 Handbook: Elevator Phase I Emergency Recall Operation

21.3* Elevator Phase I Emergency Recall Operation.

Before the 2016 edition of the Code, Elevator Phase I Emergency Recall Operation was called Elevator Recall for Fire Fighters' Service. Elevator Phase I Emergency Recall Operation involves removing elevators from normal service by having them automatically travel to a predetermined level on activation of specific smoke detectors (or other automatic fire alarm initiating devices, as permitted by 21.3.10). This feature is a requirement of ASME A17.1/CSA B44 and provides a means of moving elevator cars to a safe location for passengers to exit and for subsequent use by fire fighters. Some of the signals used for Elevator Phase I Emergency Recall Operation are also used to provide appropriate warnings to emergency personnel concerning the use of the elevators after they have been recalled.

A.21.3 The terms *machinery space*, *control space*, *machine room*, and *control room* are defined in *NFPA 70* and ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.

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Chart 2.27.3.2.1(a)
Excerpts From NFPA 72®-2019 Handbook: Elevator Phase I Emergency Recall Operation (Cont'd)

21.3.1 All fire alarm initiating devices used to initiate elevator Phase I Emergency Recall Operation shall be connected to the required building fire alarm system.



Which code requires the installation of fire alarm initiating devices for Elevator Phase I Emergency Recall Operation?

The requirements in Section 21.3 apply to the Elevator Phase I Emergency Recall Operation functions of the fire alarm or signaling system. The requirement to install fire alarm initiating devices for Elevator Phase I Emergency Recall Operation comes from ASME A17.1/CSA B44. All fire alarm initiating devices associated with Elevator Phase I Emergency Recall Operation must be connected to the building fire alarm or signaling system or, where there is no building fire alarm or signaling system, to a dedicated function FACU in accordance with 21.3.2.

ASME A17.1/CSA B44 requires a fire alarm initiating device at each floor served by the elevator, in the associated elevator machine room, machinery space containing a motor controller or driving machine, control space, or control room; and in the elevator hoistway if sprinklers are in the hoistway. The terms *machinery space*, *control space,* and *control room* are associated with elevators that use machine-room-less elevator designs. These machine-room-less designs have various configurations of elevator controller and equipment locations. These terms are defined and illustrated in ASME A17.1/CSA B44. When machine-room-less elevators are used, the elevator code requires a fire alarm initiating device to be installed at these locations. The following is an excerpt from ASME A17.1/CSA B44 showing the related elevator recall requirements:

ASME A17.1/CSA B44 (2019)

2.27.3.2 Phase I Emergency Recall Operation by Fire Alarm Initiating Devices

2.27.3.2.1 In jurisdictions not enforcing the NBCC, smoke detectors or other automatic fire detectors in environments not suitable for smoke detectors (fire alarm initiating devices) used to initiate Phase I Emergency Recall Operation shall be installed in conformance with the requirements of *NFPA 72* and shall be located

(a) at each elevator lobby served by the elevator
(b) in the associated elevator machine room, machinery space containing a motor controller or driving machine, control space, or control room
(c) in the elevator hoistway, when sprinklers are located in those hoistways

NOTE [2.27.3.2.1(b)]: A machinery space containing a motor controller or driving machine located in the elevator hoistway, or a control space located in the elevator hoistway requires a fire alarm initiating device regardless of the presence of sprinklers.

2.27.3.2.2 In jurisdictions enforcing the NBCC, smoke detectors, or heat detectors in environments not suitable for smoke detectors (fire alarm initiating devices), used to initiate Phase I Emergency Recall Operation, shall be installed in conformance with the requirements of the NBCC, and shall be located

(a) at each elevator lobby served by the elevator
(b) in the associated elevator machine room, machinery space containing a motor controller or driving machine, control space, or control room
(c) in the elevator hoistway, when sprinklers are located in those hoistways

NOTES:

(1) 2.27.3.2.2: Smoke and heat detectors (fire alarm initiating devices) are referred to as "fire detectors" in the NBCC. Pull stations are not deemed to be fire detectors.
(2) 2.27.3.2.2(b): A machinery space containing a motor controller or driving machine located in the elevator hoistway, or a control space located in the elevator hoistway requires a fire alarm initiating device regardless of the presence of sprinklers.

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Chart 2.27.3.2.1(a)
Excerpts From NFPA 72®-2019 Handbook: Elevator Phase I Emergency Recall Operation (Cont'd)

ASME A17.1/CSA B44 (2019) *(Continued)*

2.27.3.2.3 Phase I Emergency Recall Operation to the designated level shall conform to the following:

(a) The activation of a fire alarm initiating device specified in 2.27.3.2.1(a) or 2.27.3.2.2(a) at any floor, other than at the designated level, shall cause all elevators that serve that lobby, and any associated elevator of a group automatic operation, to be returned nonstop to the designated level.

(b) The activation of a fire alarm initiating device specified in 2.27.3.2.1(b) or 2.27.3.2.2(b) shall cause all elevators having any equipment located in that room or space, and any associated elevators of a group automatic operation, to be returned nonstop to the designated level. If the machine room is located at the designated level, the elevator(s) shall be returned nonstop to the alternate level.

(c) In jurisdictions not enforcing NBCC, the activation of a fire alarm initiating device specified in 2.27.3.2.1(c) shall cause all elevators having any equipment in that hoistway, and any associated elevators of a group automatic operation, to be returned nonstop to the designated level, except that initiating device(s) installed at or below the lowest landing of recall shall cause the car to be sent to the upper recall level.

(d) In jurisdictions enforcing the NBCC, the initiation of a fire detector in the hoistway shall cause all elevators having any equipment in that hoistway, and any associated elevators of a group automatic operation, to be returned nonstop to the designated level, except that initiating device(s) installed at or below the lowest landing of recall shall cause the car to be sent to the upper recall level.

(e) The Phase I Emergency Recall Operation to the designated level shall conform to 2.27.3.1.6(a) through 2.27.3.1.6(n).

2.27.3.2.4 Phase I Emergency Recall Operation to an alternate level (see Section 1.3) shall conform to the following:

(a) the activation of a fire alarm initiating device specified in 2.27.3.2.1(a) or 2.27.3.2.2(a) that is located at the designated level, shall cause all elevators serving that level to be recalled to an alternate level, unless Phase I Emergency Recall Operation is in effect

(b) the requirements of 2.27.3.1.6(f), (j), (m), and (n)

(c) the requirements of 2.27.3.1.6(a), (b), (d), (e), (g), (h), (i), (k), and (l), except that all references to the "designated level" shall be replaced with "alternate level"

2.27.3.2.5 The recall level shall be determined by the first activated fire alarm initiating device for that group (see 2.27.3.2.1 or 2.27.3.2.2).

If the car(s) is recalled to the designated level by the "FIRE RECALL" switch(es) [see also 2.27.3.1.6(j)], the recall level shall remain the designated level.

2.27.3.2.6 When Phase I Emergency Recall Operation is initiated by a fire alarm initiating device for any of the following locations, as required by 2.27.3.2.3 or 2.27.3.2.4 the visual signal [see 2.27.3.1.6(h) and Fig. 2.27.3.1.6(h)] shall illuminate intermittently only in a car(s) with equipment in that location:

(a) machine room
(b) machinery space containing a motor controller or driving machine
(c) control room
(d) control space
(e) hoistway

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Subsection 21.3.1 uses the term *fire alarm initiating devices*. The type of fire alarm initiating device for elevator recall is a system-type smoke detector, unless ambient conditions dictate the need for another type of automatic fire detection in accordance with 21.3.10. Refer to the commentary following 21.3.3.1 and 21.3.3.2 for additional discussion.

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Chart 2.27.3.2.1(a)
Excerpts From NFPA 72®-2019 Handbook: Elevator Phase I Emergency Recall Operation (Cont'd)

Some of the requirements in 2.27.3.2 of ANSI/ASME A17.1/CSA B44 use the phrase "in jurisdictions not enforcing the NBCC." There are some differences in how the *National Building Code of Canada (NBCC)* approaches the actuation of elevator recall by fire alarm initiating devices. Users of the *NBCC* should consult both the *NBCC* and ASME A17.1/CSA B44 rather than *NFPA 72* for fire alarm or signaling systems installation and interface requirements.

Some jurisdictions in the United States amend the requirements in ASME A17.1/CSA B44. System designers should consult with their local authority having jurisdiction to determine if any amendments exist and refer to the specific details of these amendments as a part of the design process.

21.3.2* In facilities without a required building fire alarm system, fire alarm initiating devices used to initiate elevator Phase I Emergency Recall Operation shall be connected to either a nonrequired building fire alarm system or a dedicated function fire alarm control unit that shall be designated as "elevator recall control and supervisory control unit," permanently identified on the dedicated function fire alarm control unit and on the record drawings.

A.21.3.2 In facilities without a building alarm system, dedicated function fire alarm control units are required by 21.3.2 for elevator recall in order that the elevator recall systems be monitored for integrity and have primary and secondary power meeting the requirements of this Code.

The fire alarm control unit used for this purpose should be located in an area that is normally occupied and should have audible and visible indicators to annunciate supervisory (elevator recall) and trouble conditions; however, no form of general occupant notification or evacuation signal is required or intended by 21.3.2.

Where elevator recall is required in buildings that do not have and are not required to have a fire alarm or signaling system, a nonrequired building fire alarm system or a dedicated function FACU designated and permanently labeled as the "Elevator Recall Control and Supervisory Control Unit" must be used. This serves the fire alarm initiating devices used for Elevator Phase I Emergency Recall Operation or elevator power shutdown and is intended solely to provide signals to the elevator controller for elevator recall or shutdown. This does not trigger the need to install any additional alarm initiating devices other than those specifically required by *NFPA 72*.

The elevator recall control and supervisory control unit should be placed in an area that is constantly attended for monitoring, especially when it is installed as a stand-alone control.

21.3.3 Phase I Emergency Recall Operation Initiation.

21.3.3.1 Unless otherwise permitted by 21.3.3.2 or required by the authority having jurisdiction, only the elevator lobby, elevator hoistway, elevator machine room, elevator machinery space, elevator control room, and elevator control space smoke detectors or other automatic fire detection as permitted by 21.3.10 shall be used to initiate Elevator Phase I Emergency Recall Operation.

Unless otherwise required by the authority having jurisdiction, only the specified fire alarm initiating devices are permitted to initiate Elevator Phase I Emergency Recall Operation.

While the more traditional term *elevator machine room* is used, some elevators now being installed are machine-room-less elevators, and ASME A17.1/CSA B44 requires fire alarm initiating devices to be installed in the associated spaces for these types of elevators. Where elevator configurations include these spaces, smoke detectors or other automatic fire alarm initiating devices as permitted by 21.3.10 must be installed.

Δ **21.3.3.2** A waterflow switch shall be permitted to initiate Elevator Phase I Emergency Recall Operation upon activation of a sprinkler installed at the bottom of the elevator hoistway (the elevator pit), provided the waterflow switch and pit sprinkler are installed on a separately valved sprinkler line dedicated solely for protecting the elevator pit.

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Chart 2.27.3.2.1(a)
Excerpts From NFPA 72®-2019 Handbook: Elevator Phase I Emergency Recall Operation (Cont'd)

Waterflow switches are permitted to initiate Elevator Phase I Emergency Recall Operation when sprinklers are in the elevator pit. (Refer to the commentary following A.21.3.8 for a discussion on when automatic sprinklers are needed in the elevator hoistway, including the elevator pit.) The 2022 edition of the Code permits a waterflow switch serving only the pit sprinkler to have a time delay in order to reduce nuisance alarm activations. This does not apply to applications of sprinklers protecting the top of the elevator hoistway. In addition, where the conditions of installation require elevator shutdown because of sprinklers in the elevator pit, the use of a waterflow switch for elevator recall might not be advisable. Elevator shutdown is required to occur on or before activation of the sprinklers. The use of a waterflow switch for Elevator Phase I Emergency Recall Operation in that situation might have little effect because power could be removed from the elevator at the same time. Refer to the commentary following Section 21.4 and 21.4.1 for a discussion of the need for elevator shutdown and the intended sequence of operation.

21.3.4 Each fire alarm initiating device used to initiate elevator Phase I Emergency Recall Operation shall be capable of initiating the elevator recall function when all other devices on the same initiating device circuit have been manually or automatically placed in the alarm condition.

Some systems cannot ensure that the individual smoke detector or relay responsible for initiating Elevator Phase I Emergency Recall Operation will be able to actuate if other devices on the circuit have already actuated. This concern is prevalent with conventional (i.e., zoned or nonaddressable) fire alarm or signaling systems, specifically two-wire initiating device circuits (IDCs) where the power for the devices (i.e., smoke detector or relay responsible for initiating recall) is carried over the same pair of wires as the monitoring for initiation. For this reason, listing agencies often will permit only one conventional two-wire smoke detector with a relay base to be on an IDC. Also see Item 17(7)(h) of Table 14.4.3.2 for testing.

Unless the smoke detectors are installed on individual IDCs without any other fire alarm devices installed on those circuits, the smoke detectors should be powered separately from the IDC. This is usually not the case for smoke detectors installed on signaling line circuits (SLCs), as they are addressable and circuit power is always available. Refer to the manufacturer's installation instructions.

21.3.5* Elevator Lobby Detector Location.

A.21.3.5 Smoke detectors should not be installed in outdoor locations or locations that are open to the weather (such as unenclosed elevator lobbies in open parking structures), because such environments can exceed the parameters of the detector listing and can result in unwanted alarms. *(See 21.3.10.)*

21.3.5.1 A lobby smoke detector shall be located on the ceiling within 21 ft (6.4 m) of the centerline of each elevator door within the elevator bank under control of the detector.



What is the basis of the 21 ft (6.4 m) requirement in 21.3.5.1?

In Chapter 17, the spacing requirements for smoke detectors require that all points on smooth ceilings have a smoke detector within a distance equal to or less than 0.7 times the nominal spacing of the detector. On smooth ceilings, 17.7.4.2.3.1 requires a nominal spacing of 30 ft (9.1 m) unless specific performance-based design criteria require different spacing. The value of 21 ft (6.4 m) specified in 21.3.5.1 correlates with this spacing [30 ft × 0.7 = 21 ft (9.1 m × 0.7 = 6.4 m)] and ensures that a smoke detector will be within 21 ft (6.4 m) of the centerline of the elevator door. High or non-smooth ceilings may require a different spacing.

A smoke detector is not required to be located immediately adjacent to elevator doors. In addition, an individual smoke detector is not required for each elevator in a bank of elevators as long as a detector is within 21 ft (6.4 m) of the centerline of each door. See Exhibit 21.2 for an illustration of the 21 ft (6.4 m) requirement.

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Chart 2.27.3.2.1(a)
Excerpts From NFPA 72®-2019 Handbook: Elevator Phase I Emergency Recall Operation (Cont'd)

Paragraph 21.3.5.2 directs users to Chapter 17 for detector locations where ceiling configurations are other than level, smooth ceilings and where ceiling heights exceed 15 ft (4.6 m). Subsection 17.4.8 addresses situations such as elevator lobbies with high ceilings. It permits locating smoke detectors close to an object or a space if it is the intent that action be initiated when smoke or fire threatens that object or space [e.g., on the wall above and within 60 in. (1.52 m) from the top of the elevator door(s)]. Refer to A.17.4.8 for further explanation.

21.3.5.2 For lobby ceiling configurations exceeding 15 ft (4.6 m) in height or that are other than flat and smooth, detector locations shall be determined in accordance with Chapter 17.

Δ **21.3.6 Fire Detection in Unsprinklered Elevator Hoistways.**

N **21.3.6.1** Smoke detectors or other automatic fire detection as permitted in 21.3.10 shall not be installed in unsprinklered elevator hoistways unless they are required by ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, to initiate Elevator Phase I Emergency Recall Operation as specified in 21.3.14.1(2) and 21.3.14.2(2) for either of the following:

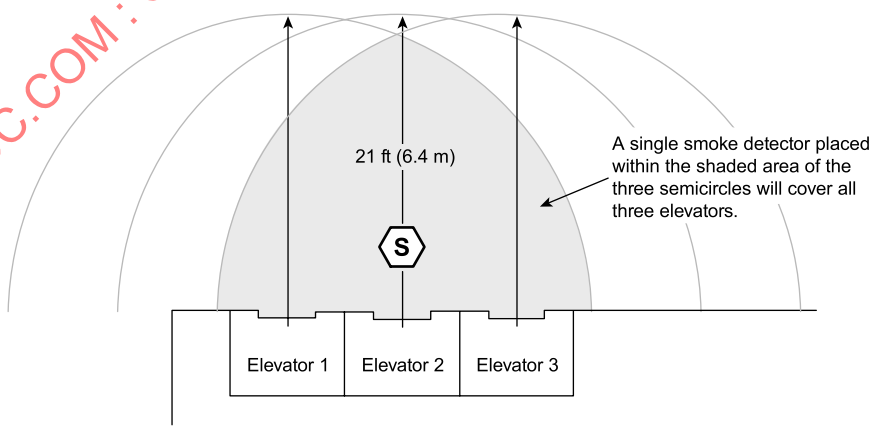
(1) Hoistway machinery spaces containing a motor controller or driving machine
(2) Control spaces located in the hoistway

For the 2022 edition of the Code, text revisions were made to 21.3.6.1 through 21.3.6.3 to avoid conflicts with ASME A17.1/CSA B44. The resulting language specifically prohibits the installation of smoke detectors in unsprinklered elevator hoistways unless required by ASME A17.1/CSA B44 to initiate Elevator Phase I Emergency Recall Operation as specified in 21.3.14.1(2) and 21.3.14.2(2), or where required by other codes and standards for the actuation of elevator hoistway smoke relief equipment. If sprinklers are installed in the hoistway, then the smoke detector (or other automatic fire alarm initiating device) is necessary to provide the required recall feature. Refer to the commentary following A.21.3.8 for a discussion of when automatic sprinklers are needed in the elevator hoistway.

N **21.3.6.2** Smoke detectors or other automatic fire detection as permitted in 21.3.10 shall be permitted to be installed in unsprinklered elevator hoistways if required by other governing codes or standards for the actuation of the elevator hoistway smoke relief equipment.

N **21.3.6.3** Detectors installed in accordance with 21.3.6.2 shall initiate Elevator Phase I Emergency Recall Operation as specified in 21.3.14.1(2) and 21.3.14.2(2).

EXHIBIT 21.2



Smoke Detector Installed Within 21 ft (6.4 m) of Elevator Door.

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Chart 2.27.3.2.1(a)
Excerpts From NFPA 72®-2019 Handbook: Elevator Phase I Emergency Recall Operation (Cont'd)

21.3.7* Fire Alarm Initiating Device(s) Inside Elevator Hoistways. Fire alarm initiating device(s) required to be installed inside an elevator hoistway by other sections of this Code or by other governing laws, codes, or standards shall be required to be accessible for service, testing, and maintenance from outside the elevator hoistway.

A.21.3.7 Since it is permitted by ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, to have access for fire alarm initiating devices installed inside elevator hoistways, the following are examples for proposed methods for providing such access (other methods could be acceptable if approved by the authority having jurisdiction):

(1) Provide an access hatch door and associated protective guard for a spot type fire detector, where the fire detector is installed within the protective guard.
(2) Provide an air sampling-type detector as specified in 17.7.4.6 installed outside the hoistway with its sampling tube installed to sample the air within the hoistway.
(3) If heat detection is required, linear heat detectors with connection points located outside the hoistway or spot type heat detectors installed in accordance with A.21.3.7(1) are acceptable.
(4) If a waterflow switch is provided per 21.3.3.2, install the waterflow switch outside the hoistway. The use of a time delay capability for this device is acceptable in order to ensure that water supply pressure fluctuations do not initiate unwanted Elevator Phase I Emergency Recall Operation.

Historically, fire alarm service personnel needed to ride the elevator or lean into the open door of the hoistway to perform routine inspection, testing, and maintenance tasks. List item (4) was added to A.21.3.7 for the 2022 edition and corresponds with 21.3.3.2, which is also new for the 2022 edition. The new annex material makes clear that the waterflow switch should not be installed within the hoistway unless it can be serviced, tested, or maintained by a technician from outside of the hoistway. This new requirement for access from outside the elevator hoistway improves the safety of these inspection, testing, and maintenance tasks.

21.3.8* When sprinklers are required in elevator hoistways by other codes and standards, fire alarm initiating devices shall be installed to initiate Elevator Phase I Emergency Recall Operation in accordance with ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators,* and the following shall apply:

(1) Where sprinklers are located at the top of the hoistway, associated fire detection device(s) shall be located at the top of the hoistway.
(2) Where sprinklers are located at the bottom of the hoistway (the pit), associated fire detection device(s) shall be installed in the pit in accordance with Chapter 17.
(3) Outputs from the fire alarm system to the elevator system shall comply with 21.3.14.
(4) The fire alarm initiating device(s) shall be installed in accordance with Chapter 17.

A.21.3.8 This requirement applies to smoke and heat detectors installed in the hoistway. It is important to note that the hoistway includes the pit. The location of smoke or heat detectors will, most likely, require special consideration in order to provide the intended response of early detection of fire in the elevator pit. The location of these detectors will likely need to be below the lowest level of recall in order to provide an adequate response. Since there is no real ceiling at this location to allow installation using the spacing provisions of Chapter 17, the provisions of 17.7.4.1.3 and 17.4.8 should be considered, which allows detectors to be placed closer to the hazard in a position where the detector can intercept the smoke or heat. Also refer to A.21.3.14.2(3).

Subsection 21.3.8(2) addresses the location of fire alarm initiating devices when sprinklers are installed in the elevator pit. A revision was made to the 2022 edition of the Code in 21.3.8(1) and 21.3.8(2) by replacing the word *the* with *associated*. This change attempts to make clear that the detectors located

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Chart 2.27.3.2.1(a)
Excerpts From NFPA 72®-2019 Handbook: Elevator Phase I Emergency Recall Operation (Cont'd)

at the top of the hoistway are only associated with the requirements in the Code for the top of the hoistway, while the detectors in the pit area are only associated with the requirements for the pit area. The need to have sprinklers installed in the elevator hoistway, including the elevator pit, is established by the following requirements in 9.3.6 of NFPA 13, *Standard for the Installation of Sprinkler Systems*:

NFPA 13 (2022)

9.3.6 Elevator Machine Rooms, Machinery Spaces, Control Rooms, Control Spaces, and Hoistways.

9.3.6.1* Sidewall spray sprinklers shall be installed at the bottom of each elevator hoistway not more than 2 ft (600 mm) above the floor of the pit.

A.9.3.6.1 The sprinklers in the pit are intended to protect against fires caused by debris, which can accumulate over time. Ideally, the sprinklers should be located near the side of the pit below the elevator doors, where most debris accumulates. However, care should be taken that the sprinkler location does not interfere with the elevator toe guard, which extends below the face of the door opening.

9.3.6.2 The sprinkler required at the bottom of the elevator hoistway by 9.3.6.1 shall not be required for enclosed, noncombustible elevator shafts that do not contain combustible hydraulic fluid.

9.3.6.3 Automatic fire sprinklers shall not be required in elevator machine rooms, machinery spaces, control rooms, control spaces, or hoistways of traction elevators installed in accordance with the applicable provisions in NFPA *101,* or the applicable building code, where all of the following conditions are met:

(1) The elevator machine room, machinery space, control room, control space, or hoistway of traction elevator is dedicated to elevator equipment only.
(2) The elevator machine room, machinery space, control room, control space, or hoistway of traction elevators are protected by smoke detectors, or other automatic fire detection, installed in accordance with *NFPA 72* or other approved fire alarm code.
(3) The elevator machinery space, control room, control space, or hoistway of traction elevators is separated from the remainder of the building by walls and floor/ceiling or roof/ceiling assemblies having a fire resistance rating of not less than that specified by the applicable building code.
(4) No materials unrelated to elevator equipment are permitted to be stored in elevator machine rooms, machinery spaces, control rooms, control spaces, or hoistways of traction elevators.
(5) The elevator machinery is not of the hydraulic type.

9.3.6.4* Automatic sprinklers in elevator machine rooms, machinery spaces, control rooms, control spaces, or hoistways shall be standard response.

A.9.3.6.4 ASME A17.1, *Safety Code for Elevators and Escalators,* requires the shutdown of power to the elevator upon or prior to the application of water in elevator machine rooms or hoistways. This shutdown can be accomplished by a detection system with sufficient sensitivity that operates prior to the activation of the sprinklers (see also *NFPA 72 or other approved fire alarm code*). As an alternative, the system can be arranged using devices or sprinklers capable of effecting power shutdown immediately upon sprinkler activation, such as a waterflow switch without a time delay. This alternative arrangement is intended to interrupt power before significant sprinkler discharge.

9.3.6.5 Upright, pendent, or sidewall spray sprinklers shall be installed at the top of elevator hoistways.

9.3.6.6* The sprinklers required at the top of the elevator hoistway by 9.3.6.5 shall not be required where the hoistway for passenger elevators is noncombustible or limited-combustible and the car enclosure materials meet the requirements of ASME A17.1, *Safety Code for Elevators and Escalators.*

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Chart 2.27.3.2.1(a)
Excerpts From NFPA 72®-2019 Handbook: Elevator Phase I Emergency Recall Operation (Cont'd)

NFPA 13 (2022) *(Continued)*

A.9.3.6.5 Passenger elevator cars that have been constructed in accordance with ASME A17.1, *Safety Code for Elevators and Escalators,* Rule 204.2a (under A17.1a-1985 and later editions of the code) have limited combustibility. Materials exposed to the interior of the car and the hoistway, in their end-use composition, are limited to a flame spread index of 0 to 75 and a smoke-developed index of 0 to 450, when tested in accordance with ASTM E84, *Standard Test Method of Surface Burning Characteristics of Building Materials.*

The requirements of NFPA 13 prescribe two basic locations for sprinklers in the elevator hoistway: the bottom of the hoistway (i.e., the elevator pit) and the top of the hoistway (see 9.3.6.1 and 9.3.6.5 in NFPA 13, respectively). The related paragraphs in 9.3.6 of NFPA 13 include detailed conditions that affect whether sprinklers are required in these locations. The design professionals responsible for the sprinkler system installation should be consulted to determine the sprinklers that will be provided for a given application.

System Design Tip

FAQ Are automatic fire alarm initiating devices required to be installed in elevator pits?

If sprinklers are installed in the elevator hoistway, ASME A17.1/CSA B44 requires fire alarm initiating devices to be installed in the hoistway to initiate elevator recall. An important note is that the elevator "pit" is part of the hoistway. ASME A17.1/CSA B44 defines *hoistway* (shaft), elevator, dumbwaiter, or material lift as "an opening through a building or structure for the travel of elevators, dumbwaiters, or material lifts, extending from the pit floor to the roof or floor above." If sprinklers are in the elevator pit, automatic fire alarm initiating devices are required to initiate elevator recall and, in accordance with 21.3.8, are located in the elevator pit.

Fire protection professionals have been hesitant to install fire alarm initiating devices in elevator pits, citing that they are not required or the environment is unacceptable for detectors. Subsection 21.3.8 clarifies that automatic fire alarm initiating devices are required to initiate elevator recall when sprinklers are installed in the elevator pit, even if sprinklers are not located at the top of the hoistway. Paragraph 21.3.14.2(3) correlates with the requirements of ASME A17.1/CSA B44 and applies in cases where initiating devices are located below the lowest level of recall so that the elevator will be recalled up and away from the fire hazard in the pit. Paragraph 21.3.3.2 permits the use of a waterflow switch to meet this detection requirement. However, if elevator shutdown is also required, refer to the cautionary commentary following 21.3.3.2.

System Design Tip

21.3.9* Smoke detectors shall not be installed in elevator hoistways to initiate Elevator Phase I Emergency Recall Operation unless listed for the environmental conditions.

The environment in elevator hoistways, and especially in elevator pits, is generally not suitable for the installation of most smoke detectors. However, some smoke detectors are designed and listed for installation in such environments and can be installed in those locations.

A.21.3.9 It should be noted that smoke detectors installed in hoistways can be a source of nuisance activation. Therefore, hoistways need smoke detectors specifically intended for those types of spaces (environments).

21.3.10* If ambient conditions prohibit installation of automatic smoke detection used to initiate elevator Phase I Emergency Recall Operation, other automatic fire detection initiating devices shall be permitted.

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Chart 2.27.3.2.1(a)
Excerpts From NFPA 72®-2019 Handbook: Elevator Phase I Emergency Recall Operation (Cont'd)

Some elevator lobbies, hoistways, and machine rooms are not suitable environments for the installation of spot-type smoke detectors. Dust, dirt, humidity, and temperature extremes may exceed the operating parameters of the smoke detector. A spot-type smoke detector installed in the elevator lobby of an unheated parking garage would likely experience problems due to vehicle exhaust, dust, dirt, humidity, and temperature extremes. Subsection 21.3.10 prevents nuisance alarms from smoke detectors installed in such areas and unnecessary initiation of Elevator Phase I Emergency Recall Operation. Another type of fire detector may be substituted for a smoke detector where the authority having jurisdiction or another code requires detection in an area with ambient conditions unsuitable for a smoke detector. Also refer to 21.3.9.

A.21.3.10 The objective of elevator Phase I Emergency Recall Operation is to have the elevator automatically return to the recall level before fire can affect the safe operation of the elevator. This includes both the safe mechanical operation of the elevator, as well as the delivery of passengers to a safe lobby location. Where ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, specifies the use of fire alarm initiating devices used to initiate Phase I Emergency Recall Operation, these devices are expected to provide the earliest response to situations that would require Phase I Emergency Recall Operations. The use of other automatic fire detection is only intended where smoke detection would not be appropriate due to the environment. Where ambient conditions prohibit the installation of smoke detectors, the selection and location of other automatic fire detection should be evaluated to ensure the best response is achieved. When heat detectors are used, consideration should be given to both detector temperature and time lag characteristics (Response Time Index). The consideration of a low temperature rating alone might not provide the earliest response. It should be noted that smoke detectors installed in hoistways can be a source of nuisance activation. Therefore, hoistways need smoke detectors specifically intended for those types of spaces (environments). Performance-based selection of specific automatic fire detection suitable for elevator hoistways can be based on Annex B as acceptable to the authority having jurisdiction.

21.3.11 When actuated, any fire alarm initiating device that is used to initiate elevator Phase I Emergency Recall Operation shall be annunciated at the building fire alarm control unit or at the fire alarm control unit described in 21.3.2.

21.3.12 Actuation of the elevator hoistway, elevator machine room, elevator machinery space, elevator control space, or elevator control room smoke detectors or other automatic fire detection as permitted by 21.3.10 shall cause separate and distinct visible annunciation at the building fire alarm control unit or at the fire alarm control unit described in 21.3.2.

An elevator hoistway smoke detector (if one is present) and the elevator machine room, elevator machinery space, elevator control space, or elevator control room smoke detector(s) must be connected to the building FACU or the elevator recall control and supervisory control unit. Refer to A.21.3.14.1 and the associated commentary regarding the elevator warning signal.

21.3.13 Where approved by the authority having jurisdiction, the detectors used to initiate Elevator Phase I Emergency Recall Operation shall be permitted to initiate a supervisory signal in lieu of an alarm signal.

This allowance is provided to minimize nuisance alarms from smoke detectors in these areas. This option should be used only where trained personnel are constantly in attendance and can immediately respond to the supervisory signal. A means should be provided to initiate the fire alarm signal if investigation of the supervisory signal indicates that building evacuation is necessary.

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Chart 2.27.3.2.1(a)
Excerpts From NFPA 72®-2019 Handbook: Elevator Phase I Emergency Recall Operation (Cont'd)

21.3.14 The following three separate outputs from the building fire alarm control unit or the fire alarm control unit described in 21.3.2 to the elevator system shall be provided to implement Elevator Phase I Emergency Recall Operation in accordance with Section 2.27 of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, as required in 21.3.14.1 and 21.3.14.2:

(1) Designated level associated output
(2) Alternate level associated output
(3) Elevator machine room, elevator machinery space, elevator control space, or elevator control room associated output

Subsection 21.3.14 addresses requirements for fire alarm or signaling system outputs to the elevator controller(s) and correlates with the Elevator Phase I Emergency Recall Operation requirements of ASME A17.1/CSA B44. This subsection is divided into three subparagraphs to address the three outputs involved: designated level recall, alternate level recall, and elevator warning signal.

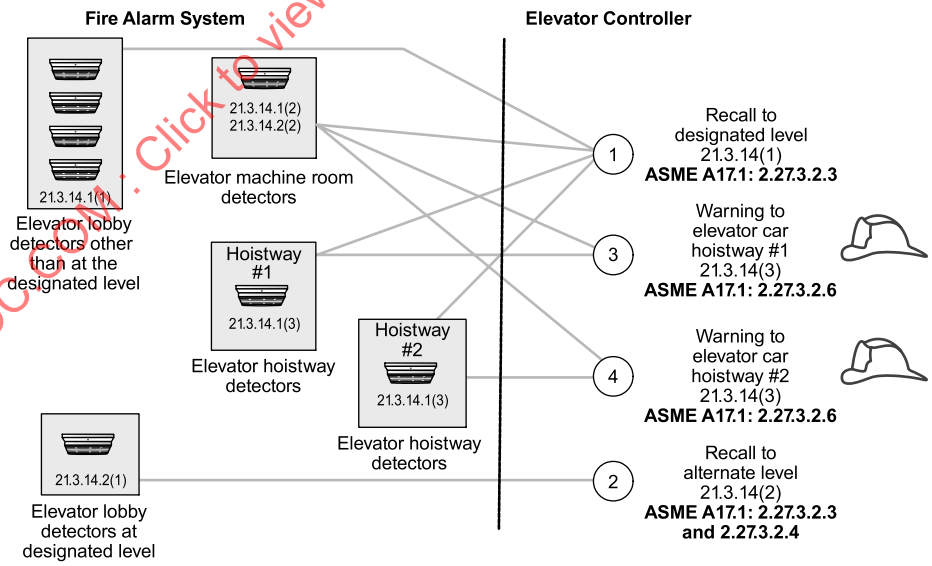
The requirements in Section 2.27 of ASME A17.1/CSA B44 specify the conditions required to cause recall to the designated level or to the alternate level. The location of the initial fire alarm initiating device actuated determines which of the two recall levels will be used. Requirements for the elevator warning signal are also provided in Section 2.27. Refer to the commentary following 21.3.1 for an excerpt of the related ASME A17.1/CSA B44 requirements.

FAQ How are the designated and alternate levels determined?

The building code or authority having jurisdiction assigns the floors that are to be used as the designated level and the alternate level. The designated level is usually, but not always, the lowest recall level.

Exhibit 21.3 shows a typical arrangement in which the designated level is the lowest recall level, the machine room is not located at the designated level, and the hoistway fire alarm initiating devices are not at or below the designated level. (Note: This exhibit shows the relationship of signals and should not be used as a wiring diagram.)

EXHIBIT 21.3



Note: NFPA 72, NFPA 13, and ASME A17.1 must be used jointly.

Detectors for Control of Elevator. (Courtesy of Johnson Controls, Westminster, MA)

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Chart 2.27.3.2.1(a)
Excerpts From NFPA 72®-2019 Handbook: Elevator Phase I Emergency Recall Operation (Cont'd)

21.3.14.1* Elevator Phase I Emergency Recall Operation to Designated Level. For each elevator or group of elevators operating in a group automatic operation, an output shall be provided from the fire alarm system to the elevator system in response to the following:

(1) Activation of smoke detector(s) or other automatic fire detection as permitted by 21.3.10 located at any associated elevator(s) lobby other than the lobby at the designated level
(2) Activation of smoke detector(s) or other automatic fire detection as permitted by 21.3.10 located at any associated elevator(s) machine room, elevator machinery space containing a motor controller or driving machine, elevator control space, or elevator control room, except where such rooms or spaces are located at the designated level
(3) Activation of smoke detector(s) or other automatic fire detection as permitted by 21.3.10 located at any associated elevator(s) hoistway when sprinklers are located in those hoistways, unless otherwise specified in 21.3.14.2(3)

The fire alarm or signaling system output for designated level recall is required when any of the conditions described in 21.3.14.1(1) through 21.3.14.1(3) occur. These conditions relate to Section 2.27 of ASME A17.1/CSA B44. Refer to the commentary following 21.3.1 for an excerpt of the related ASME A17.1/CSA B44 requirements. Also, refer to Exhibit 21.3 for detectors used for elevator recall.

A.21.3.14.1 Refer to the definition of *Group Automatic Operation* in ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.

In addition to performing elevator Phase I Emergency Recall Operation to the Designated Level, the elevator system, upon receiving the fire alarm system output specified in 21.3.14.1(1), 21.3.14.1(2), or 21.3.14.1(3), will also actuate the elevator car visual signal (fire fighter's hat) in accordance with ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.

Each elevator car is equipped with a visual signal in the form of a fire fighter's fire hat. Section 2.27.3.1.6(h) and Figure 2.27.3.1.6(h) of ASME A17.1/CSA B44, shown in Exhibit 21.4(a), provide the requirements for the appearance of the fire fighter's fire hat symbol shown in Exhibit 21.4(b). Old elevator cars or those that are in jurisdictions with other requirements might have a different symbol in the elevator car, such as a Maltese cross or a fire service symbol, shown respectively in Exhibit 21.4(c) and Exhibit 21.4(d). Although these symbols appear different from Exhibit 21.4(b), they should function in the same manner.

When recall is initiated by the elevator controller because of an actuated fire alarm initiating device located in the elevator machine room, machinery space, control space, control room, or hoistway, the fire hat "illuminates intermittently" (i.e., flashes) as a warning that conditions in these locations could inhibit elevator operation. Fire fighters are permitted to use their own judgment as to whether to continue to use the elevator based on the fire conditions. This function is often referred to as "flashing hat" in the fire protection industry. Most often, the fire alarm or signaling system provides a steady output to the elevator controller, and the elevator controller causes the visual signal to illuminate intermittently as required by Section 2.27 of ASME A17.1/CSA B44.

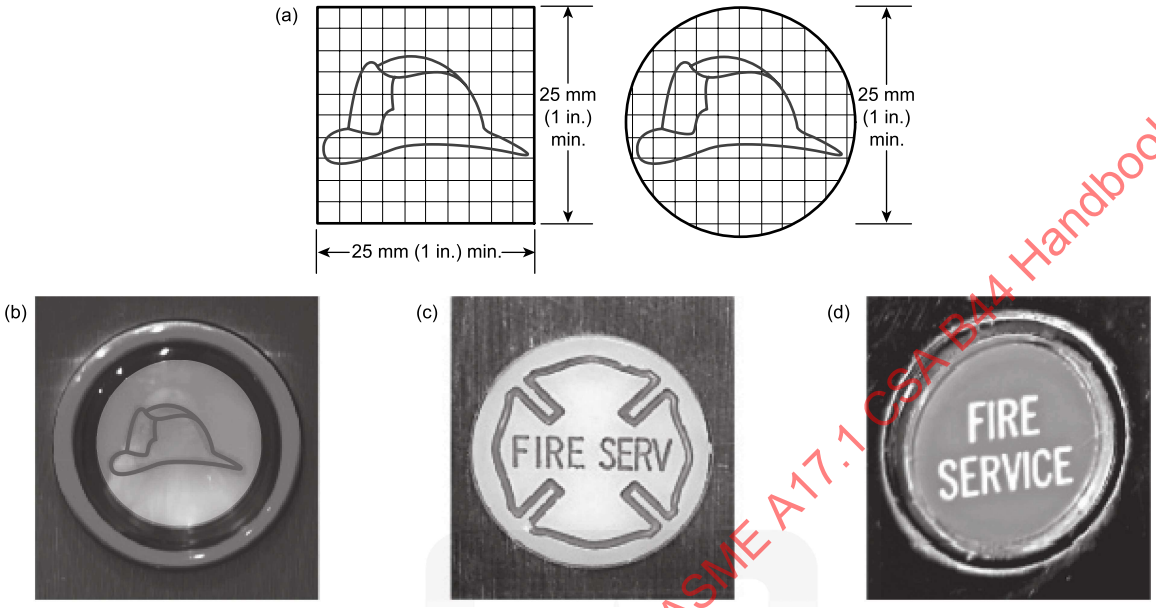
21.3.14.2* Elevator Phase I Emergency Recall Operation to Alternate Level. For each elevator or group of elevators operating in a group automatic operation, an output shall be provided from the fire alarm system to the elevator system in response to the following:

(1) Activation of smoke detector(s), or other automatic fire detection as permitted by 21.3.10, located at the designated level lobby served by the elevator(s)
(2) Activation of smoke detector(s), or other automatic fire detection as permitted by 21.3.10, located in the elevator machine room, elevator machinery space containing a motor controller or driving machine, elevator control space, or elevator control room serving the elevator(s) if such rooms or spaces are located at the designated level

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Chart 2.27.3.2.1(a)
Excerpts From NFPA 72®-2019 Handbook: Elevator Phase I Emergency Recall Operation (Cont'd)

EXHIBIT 21.4



Visual Symbols. (a) Fire Fighter's Hat Symbol [Source: ASME A17.1/CSA B44, Figure 2.27.3.1.6(h) Visual Signal], (b) Fire Fighter's Hat Symbol, (c) Maltese Cross Symbol, and (d) Fire Service Symbol.

(3)* Activation of the fire alarm initiating device(s) identified in 21.3.14.1(3) if they are installed at or below the lowest level of recall in the elevator hoistway and the alternate level is located above the designated level

The fire alarm or signaling system output for alternate level recall is required when any of the conditions described in 21.3.14.2(1) through 21.3.14.2(3) occur. The first two conditions are similar to those of 21.3.14.1(1) and 21.3.14.1(2), except that they apply where the locations are at the dedicated level. The condition in 21.3.14.2(3) is unique in that it applies where fire alarm initiating devices are installed in the elevator hoistway at or below the lowest level of recall and the alternate level of recall is located above the designated level. Paragraph A.21.3.14.2(3) provides further explanation concerning this condition. Also, refer to Exhibit 21.3 for detectors used for elevator recall.

Regarding 21.3.14.1(3), the installation of smoke detectors or other automatic fire alarm initiating devices in hoistways as permitted by 21.3.10 depends on whether sprinklers are located in the hoistways. The decision to have sprinklers in a hoistway is determined by the requirements of NFPA 13. Refer to the commentary following A.21.3.8 and the excerpt from NFPA 13.

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Chart 2.27.3.2.1(b)
Fire Alarm/Elevator Recall Matrix (Including Visual Signal)

Fire Alarm Initiating Device Location	Recall to Designated or Alternate Level	ASME A17.1-2022/ CSA B44-22	NFPA 72®-2022	NFPA 72®-2022 Requirement [Note (1)]
Elevator lobby [served by the elevator(s)] on any building floor except at designated level	Designated level	2.27.3.2.3(a)	21.3.14.1(1)	**Elevator Phase I Emergency Recall Operation to Designated Level.** For each elevator or group of elevators operating in a group automatic operation, an output shall be provided from the fire alarm system to the elevator system in response to the following: (1) Activation of smoke detector(s) or other automatic fire detection as permitted by 21.3.10 located at any associated elevator(s) lobby other than the lobby at the designated level
Elevator lobby [served by the elevator(s)] at designated level	Alternate level	2.27.3.2.4(a)	21.3.14.2(1)	**Elevator Phase I Emergency Recall Operation to Alternate Level.** For each elevator or group of elevators operating in a group automatic operation, an output shall be provided from the fire alarm system to the elevator system in response to the following: (1) Activation of smoke detector(s), or other automatic fire detection as permitted by 21.3.10, located at the designated level lobby served by the elevator(s)
Machine room, control room, control space elevator(s)] (not at designated level)	Designated level [Note (2)]	2.27.3.2.3(b)	21.3.14.1(2)	**Elevator Phase I Emergency Recall Operation to Designated Level.** For each elevator or group of elevators operating in a group automatic operation, an output shall be provided from the fire alarm system to the elevator system in response to the following: (2) Activation of smoke detector(s) or other automatic fire detection as permitted by 21.3.10 located at any associated elevator(s) machine room, elevator machinery space containing a motor controller or driving machine, elevator control space, or elevator control room, except where such rooms or spaces are located at the designated level

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Chart 2.27.3.2.1(b)
Fire Alarm/Elevator Recall Matrix (Including Visual Signal) (Cont'd)

Fire Alarm Initiating Device Location	Recall to Designated or Alternate Level	ASME A17.1-2022/ CSA B44-22	NFPA 72®-2022	NFPA 72®-2022 Requirement [Note (1)]
Machine room, control room, control space [serving the elevator(s)] (at designated level)	Alternate level [Note (2)]	2.27.3.2.3(b)	21.3.14.2(2)	**Elevator Phase I Emergency Recall Operation to Alternate Level.** For each elevator or group of elevators operating in a group automatic operation, an output shall be provided from the fire alarm system to the elevator system in response to the following: (2) Activation of smoke detector(s), or other automatic fire detection as permitted by 21.3.10, located in the elevator machine room, elevator machinery space containing a motor controller or driving machine, elevator control space, or elevator control room serving the elevator(s) if such rooms or spaces are located at the designated level
Hoistway (serving the elevator) (above lowest recall level)	Designated level [Note (2)]	2.27.3.2.3(c)	21.3.14.1(3)	**Elevator Phase I Emergency Recall Operation to Designated Level.** For each elevator or group of elevators operating in a group automatic operation, an output shall be provided from the fire alarm system to the elevator system in response to the following: (3) Activation of smoke detector(s) or other automatic fire detection as permitted by 21.3.10 located at any associated elevator(s) hoistway when sprinklers are located in those hoistways, unless otherwise specified in 21.3.14.2(3)
Hoistway (serving the elevator) (at or below lowest recall level)	Higher of alternate or designated level [Note (2)]	2.27.3.2.3(c)	21.3.14.2(3)	**Elevator Phase I Emergency Recall Operation to Alternate Level.** For each elevator or group of elevators operating in a group automatic operation, an output shall be provided from the fire alarm system to the elevator system in response to the following:

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Chart 2.27.3.2.1(b)
Fire Alarm/Elevator Recall Matrix (Including Visual Signal) (Cont'd)

Fire Alarm Initiating Device Location	Recall to Designated or Alternate Level	ASME A17.1-2022/ CSA B44-22	NFPA 72®-2022	NFPA 72®-2022 Requirement [Note (1)]
				(3) Activation of the fire alarm initiating device(s) identified in 21.3.14.1(3) if they are installed at or below the lowest level of recall in the elevator hoistway and the alternate level is located above the designated level

GENERAL NOTE: Courtesy of Edward A. Donoghue and Lee Richardson.

NOTES:
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(2) Visual signal in the car must flash if this is the first device to activate Fire Service (i.e., it does not flash if the Phase I key switch has already initiated Fire Service).

SECTION 2.28
LAYOUT DRAWINGS

2.28.1 Information Required on Layout Drawings

All the necessary layout data has been consolidated in this requirement. The purpose is to require that the elevator company provide the building designer with the forces that the elevator system will impart on the building structure and foundation. With this information, the Authority Having Jurisdiction (regulatory authority) is also in a position to confirm that the elevator is designed to conform to the requirements of ASME A17.1/CSA B44.

2.28.1(b) Requirement ensures elevator personnel have the necessary dimensions to take measurements from the top landing to verify the top car clearance complies with the Code requirements. See Handbook commentary on Section 2.26.

Requirement 2.28.1(k) was added in ASME A17.1-2019/CSA B44:19 to provide information for the location of access panels and guarding allowed by the new requirements in 2.8.2.4 for a means for testing and inspection of fire alarm initiating devices from outside the hoistway.

Requirement 2.28.1(i) was revised in ASME A17.1-2022/CSA B44:22 to correlate with changes made to relocate design requirements for building elements that support hoistway doors to make them applicable to vertical slide doors and swing-type doors.

Several new requirements were also added. Requirement 2.28.1(l) requires the layout drawings to include the location of access panels for ERRC antennas installed in the hoistway (see Handbook commentary on 2.8.7). Requirement 2.28.1(m) added requirements for the location of hoistway lighting (see Handbook commentary on 2.1.7) to ensure running clearances and illumination levels are achieved. Requirement 2.28.1(n) added requirements for the minimum flood elevation (see Handbook commentary on 2.27.13).

SECTION 2.29
IDENTIFICATION

2.29.1 Identification of Equipment

This requirement was revised in ASME A17.1-2013/CSA B44-13 to clarify that the marking requirements related to size of alphanumeric marking and marking methods apply only to those items listed in the proposed 2.29.1.2. Requirement 2.29.1.3 was added to address the possible incorrect operation of these devices due to the lack of proper identification where such devices for multiple elevators are located in the same enclosure. It is also permitted to group these devices with demarcation for identification.

Requirement 2.29.1 was further revised in ASME A17.1-2016/CSA B44-16 to clarify that the requirements for the size of alphanumeric marking and for marking methods apply only to those items listed in 2.29.1.2. The updates cover the marking requirements for equipment located in nontraditional areas and spaces. Panels may not be located in common enclosures but may be mounted in common areas of hallways and lobbies, in any configuration, adjacent to or across from entrances or remotely located in the building not within sight of the elevator. In addition, a requirement was added to ensure that the single unique identification assigned to each elevator is also used as the destination-oriented control car identification.

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The requirement that disconnecting means be numbered when there is more than one driving machine in the machine room, in conjunction with the National Electrical Code® Section 620.51(D) and Canadian Electrical Code Section 38-051(8), provides elevator personnel and emergency personnel with the information necessary to remove power from only one machine without interrupting the power to other equipment.

2.29.2 Identification of Floors

The floor numbers are necessary for elevator personnel when on top of an elevator car.

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Part 3
Hydraulic Elevators

NOTE: Throughout Part 3, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

SCOPE

Part 3 applies to new direct-acting hydraulic elevators and roped-hydraulic elevators. Other types of hydraulic elevators, such as private residence, screw-column, sidewalk, hand, inclined, rack-and-pinion, shipboard, rooftop, limited-use/limited-application and special purpose personnel elevators; elevators used for construction; dumbwaiters; and material lifts reference many of the requirements in Part 3 in their respective Sections of ASME A17.1/CSA B44. Part 3 requirements may also apply when an alteration is made as required by Section 8.7.

Roped-hydraulic elevators were not permitted by A17.1-1955 through A17.1-1988. In the early part of the twentieth century, many multireeved roped-hydraulic elevators were installed. Some were operated by city water pressure, others by hydraulic driving machines. Cylinders were commonly mounted horizontally, as shown in Diagram 8.6.3.2(l), or vertically, as shown in Diagram 8.6.3.2(k).

Elevators reeved with ratios as high as 12:1 were common. One meter or foot of plunger travel resulted in 3.66 m or 12 ft of car rise. If the plunger traveled at 0.305 m/s or 1 ft/sec, the resulting car speed would be 3.6 m/s or 720 ft/min. These installations were plagued with leaks. At this high reeving ratio, a small leak could cause the car to have excessive downward drift when parked for a short period of time.

In those days, interlocks meeting today's code requirements were not required. There were many accidents resulting from people opening the hoistway doors and stepping through the entrance when the car was not there.

Most of these installations had wedge clamp safeties on the car. When the car was on the safety, a mechanic could get on the car with a tee wrench, remove the cover in the floor, and release the safety without realizing the piston had retracted and the hoist ropes were slack.

The directional valves were mechanically operated by an abundance of levers, cams, and other devices that were connected to a lever in the car by a rope or cable. These valves and the operating linkages had a tendency to freeze, causing the car to attempt to exceed its extreme limits of rise, resulting in a catastrophic accident. Many of these valves were later converted to electric solenoid operation, but they still had a tendency to freeze up due to the corrosive action of the water.

On many of these installations, there were also speed-regulating valves installed in the circulating piping that were supposed to regulate the amount of water exiting the hydraulic system so the down car speed would not reach the governor trip speed and set the car safety, regardless of how far the operator pushed the control lever in the car. These valves consisted of a group of levers, cams, and other parts and had a tendency to become gummed up, so they would not open properly and thus slowed the car down considerably. A car that was supposed to be operating at 3.05 m/s or 600 ft/min would sometimes be slowed down to less than 152 m/s or 300 ft/min. These valves were very difficult and expensive to maintain, so in many cases all the internal workings were removed from them, leaving only the housing. When this happened, only the operator had control of the down speed of the elevator car, which then depended on his skill at operating the lever in the car. If the operator lacked the necessary skill, he could cause an unnecessary stop on the car safety or run the car into the pit at a car speed much greater than the designed striking speed of the pit buffers.

It has also been determined that during the time the requirements for the 1955 edition of the Code were being drafted, not a single manufacturer of roped hydraulics had any intention of continuing the product line. The A17 Committee saw no need to spend its time writing requirements for something that was no longer being manufactured. In the mid-1980s, a renewed interest was shown in roped-hydraulic elevators. The A17 Committee was aware of the problem associated with earlier equipment of this design as described above. They were also aware that roped-hydraulic elevators had been safely used in Europe for many years. A study was undertaken and requirements for roped-hydraulic elevators were incorporated in the 1989 Addenda to ASME A17.1.

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SECTION 3.1
CONSTRUCTION OF HOISTWAYS AND HOISTWAY ENCLOSURES

Hoistways must be enclosed as required by the local building code, or if there is no local building code, compliance with one of the following model building codes is required:

(a) International Building Code (IBC)

(b) NFPA 5000®, Building Construction and Safety Code

(c) National Building Code of Canada (NBCC)

Most of the building codes in the United States are based on one of these model building codes. The IBC is the model building code that is widely adopted in the United States. It is published by the International Code Council (ICC). The National Fire Protection Association (NFPA) publishes NFPA 5000®. To the author's knowledge, no major jurisdiction in the United States or Canada had adopted NFPA 5000® as of the publication of this Handbook. The model building code used in Canada is the NBCC, which is promulgated by National Research Council of Canada.

Where fire-resistive construction is required by the building code, the hoistway must comply with the requirements of 2.1.1.1. When non-fire-resistive construction is permitted by the building code, the hoistway must conform to the requirements of 2.1.1.2. Partially enclosed hoistways must conform to the requirements of 2.1.1.3. After determining the type of hoistway construction required, see Handbook commentary related to referenced requirement.

The number of elevators permissible in a hoistway (2.1.1.4) shall be in accordance with the local building code, or if there is no local building code, one of the model building codes listed herein. Requirements are given in 2.1.1 for the strength of the enclosure, construction at the top and bottom of the hoistway, and protection of the hoistway in case of fire.

3.1.1 Strength of Pit Floor

The loads of the cylinder, buffer, and plunger gripper, if provided, have to be considered. As roped-hydraulic elevators are roped 1:2 and have the dead end of the hoist ropes terminated in the pit, rope up-pull also has to be considered.

SECTION 3.4
BOTTOM AND TOP CLEARANCES AND RUNBYS FOR CARS AND COUNTERWEIGHTS

3.4.1 Bottom Car Clearance

The intent of this requirement is to provide safe refuge space for a person under a car. Trenches and depressions or foundation encroachments permitted by 3.4.1.4 (2.2.2) are not considered in determining bottom car clearance. When the car rests on its fully compressed buffer, no part of the car or any equipment attached thereto is permitted to strike any part of the pit or any part of the equipment located therein. It is not the intent of this requirement to consider the hydraulic supply pipe, the cylinder support, or the buffer support channels as the pit floor reference.

The intent of 3.4.1.3 is that there be no encroachment on the floor area in the refuge space. However, in situations where it is necessary for the pipe or beam to encroach the refuge area, the volume is measured from the top of the pipe or beam. The minimum refuge area specified must be provided.

3.4.1.6 Marking of the spaces where refuge clearance is not provided throughout the entire cross-sectional area of the pit, except the area under the apron and guiding means, is required. The marking is the color for danger. This will assist elevator personnel in identifying where the refuge space is located. A sign is also required to notify elevator personnel of the condition.

3.4.2 Minimum Bottom and Top Car Runby

The bottom car runby is the distance between the car buffer striker plate and the striking surface of the car buffer when the car floor is level with the bottom terminal landing. Top car runby for direct-plunger hydraulic elevators is the distance the elevator car can move above its top terminal landing before the plunger strikes its mechanical stop.

The minimum runby is based on the operating speed in the down direction with rated load in the car. These distances allow adequate space for an elevator to stop after passing its top terminal landing without the plunger striking its mechanical stop, and for the car to run past the bottom terminal landing without striking its buffers. See Diagram 3.4.2.

3.4.3 Car Top and Bottom Maximum Runby

The bottom car runby is the distance between the car buffer striker plate and the striking surface of the car buffer when the car floor is level with the bottom terminal landing. The top car runby, for direct-plunger hydraulic elevators, is the distance the elevator car can run above its top terminal landing before the plunger strikes its mechanical stop. The maximum distance for bottom and top car runby ensures that, if the elevator passes its terminal landings, there is adequate space to evacuate the passengers from the stalled elevator through the car entrance. See Diagram 3.4.2.

3.4.5 Top-of-Car Clearances

The requirements provide adequate space for elevator personnel when they are in on top-of-car enclosure and require warning when clearance is inadequate. ISO 15534-3:2000, Ergonomic design for the safety of machinery — Part 3: Anthropometric data,

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anthropometric data was used to establish sufficient space on top of the car for a person when a car is at its maximum upward movement.

See Diagram 2.4.7(a) through 2.4.7(f).

3.4.6 Top Clearance and Bottom Runby of Counterweight

When a counterweight is provided and the car has reached its uppermost limit of travel (the plunger is against its mechanical stop), there must be at least 150 mm or 6 in. of clearance between the bottom of the counterweight and its striking surface. The 150 mm or 6 in. clearance allows for rope stretch. A counterweight buffer is prohibited by 3.22.2. If a counterweight was allowed to strike anything, including a buffer, a slack rope condition could be created.

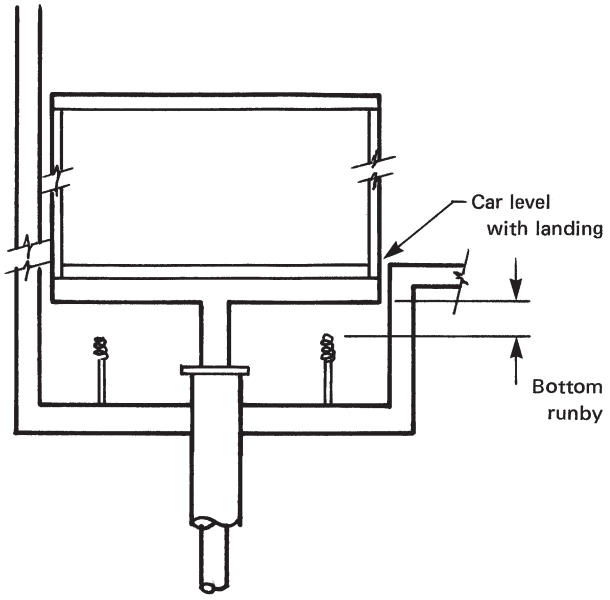
When the car is on its fully compressed buffer, there must be at least 150 mm or 6 in. of clearance between the top of the counterweight and any part of the overhead structure. If a counterweight was allowed to be pulled into the overhead structure, the ropes could separate from the counterweight, allowing it to fall. See Diagrams 3.4.6.1 and 3.4.6.2.

3.4.8 Clearances Above Hydraulic Jack Projecting Above the Car

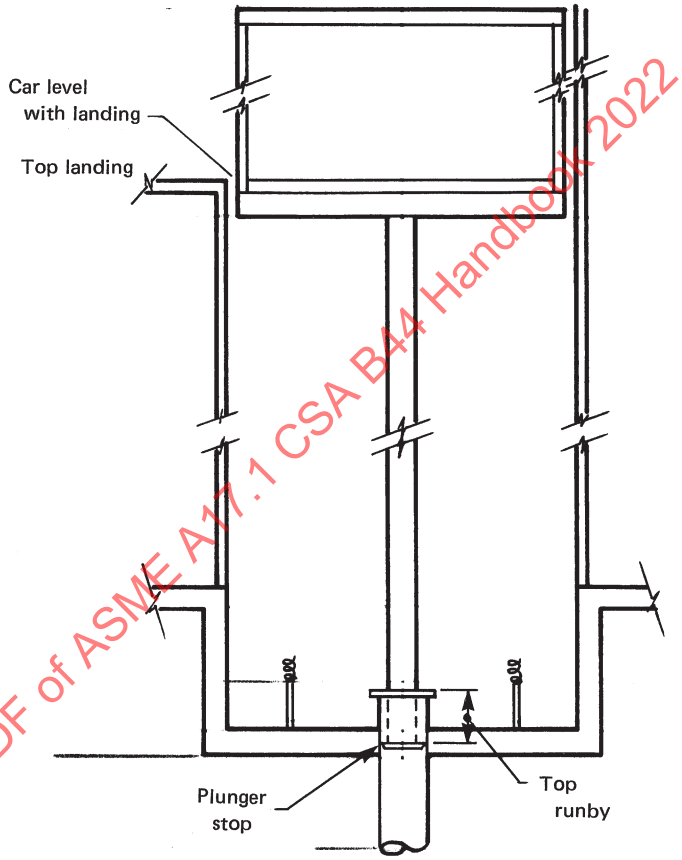
To specify clearance requirements when a hydraulic jack extends above the car enclosure top, ISO 15534-3:2000 anthropometric data was used to establish sufficient space over hydraulic jack.

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Diagram 3.4.2
Hydraulic Elevator Runby



Bottom Runby

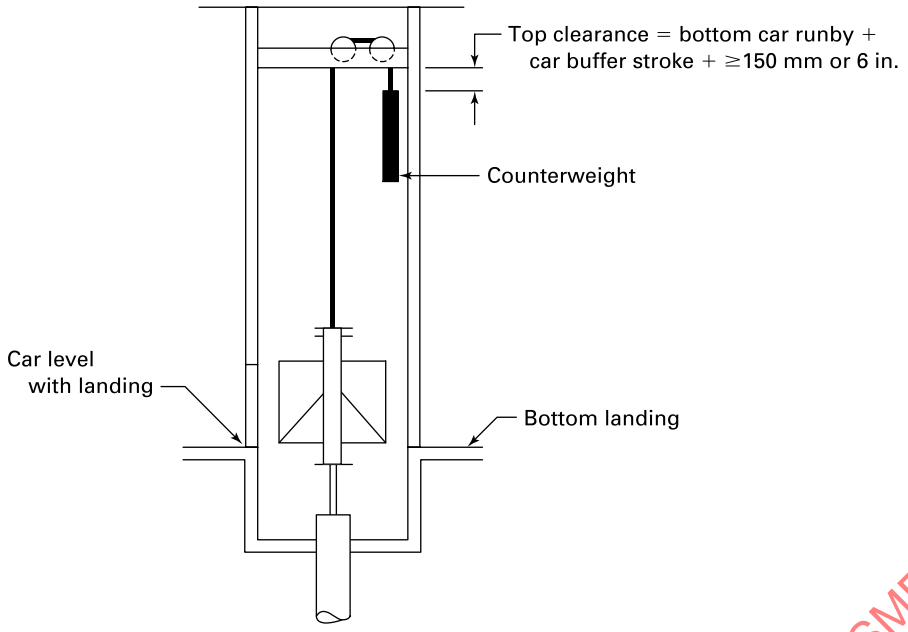


Top Runby

GENERAL NOTES:
(a) Courtesy of William Banister.
(b) Minimum runby is
(1) not less than 75 mm or 3 in. for rated speeds up to 0.50 m/s or 100 ft/min
(2) increased from 75 mm or 3 in. to 150 mm or 6 in. in proportion to the increase in rated speed from 0.50 m/s or 100 ft/min to 1.00 m/s or 200 ft/min
(3) a minimum of 150 mm or 6 in. for rated speeds exceeding 1.00 m/s or 200 ft/min
(c) Maximum runby is 600 mm or 24 in.

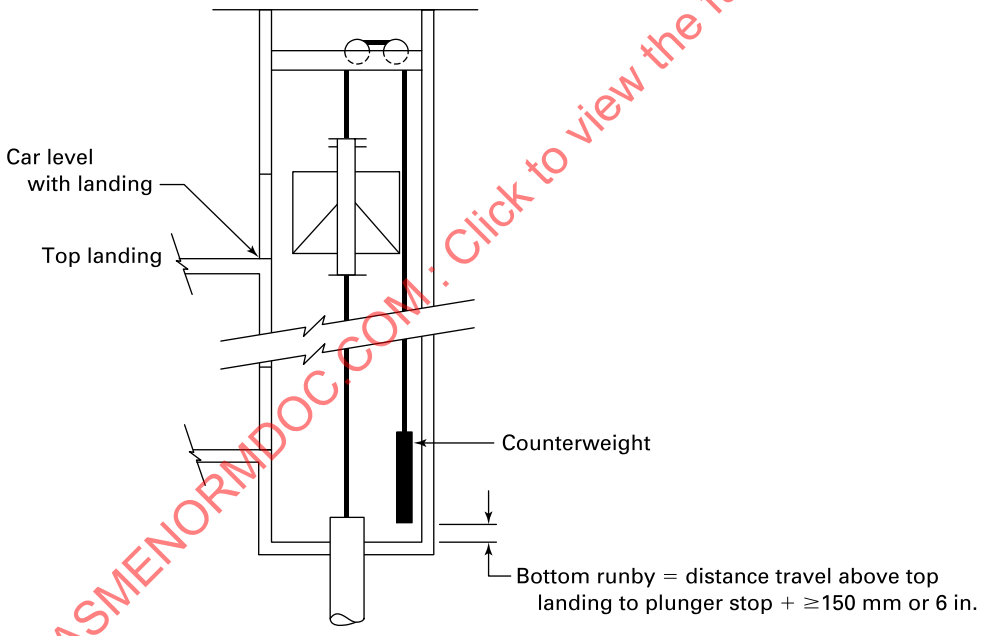
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Diagram 3.4.6.1
Top Car Clearance Counterweighted Hydraulic Elevator



GENERAL NOTE: Courtesy of William Banister.

Diagram 3.4.6.2
Bottom Runby Counterweighted Hydraulic Elevator



GENERAL NOTE: Courtesy of William Banister.

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SECTION 3.6
PROTECTION OF SPACES BELOW HOISTWAY

The requirements are intended to ensure that the occupiable portions of a building below a hydraulic elevator are safe. This requirement is to be complied with when any of the spaces on each succeeding floor directly below the hoistway are not permanently secured against access. The operating speed attained in the down direction is the maximum speed with rated load under normal operating conditions. See definition in Section 1.3.

The building structure must be adequate to support the jack. If a counterweight is used, a counterweight safety must be provided. Spring buffers and elastomeric buffers must not be fully compressed by a fully loaded car striking at maximum speed in the down direction. Requirement 3.6.3 was revised in ASME A17.1-2016/CSA B44-16 to permit the use of elastomeric buffers with hydraulic elevator applications. Energy dissipation buffers are always required. The buffer support structure must resist the impact load.

SECTION 3.7
MACHINERY SPACES, MACHINE ROOMS, CONTROL SPACES, AND CONTROL ROOMS

Spaces outside the hoistway enclosure, which contain hydraulic machinery and electric control equipment, must be enclosed as required by the building code. Access doors to machine rooms and control rooms must be 750 mm or 29½ in. wide by 2 030 mm or 80 in. high. They must be

(a) self-closing

(b) self-locking

(c) provided with a spring-type lock arranged to permit the door to be opened from the inside without a key

(d) kept closed and locked

Access doors to machinery spaces must comply with the requirements of 2.7.3.4.

The 2015 (and later) IBC, Section 3005.4, and the 2015 (and later) NFPA 5000®, Section 54.5 require "machine rooms and machinery spaces to be enclosed with construction having a fire resistance rating not less than the required rating of the hoistway enclosure served by the machinery." This may be a departure from past practices in some jurisdictions.

Requirement 3.7.1 was revised in ASME A17.1-2022/CSA B44:22 to add a note to alert users of the Code that there may be additional requirements in 8.12.1 that could affect equipment location.

SECTION 3.11
PROTECTION OF HOISTWAY LANDING OPENINGS

3.11.1 Emergency Doors

Requirement 2.11.1 provides for emergency access to a single blind hoistway to evacuate a stalled elevator.

When a car safety is not provided, a stalled elevator can be lowered with a manual-lowering valve by elevator personnel to a lower landing and the car and hoistway doors opened to allow normal egress from the elevator. Nonroped hydraulic elevators are not normally provided with a car safety but are provided with a manual lowering valve.

SECTION 3.12
HOISTWAY DOOR LOCKING DEVICES, CLOSED DETECTION MEANS, AND HOISTWAY ACCESS SWITCHES

This requirement was revised in ASME A17.1-2019/CSA B44:19 to include new terminology "closed detection means," to be consistent with changes in Part 2. See Handbook Section 2.12 for a more detailed description of the changes.

SECTION 3.14
CAR ENCLOSURES, CAR DOORS AND GATES, AND CAR ILLUMINATION

Observation hydraulic elevators exposed to direct sunlight do not require an auxiliary source of power for forced ventilation when an auxiliary power lowering unit is provided.

SECTION 3.15
CAR FRAMES AND PLATFORMS

The car frame of a roped-hydraulic elevator is suspended, thus it must conform to requirements in 2.15 and 8.2.2 as modified by 3.15.1.1 through 3.15.1.2.

3.15.1 Requirements

The car frame of a direct-acting hydraulic elevator may be omitted provided that

(a) platform frame can withstand any eccentric loads and transmit them safely to the plunger. The system must be designed to withstand additional loads.

(b) only one guide shoe per rail is provided on platform frame.

(c) car safeties are not used.

The platform guard on a hydraulic elevator is only required to have a minimum straight vertical face of 525 mm or 21 in. since unintended car movement protection (2.19.2.2) is not required.

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SECTION 3.16
CAPACITY AND LOADING

The requirements in 3.16 are based on the requirement in 2.16, modified as applicable for hydraulic elevators.

3.16.3 Capacity and Data Plates

For hydraulic elevator data plates, wire rope data is required only for roped-hydraulic elevators. A rail lubrication plate is required only where car safeties are used.

3.16.8 Additional Requirements for Passenger Overload

Requirement 2.16.8 does not apply as it mainly deals with electric traction elevators and traction relations maintaining up to 125% of rated load, machine brakes, regenerated power, etc. These items are not applicable to hydraulic elevator systems. The factors of safety built into the requirements governing hydraulic elevators ensure the safety of the elevator system when designed for 100% of rated load. The hydraulic relief valve is intended to open and prevent failure of pressure components under overload condition, which could occur if the elevator travels up allowing the plunger stop ring to engage the top of the cylinder.

SECTION 3.17
CAR SAFETIES, COUNTERWEIGHT SAFETIES, PLUNGER GRIPPER, AND GOVERNORS

3.17.1 Car Safeties

Car safeties are not required or normally provided on direct-acting hydraulic elevators. A roped-hydraulic elevator is suspended rather than supported, thus car safeties are required. A slack rope device removes power to stop the jack from lowering if slack develops in the rope. The car must move in the up direction to release the safety. This ensures there is no slack rope or loss of pressure in the hydraulic system, which would allow the car to fall after the safety was released. When car safeties are provided, see the Handbook commentary on Section 2.17, and Diagram 3.17.1.

ASME A17.1/CSA B44 gives performance criteria such that the car must be raised to reset the safety. The design of the device to do this is up to the manufacturer. Hand pumps may be used since they are readily available and designed for this purpose. Other means such as an auxiliary power-driven pump are permitted.

Roped-hydraulic elevators equipped with pistons have an indirect coupling means, usually ropes, passing through a seal fixed in the cylinder. A rope break is theoretically possible such that there is no rope contained in the seal and there is an open hole and a serious high-pressure oil leak.

A function of the slack rope device is to set the safety for a broken rope condition as well as the overspeed condition. The additional slack rope device is permitted, but not required, to set the safety for roped-hydraulic elevators using hydraulic jacks equipped with plungers. To the author's knowledge, no one is currently producing a roped-hydraulic elevator using hydraulic jacks equipped with pistons.

3.17.1.2 If a safety set is particularly forceful, the system may require more than 150% working pressure to move the car upward. This requirement, which was introduced in ASME A17.1a-2005 and CSA B44-04 Update 1-05, allows other than the elevator hydraulic system to raise the car.

3.17.1.3 This requirement refers to car safeties and therefore applies to the applicable safety switch but not to the governor switch.

3.17.2 Counterweight Safeties

A hydraulic elevator normally would not attain sufficient overspeed to operate a safety governor, hence the requirement to operate the safety as a result of the breaking or slackening of the counterweight suspension ropes. Counterweight safeties are required only when there is occupiable space below the counterweight runway. Counterweights are very seldom found on hydraulic elevators.

3.17.3 Plunger Gripper

A plunger gripper is a mechanical device attached to a supporting structure in the pit. It will stop and hold the car by gripping the plunger when an overspeed is detected and/or upon detection of a fluid pressure failure in the system. These requirements were added in ASME A17.1a-2002 and CSA B44 Update No. 2-03.

Plunger grippers are not required by ASME A17.1/CSA B44. When provided, they must comply with the requirements of 3.17.3. See Diagrams 3.17.3(a) and 3.17.3(b).

3.17.3.1 Limits of Application. This requirement prevents excessive stress in the plunger wall based on the inherent factors of safety required for plunger design.

3.17.3.2 Means of Application. This requirement was revised in ASME A17.1-2013/CSA B44-13 to clarify requirements for actuation means. Loss of pressure or fluid typically indicates a cylinder or piping failure. Detection of failure will cause the plunger gripper to actuate. Not all pressure system failures cause total pressure loss, so using electrical means to detect uncontrolled motion is permitted. There are also electrical redundancy requirements similar to other requirements of ASME A17.1/CSA B44.

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3.17.3.2.2 Inspection and Test Means. A requirement to provide for inspection and test means was added in ASME A17.1-2013/CSA B44-13.

3.17.3.3 Release. The requirement prevents the car from being returned to service until the pressure system is repaired and can show an ability to support at least the weight of the car without load.

3.17.3.4 Normal Retracted Position. Performance language allows the open grippers to stay in contact with the plunger as long as there are no adverse effects.

3.17.3.5 Deceleration. Knowledge gained during the investigation of overspeed valves is also applicable to plunger grippers. Deceleration of 0.1g is sufficient to ensure the elevator starts to slow down. This deceleration is consistent with similar requirements in ASME A17.1/CSA B44, such as buffer stops. A 2.0g peak for 0.04 s ensures that no greater stopping forces are generated than are allowed in other requirements of ASME A17.1/CSA B44. See Chart 3.17.3.5(a).

3.17.3.6 Minimum Factors of Safety and Stresses of Safety Parts and Rope Connections. Relevant portions of 2.17.12 are referenced since they have stood the test of time. Due to dissimilarities in functioning and application, specific requirements were also added.

3.17.3.7 Corrosion-Resistant Bearings in Plunger Gripper and Gripper Operating Mechanisms. Requirement 2.17.3 has stood the test of time and the same values are applicable to plunger grippers.

3.17.3.8 Marking Plate for a Plunger Gripper. This requirement was revised in ASME A17.1-2013/CSA B44-13 to allow stamped characters that are depressed. Such characters would require a metal punching tool, and a simple rubber ink stamp could not be used. It is noted that hydraulic equipment is often located in pits that have minimal illumination.

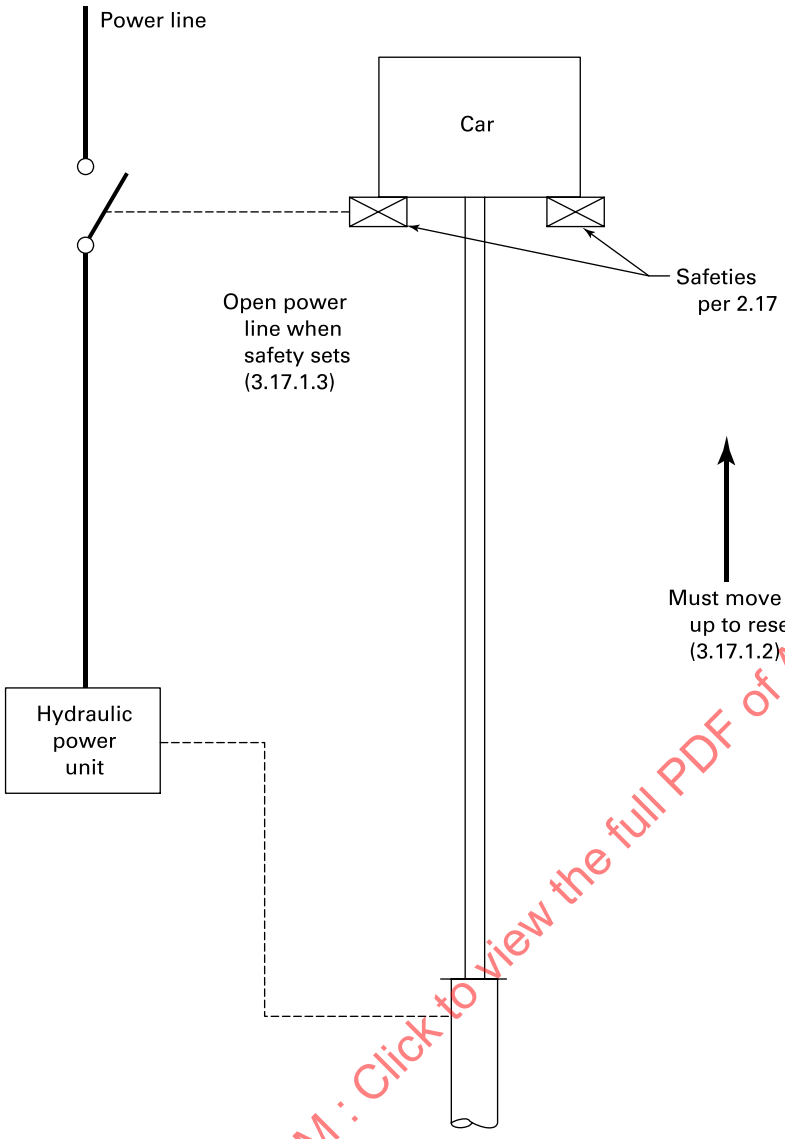
3.17.3.9 Flexible Hoses. Permissive language is used for flexible hoses to accommodate the control function of plunger gripper devices. The failure of these hoses shall not cause an uncontrolled descent.

3.17.4 Governors

Access to governors is the same as required for electric elevators. See Handbook commentary on Sections 2.7 and 3.7.

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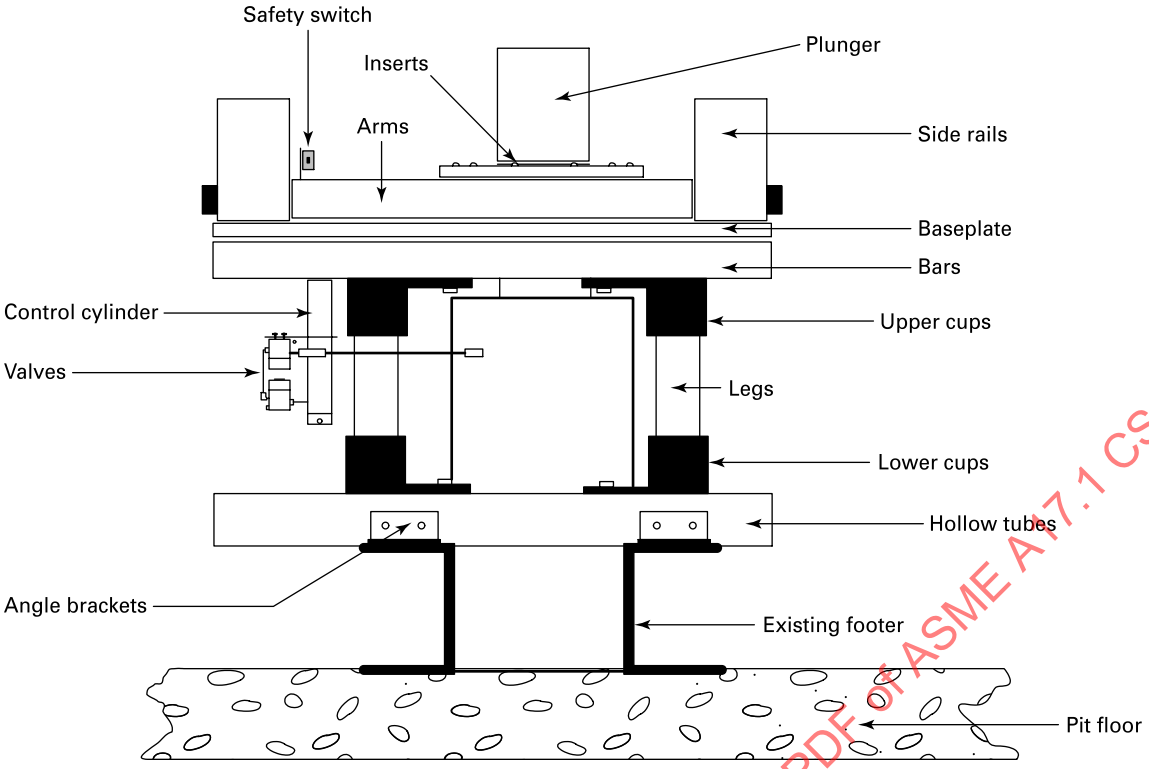
Diagram 3.17.1
Hydraulic Elevator Car Safeties



GENERAL NOTE: Courtesy of William Banister.

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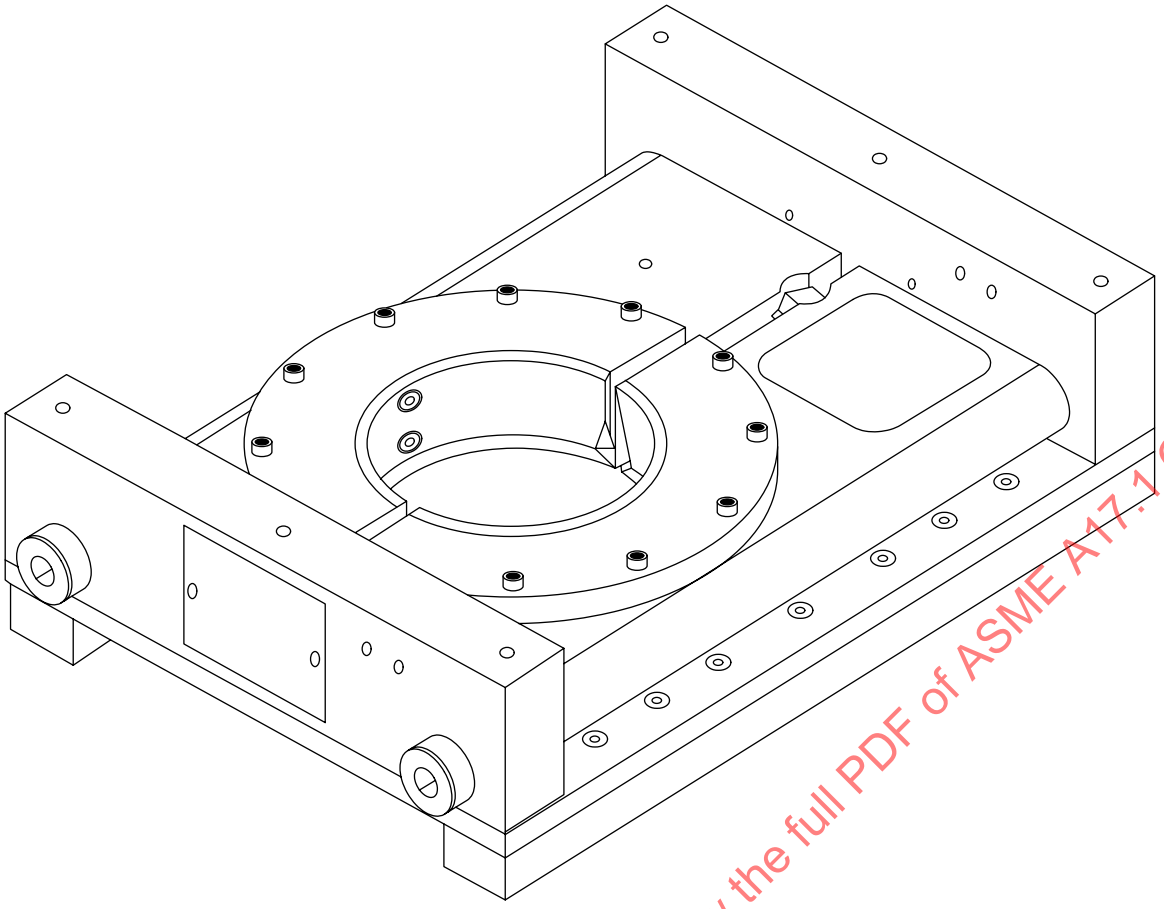
Diagram 3.17.3(a)
Typical Plunger Gripper



GENERAL NOTE: Courtesy of John W. Koshak.

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Diagram 3.17.3(b)
Typical Plunger Gripper



GENERAL NOTE: Courtesy of John W. Koshak

Chart 3.17.3.5(a)
Plunger Gripper Stopping Distances

Operating Speed in the Down Direction, m/s (ft/min)	Maximum Tripping Speed, m/s (ft/min)	Stopping Distances, mm (in.)	
		Min.	Max.
0–0.63 (0–125)	0.90 (175)	25 (1)	406 (16)
0.75 (150)	1.05 (210)	50 (2)	584 (23)
0.87 (175)	1.25 (250)	75 (3)	838 (33)
1.00 (200)	1.40 (280)	100 (4)	1 041 (41)
1.12 (225)	1.55 (308)	125 (5)	1 270 (50)
1.25 (250)	1.70 (337)	150 (6)	1 524 (60)
1.50 (300)	2.00 (395)	200 (8)	2 108 (83)

GENERAL NOTE: Maximum distance calculated using requirement 8.2.6 and substituting 0.1 gravity for deceleration in lieu of 0.35 gravity.

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SECTION 3.18
HYDRAULIC JACKS

3.18.1 Hydraulic Jack and Connections

3.18.1.1 Direct-Acting Hydraulic Elevators. A direct-acting hydraulic elevator is an elevator having a plunger or cylinder directly attached to the car frame or platform. This requirement does not mandate any particular design, but does specify the design criteria of the connection of the driving member to the car frame or car platform. See Diagram 3.18.1.1 for a typical connection.

3.18.1.2 Roped-Hydraulic Elevators. Requirements are specified for the suspension members and sheaves.

The loss of one hydraulic jack is essentially equivalent to loss of one rope where there are two or more ropes per driving machine and the requirements allow for alternate designs. The pressure is limited to 150%, equivalent to the maximum relief valve pressure. The requirement that the remaining hydraulic jacks be capable of supporting the load without overloading the frame is to protect these items in the unlikely event of a rope failure.

Rope retaining means are always required whether or not seismic conditions are applicable. See Diagram 3.18.1.2.

3.18.1.2.3 The reference to 2.24.2 requires that the sheave have a pitch diameter of 40 times the rope diameter. The reference to 2.24.3 requires a safety factor of 8 for a steel sheave. The reference to 2.24.5 requires that fillets be provided at any change in diameter to prevent stress concentration.

3.18.2 Plungers

3.18.2.3 Plunger Connection. The plunger must be capable of carrying in tension the weight of the plunger. Thus the weight of the plunger is included in the buffer calculations where applicable, such as on conventional (noninverted) direct-acting hydraulic jacks. This is the reason 3.16.3(b) requires the plunger weight to be specified on the data plate. The plunger weight would typically not be included in roped-hydraulic elevator buffer designs.

3.18.2.4 Plunger Joints. See Diagram 3.18.2.4 for a typical plunger joint.

3.18.2.7 Plunger-Follower Guide. The intent of this requirement is to retain the L/R ratio required by 8.2.8.1 and further require that the power circuit be opened when this requirement is not met.

The intent of this requirement is to adjust the free length based on the use of a plunger follower. If one follower is positioned at the halfway point, the free length is half of the full length measured from the bearing point in the cylinder head to the bearing point at the car frame. The plunger-follower guide is to be designed to be within the car frame stresses tabulated in Section 2.15 since the follower functions as an auxiliary car plank to provide lateral stability.

If the maximum free length is exceeded, returning the car to the lowest landing and rendering the elevator inoperative will maintain the elevator in a safe condition.

3.18.3 Cylinders

3.18.3.3 Clearance at Bottom of Cylinder. The intent of this requirement is to protect a cylinder from the impact forces and a possible rupture caused by the plunger striking the bottom of the cylinder.

3.18.3.4 Safety Bulkhead. See Diagram 3.18.3.4 for typical safety bulkhead design.

A slip casing (sleeving) does not meet the requirements for a double-wall cylinder.

3.18.3.5 Cylinder Packing Heads. See Diagram 3.18.3.5.

3.18.3.6 Closed Cylinder and Plunger Heads. Cylinders supported at the bottom and not installed below ground are exempted by 3.18.3.6.1 from the requirements of 3.18.3.4 as they are not subject to corrosion and are readily available to visual inspection.

3.18.3.7 Collection of Oil Leakage. This requirement is normally addressed by providing a collector ring with tubing running to a container in the pit or to the hydraulic oil storage tank. The container capacity is normally 4 L to 19 L or 1 gal to 5 gal that is manually emptied by the service mechanic. The limit of 19 L or 5 gal is imposed to prevent an unnecessary fire hazard and provide assistance in identifying a leak. This requirement applies to all hydraulic jacks including those with neoprene seals and those with packing.

3.18.3.8 Cylinders Buried in the Ground. The Code does not specifically require PVC jack encapsulation. PVC encapsulation is one of several acceptable methods covered by 3.18.3.8.2, as long as it complies with the requirements of 3.18.3.8.3(b). The Code requires a means to monitor ongoing compliance of the protection means. Monitoring of oil loss does not ensure or verify that there is ongoing compliance with the requirements for monitoring cylinder protection.

In the summer of 1987, the U.S. Environmental Protection Agency (EPA) released the regulations on underground storage tanks for public comments. At the time, the EPA included in the regulations underground cylinders of hydraulic elevators. The final regulations did not include requirements for hydraulic elevators. National Elevator Industry, Inc. presented the EPA with statistics showing the reliability of underground cylinders. The information provided also indicated that a leak would not go undetected.

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The average rise of these hydraulic elevators is about 7.92 m or 26 ft with an average cylinder volume of 11.4 L/m or 3 gal/ft or a total of 291.5 L or 77 gal of oil encased by the cylinder below ground when the elevator is in the uppermost position. When the elevator car is lowered, the volume of oil in this cylinder would be 159 L or 42 gal.

The total oil in the average elevator system installed in the 1980s was about 363.4 L or 96 gal, including 56.8 L or 15 gal of oil reserved over and above that required for moving the car to the top floor and that oil in the oil line connecting the power unit to the cylinder.

The hydraulic cylinder in a hydraulic elevator system is considered a process tank enabling a reversible flow system to power the plunger for car movement and not viewed as a well or storage tank.

The hydraulic elevator system is filled at the time of installation and the same oil is normally used in the system throughout the life of the elevator, assuming it is not contaminated by water, etc. It is often filtered to remove particulate contaminants.

The elevator seal through which the plunger passes is made of neoprene or similar material, which provides a dry wipe of the micro-finished jack without oil loss. In the event of damage to the jack seal, which could cause a leak, an oil recovery ring is provided on the jack head. In addition, ASME A17.1/CSA B44 requires that a container not exceeding 19 L or 5 gal be installed in the elevator pit. This container would, of course, be checked during routine maintenance. An oil usage log must also be maintained (8.6.5.7). Hydraulic elevators are also required to be regularly inspected by a certified QEI (8.11.1.1). A substantial loss of oil, such that the pump sucks air as the elevator tries to go to the top landing, produces a significant noise. A leak should not go undetected for long.

A periodic inspection includes an examination of the record of oil usage, the power unit in the machine room, the oil piping, and the 19 L or 5 gal container required by ASME A17.1/CSA B44 in the pit for oil leakage. A written record of the quantity of hydraulic fluid added and emptied is required when any part of the cylinder or piping is not visible for inspection (8.6.5.7).

In a hydraulic elevator system, there is no removal and filling up of oil as is characteristic of a storage tank. The need for an elevator in a building will mandate the replacement of a cylinder if a leak occurs since without the elevator the building may not be usable.

Additionally, to conform with a requirement in the National Electrical Code® (NEC®) or Canadian Electrical Code, a timer is furnished as an industry standard on each controller. The purpose of this timer is to meet the requirement in the NEC®, Canadian Electrical Code, and 3.26.5 for phase reversal protection. Since the hydraulic elevator pump would turn backwards, the car would not move, and of course the motor could run to a point of overheating. With the timer set for 20 s more than the trip time from bottom to top, the motor is then cut off and the timer must be manually reset, thereby requiring elevator personnel to make a determination of the cause. This protection would likewise announce the loss of oil in the system since, generally, only 56.8 L or 15 gal of reserve is installed in the system. If there were an oil loss either above or below ground exceeding this amount, the car, in attempting to go to the top floor, would stall at some point, but the motor would continue to run until the expiration of the preset time and then the car would reverse, lower to the bottom floor, and wait for elevator personnel to reset the time. See 3.26.9.

The EPA was satisfied with this information but requested that corrosion protection be provided on all underground cylinders and piping. The ASME A17 Committee developed these requirements in 3.18.3.8 and in exchange, the EPA excluded elevator cylinders from the final regulations.

The requirements are performance oriented and the manufacturer has the option of choosing one or more, whichever best suits its needs.

3.18.4 Plunger Stops

On a new installation, it is important to verify that the stop ring has been installed. This can be accomplished by running the car up to engage the stop ring at inspection speed, with or without a load, until the car stops and the relief valve operates. Running the car up to engage the stop ring at full speed is unnecessary and could damage the stop ring. See Diagram 3.18.3.4 for a typical plunger stop.

3.18.4.1 Metal Stops and/or Other Means. Requirement 3.18.4.1 was revised in ASME A17.1-2022/CSA B44:22 to correct a reference.

3.18.4.2 Hydraulic System. The requirements apply to both the hydraulic machine and hydraulic jack.

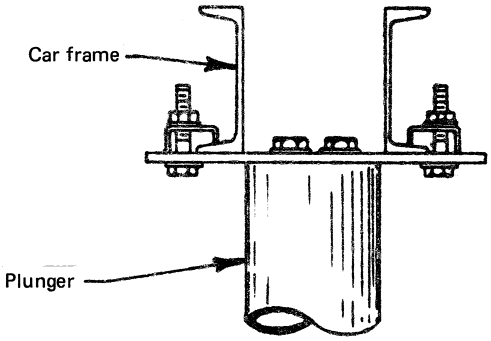
3.18.6 Marking of Hydraulic Jack

This information is important to ensure proper component replacement when repairing hydraulic jacks. Replacement parts are to be of equivalent material, strength, and design as the original.

This requirement was revised in ASME A17.1-2013/CSA B44-13 as it was felt that a data tag is not required, and drilling holes on the cylinder to attach a tag is not recommended. It was preferred to apply the markings directly to the cylinder. The requirements allow stamped characters that are depressed. Such characters would require a metal punching tool, and a simple rubber ink stamp could not be used.

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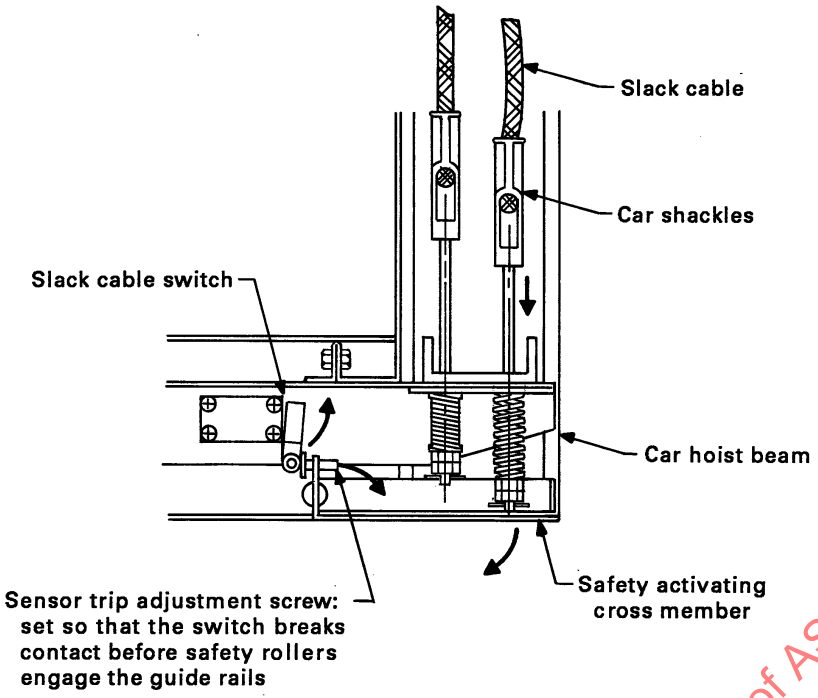
Diagram 3.18.1.1
Typical Driving-Machine Connection



GENERAL NOTE: Courtesy of Dover Elevator Co.

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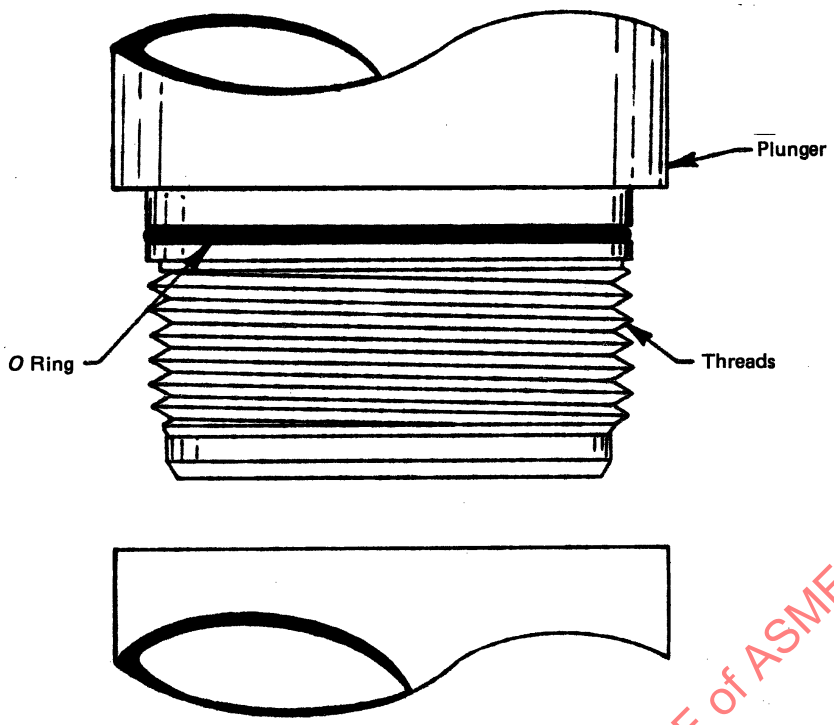
Diagram 3.18.1.2
Typical Slack Rope Switch



GENERAL NOTE: Courtesy of Cemco Lift, Inc.

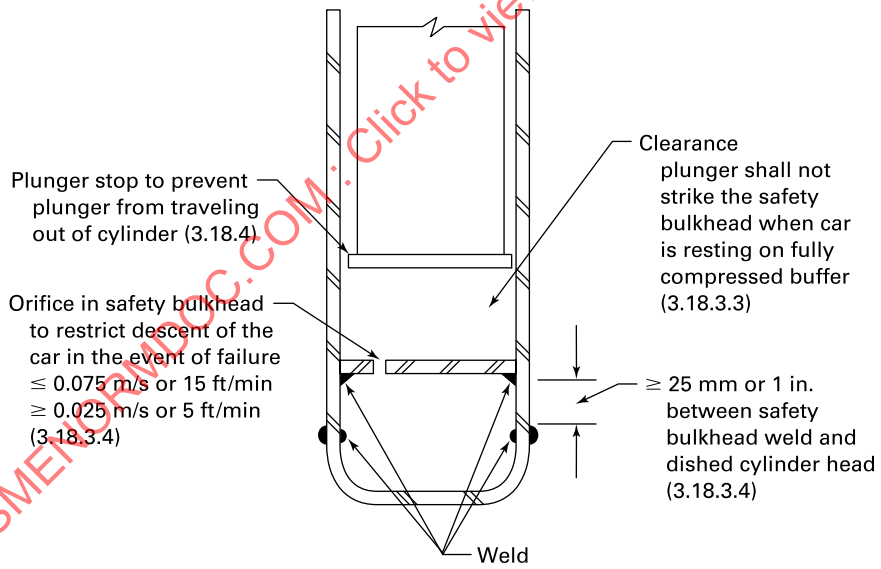
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Diagram 3.18.2.4
Typical Plunger Joint



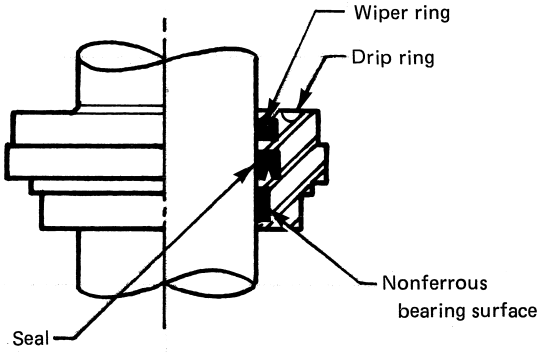
GENERAL NOTE: Courtesy of Dover Elevator Co.

Diagram 3.18.3.4
Typical Cylinder, Plunger Head, and Plunger Stop



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Diagram 3.18.3.5
Typical Cylinder Packing Head



SECTION 3.19
VALVES, PRESSURE PIPING, AND FITTINGS

3.19.1 Materials and Working Pressures

3.19.1.2 Working Pressures. All supply piping materials, valves, and fittings, with the exception of flexible hydraulic hose and fitting assemblies and flexible couplings, must be of ductile material and have a factor of safety equal to 5 times the working pressure based on tensile strength and elongation not less than 10%. A factor of safety equal to 3 times the working pressure and elongation not less than 10% is permitted if validated by a proof test (3.19.1.3). Working pressure (see Section 1.3) is not allowed to exceed component-rated pressure (see Section 1.3). The requirement makes it clear that component-rated pressure is based on working pressure.

Working pressure is the pressure measured at the hydraulic machine when lifting a car and its rated load at rated speed or with Class C2 loading when leveling up with maximum static load. Component-rated pressure is the design pressure to which any component can be subjected.

3.19.2 Pressure Piping

3.19.2.1 Wall Thickness. The working pressure for a completed oil line is limited by the lowest rated element in the line, including fittings, valves, and connections.

The requirement, introduced in ASME A17.1-2004 and CSA B44-04, provides standards for identification of hydraulic elevator oil lines, consistent with other piping applications that convey gases, vapors, and liquids, to prevent inadvertent component substitution due to missing identification.

3.19.2.5 Pressure Gauge Fittings. The location specified allows static pressure to be read at the hydraulic machine; to determine the pressure at the hydraulic jack, the pipe pressure drop must be determined and subtracted from the hydraulic machine pressure. A shutoff valve is used to prevent oil loss in the event of a leaky or broken fitting or gauge.

This requirement was revised in ASME A17.1-2019/CSA B44:19 to use performance-based language and to allow a pressure-sensing means with a pressure display to provide system pressure readings without having to connect a pressure gauge.

3.19.2.7 Hydraulic piping, tubing, or fittings located outside the hoistway shall be protected (e.g., inside machine room, etc.) or means shall be provided to prevent uncontrolled movement (e.g., overspeed valve, governor, and safeties, etc.) of the car.

3.19.2.8 This requirement was revised in ASME A17.1-2013/CSA B44-13 as damage to piping can occur as a result of excavating overburied pipe. A hazard assessment indicates that the chance of such an occurrence is remote; however, it is prudent to protect against such a happening. This requirement should mitigate possible damage to piping as a result of excavation.

3.19.3 Connections and Fittings

3.19.3.2 Grooved Pipe Fittings. Fittings must be of the type designed and constructed for use on grooved pipe. There is also available a type of coupling for use on nongrooved pipe called a "roustabout" coupling. This type of coupling is fitted with threads that, when the coupling is tightened in place, presses into the pipe securing the coupling in place. This type of coupling does not comply with the requirements in ASME A17.1/CSA B44.

3.19.3.3 Flexible Hydraulic Connections. All markings required must be permanent and indelible. The markings can be either on the hose or fittings. Compression-type fittings are prohibited. A mechanical means is required to prevent the complete separation of a connection if a gasket, seal, or other sealing device fails.

Flexible hoses must

(a) be designed for 10 times working pressure
(b) be tested at 5 times working pressure
(c) have the date of test permanently marked
(d) not be used in the hoistway
(e) not project into or through any wall

This requirement does not apply to a flexible hose installed between the pump and tank.

3.19.4 Valves

See Diagram 3.19.4.

3.19.4.1 Shutoff Valve. Relief valve pressure should be set using the shutoff valve prior to an entire system being subjected to relief pressure. This protects a system from excessive pressure if the relief valve fails to open and the system is overpressured. A shutoff valve in the machine room provides an additional degree of safety for elevator

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personnel entering and working in the pit of a hydraulic elevator. It is safer to locate the shutoff valve outside the hoistway than in the pit. In the case of a hydraulic elevator with the hydraulic machine in the hoistway, the shutoff valve is required to be accessible to elevator personnel from outside the hoistway. The shutoff valve does not need to be adjacent to the hydraulic machine. If an additional shutoff valve is provided in the pit, as is sometimes the case, it must meet pressure-rating criteria. Brass valves used in plumbing systems do not usually comply with the pressure and safety factor requirements for hydraulic elevators. Additional shutoff valves do not require a permanent handle, since they are not provided for emergency use.

This requirement was revised in ASME A17.1-2019/CSA B44:19 to address the new definition for "manually operated valve" and the required security level for valves whether they are located inside or outside the hoistway. All valves must be accessible to elevator personnel only and without entering the hoistway.

3.19.4.2 Pump Relief Valve. The pump relief valve is to be set to allow full flow at a pressure not greater than 150% of the working pressure (see Section 1.3). The opening pressure is usually lower; however, it is very difficult to accurately measure. The requirement allows large pumps or groups of pumps to use more than one relief valve to achieve the required flow capacity so pressure never goes more than 50% above working pressure. See Diagram 3.19.4.

3.19.4.4 Manual Lowering Valve. This requirement was revised in ASME A17.1-2019/CSA B44:19 to provide performance-based language and to allow direct or indirect means from outside the hoistway to actuate the valve.

3.19.4.6 Type Tests, Certification, and Marking Plates for Control Valves

3.19.4.6.3 The requirement for marking electrical coil data, formerly designated 3.19.4.6.2(f), was revised in ASME A17.1-2013/CSA B44-13 as the valve coil is interchangeable based on voltage, frequency, and whether AC/DC is used in the system. Therefore, the required markings should not be on valve body itself but on the coil.

3.19.5 Piping Buried in the Ground

See Handbook commentary on 3.18.3.8.

3.19.6 Welding

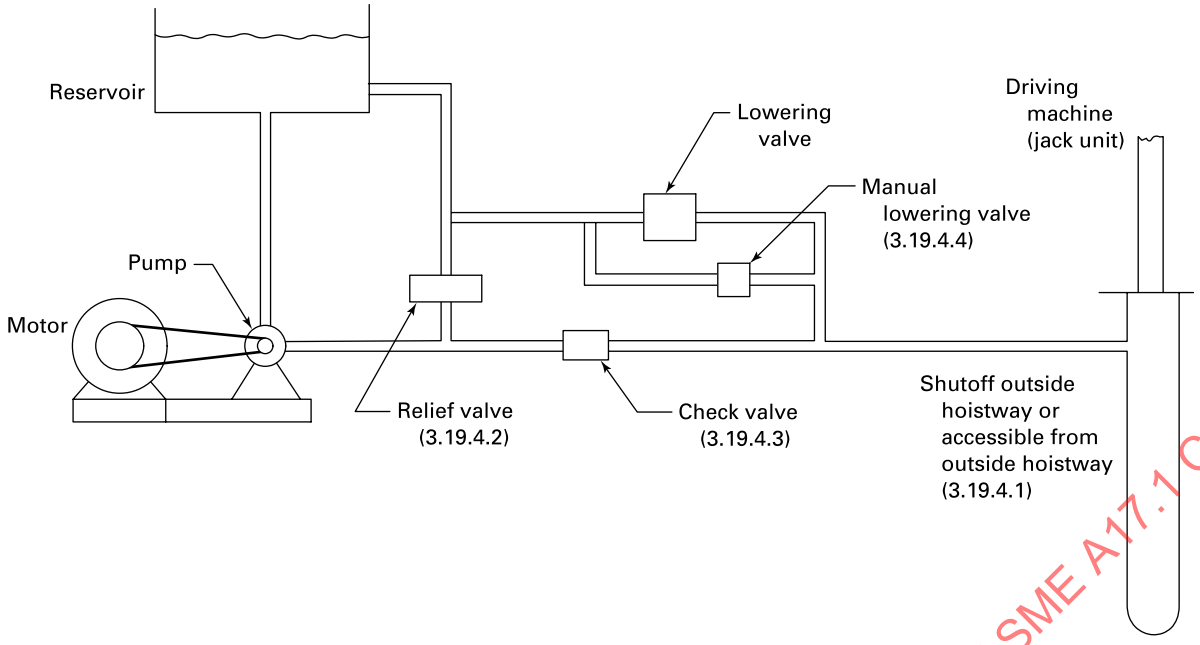
Welding of supply piping, valves, and fittings in the United States must be done by welders qualified in accordance with the requirements of the American Welding Society. The welders may be qualified, at the option of the manufacturer, by one of the following: the manufacturer, a professional consulting engineer, or a recognized testing laboratory.

In Canada, welding must be done in compliance with the requirements in CSA W59.

See Handbook commentary on Section 8.8.

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Diagram 3.19.4
Relief, Check, and Manual Lowering Valves



GENERAL NOTE: Courtesy of William Banister.

SECTION 3.21
COUNTERWEIGHTS

3.21.1 Counterweights

Requirements limit pressure and therefore stress on hydraulic components in case of separation of the counterweight. This protects a system from catastrophic failure.

SECTION 3.22
BUFFERS AND BUMPERS

3.22.1 Car Buffers or Bumpers

Bumpers can be used when the car is equipped with a Type C safety or on hydraulic elevators having a maximum speed in the down direction with rated load in the car of 0.25 m/s or 50 ft/min.

Requirement 3.22.1.2.1 was revised in ASME A17.1-2016/CSA B44-16 to add elastomeric buffers and to clarify compression differences between spring and elastomeric buffers. Requirement 3.22.1.2.2 was revised to clarify the consistency of application between electric and hydraulic elevator buffers.

Requirement 3.22.1.2.1 was revised in ASME A17.1-2022/CSA B44:22 to remove the requirement for elastomeric buffers, because 3.22.1.2.1 deals with spring buffers. Elastomeric buffers are already addressed by the reference to Section 2.22 in 3.1.1.

3.22.2 Counterweight Buffers

An up-traveling hydraulic elevator will be stopped when its stop ring is struck; therefore, a counterweight buffer is not needed. The hydraulic system for a counterweighted hydraulic elevator is designed for counterweight load always being effective. The need for the counterweight is never removed. Removal of the counterweight with car at the top would result in a buckling load on the plunger, which reduces the design safety factor. The removal of the counterweight load also creates excess system hydraulic pressure on valves, fittings, and supply piping. Counterweight buffers could also create a slack rope condition with rope stretch.

SECTION 3.23
GUIDE RAILS, GUIDE-RAIL SUPPORTS, AND FASTENINGS

3.23.1 Direct-Acting Hydraulic Elevators

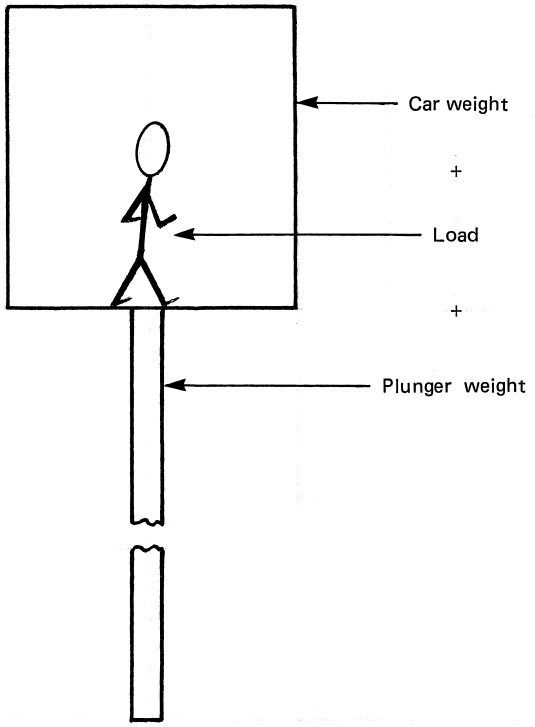
See Diagram 3.23.1.

3.23.2 Roped-Hydraulic Elevators

Car safeties are required on roped-hydraulic elevators. Therefore, all of Section 2.23 is applicable. A means of keeping the traveling sheave, when provided, in alignment is required.

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Diagram 3.23.1
Rail Bracket Spacing, Hydraulic Elevator With Safeties



GENERAL NOTE: Courtesy of William Banister.

SECTION 3.24
HYDRAULIC MACHINES AND TANKS

3.24.2 Tanks

3.24.2.2 Minimum Level Indication. See Handbook commentary on 3.24.3.3.

3.24.3 Atmosphere Storage and Discharge Tanks

3.24.3.1 Covers and Venting. Covering tanks prevents foreign materials from entering the oil system and reduces fire hazards. ASME A17.1S-2005 and CSA B44-04, Supplement 1 added requirements for hydraulic tanks located in hoistways to prevent accumulation of fumes and structural requirements to protect tank from falling objects.

3.24.3.3 Means for Checking Liquid Level. The most common means of complying with these requirements is to provide a dipstick in the top of the tank similar to the type used in an automobile engine. Another method is to provide a sight glass on the side of the tank. Both methods require the car be at its lowest landing to obtain a correct reading of the oil level.

Requirement 3.24.3.3 was revised in ASME A17.1-2022/CSA B44:22 to simplify checking the liquid level.

SECTION 3.25
TERMINAL STOPPING DEVICES

3.25.1 Normal Terminal Stopping Devices

3.25.1.1 Where Required and Function. This requirement was revised in ASME A17.1-2013/CSA B44-13 to clarify the intent and scope of the term "function independently" based on past interpretations and accepted practice, without changing the scope of the existing requirement.

The normal terminal stopping device is required to stop the car at the terminal landing when the normal stopping means fails to stop the car. The normal terminal stopping device is required to function until

(a) at the top terminal, the stop ring is engaged

(b) at the bottom terminal, the car is resting on its fully compressed buffer(s)

During the recycling operation for telescopic plungers, the normal terminal stopping device can be bypassed if the requirements of 3.26.7 are met.

3.25.1.3 Requirements for Stopping Devices on the Car or in the Hoistway. When the device is located on the car or in the hoistway, it must be of the enclosed type. It must be securely mounted so that horizontal movement of the car does not affect its operation. Operating cams must be metal, and the device contacts must be directly opened mechanically. Opening of contacts must not depend on a spring or gravity or a combination thereof. Stopping devices are not emergency stop switches.

3.25.2 Terminal Speed-Reducing Devices

The term "solid limit of travel" used in this requirement refers to the stop ring (plunger stop). In the up direction, the car speed is to be reduced to 0.25 m/s or 50 ft/min, with a retardation rate not greater than gravity, before the plunger strikes the stop ring (3.18.2.5), if the normal terminal stopping device fails to slow down the car. Two independent control means are required, at least one of which is operated by the terminal speed-reducing device, and the other or both by the terminal stopping device. The terminal speed-reducing device is permitted to be mechanically operated.

3.25.2.2 General Requirements. A terminal speed-reducing device is required only at the top terminal. The device can be any one of the technologies listed (mechanical, hydraulic, or electrical).

3.25.2.2.1 This requirement was revised in ASME A17.1-2013/CSA B44-13 to clarify the intent and scope of the term "operate independently" based on past accepted practice without changing the scope of the existing requirement.

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3.25.2.2.2 A mechanical or hydraulic means used to implement terminal speed reducing may cause overheating of the pump or motor unless the mechanical or hydraulic means removes power from the motor. A method is required to prevent overheating of the system. A pump run timer is one such method. Mechanical or hydraulic means may cause certain stresses, in which case additional requirements are specified.

3.25.2.3 Requirements for Mechanical or Hydraulic Means. A mechanical or hydraulic means used to implement terminal speed reduction may overheat the pump or motor unless a mechanical or hydraulic means is provided to remove power from the motor. A method is required to prevent overheating of the system. A pump run timer is one such method. Mechanical or hydraulic means may cause certain stresses, in which case additional requirements are specified.

3.25.2.4 Requirement for Electrical Means. These requirements are similar to the emergency terminal speed-limiting requirements for electric elevators.

3.25.2.4.4 Allowance for use of solid-state devices or software systems as intermediate devices lead to the need for single failure requirements.

3.25.3 Final Terminal Stopping Devices

Final terminal stopping devices are not necessary since the stop ring would stop the elevator if the normal devices do not function. The run timer would prevent running of the motor after the plunger is against the stop ring.

SECTION 3.26
OPERATING DEVICES AND CONTROL EQUIPMENT

3.26.1 Operating Devices and Control Equipment

By referencing all of Section 2.26, except those requirements specifically excluded, 3.26.1 specifies the following requirements:

(a) inspection operation, 2.26.1.4

(b) inspection operation with open door circuits, 2.26.1.6

(c) contactors and relays in critical operating circuits, 2.26.3

(d) electrical equipment and wiring including listing and labeling requirements and EMC immunity, 2.26.4

(e) monitoring of door circuits, 2.26.5

(f) making electrical protective devices inoperative, 2.26.7

(g) redundancy and checking of redundancy

(h) requirements for executable software

This requirement was revised in ASME A17.1-2019/CSA B44:19 to include a reference to the new requirements for executable software. See Handbook commentary on 3.26.11.

Requirement 3.26.1 was revised in ASME A17.1-2022/CSA B44:22 to permit the means necessary for limited and general tests to be applied to hydraulic elevators. See Handbook commentary on 2.26.14. A new requirement 3.26.1(j) was added to specify requirements for remote interaction operation (RIO) on hydraulic elevators. See Handbook commentary on 2.26.13.

3.26.3 Anticreep and Leveling Operation

The anticreep operation remains operational when the in-car stop switch or the emergency stop switch is in the stop position (3.26.4). At one time it was common practice to shut an elevator down for the night or over a weekend using the in-car emergency stop switch, and also turning the lights off. If the anticreep operation was not functioning and the door closing device did not function as required by 2.11.3, the car could descend to the pit, leaving the hoistway door in the open position. A person could inadvertently step into the hoistway thinking they were entering a dark car.

Anticreep operation may be bypassed during the recycling operation of telescopic plungers (3.26.7).

The anticreep operation is required to prevent the car from drifting away from a floor. The anticreep operation needs to operate in the up direction only for electrohydraulic elevators. The requirements do not apply to a car when it is in the process of responding to a call, or to a malfunction of a switch.

Requirement 3.26.3.1.4(a) was revised in ASME A17.1-2022/CSA B44:22 to provide consistency with the new definition for "main line power."

3.26.4.2 This requirement was revised in ASME A17.1-2019/CSA B44:19 to include new terminology, "closed detection means," to be consistent with changes in Part 2. See Handbook Section 2.12 for a more detailed description of the changes.

3.26.5 Phase Reversal and Failure Protection

Since there is no immediate danger, as there is with electric elevators, of running in the wrong direction, the need for immediate action in case of a phase-reversal as called for in 2.26.6 is not required. Means should be provided to prevent the pump from running backward for any extended period of time and to remove the drive motor from the power supply in the event of a single-phase condition. The "run" indication timer used by some manufacturers on hydraulic controllers to protect against pump failure (i.e., loss of oil) also provides protection against phase reversal (i.e., oil is not delivered to jack).

Thermistors, bimetallics temperature sensors, and phase failure and phase loss relays are options that can be used.

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3.26.6 Control and Operating Circuits

Springs in switches, relays, etc., to stop elevators must be in compression. Power should not be required to stop the elevator.

3.26.6.3 Since there are two means to independently control upward movement of an elevator at any floor (e.g., pump motor and valve), no single failure of a solid-state device should cause an unsafe condition.

3.26.6.5 Requirement added in ASME A17.1-2010/CSA B44-10 to prevent hydraulic liquid from continuing to heat above its maximum operating temperature due to failure of the motor controller. Other requirements (3.25.2.3, 3.26.3.1.5, and 3.26.5) already address overheating.

3.26.7 Recycling Operation for Multiple or Telescopic Plungers

Telescopic plungers are normally found on holeless hydraulic elevator installations and may need to be vertically realigned periodically. Realignment must be accomplished in accordance with these requirements. If a two-stage plunger is not lowered for realignment, a micro-leveling pump will typically be used.

3.26.8 Pressure Switch

If a car hangs up mechanically for any reason and the lowering valve is opened, the oil is free to flow back to the tank, leaving the cylinder void or partially void of oil. Experiments have shown that present seals are not effective in maintaining a vacuum in the cylinder. See Diagram 3.26.8.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to reference 2.12.1 so users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

This requirement was revised in ASME A17.1-2019/CSA B44:19 to provide more performance-based language that includes a "pressure sensing means" instead of a "switch."

3.26.9 Low Oil Protection

A low oil condition could result in the elevator stopping short of a landing while the motor and pump continue to run. This would result in overheating of the motor/pump and oil, creating a dangerous condition and fire hazard. Compliance with this requirement is usually achieved by using a pump run timer. If the pump runs significantly longer than the time for the elevator to travel from the bottom to the top landing, the timer will stop the motor and lower the elevator to the lowest landing to prevent entrapment. A pump run timer also serves as a protection against phase reversal.

The elevator is not permitted to stop at any intermediate landing as it travels toward the lowest landing. This requirement does not address manual or continuous-pressure-operated doors.

3.26.9.2 Specifying door open time ensures that doors are open for a sufficient time to move passengers out of the car before door closing. As obstructions will cause the doors to stop and reopen, the actual amount of time to achieve full close will vary. However, the time a door will remain open before starting automatic close can be defined absolutely, and can be built into the system and field measured. Automatic-closing vertically acting doors can take longer to close as they are subject to closing-speed limitations.

3.26.10 Auxiliary Power Lowering Operation.

Requirement 3.26.10 was revised in ASME A17.1-2022/CSA B44:22 to provide consistency with the new definition for "normal building power."

3.26.11 Executable Software

This requirement was added in ASME A17.1-2019/CSA B44:19 to provide hydraulic-specific requirements for executable software and for the unique software identifier (USI). See Handbook Section 2.26.1.7 for a more detailed description of the changes.

Requirement 3.26.11.1 was revised in ASME A17.1-2022/CSA B44:22 to require a USI update when changes are made to test enable operation. See Handbook commentary on 2.26.14. It was also revised to add safety-relevant functions to executable software requiring a USI and to add critical software functions not covered in the current Code. See Handbook commentary on 2.26.13.

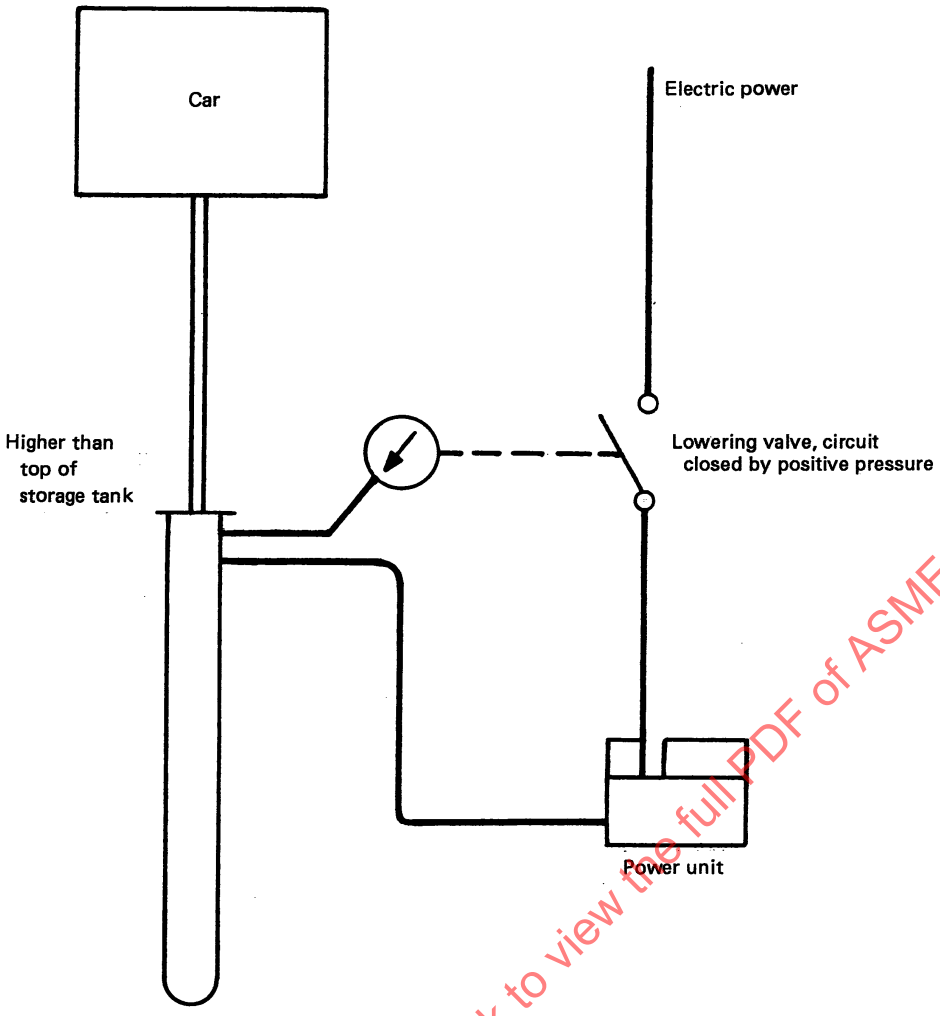
Requirement 3.26.11.1 was revised in ASME A17.1-2022/CSA B44:22 to direct the user of the Code to the cybersecurity requirements for the means to permit on-site software download or to modify parameters of executable software requiring a USI.

3.26.12 Remote Interaction Operation

Requirement 3.26.12, including subsections, was added in ASME A17.1-2022/CSA B44:22 to provide requirements for remote interaction operation (RIO) on hydraulic elevators. See Handbook commentary on 2.26.13.

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Diagram 3.26.8
Pressure Switch



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SECTION 3.27
EMERGENCY OPERATION AND SIGNALING DEVICES

The firefighter community has advised that in their opinion passengers should not be restricted from exiting an elevator even if the elevator is not capable of reaching the recall level. It is safer to exit even at a potential fire floor since the fire is most likely in its early stages. If passengers are not allowed to exit, they may be overcome by smoke. The low oil indicator means the car cannot reach all floors, but it may still be able to reach the fire recall level; it should make the attempt. A car with low oil or only emergency lowering will not be useful to the firefighters after Phase I recall and may sink away from the floor, so once the passengers are out at the recall level the doors should close.

Once firefighters are in the car on Phase II, it should give them as much control of the cars as possible. Firefighters are provided with a visual indication [see 3.27.3(c)] when an elevator should not be used.

Section 3.27, including 3.27.1 and 3.27.2, was revised in ASME A17.1-2022/CSA B44:22 to update the requirements for door operation while on emergency or standby power. While on emergency or standby power, the doors are required to remain operative; however, since the power to move the elevators can be transferred from one car to another, there may not be sufficient power to provide anticreep operation. The revisions require the doors to initiate closing after 15 s to ensure the doors are not open if the car moves away from the landing due to lack of anticreep operation. Since the door open button must remain active, any passengers in the car are still able to open the doors to exit.

3.27.2 Phase I Emergency Recall Operation After Device Actuation

This requirement was revised in ASME A17.1-2016/CSA B44-16 to clarify the action the car shall take when it is above the recall level and the action it shall take when it is below the recall level.

3.27.4 Device Actuation With Phase II Emergency In-Car Operation in Effect

This requirement was revised in ASME A17.1-2016/CSA B44-16 to clarify that when the car is traveling down, stopping between floors is not required and provides no benefit to the firefighter. The devices specified in 3.27.1, when activated, will prevent upward travel; therefore, the devices will immediately stop a car traveling up. Once the car is stopped, the firefighter can travel down only by entering a call below. Because the 3.27.1 devices do not limit downward travel, an immediate stop on activation is not required, and if possible, the elevator should continue to run to the next available floor.

3.27.5 Flood Detection Operation

Requirement 3.27.5 was added in ASME A17.1-2022/CSA B44:22 to require Flood Detection Operation on hydraulic elevators and while making the necessary revisions to distinguish between electric and hydraulic elevator operation including door operation during a flood event. In general, Flood Detection Operation is required to comply with 2.27.13; however, if the car is not able to travel to a level above the flood elevation, it must move to the highest level possible. The doors are required to open upon reaching the landing, and closing must be initiated after 15 s. The door open button must remain operative. The new requirements also detail conditions under which the car cannot travel down when below the flood elevation. See also Handbook commentary on 2.27.13.

SECTION 3.28
LAYOUT DATA

3.28.1 Information Required on Layout Drawing

All the necessary layout data has been consolidated in this requirement. The intent is to require that the elevator company provide the building designer with the necessary forces that the elevator will impart on the building and other needed data for the designer. With this information, the authority having jurisdiction is also in a position to confirm that the elevator is designed to conform with the requirements of ASME A17.1/CSA B44.

Requirement 3.28.1 was revised in ASME A17.1-2022/CSA B44:22 to require the flood elevation on layout drawings.

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Part 4
Elevators With Other Types of Driving Machines

SECTION 4.1
RACK-AND-PINION ELEVATORS

NOTE: Throughout Section 4.1, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

This Part covers rack-and-pinion elevators with the driving machine located on the car with one or more fixed racks and one or more rotating pinions. Rack-and-pinion elevators conforming to the requirements in this Section can be used for passenger and freight service. See Diagram 4.1.

In Section 4.1 of ASME A17.1-2016/CSA B44-16, language was revised to harmonize with that developed in other sections of the Code; paragraphs were restructured and redesignated to parallel the requirement designations and titles used in Part 2; and requirements for rack-and-pinion drives were updated with the appropriate machine-room-less (MRL) elevator requirements. An editorial change was also made to indicate that more than one rack is possible.

4.1.1 Construction of Hoistways and Hoistway Enclosures

This requirement was retitled in ASME A17.1-2016/CSA B44-16 to correlate with Part 2 and was revised to reference only the Part 2 requirements specific to construction of hoistways and hoistway enclosures.

4.1.2 Pits

This requirement was added in ASME A17.1-2016/CSA B44-16.

4.1.3 Location and Guarding of Counterweights

This requirement was added in ASME A17.1-2016/CSA B44-16.

4.1.4 Vertical Clearance and Runbys for Cars and Counterweights

This requirement was added in ASME A17.1-2016/CSA B44-16.

4.1.5 Horizontal Car and Counterweight Clearances

This requirement was added in ASME A17.1-2016/CSA B44-16.

4.1.6 Protection of Space Below Hoistways

This requirement was added in ASME A17.1-2016/CSA B44-16. This requirement provides protection for people in spaces below an elevator hoistway. Where the hoistway does not extend to the lowest level of a building and the space underneath the counterweight and/or its guides is not permanently secured against access, the requirements of 4.1.6.1 apply. Where the space is underneath the car and/or its guides and if spring buffers are used, the requirements of 4.1.6.2 apply.

The counterweight, in addition to the car, is required to be equipped with a safety device to stop and hold the counterweight in case of free fall or overspeed. This is intended to prevent building damage, which would endanger people below the hoistway if the counterweight were to strike its buffer at excessive speed. These requirements are to be met when any of the spaces on each succeeding floor directly below the hoistway are not permanently secured against access.

4.1.7 Machinery Spaces, Control Spaces, and Control Rooms

This requirement (formerly 4.1.2) was revised in ASME A17.1-2016/CSA B44-16 to clarify that machine rooms do not apply to rack-and-pinion elevators and to include the terms “machinery space” and “control space.” Also, detailed requirements for equipment located in the hoistway and exterior to the hoistway were added, as were additional requirements for a means necessary for test.

Rack-and-pinion driving machines are located in the hoistway, on the car. These requirements cover those conditions. If a separate control room is provided, it must conform to the requirements in 2.7.6.1.

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4.1.8 Equipment in Hoistways or Machinery Spaces, Control Spaces, and Control Rooms

This requirement (formerly 4.1.3) was revised in ASME A17.1-2016/CSA B44-16 to clarify that machine rooms do not apply to rack-and-pinion elevators and to include the terms "machinery space" and "control space."

The requirements are similar to those for electric elevators except that the installation of the main electrical feeder inside the hoistway is permitted. This is necessary since the driving machine is located on the car. Design requirements of rack-and-pinion machines necessitate that the drive assembly be located on the car, usually requiring a 480-V main electrical feeder to the motor. This requirement has been an industry standard reflected in ANSI A10.4, Safety Requirements for Personnel Hoists, since 1973.

4.1.9 Supports and Foundations

This requirement (formerly 4.1.4) was revised in ASME A17.1-2016/CSA B44-16 to eliminate drive nut failure since it is not applicable to rack-and-pinion elevators and to add requirements specific to the kinetic energy of rack-and-pinion elevators.

These requirements are similar to those for electric elevators. See Handbook commentary on 2.9.4.

4.1.10 Guarding of Equipment and Standard Railing

This requirement was added in ASME A17.1-2016/CSA B44-16 to specify requirements for guarding of equipment and standard railing and to clarify standard railing requirements.

4.1.11 Protection of Hoistway Doors

This requirement (formerly 4.1.5) was revised in ASME A17.1-2016/CSA B44-16 to reference all of Section 2.11.

Where emergency doors are required, they must comply with 2.11.1. See Handbook commentary on 2.11.

4.1.12 Hoistway Door Locking Devices and Electric Contacts and Hoistway Access Switches

This requirement was added in ASME A17.1-2016/CSA B44-16.

4.1.13 Power Operation of Hoistway Doors and Car Doors

This requirement was added in ASME A17.1-2016/CSA B44-16.

4.1.14 Car Enclosures, Car Doors and Gates, and Car Illumination

The requirements in 4.1.14 (formerly 4.1.6) are the same as for an electric elevator. See Handbook commentary on reference requirements.

4.1.15 Car Frames and Platforms

This requirement (formerly 4.1.7) was revised in ASME A17.1-2016/CSA B44-16 to exclude reference to requirements for electric traction elevators.

The requirements are the same as for an electric elevator. See Handbook commentary on reference requirements.

4.1.16 Capacity and Loading

The requirements in 4.1.16 (formerly 4.1.8) are the same as for an electric elevator. See Handbook commentary on reference requirements.

4.1.17 Car and Counterweight Safeties

This requirement (formerly 4.1.9) was revised in ASME A17.1-2016/CSA B44-16 to move speed governors to a separate requirement (see 4.1.18) and to clarify minimum factor of safety and marking plate requirements.

The basic requirements are equivalent to those for an electric elevator. (See also Diagram 4.1.17.)

4.1.17.1 Stopping Distances. Deviation for jurisdictions enforcing NBCC requires consideration of kinetic energy of the driving unit when calculating stopping distances of safeties.

4.1.18 Speed Governor

This requirement was added in ASME A17.1-2016/CSA B44-16 to separate the speed governor requirements from those for car and counterweight safeties (see 4.1.17).

The basic requirements are equivalent to those for an electric elevator. However, the requirement allows rack-and-pinion safeties and governors to be an integral unit mounted on the car. Stopping distances in Table 4.1.9.1 are derived from combining the requirements in 2.17.3 and 2.17.11. Most manufacturers require that integral rack-and-pinion governor/safety systems be returned to the factory periodically for rebuilding, typically every 5 yr. This is in addition to the periodic inspection and test required by 8.11.5.11. See Diagram 4.1.17.

4.1.19 Ascending Car Overspeed and Unintended Car Movement Protection

This requirement was added in ASME A17.1-2016/CSA B44-16.

4.1.20 Suspension Ropes and Their Connections

This requirement was added in ASME A17.1-2016/CSA B44-16.

4.1.21 Counterweights

This requirement (formerly 4.1.10) was revised in ASME A17.1-2016/CSA B44-16 to add requirements for counterweight sheaves.

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Counterweights are not required, but if used, they must conform to the same requirements as for an electric elevator.

4.1.22 Buffers and Bumpers

This requirement (formerly 4.1.11) was revised in ASME A17.1-2016/CSA B44-16 to provide separate requirements for car buffers.

The requirements are the same as for electric elevators except the rotational kinetic energy must be added to the translative kinetic energy of the car.

4.1.23 Car and Counterweight Guide Rails, Guide-Rail Supports, and Fastenings

The title of this requirement (formerly 4.1.12) was revised in ASME A17.1-2016/CSA B44-16 to correlate with that used in Section 2.23.

See Diagram 4.1.23.

4.1.24 Rack-and-Pinion Drive Machine

This requirement (formerly 4.1.13) was revised in ASME A17.1-2016/CSA B44-16 to specify the rack-and-pinion machine requirements in Section 4.1. Since the vertical rack is installed in sections made to standard lengths, it is not probable that two backup rollers will occupy the same section of rack at all times. Also, the general reference to Part 2 was deleted and requirements were added.

The safety requirements for the drive machine and the rack are unique to rack-and-pinion elevators. However, many of the requirements parallel those for other types of elevators. See Diagrams 4.1.24(a) and 4.1.24(b).

4.1.25 Terminal Stopping Devices

This requirement (formerly 4.1.14) was revised in ASME A17.1-2016/CSA B44-16 to delete references to requirements for traction and winding-drum machines.

4.1.25.1 Normal and Final Terminal Stopping Devices. The requirements are basically the same as those for an electric elevator. Typically, the limit switches are on the car as illustrated in Diagram 4.1.25.1.

4.1.26 Operating Devices and Control Equipment

This requirement (formerly 4.1.15) was revised in ASME A17.1-2016/CSA B44-16 to delete referenced requirements that apply only to traction elevators and/or machine rooms. Also, the requirements for operating devices and control equipment applicable to rack-and-pinion elevators were reformatted, and reference to permitted voltage was deleted. (Requirements for permitted voltage fall under the applicable electrical codes, as referenced.)

4.1.26.1 Operating Devices. The requirements are generally the same as for an electric elevator with the exception of those that are not applicable due to the design of the equipment.

The requirements in 4.1.26.1 were revised in ASME A17.1-2016/CSA B44-16 to delete references to requirements that apply only to traction elevators and/or machine rooms and to clarify that car top inspection operation provides equivalent function for machinery spaces located on the car.

4.1.26.2 Electrical Protective Devices. Control and operating circuit voltages are not permitted above 300 V. See also Handbook commentary on 4.1.8.

The requirements in 4.1.26.2 were revised in ASME A17.1-2016/CSA B44-16 to delete references to requirements that apply only to traction elevators and/or machine rooms. Requirement 4.1.26.2.39 is shown as optional because a rack-and-pinion drive is a direct drive system using a vertical stationary rack.

4.1.26.7 Installation of Capacitors or Other Devices or Means to Make Electrical Protective Devices Ineffective. The title of this requirement was revised in ASME A17.1-2022/CSA B44:22 to align with changes to the title of 2.26.7. See Handbook commentary on 2.26.7 for more information.

4.1.27 Emergency Operation and Signal Devices

The requirements in 4.1.27 (formerly 4.1.16) are equivalent to those for electric elevators. See Handbook commentary on reference requirements.

4.1.28 Layout Drawings

The requirements in 4.1.28 (formerly 4.1.17) are the same as for electric elevators except for two additional requirements, which address needs unique to rack-and-pinion elevators.

4.1.29 Identification

This requirement was added in ASME A17.1-2016/CSA B44-16.

4.1.30 Sway Control Guides

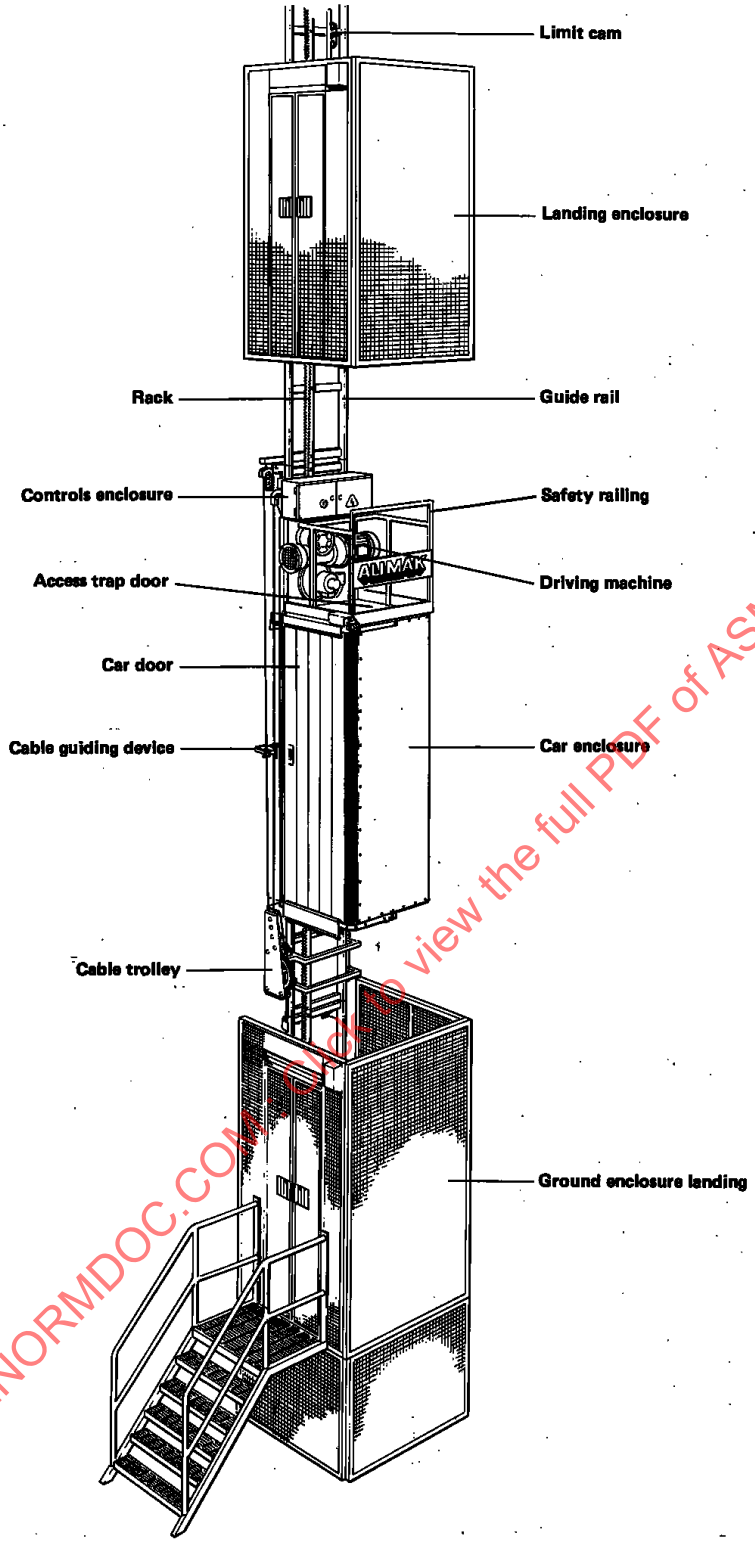
This requirement was added in ASME A17.1-2016/CSA B44-16.

4.1.31 Welding

This requirement (formerly 4.1.18) was renumbered in ASME A17.1-2016/CSA B44-16 due to the reformatting of Section 4.1.

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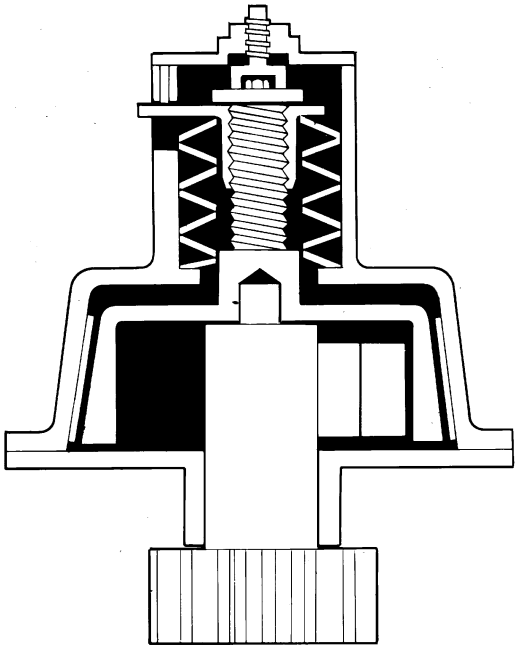
Diagram 4.1
Typical Rack-and-Pinion Elevator Arrangement



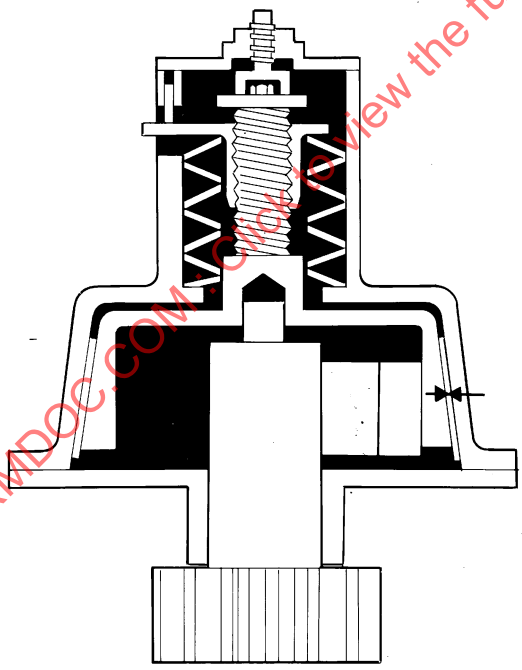
GENERAL NOTE: Courtesy of Alimak, Inc.

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Diagram 4.1.17
Typical Rack-and-Pinion Safety



Released Position

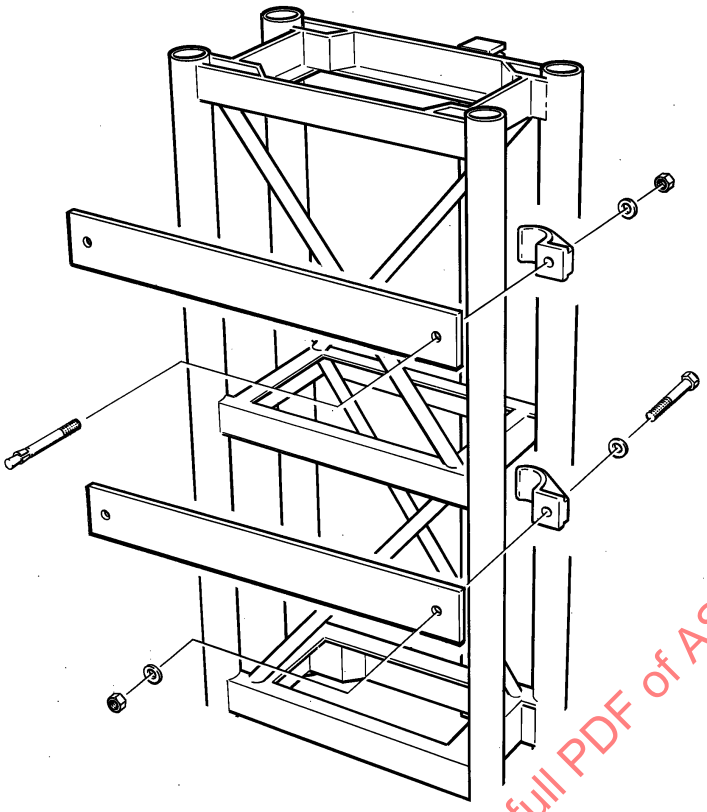


Applied Position

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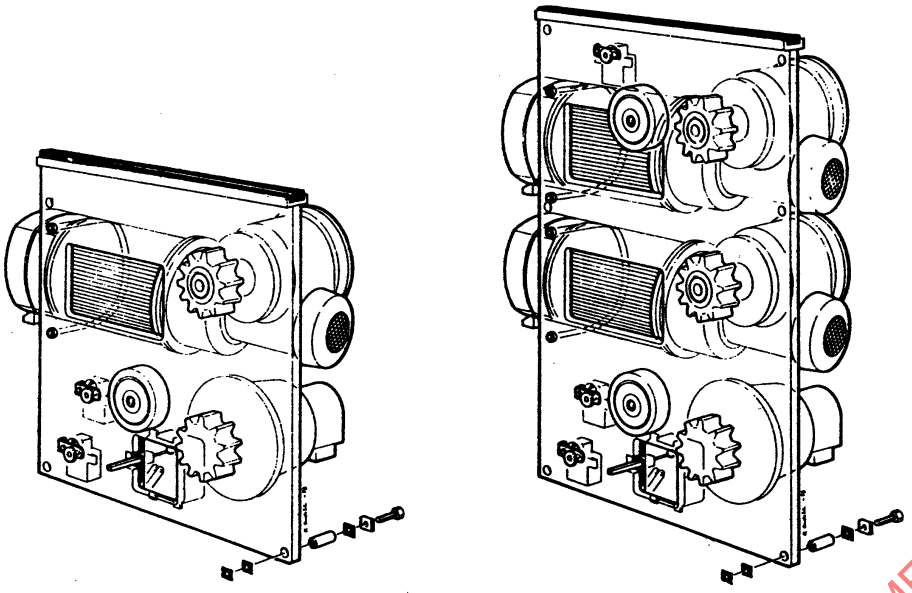
Diagram 4.1.23
Typical Guide-Rail Support Tower



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Diagram 4.1.24(a)
Typical Rack-and-Pinion Driving Machine



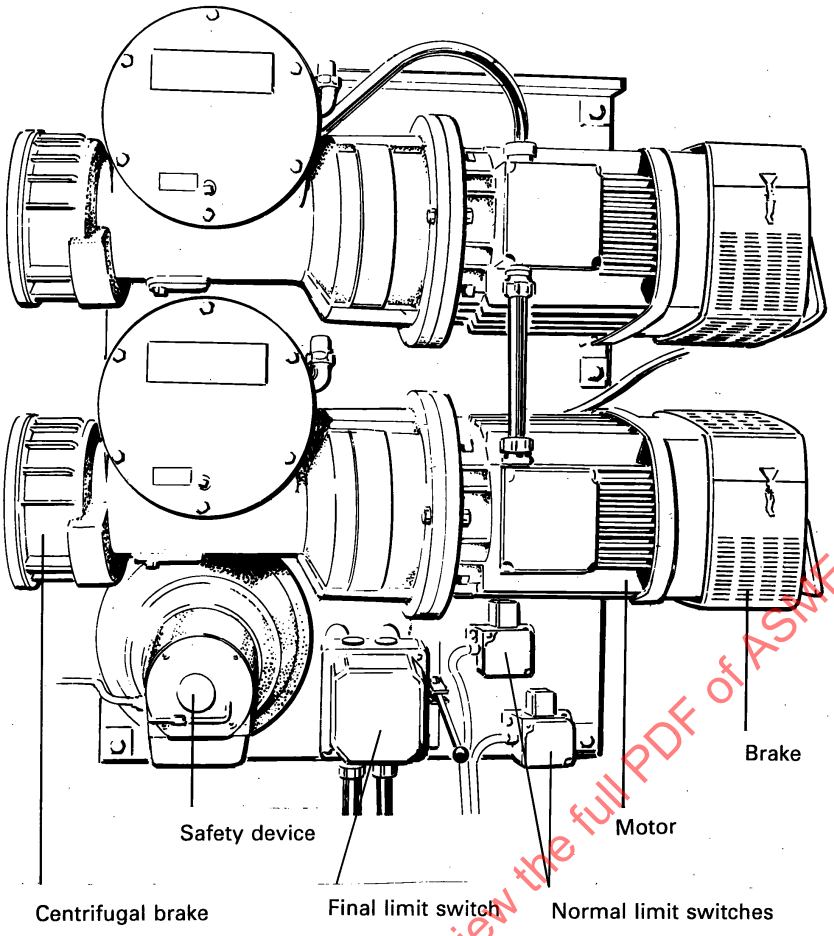
Simple Drive Unit

Double Drive Unit

GENERAL NOTES:
(a) Courtesy of Alimak, Inc.
(b) A drive unit is a compact unit with one or two pinions engaging into the rack of the mast. The pinion is mounted on a key joint and fitted to the secondary shaft of the worm gear, which is driven by a direct-started, squirrel-cage induction motor with built-in electromagnetic disc brake.

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Diagram 4.1.24(b)
Typical Rack-and-Pinion Driving Machine

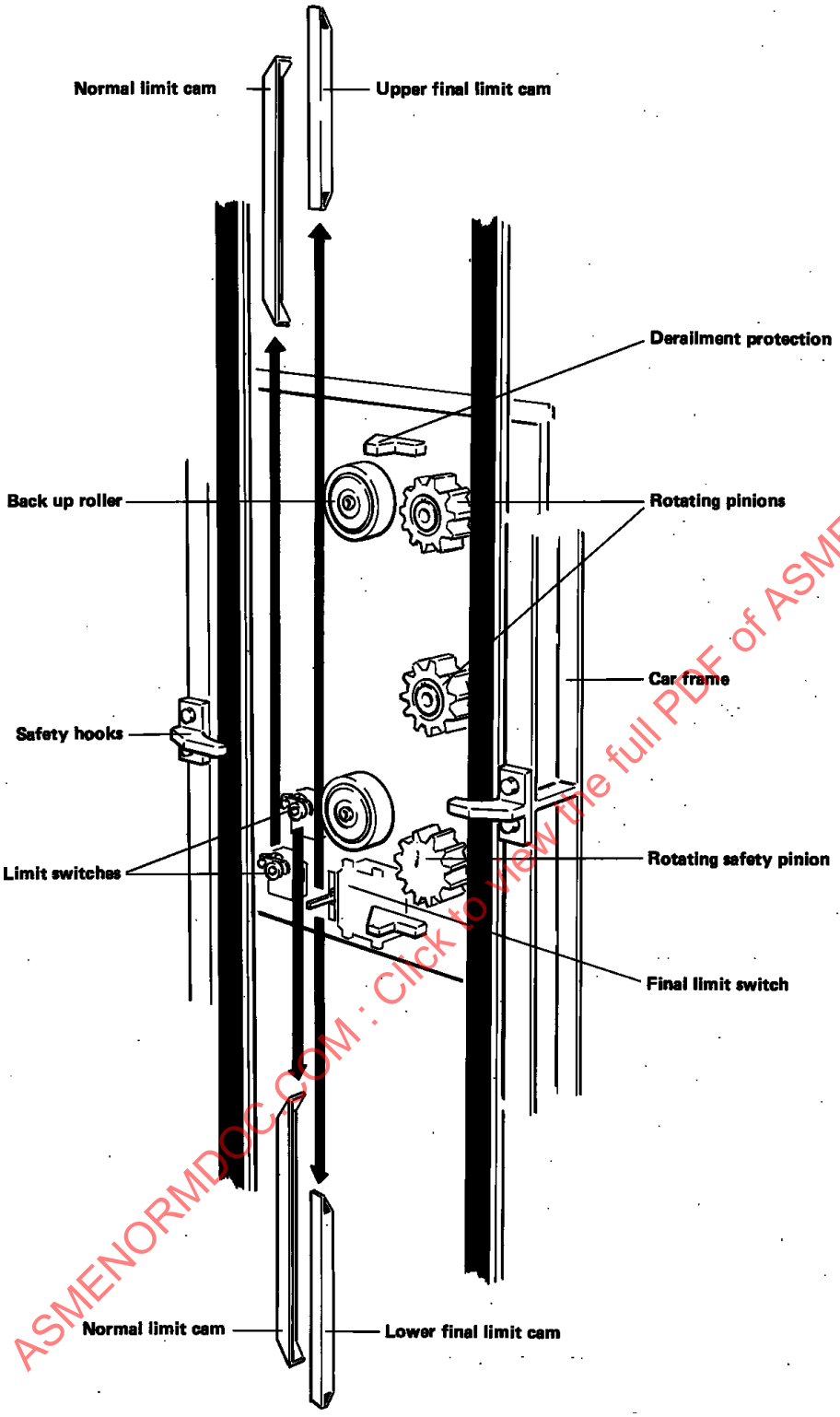


Rack-and-Pinion Driving Machine

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Diagram 4.1.25.1
Typical Terminal Stopping Device Arrangement



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SECTION 4.2
SCREW-COLUMN ELEVATORS

NOTE: Throughout Section 4.2, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

4.2.1 Hoistways, Hoistway Enclosures, and Related Construction

Fire-resistive hoistway construction is typically required by the building code for all screw-column elevators except

(a) elevators that are entirely within one story or that pierce no solid floors.

(b) observation elevators that are located adjacent to a building wall without penetrating the fire-resistive areas of the building. The requirements for the following components, construction, or operations are the same as for electric elevators: guards for exposed auxiliary equipment, pits, protection of hoistway landing openings, hoistway door locking devices, car door or gate electric contacts, hoistway access switches, elevator parking devices, power operation, power opening, and power closing of hoistway doors and car doors or gates. See Handbook commentary on reference requirements.

4.2.2 Vertical Clearance and Runby for Cars

The bottom and top clearance requirements ensure there will be no damage to the elevator equipment or the building in the event the elevator overtravels in either up or down direction. Bottom and top clearances also provide sufficient space for elevator personnel to take refuge and avoid injury if trapped either on top of the car or in the pit when the car reaches its extreme limit of rise.

Requirements 4.2.2.3 and 4.2.2.4 were revised in ASME A17.1-2016/CSA B44-16 because a separate refuge space is no longer specified in the Code. The clearances necessary for refuge space are now incorporated into the top-of-car clearances for both electric and hydraulic elevators.

4.2.3 Horizontal Car Clearance

The requirements for horizontal car clearance in relation to the hoistway enclosure are the same as for electric elevators. Since screw-column elevators have no counterweights, the clearance requirements are the same for all sides not used for loading and unloading.

4.2.4 Protection of Spaces Below Hoistway

In the event the elevator is located above a space to which persons have access, the supporting structure for the screw column, guide rails, and buffers are required to be strong enough to withstand the most severe impact that might occur due to a failure of the driving nut, a safety application, or a buffer engagement by the car while carrying rated load at maximum down speed. The structure must withstand this impact without permanent deformation, thus eliminating hazards to persons who might be underneath the elevator at the time such an impact occurs.

4.2.5 Machine Rooms and Machinery Spaces

Depending on the design of the screw-column elevator, the screw machine may be located in a machinery space within the hoistway, on the elevator car, in the elevator pit, or in a separate machinery room or machinery space. Where the screw machine is located in the pit, the normal means of access to the pit is considered adequate. See Diagram 4.2.5.

4.2.6 Equipment in Hoistways and Machine Rooms

Main line feeders are permitted in the hoistway. However, there must be no intermediate access to the conductors between the disconnecting means and the termination at the motor or controller. This arrangement eliminates any need for other building personnel to enter the hoistway to inspect, service, or alter any electrical connections.

4.2.7 Supports and Foundations

The design of the supports and foundations is required to be in accord with the building code (see Section 1.3). Since the elevator may transmit impact loading into its supports and the building structure, the maximum normal loading is doubled when calculating the unit stresses, to compensate for impact and accelerating stresses.

4.2.8 Car Enclosures, Car Doors and Gates, and Car Illumination

The requirements for car enclosures, car doors and gates, and car illumination are identical to those for electric elevators. See Handbook commentary on reference requirements.

4.2.9 Car Frames and Platforms

The requirements for car frames and platforms are substantially the same as for electric elevators. See Handbook commentary on reference requirements.

4.2.10 Capacity and Loading

The capacity and loading requirements are identical to those for electric elevators. See Handbook commentary on reference requirements.

4.2.11 Car Safeties and Speed Governor

The requirements for the car safeties and speed governors are identical to those for electric elevators, except that either one of two specified alternate safety

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devices may be used for slow speed (not exceeding 0.37 m/s or 75 ft/min) screw-column elevators that are driven by a substantially constant speed alternating-current motor. The alternate safety devices provide safety by either

(a) limiting the down speed of the elevator car with rated load to 0.87 m/s or 175 ft/min in the event of failure of the driving means, or

(b) limiting the fall to a distance not exceeding 13 mm or 0.5 in. in the event of failure of the driving nut

Since these alternate safety devices cannot be readily tested in the field, engineering-type tests of such devices are required before use in the field.

Requirement 4.2.11.1 was editorially revised in ASME A17.1-2022/CSA B44:22.

4.2.12 Safety Nut and Data Tag

A safety nut is required as a backup to the drive nut on all screw machines that use a drive nut made of material other than metal. Further, a safety nut may be used on all screw machines. The safety nut travels parallel with the driving nut but is not subject to any load and thus has no wear. The metal data tag provides a record at the machine as to when the driving nut and safety nut were installed. It also records the initial spacing between the driving and safety nuts. The inspector can get an indication of when the driving nut is beginning to wear by determining any reduction from the original spacing between the two nuts.

Requirement 4.2.12 was inadvertently deleted in ASME A17.1-2019/CSA B44:19. This requirement was originally intended to be revised as part of Record 10-0967. It is the author's understanding that the changes to 4.2.12 were supposed to be removed from the proposal based on ballot comments; however, the revised proposal following that ballot included the language from 4.12.2 with black strike-through of the requirements and rationale. It seems like this was mistaken to mean that these should be deleted from the Code rather than deleted from the Record. It is the author's understanding that an errata will be proposed to address this revision; however, no changes were made in ASME A17.1-2022/CSA B44:22.

4.2.13 Car Buffers

Solid bumpers are permitted on cars having a maximum down speed of 0.25 m/s or 50 ft/min or less provided with a safety nut. The option of providing solid bumpers is not permitted on elevators equipped with a speed-limiting device or a conventional governor and safety. Either of these safety devices might allow the car to approach the lower limit of travel at up to 0.87 m/s or 175 ft/min in the event of failure of the driving nut, a speed considered excessive for solid bumpers. The option permitting the use of solid bumpers parallels the requirements for hydraulic elevators.

4.2.14 Guide Rails, Guide-Rail Supports, and Fastenings

The requirements for guide rails, guide-rail supports, and fastenings are substantially the same as for electric elevators.

4.2.15 Driving Machine and Screw Column

The elevator car is directly supported by a screw column, which may be in either tension or compression. Design formulas for screw columns in compression are similar to those for the plunger of a hydraulic elevator. Design guidance is included for screw columns in tension to ensure a safe design.

Means are required to permit the release of passengers who may be trapped in the elevator car because of a power failure. For elevators available to the general public, either manual means to move the car from a location outside the car or standby emergency power is required. For private residence elevators and special purpose personnel elevators, means for moving the car may be the same as those for elevators available to the general public, or such elevators may be provided only with means to permit the trapped passenger to move the car to a landing manually. Should the trapped passenger be unable to move the car to a landing, the car emergency signal devices are available to summon help. See Diagram 4.2.15.

Requirement 4.2.15.11 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definitions for "normal building power" and "emergency or standby power."

4.2.16 Terminal Stopping Devices

4.2.16.1 Normal Terminal Stopping Devices. The requirements for normal terminal stopping devices are identical to those for electric elevators. See Handbook commentary on reference requirements.

4.2.16.2 Final Terminal Stopping Devices. Final terminal stopping devices identical to those for electric elevators are required for screw-column elevators having a rated speed exceeding 0.50 m/s or 100 ft/min. Screw-column elevators having a rated speed of 0.50 m/s or 100 ft/min or less have less potential for severe impact in the event of overtravel at a terminal, and thus final terminal stopping devices are not required. Instead, the elevator car must be brought to a mechanical stop without damage in the event of overtravel at either terminal due to a malfunction.

4.2.16.3 Emergency Terminal Speed-Limiting Devices. The requirements for emergency terminal speed-limiting devices, where used, are identical to those for electric elevators.

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4.2.17 Operating Devices and Control Equipment

4.2.17.1 Applicable Requirements. The listed requirements for operating devices and control equipment are identical to those for electric elevators. See Handbook commentary on reference requirements.

Requirement 4.2.17.1(i) was revised in ASME A17.1-2022/CSA B44:22 to align with changes to the title of 2.26.7. See Handbook commentary on 2.26.7 for more information.

4.2.18 Emergency Operation and Signaling Devices

The requirements for emergency operation and signaling devices are identical to those for electric elevators. See Handbook commentary on reference requirements.

4.2.19 Layout Drawings

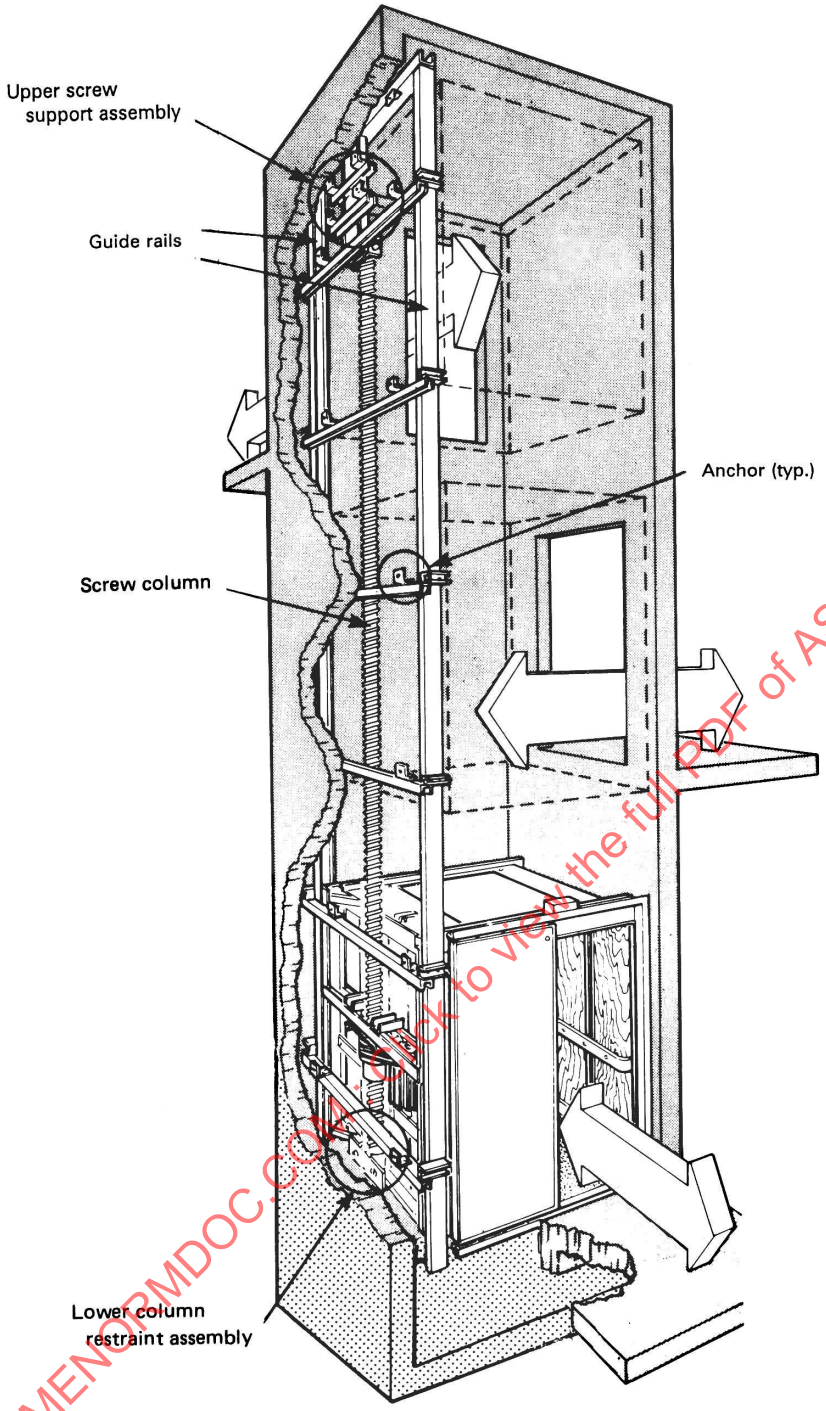
The layout information required for electric elevators is supplemented by information unique to screw-column elevators. The complete layout information will permit the authority having jurisdiction to check the structural adequacy of the building to support the elevator, prior to approval for installation.

4.2.20 Welding

The requirements for welding are identical to those for electric elevators. See Handbook commentary on reference requirements.

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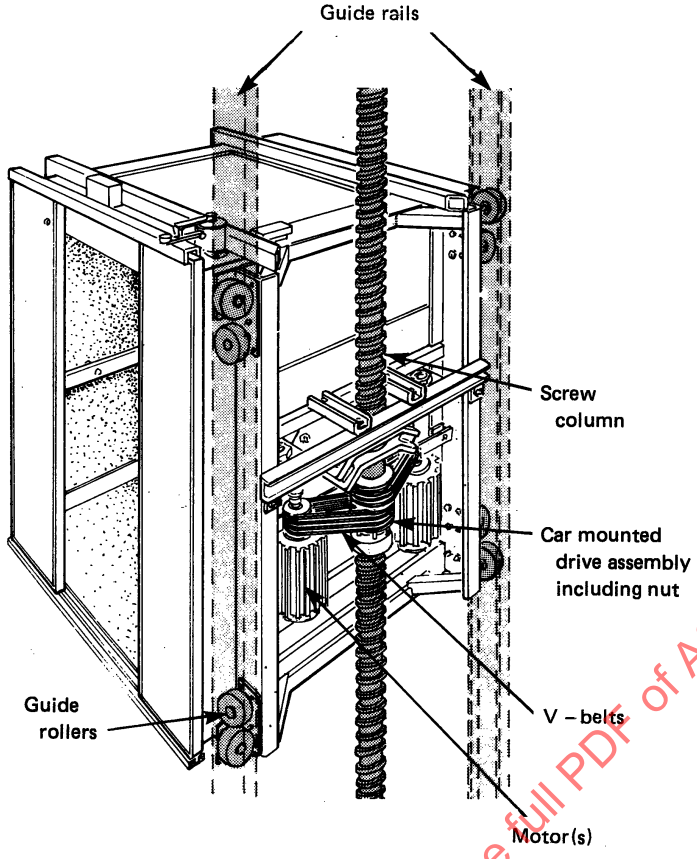
Diagram 4.2.5
Typical Screw-Column Elevator Schematic



GENERAL NOTE: Courtesy of Urban Mass Transportation Administration.

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Diagram 4.2.15
Detail of Car-Mounted Drive Assembly, Nut, and Screw Column



GENERAL NOTE: Courtesy of Urban Mass Transportation Administration.

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SECTION 4.3
HAND ELEVATORS

NOTE: Throughout Section 4.3, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

A hand elevator is an elevator using manual energy to move the car. New installations of hand elevators are very rare, and these are usually installed in private residences or where unusual circumstances exist. Few companies, if any, are currently manufacturing hand elevators.

4.3.6 Hoistway Entrances

Hoistway entrances cannot be completely closed when the car is not at the landing, as the lifting rope must be accessible from the landing to bring the car to same. The 1 070 mm or 42 in. high, lower section of a dutch door [4.3.6.1(b)] or hoistway gate (4.3.7) provides protection at the opening from the danger of falling into the hoistway when operating the elevator from the landing.

4.3.7 Hoistway Gates for Landing Openings

This requirement ensures that the gate in the extended position cannot be forced toward the hoistway and thus interfere with the running clearances of the car. This requirement applies when a single-section swinging door is provided, whereas 4.3.6.1(b) applies when a two-section (Dutch type) swinging door is provided.

4.3.16 Suspension Means

4.3.16.4 Securing of Drum Ends, and Turns on Drum. This requirement ensures that the rope will not be pulled off the drum when the car or counterweight reaches its maximum overtravel in the down direction.

4.3.16.5 Suspension Member Data. The suspension member data plate is installed by the manufacturer to advise maintenance and inspection personnel of the design characteristics of the suspension members. The data tag should be checked against the suspension member data plate at the time of inspection to ensure that the proper suspension member is installed. It should also be checked at the time of replacement to ensure that the proper suspension member is being placed on the hand elevator.

4.3.18 Guide Rails and Fastenings

4.3.18.3 Extension of Guide Rails at Top and Bottom of Hoistway. Car and counterweight guide rails must extend at the bottom to a point that the car or counterweight will not become disengaged from its guide rail when it is resting on its fully compressed buffer(s). The car guide rails must extend to the top of the hoistway to a point that the car will not become disengaged when the counterweight is on its fully compressed buffer plus a distance equal to one-half the gravity stopping distance calculated using the governor tripping speed when spring buffers are used. The counterweight guide rails must extend to the top of the hoistway to a point that the counterweight will not become disengaged when the car is on its fully compressed buffer plus a distance equal to one-half the gravity stopping distance calculated using the governor tripping speed when spring buffers are used.

4.3.20 Power Attachments

If power attachments are added to a hand elevator, that elevator must meet all of the applicable requirements for electric elevator (Part 2) or hydraulic elevator (Part 3) of ASME A17.1/CSA B44.

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Part 5
Special Application Elevators

SECTION 5.1
INCLINED ELEVATORS

NOTE: Throughout Section 5.1, references are made to other requirements in the ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

An inclined elevator is defined as an elevator that travels at an angle of inclination of 70 deg or less from the horizontal. See Section 5.14 for private residence inclined elevators.

5.1.2 Construction of Hoistway and Hoistway Enclosures

5.1.2.2 Non-Fire-Resistive Construction. These requirements apply where non-fire-resistive construction is permitted by the building code. An example is the condition where an inclined elevator is located between two escalators and the perimeter walls surrounding the escalator meet the fire-resistive construction requirements. However, hoistway guarding would be required between the inclined elevator and the escalator. Examples include areas where people may come in contact with the elevator, such as a passageway, stairway, elevator landing, or walkway; these must be enclosed as specified by the requirements. See Diagrams 5.1.2.2(a), 5.1.2.2(b), and 5.1.2.2(c).

5.1.3 Pits and Work Spaces

5.1.3.1 Work Space Dimensions. See Diagram 5.1.3.1.

5.1.5 Clearances for Cars and Counterweights

5.1.5.1 Bottom Car Clearances. The purpose of this requirement is to provide refuge space below the car even when it is resting on its fully compressed buffer. Bottom car clearance is defined as the clear vertical distance from the pit floor to the lowest structural or mechanical part, equipment, or device installed beneath the car platform except guide shoes or rollers, safety jaw assemblies, and platform aprons or guards when the car rests on its fully compressed buffer. See Diagram 5.1.5.1.

5.1.5.2 Top Car Clearance for Uncounterweighted Inclined Elevators. Top car clearance is the shortest vertical distance of travel between the upward most portion of the chassis (car frame) and the nearest obstruction when the car is level with the top terminal landing.

5.1.6 Protection of Spaces in Line With the Direction of Travel

Requirements provide for the angular direction of travel.

5.1.8 Protection of Hoistway Openings

5.1.8.2 Landing-Sill Guards. See Diagram 5.1.8.2.

5.1.10 Access to Hoistways for Inspection, Maintenance, and Repairs

5.1.10.3 Special Operating Requirements

5.1.10.3.1 Slower speed is required due to the horizontal component of travel.

5.1.11 Car Enclosures

5.1.11.1 Car Emergency Exits. Above 49 deg, it is considered safe to access the car top from a landing opening. At 49 deg and below, a top emergency exit is not required. Emergency exiting is taken into account by the requirements of 5.1.11.1.2 and 5.1.11.1.3.

5.1.11.1.2 Uphill End Emergency Exit

5.1.11.1.2(e) The uphill emergency exit is the preferred location for inspection of the hoistway.

5.1.11.4 Restricted Opening of Car Doors. The maximum unlocking zone is reduced due to the horizontal movement of the car. Note that the maximum unlocking zone is measured in the direction of travel.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to reference 2.12.1 so users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

5.1.11.5 Collapsible Gates. Gates of this type represent a hazard when used on inclined elevators since inclined elevators move horizontally.

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5.1.12 Car Frames and Platforms

5.1.12.2 Platform Guards (Aprons). The purpose of the guard is to reduce the shearing action at the edge of the car sill and to block the opening from the landing to reduce the possibility of falling into the hoist. See Diagram 5.1.12.2.

5.1.12.2.6 Platform Stringers. Horizontal forces developed during a safety set preclude the use of wood for stringers.

5.1.13 Capacity and Loading

5.1.13.1 Benches or Seats. This provision allows the installation of seats without restricting standing capacity. See Diagram 5.1.13.1.

5.1.15 Speed Governor Drive

See Diagrams 5.1.15(a) and 5.1.15(b).

5.1.16 Suspension Ropes and Their Connections

5.1.16.1 Protection of Ropes. See Diagram 5.1.16.1.

5.1.17 Car and Counterweight Buffers

The basis of the tables and formulas for buffer strokes and safety stopping distances was the preliminary acceptance of $\frac{1}{2}g$ by enforcing authorities familiar with inclined elevators. Additionally, in developing the requirement, reference was made to a study performed some years ago in Japan regarding braking on passenger trains.

Allowable maximum acceleration and deceleration during normal operation is not addressed in ASME A17.1/CSA B44. Each manufacturer should evaluate its control system as is done with vertical elevators and then set a standard that would be acceptable using $\frac{1}{2}$ g as a maximum.

5.1.18 Car and Counterweight Guide Rails, Guide-Rail Supports, and Fastenings

5.1.18.1 Guide-Rail Section. See Diagram 5.1.18.1.

5.1.18.4 Safety Guide Rail. On many inclined elevators using other than "T" rails for main guides, the historical method for application of the safety is to use a centrally located "T" rail.

5.1.21 Emergency Operations and Signaling Devices

5.1.21.1 Emergency Signal and/or Communications. Requirement 5.1.21.1 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definitions for "normal building power" and "auxiliary power supply."

5.1.22 End-Loading Inclined Elevators

5.1.22.2 Speed. Slow speeds are required due to the combined horizontal/vertical movement of the car.

5.1.22.3 Buffers. These requirements were developed as these buffers are directional and not intended to stop all operation.

5.1.22.5 Retractable Sills. See Diagram 5.1.22.5.

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Diagram 5.1.2.2(a)
Hoistway Enclosure Non-Fire-Resistive Construction

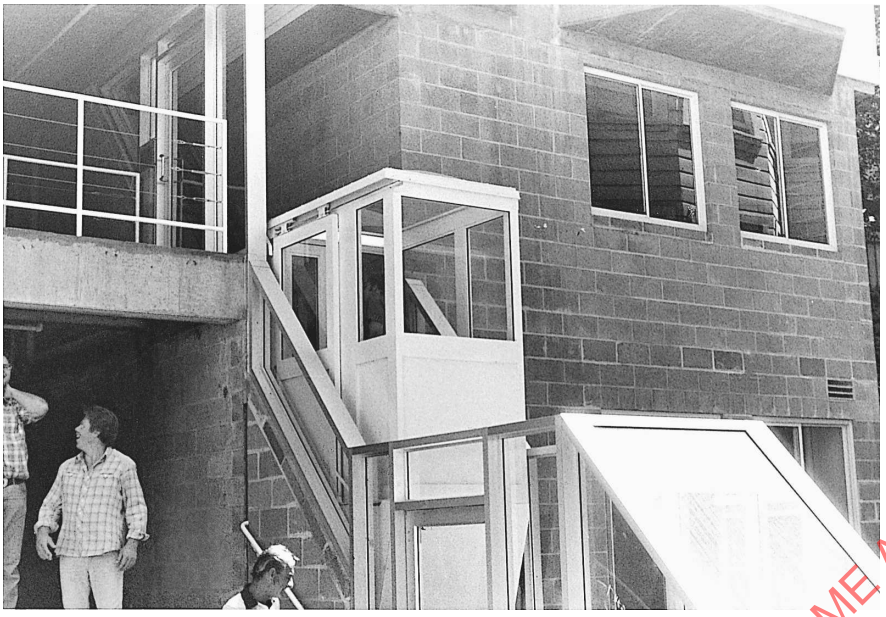


Diagram 5.1.2.2(b)
Hoistway Without Enclosure



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Diagram 5.1.2.2(c)
Non-Fire-Resistive Hoistway Enclosure Details

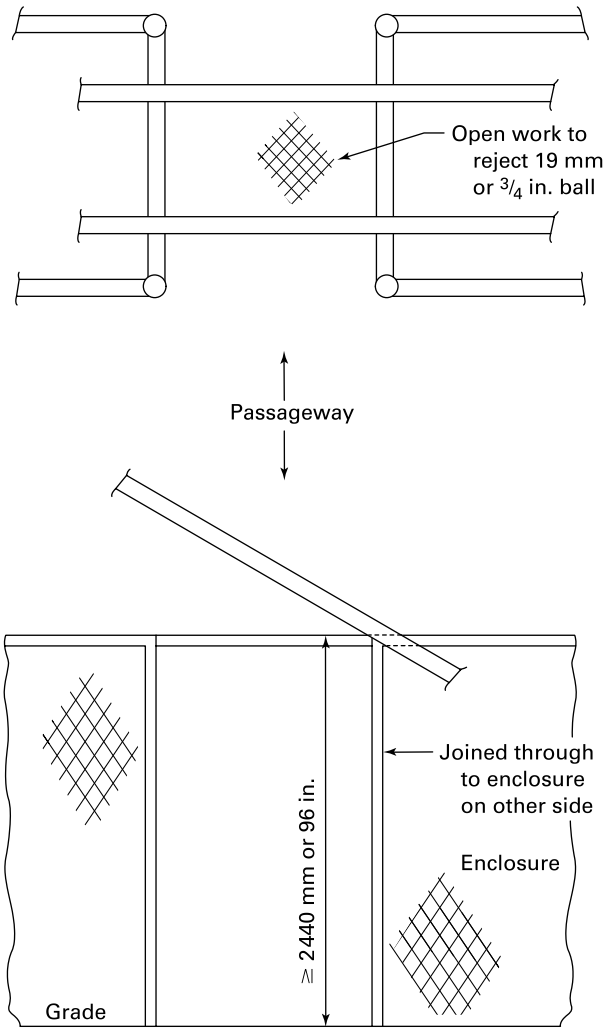
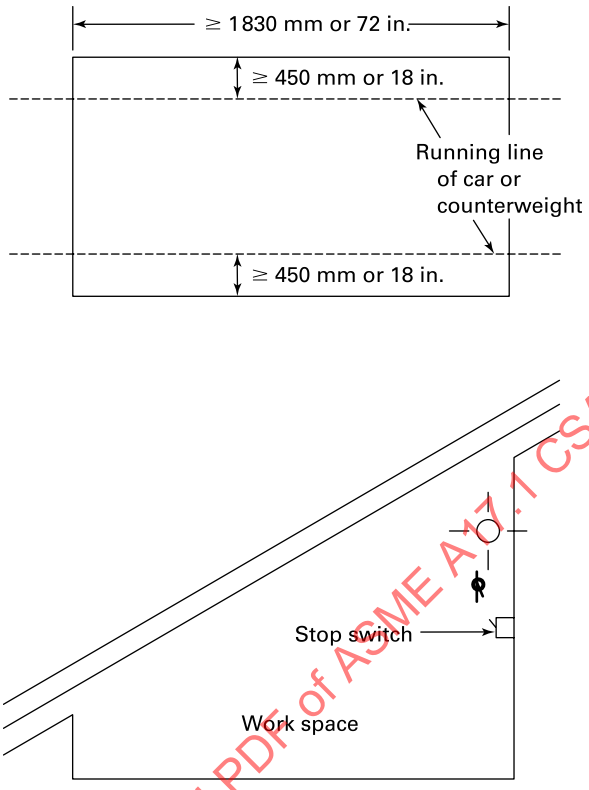


Diagram 5.1.3.1
Work Space Dimensions



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Diagram 5.1.5.1
Refuge Space (When Conformance to Requirement 2.4.1 Is Not Provided)

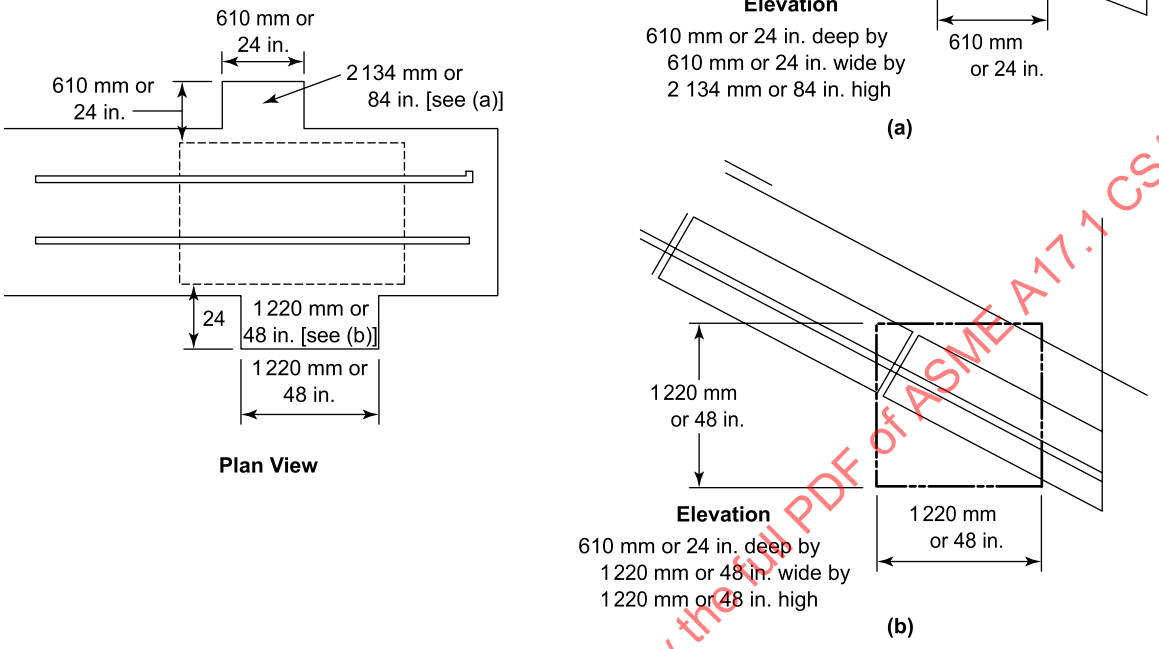
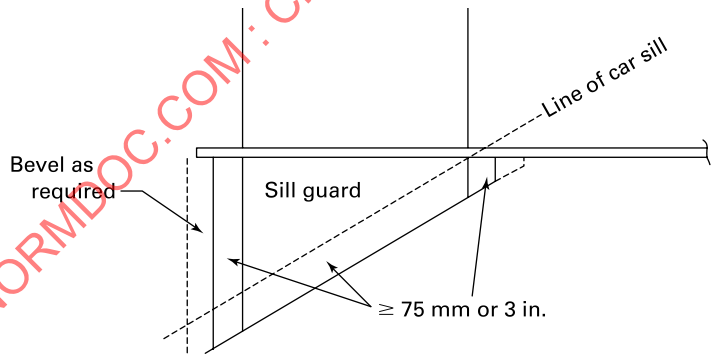


Diagram 5.1.8.2
Landing-Sill Guards



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Diagram 5.1.12.2
Platform Guards (Aprons)

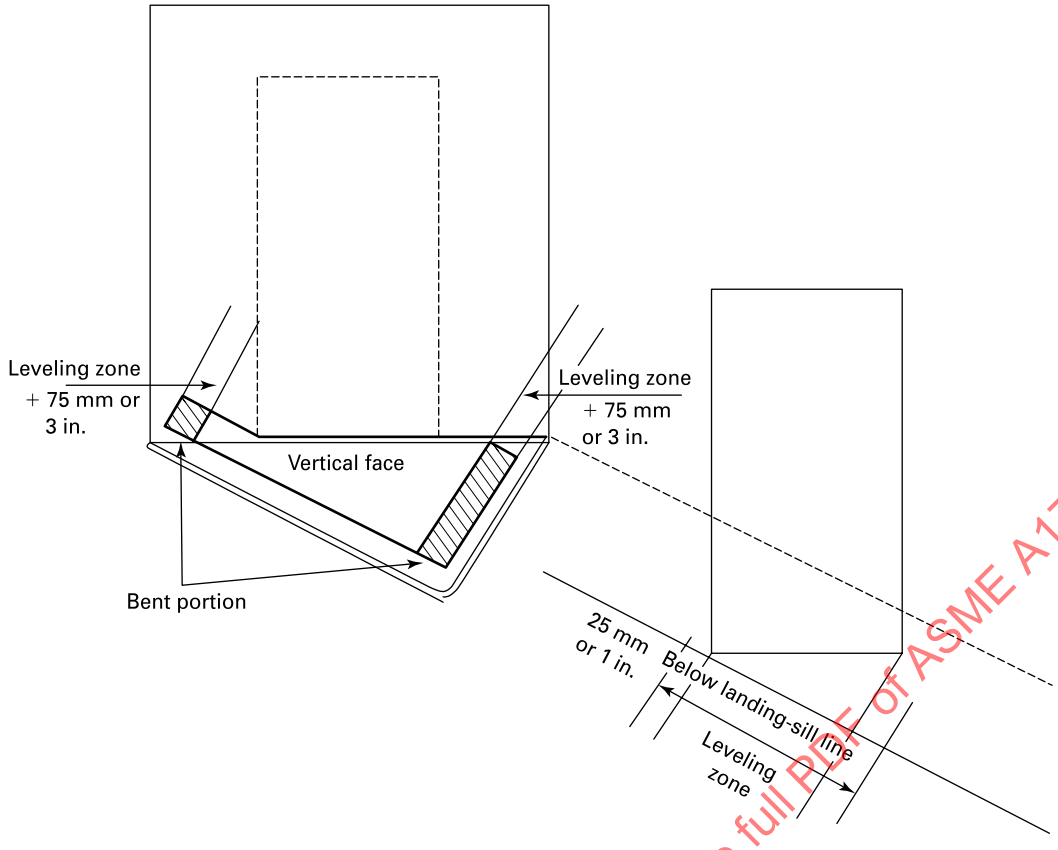
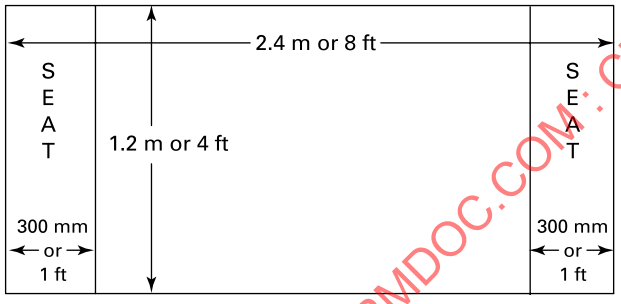


Diagram 5.1.13.1
Measurement of Net Platform Area



EXAMPLE:
2.4 m × 1.2 m = 2.88 m^2 gross platform area
0.3 m × 1.2 m × 2 = 0.72 m^2 seats
2.88 m^2 - (0.72 m^2 × 0.5 = 0.375 m^2) = 2.505 m^2 net platform area
or
8 ft × 4 ft = 32 ft^2 gross platform area
1 ft × 4 ft × 2 = 8 ft^2 seats
32 ft^2 - (8 ft^2 x 0.5 = 4 ft^2) = 28 ft^2 net platform area

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Diagram 5.1.15(a)
Example of Static Governor Rope Drive Arrangement

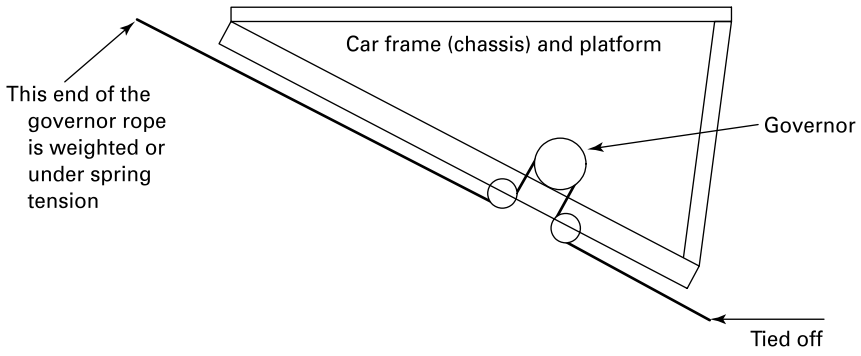
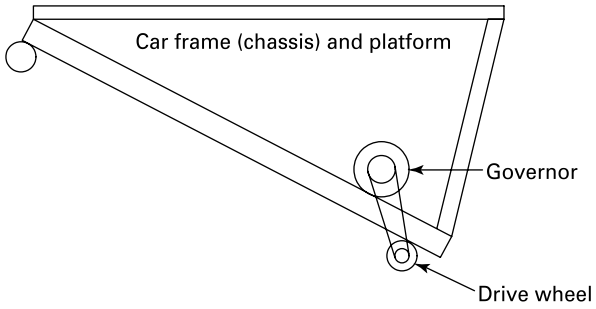
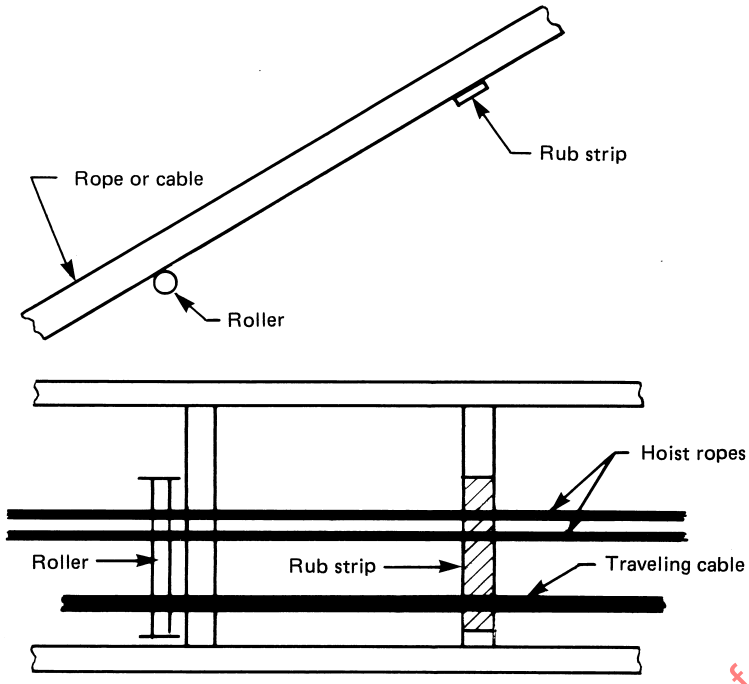


Diagram 5.1.15(b)
Example of Wheel-Driven Governor Arrangement



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Diagram 5.1.16.1
Example of Protection of Ropes and Traveling Cable



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Diagram 5.1.18.1
Examples of Typical Guide-Rail Sections

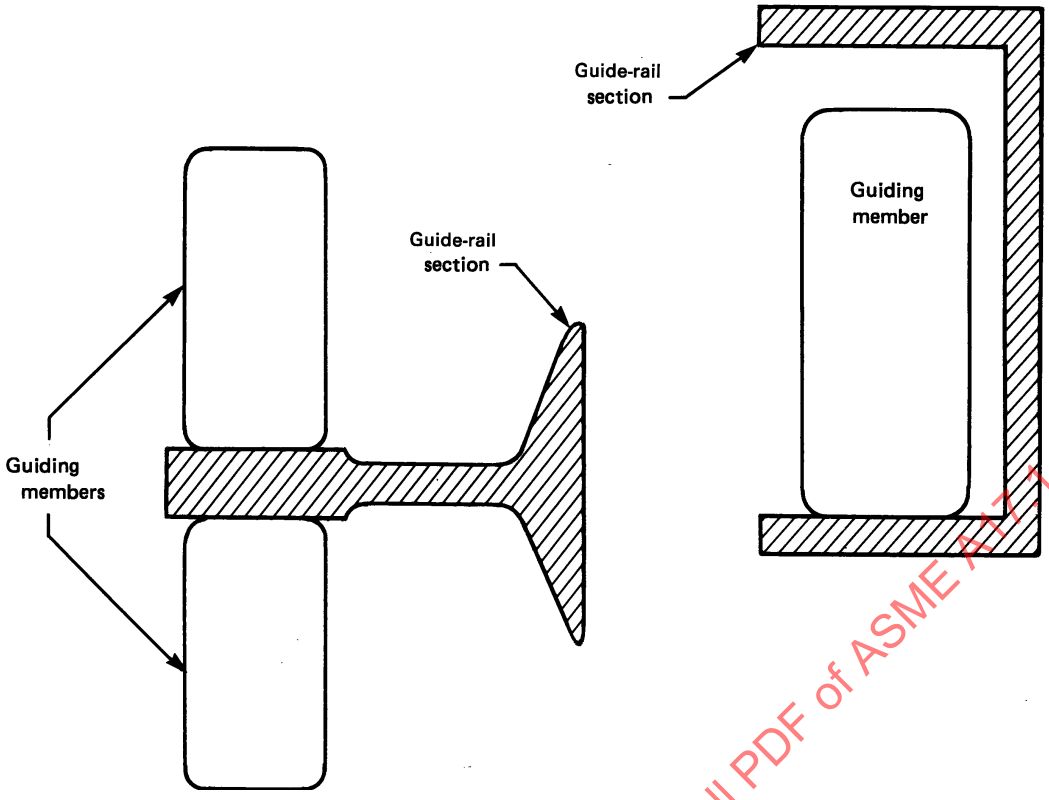
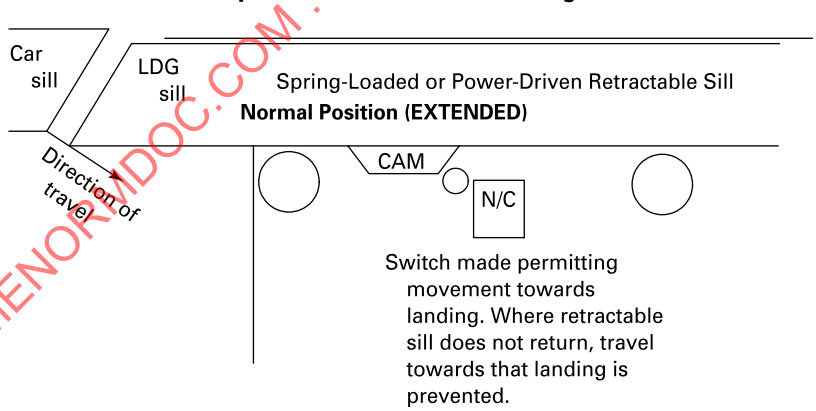


Diagram 5.1.22.5
Example of Retractable Sill Arrangement



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SECTION 5.2
LIMITED-USE/LIMITED-APPLICATION ELEVATORS

NOTE: Throughout Section 5.2, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

A limited-use/limited-application elevator provides vertical transportation for people with physical disabilities. It is recognized that people who do not have a disability will also use limited-use/limited-application elevators. The Code restrictions on size, capacity, speed, and rise limits use of this type of elevator.

The Architectural Transportation Barriers Compliance Board (Access Board) has published the Americans With Disabilities Act/Architectural Barriers Act Accessibility Guidelines (ADA/ABA AG) as a successor to ADAAG and the Uniform Federal Accessibility Standards (UFAS). ADA/ABA AG specifies accessibility requirements for LU/LA elevators. For specific details on what federal regulation applies, ADA or ABA, see ADA and *Building Transportation*, Fourth Edition, by Edward A. Donoghue, CPCA, and Brian D. Black. Procurement information for ADA and *Building Transportation* can be found in Part 9 of this Handbook.

Accessibility regulations for LU/LA elevators in jurisdictions enforcing NBCC are in Nonmandatory Appendix E of ASME A17.1/CSA B44. If the building code requires compliance with ICC/ANSI A117.1, Accessible and Usable Buildings and Facilities, then any LU/LA elevator must also comply with ICC/ANSI A117.1, Section 407.4, along with Section 5.2 in ASME A17.1/CSA B44.

Requirements in ADA/ABA AG are basically the same as those in ICC/ANSI A117.1-2003, except their use would be permitted only in a building where an elevator is not required by ADA. LU/LA elevators complying with ICC/ANSI A117.1 require inside car dimensions sufficient to carry but not turn around a wheelchair. The car door is required to be on the narrow side of the enclosure, except for cars that are 1 300 mm × 1 300 mm or 51 in. × 51 in., which can have doors on adjacent sides. ICC/ANSI A117.1-2009 includes additional options for car configurations. ICC/ANSI A117.1-2017 modified the available car configuration options to align with new clear floor length requirements for wheelchair spaces. Power-operated swinging doors are permitted. They shall be low energy power operated complying with ANSI/BHMA A156.19, Power Assist and Low Energy Power Operated Doors, and shall be required to remain open a minimum of 20 s. The reader would be well advised to check the federal and local regulations for accessibility requirements before providing a LU/LA elevator.

5.2.1 Electric Limited-Use/Limited-Application Elevators

5.2.1.1 Construction of Hoistway and Hoistway Enclosures. Due to the differences in intended use and Code requirements, a LU/LA elevator is not permitted in a hoistway with other elevators. A separate machine room is not envisioned for a LU/LA elevator. The floor loading in 2.1.3.3 is excessive for the light machines used for LU/LA elevators. The requirement also recognizes that wood floors may be throughout the building, including the machine room.

5.2.1.2 Pits. The requirement for a sump is not necessary since Phase II Firefighters' Emergency Operation is prohibited on LU/LA elevators.

5.2.1.3 Location and Guarding of Counterweights. The use of warning chains in lieu of counterweight guards is acceptable due to the slow speed of the elevator.

5.2.1.4 Vertical Clearances and Runbys for Cars and Counterweights. It is assumed that persons will have to be on top of the car and in the pit for maintenance and inspections. Requirements 5.2.1.4.2 and 5.2.1.4.4 allow the use of an alternative mechanical means to provide a safe area of refuge on top of the car and in the pit. An important provision in both requirements is that this means be capable of being activated without complete bodily entry into the hoistway or pit.

5.2.1.4.3 Top-of-Car Clearances. Requirement 5.2.1.4.3 was revised in ASME A17.1-2019/CSA B44:19 to align the title with Part 2, add a reference, and update references to align with previous changes in Part 2 to remove the term "refuge space."

5.2.1.4.4 Alternative to Top Car Clearance Requirements. Requirement 5.2.1.4.4 was revised in ASME A17.1-2019/CSA B44:19 to update references to align with previous changes in Part 2 to remove the term "refuge space."

5.2.1.4.4(b) Requirement was revised in ASME A17.1-2013/CSA B44-13 to clarify that the brake cannot be used as the mechanical means.

5.2.1.4.5 Space on Top-of-Car Enclosure. Requirement 5.2.1.4.5 was revised in ASME A17.1-2019/CSA B44:19 to align the title with Part 2 and to align with previous changes in Part 2 to remove the term "refuge space." Requirement 5.2.1.4.5(b) was revised to reflect new code requirements in 2.4.7.2.

5.2.1.7 Machinery Spaces, Machine Rooms, Control Spaces, and Control Rooms. To control the location of mechanical equipment. Electrical equipment location and guarding is subject to the requirements of NFPA 70 or CSA C22.1.

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5.2.1.7.1 Space where equipment can be used will not always permit construction of machine rooms 2 130 mm or 84 in. high. Equipment will be small and compact, such that reduced ceiling height is considered adequate.

5.2.1.11 Protection of Hoistway Landing Openings. All references to freight requirements have been deleted, as a LU/LA elevator by definition (see Section 1.3) is a passenger elevator.

5.2.1.12 Hoistway Door Locking Devices and Electric Contacts, and Hoistway Access Switches. All references to freight requirements have been deleted, as a LU/LA elevator by definition (see Section 1.3) is a passenger elevator.

5.2.1.12(e) The platform guard shall be at least 75 mm or 3 in. longer than the unlocking zone.

5.2.1.13 Power Operation of Hoistway Doors and Car Doors. All references to freight requirements have been deleted. A LU/LA elevator by definition (see Section 1.3) is a passenger elevator. This requirement was revised in ASME A17.1-2016/CSA B44-16 to eliminate folding car doors on LU/LA applications based on a hazard analysis and current commercial industry practice. The revised language closely aligns with the current requirements of Part 2.

5.2.1.14 Car Enclosures, Car Doors, and Car Illumination. The provision in 5.2.1.14 is subject to the requirements for manual lowering operation, similar to 5.3.1.16.2(i), being incorporated in the driving-machine requirements.

Typically, the top of the car is too small to allow for the installation of a top emergency exit. This alternative allows for the rescue of trapped passengers from a stalled elevator.

Requirement 5.2.1.14 was revised in ASME A17.1-2016/CSA B44-16. Requirement 5.2.1.14(f) was deleted, the remaining requirements were renumbered, and a new 5.2.1.14(m) was added to eliminate folding car doors on LU/LA applications based on a hazard analysis and current commercial industry practice. The revised language closely aligns with the current requirements of Part 2. Requirement 5.2.1.14(l) [formerly 5.2.1.14(m)] was revised to reference 2.12.1 so users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

5.2.1.15 Car Frames and Platforms

5.2.1.15.2 Platform Guards. For a LU/LA elevator with a maximum speed of 0.15 m/s or 30 ft/min and a speed governor tripping speed maximum of 0.38 m/s or 75 ft/min, the device used to conform to requirement 2.19.2 will by design typically stop and hold a car within a short travel distance. The maximum distance of 220 mm or 48 in. is still retained, but in those design cases where equipment will function in a shorter distance, it should not be required to have a platform guard protecting a distance greater than that within which the device operates, thereby defeating the lesser pit depth requirements in Section 5.2. Additional required marking plate data allows for proper inspection of the platform guard length. Requirement 5.2.1.15.2 is performance based in reference to this design choice.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to reference 2.12.1 so users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

5.2.1.16 Capacity, Loading, Speed, and Rise

5.2.1.16.1 Rated Load and Platform Area. Limiting the size of the equipment limits its use and lessens the chance that it will be misused for transporting freight. A LU/LA elevator by definition is a "passenger elevator" (see Section 1.3). Also, three standard ISO car sizes — 320 kg or 8.75 ft^2, 400 kg or 11 ft^2, and 630 kg or 15 ft^2 — would fit within the 1.67 m^2 or 18 ft^2 limitation.

5.2.1.16.2 Capacity and Data Plates. Requirement 5.2.1.4.5 was revised in ASME A17.1-2019/CSA B44:19 to clarify that the data plate is required and to specify the location of the data plate.

5.2.1.16.5 Maximum Rise. Limiting the speed and rise will reduce the use of the elevator and allow the use of alternate provisions for some of the requirements in Parts 2 or 3.

5.2.1.19 Ascending Car Overspeed and Unintended Car Movement Protection. For a LU/LA elevator with a maximum speed of 0.15 m/s or 30 ft/min and a speed governor tripping speed maximum of 0.38 m/s or 75 ft/min, the device used to conform to requirement 2.19.2 will by design typically stop and hold car within a short travel distance. The maximum distance of 220 mm or 48 in. is still retained, but in those design cases where equipment will function in a shorter distance, it should not be required to have a platform guard protecting a distance greater than that within which the device operates, thereby defeating the lesser pit depth requirements in Section 5.2. Additional required marking plate data allows for proper inspection of the platform guard length. Requirement 5.2.1.15.2 is performance based in reference to this design choice.

5.2.1.20 Suspension Means and Their Connections. The title of Requirement 5.2.1.20 was updated in ASME A17.1-2022/CSA B44:22 to align with Section 2.20.

5.2.1.20.1 Suspension Means. The requirements in 5.2.1.20.1(b) are based on aircraft cable fully tested to a Military Specification and successfully used in aircraft application. Aircraft cable has long been permitted for use

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on private residence elevators with no safety concerns. These elevators run at speeds higher than allowed for LU/LA elevators. They are allowed up to 15.2 m or 50 ft of rise, which is twice as high as the 7.6 m or 25 ft of rise allowed for LU/LA elevators. Based on the LU/LA elevators' lower speed, lower rise, and stringent specification, the use of aircraft cable was deemed acceptable.

Requirements 5.2.1.20.1 and 5.2.1.20.2 were revised in ASME A17.1-2022/CSA B44:22 to align with Section 2.20 while still allowing the alternative suspension means previously permitted for use on LU/LA elevators.

5.2.1.21 Counterweights

5.2.1.21.1 Independent Car Counterweights. See Handbook commentary on 5.2.1.23.1.

5.2.1.22 Buffers and Bumpers

5.2.1.22.1 Bumpers. This requirement was deleted in ASME A17.1-2016/CSA B44-16 because the exception for elastomeric bumpers is no longer needed. Elastomeric buffers are now included in Section 2.2.

5.2.1.23 Car and Counterweight Guide Rails, Guide-Rail Supports, and Fastenings

5.2.1.23.1 Use of Common Guide Rails. It is common practice for small elevators such as LU/LA elevators, private residence elevators, special purpose personnel elevators, and dumbwaiters to have the car and counterweight run on a common rail.

5.2.1.23.2 Guide-Rail Sections. Allows for rails with smaller section modulus and moment of inertia consistent with cars and counterweights of smaller size, weight, and rated capacity. This requirement does not dictate the size of bolts required for fastening the guide rail to the rail brackets; however, 2.23.10.1, which defines the strength requirements, remains applicable. The guide-rail deflection must comply with the requirements in 2.23. In addition, the deflection must be limited during safety application such that the safeties will not disengage from the rail.

5.2.1.24 Driving Machine and Sheaves. Winding-drum machines are permitted. They must be designed to prevent multiple layering of wire rope on the drum and cannot include a counterweight.

5.2.1.24.1 Type of Driving Machines. Counterweights with a winding-drum machine are prohibited, which is the same as required by 2.24.1.

5.2.1.24.2 Material and Grooving

5.2.1.24.2(b) The Elevator Wire Rope Technical Board stated that 6 × 19 WSC (7 × 19) aircraft cable is made as a cross-laid strand design and therefore should not be subjected to crushing pressure in its application. Thus, no V-type or undercut grooves are permitted, only finished "U" grooves.

5.2.1.25 Terminal Stopping Devices. Requirements for emergency terminal stopping means are not applicable since the speed is limited to 0.15 m/s or 30 ft/min. Due to the limited rise of this device, a redundant final stopping device is required.

5.2.1.26 Operating Devices and Control Equipment. Requirement 5.2.1.26(f) was added in ASME A17.1-2022/CSA B44:22 to exclude LU/LA elevators from having remote interaction operation (RIO) until such time that specific requirements and limitations are developed for the application of RIO on LU/LA elevators.

5.2.1.27 Emergency Operations and Signaling Devices. LU/LA elevators should not be available for public use during fire emergencies. Hazard analysis conducted by LU/LA and Emergency Operations Committees indicated that LU/LA elevators should have Phase I but not Phase II operation.

Additionally, 0.15 m/s or 30 ft/min is too slow for effective elevator use by firefighters. Firefighters would use the stairs rather than take an elevator with a minimum travel of 7.6 m or 25 ft.

5.2.1.28 Manual Operation. The top of a LU/LA elevator typically will not be large enough to provide a top emergency exit. These requirements provide an alternative means for evacuating a passenger from a stalled elevator.

5.2.2 Hydraulic Limited-Use/Limited-Application Elevators

See Handbook commentary on referenced requirements.

5.2.2.5 Car Safeties, Counterweight Safeties, Plunger Grippers, and Governors. In ASME A17.1-2016/CSA B44-16, the title of 5.2.2.5 was updated to clarify that the requirements apply to all types of hydraulic LU/LA elevators.

5.2.2.5.1 An overspeed condition without "loss of suspension support" may occur with a traction drive system, but the cause of the overspeed is not the same as with a roped-hydraulic drive system. Overspeed in traction drive systems can occur on loss of traction, failure of the electric brake, or the loss of support provided by the gear unit. Up-direction overspeed is not part of this discussion. Clearly, an overspeed governor is the only device that can provide the needed protection, and that is its main function.

By design, an overspeed governor will also protect against a failure of "loss of suspension support" but only indirectly. The operation of the car safety is in reaction to the "overspeed condition" caused by the loss of suspension support. The "overspeed condition" could

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have been prevented with a device that would actuate the safety immediately upon sensing a broken or slack rope condition. The potential trauma to passengers, as well as the stresses transferred into the elevator and building structures, would be reduced because the car would not build up velocity before the safety actuates. We must keep in mind the original intention of the LU/LA elevator and realize that the users of this equipment may have disabilities.

Other than failure of the ropes or rope terminations, "overspeed" for a roped-hydraulic elevator can occur only if there is loss of pressure to the cylinder. Therefore, an overspeed valve conforming to 3.19.4.7, which will stop a loaded car at a preset speed, provides equivalent protection to an overspeed governor.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to clarify that safeties operated by inertia are an alternative to speed governors on roped-hydraulic LU/LA elevators that have an overspeed valve conforming to 3.19.4.7.

5.2.2.14 Emergency Operations and Signaling Devices. See Handbook commentary on 5.2.1.27.

SECTION 5.3
PRIVATE RESIDENCE ELEVATORS

NOTE: Throughout Section 5.3, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

Section 5.3 applies to elevators installed in or at a private residence. It also applies to similar elevators installed in buildings other than private residences as a means of access to a private residence in that building, provided the elevator is installed so that it is not accessible to the general public or to other occupants of the building. A private residence is defined in ASME A17.1/CSA B44 as "a separate dwelling or separate apartment in a multiple dwelling that is occupied only by the members of a single family unit" (see Section 1.3). This definition may not be identical to that used by the building code.

ASME A17.1/CSA B44 does not permit the installation of private residence elevators in locations other than described herein even if they are key operated.

The rationale for Section 5.3 is best described by the introduction to ASA A17.1-1953, which was written when requirements for private residence elevators were first added to the Code.

> This Part of the Code has been developed in response to demands for a separate section of Rules to cover the installation in a private residence of a small electric power passenger elevator or inclined lift which serves only the members of a single family. These elevators or inclined lifts are installed primarily for the convenience of elderly persons or invalids who are unable to walk up or down stairs. In such cases, equipment of very low speed and small capacity meets the requirements. Such elevators and lifts, while usually installed in single-family private residences, may be installed within a separate apartment in a multiple dwelling.
>
> It is frequently necessary to install such elevators in open stairwells, as the construction of the building does not provide space to permit installing a standard type of enclosed hoistway inside the building.
>
> Due to their limited size, speed, load, and rise, and the fact that their use is limited to the members of a single family and is under the control of the head of the family, adequate safety of operation can be secured without requiring that such equipment meet the standards set up in other parts of this Code for equipment installed in buildings of other types which is used by the general public and is thus subjected to much more severe and frequent service. The Rules of this Part of the Code have, therefore, been developed to set up minimum standards for equipment of the type described which, if conformed to, should result in adequate safety of operation and use.
>
> It should be noted that the Rules of this Part of the Code do not apply to all power elevators installed in private residences, but only to those which meet the definition for Private Residence Elevator as given in this Code and which are installed in a Private Residence as defined in this Code. All other elevators in private residences, even when the latter terms conform to the definition in this Code, are required to comply with all the Rules of the other Parts of this Code.

The number of private residence elevators has grown steadily since the turn of the century. The available options also increased and the technology has advanced. One of the trends that has followed the path of other passenger elevators is a move to locate equipment in the hoistway. Section 5.3 was revised in ASME A17.1-2019/CSA B44:19 to address changes in equipment and to provide additional requirements related to location of that equipment. Previous editions had a limited number of requirements for location of equipment whether it was located inside or outside the hoistway. A new section was added to 5.3 to provide additional requirements and it was patterned after the requirements in Parts 2 and 3 for machinery spaces, machine rooms, control spaces, and control rooms both inside and outside the hoistway.

See Diagram 5.3 for an illustration of a typical traction private residence elevator.

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5.3.1 Private Residence Electric Elevators

5.3.1.1 Construction of Hoistway and Hoistway Enclosures

5.3.1.1.1 The under-platform pressure device is commonly found on a private residence elevator that does not have a hoistway enclosure and normally consists of sensitive switches covered by an operating surface of metal or plywood for the full width and depth of the platform. See Diagram 5.3.1.1.1.

Requirements were added in ASME A17.1-2013/CSA B44-13 for glass hoistway enclosures consistent with requirements in other parts of this Code.

5.3.1.1.2 When 90 N or 20 lbf force is placed on the cover, the springs or cushioning materials are compressed sufficiently to activate the electric contacts, which stop the car from moving in the up direction. This also can be accomplished by a lift frame with switch gear located on the car top, which will stop the upward motion of the car when the lift frame attempts to lift the hatch with the 90 N or 20 lbf. See Diagram 5.3.1.1.2.

The electric contact [5.3.1.1.2(b)(3)] can be located on the car or on the cover supports.

5.3.1.2 Pits. A pit is normally provided with a private residence elevator unless the elevator does not have a hoistway enclosure. When a pit is provided, it must be in compliance with 5.3.1.2. A pit can be created by a depression in the floor or a ramp providing access to the car.

5.3.1.2.3 Stop Switch in Pits. This requirement was added in ASME A17.1-2013/CSA B44-13. Residential elevators typically have shallow pits. A pit stop switch is provided for elevator personnel safety.

5.3.1.3 Top Car Clearance. The top car clearance is measured between the top of the car crosshead or between the top of the car when no crosshead is provided and the nearest part of the overhead structure and any other obstruction when the car floor is level with the top terminal landing. Two examples of top car clearance are

(a) for a car with a rated speed of 0.13 m/s or 25 ft/min: 152 mm or 6 in.

(b) for a car with a rated speed of 0.25 m/s or 50 ft/min: 305 mm or 12 in.

Where the machine or its controls are located on the top of the car, a refuge space is required on the car top.

Requirement 5.3.1.3 was revised in ASME A17.1-2019/CSA B44:19 to update requirements for top car clearance when bodily entry into the hoistway is required to inspect, test, or maintain equipment and to update references. The top car clearance must be increased to comply with Requirement 2.4.7, or an alternate means must be provided to create a space to protect workers who may be on top of the car.

5.3.1.4 Horizontal Car Clearances

5.3.1.4.2 Between Car and Landing Sill. Correlate with the requirements in ADA/ABA AG and with the requirements of ICC/ANSI A117.1, Accessible and Usable Buildings and Facilities.

5.3.1.5 Pipes and Other Equipment in Hoistways. The user of the private residence elevator is confined within the car and would not be able to immediately retreat from the effects of a ruptured pipe; therefore, pipes are prohibited in hoistways of private residence elevators.

Requirement 5.3.1.5 was revised in ASME A17.1-2019/CSA B44:19 to clarify that other equipment may be installed in the hoistway provided that it is used in conjunction with the elevator.

5.3.1.6 Machinery Spaces, Machine Rooms, Control Spaces, and Control Rooms. Requirement 5.3.1.6 was added in ASME A17.1-2019/CSA B44:19 to provide additional requirements, patterned after the requirements in Parts 2 and 3, for machinery spaces, machine rooms, control spaces, and control rooms both inside and outside the hoistway. Previous editions had a limited number of requirements for location of equipment whether it was located inside or outside the hoistway. Previous Requirements 5.3.1.6 through 5.3.1.20 were renumbered to 5.3.1.7 through 5.3.1.21.

5.3.1.6.1 Requirement 5.3.1.6.1 was added in ASME A17.1-2019/CSA B44:19 to provide additional guarding requirements when private residence elevator equipment is located in a room or space that contains other equipment. Many private residence applications do not have a dedicated machine room, so elevator equipment may be located in the attic, basement, or a room containing other mechanical and electrical equipment for the house.

5.3.1.6.2 Requirement 5.3.1.6.2 was added in ASME A17.1-2019/CSA B44:19 to ensure that the motor controller and operation controllers are located in a cabinet that can be closed and secured from unauthorized access since this equipment can also be located in rooms or spaces containing other equipment.

5.3.1.6.3 Requirement 5.3.1.6.3 was added in ASME A17.1-2019/CSA B44:19 to ensure that all sheaves and sprockets are properly guarded to prevent accidental contact.

5.3.1.6.4 Requirement 5.3.1.6.4 was added in ASME A17.1-2019/CSA B44:19 to ensure proper access to elevator equipment for maintenance. Private residence elevators have much less usage than passenger elevators; however, it is important to provide access to ensure required maintenance is done. The requirements were based on those found in Part 2.

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5.3.1.6.5 Requirement 5.3.1.6.5 was added in ASME A17.1-2019/CSA B44:19 to require temperature and humidity control for equipment spaces and rooms per the requirements in Part 2.

5.3.1.6.6 Requirement 5.3.1.6.6 was added in ASME A17.1-2019/CSA B44:19 to provide requirements for access doors and openings necessary for the inspection, testing, and maintenance of the elevator equipment. Requirements are included to limit the size of the opening where full bodily entry is not required and to include a means to remove power from the motor and brake where access doors are provided into the hoistway. All doors and openings are required to have a key with Group 2 security to prevent unauthorized access.

5.3.1.6.7 Requirement 5.3.1.6.7 was added in ASME A17.1-2019/CSA B44:19 to provide additional requirements when the driving machine or controller is mounted inside the hoistway. When the machine is located in the hoistway, it is important to have a means to move the car from outside the hoistway for inspection, test, or maintenance and to be able to determine the location and travel direction of the car within the hoistway.

5.3.1.6.8 Requirement 5.3.1.6.8 was added in ASME A17.1-2019/CSA B44:19 to provide requirements when the machine or controls are located on the car. The requirements differ depending on whether inspection, testing, and maintenance can be done from inside the car or if these tasks must be completed from the car top.

5.3.1.6.9 Requirement 5.3.1.6.9 was added in ASME A17.1-2019/CSA B44:19 to require proper illumination for equipment spaces and rooms per the requirements in Part 2.

5.3.1.7 Guarding of Suspension Means and Other Equipment

5.3.1.7.2 Suspension or Support Means Having an Opening Facing Away From the Stair. See Diagram 5.3.1.7.2 for an illustration of ropes or chains, which are guarded by their location within a guide or track.

5.3.1.7.3 Requirement 5.3.1.7.3 was added in ASME A17.1-2019/CSA B44:19 to provide requirements for guarding of equipment for elevators with a remote machinery space, machine room, or control room.

5.3.1.8 Protection of Hoistway Openings

5.3.1.8.1 Hoistway Enclosure Provided. This requirement was revised in ASME A17.1-2016/CSA B44-16 to clarify that hoistway doors are required whenever a hoistway enclosure is provided.

Requirement 5.3.1.8.1 was revised in ASME A17.1-2019/CSA B44:19 to add a maximum clearance around hoistway doors. The clearances are based on anthropometric data for children to ensure that they cannot reach over, under, or around the door.

5.3.1.8.2 Clearance Between Hoistway Doors and Landing Sills. Diagram 5.3.1.8.2 illustrates the required clearances between the hoistway doors or gates and landing sills and car doors or gates. Requirement 5.3.1.7.2 was revised in ASME A17.1-2016/CSA B44-16 to reduce the clearance between the hoistway door and the edge of the landing sill from 75 mm or 3 in. to 19 mm or 0.75 in. This revision was the result of a hazard analysis conducted to review the clearance between the hoistway door and car door for the potential for child entrapment. A task group made up of interested parties from various ASME Working Groups conducted the hazard analysis, considering anthropometric data for children to determine the recommendations for change. This revision also moved the hoistway door to car door clearance requirements to 5.3.1.8.3.

5.3.1.8.4 Locking Devices for Hoistway Doors and Gates. The car must be prevented from moving if a door is not locked, or the car must be stopped if it is within 150 mm or 6 in. of the landing with a door unlocked. ASME A17.1a-2002 and CSA B44 Update No. 1-02 and later editions require that the locking device be listed/certified (2.12.4).

5.3.1.8.5 Opening of Hoistway Doors or Gates. The requirements, as illustrated in Diagram 5.3.1.8.2, ensure that a pinching hazard is not present when opening or closing the hoistway door or gate.

5.3.1.8.6 Hangers and Stops for Hoistway Sliding Doors. Door stops are required to prevent the door from traveling beyond the length of the door track.

5.3.1.8.9 Landing-Sill Guards. When a private residence elevator is equipped with a two-way leveling device or anticreep device, the elevator is allowed to relevel with the car door or gate open. A shear hazard is created if the hoistway side door sill/wall is not smooth and continuous for the depth of the leveling zone below the landing sill.

5.3.1.9 Car Enclosures, Car Doors and Gates, and Car Illumination

5.3.1.9.1 Car Enclosures

5.3.1.9.1(d) Access Panels for Elevator Equipment Outside of the Car. Where the machine or controls are located on the car top, the car top must then be designed to support the weight of elevator personnel, provide a means of operating the car from the car top, and ensure that the machine or controls are properly guarded.

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5.3.1.9.1(f) Requirement 5.3.1.9.1(f) was revised in ASME A17.1-2019/CSA B44:19 to relocate car top enclosure strength and railing requirements to the appropriate section.

5.3.1.9.2 Car Doors and Gates

5.3.1.9.2(c) Car Door or Gate Electric Contacts. ASME A17.1a-2002 and CSA B44 Update No. 1-02 and later editions require car door or gate electric contacts be listed/certified (2.12.4.2.3 and 2.14.4.2.5).

5.3.1.9.2(d) Strength and Deflection of Doors, Gates, and Their Guides, Guide Shoes, Track, and Hangers. This requirement was added in ASME A17.1-2016/CSA B44-16 to specify strength and deflection requirements for car doors and gates. This revision was the result of a hazard analysis conducted to review the clearance between the hoistway door and car door for the potential for child entrapment. A task group made up of interested parties from various ASME Working Groups conducted the analysis, considering anthropometric data for children to determine the recommendations for change. Strength and deflection of the car door or gate were felt to be an important element in defining the required clearance between hoistway doors and car doors (see also Handbook commentary on 5.3.1.9.3).

Requirement 5.3.1.9.2 was revised in ASME A17.1-2019/CSA B44:19 to eliminate references to vertical sliding doors since they are not used on private residence elevators.

5.3.1.9.3 Clearance Between Hoistway Doors and Car Doors or Gates. This requirement was added in ASME A17.1-2016/CSA B44-16 to relocate the clearance requirements to a more appropriate location and to reduce the clearance between the hoistway door and the car door or gate from 125 mm or 5 in. to 100 mm or 4 in. This revision was the result of a hazard analysis conducted to review the clearance between the hoistway door and car door for the potential for child entrapment. A task group made up of interested parties from various ASME Working Groups conducted the hazard analysis, considering anthropometric data for children to determine the recommendations for change. This revision also reduced the hoistway door to sill requirements (see Handbook commentary on 5.3.1.8.2).

5.3.1.9.4 Light in Car. The minimum illumination level ensures adequate lighting for safe ingress to and egress from the car. Automatic lighting is currently allowed in other areas of the Code including passenger and LU/LA elevators when it meets the requirements of 2.14.7.2.2. Automatic lighting could actually improve safety because a user would not have to try to find the switch in the dark.

Requirement 5.3.1.9.4 was revised in ASME A17.1-2022/CSA B44:22 to address lighting during a failure of the normal power supply by using either auxiliary lighting or auxiliary power for the primary lighting.

5.3.1.10 Car Frames and Platforms

5.3.1.10.1 Car Frame. Cast iron is an alloy of iron, carbon, and silicon that is cast in a mold and is hard, nonmalleable, and brittle with low tensile strength. Being brittle, it will not withstand the forces applied to the car frame or platform.

5.3.1.11 Capacity, Loading, Speed, and Rise. If any of these parameters are exceeded, the installation must comply in its entirety with Part 2, Part 3, or Section 4.2 of ASME A17.1/CSA B44.

5.3.1.11.1 Capacity. The permitted net inside platform area was increased in ASME A17.1-2000 and CSA B44-00 to 1.4 m^2 or 15 ft^2. Prior to this edition, the maximum platform area was limited to 1.1 m^2 or 12 ft^2. A 1.1 m^2 or 12 ft^2 inside net area platform is not adequate space to accommodate today's wheelchair, especially if an attendant is present. History has shown that private residence elevators designed for a floor loading of 195 kg/m^2 or 40 lb/ft^2 is sufficient for platform sizes up to and including 1.1 m^2 or 12 ft^2. When a platform area exceeds 1.1 m^2 or 12 ft^2, the committee used the requirements in 2.16.1 to determine that the rated load should be based on 305 kg/m^2 or 62.5 lb/ft^2.

Requirement 5.3.1.11.1 was revised in ASME A17.1-2022/CSA B44:22 to provide a standard means to determine net car platform area and include a new figure.

5.3.1.11.3 Rise. There is no limitation to the number of floors served, provided total rise does not exceed 15 m or 50 ft (5.3.1.10.3).

5.3.1.12 Safeties and Governors. See Diagrams 5.3.1.12(a) and 5.3.1.12(b) of typical private residence elevator counterweight safety arrangements.

5.3.1.12.3 Application of Safeties. These requirements address guide-rail shapes other than T-shaped.

5.3.1.13 Suspension Means. Welded link chain is not permitted, as there is no visual indication of impending failure at a weld. In addition, there appears to be no practical way to detect an impending failure due to fatigue. Hairline cracks indicating a fatigue situation can appear at any moment. Any chain failure could result in a life-threatening exposure.

5.3.1.15 Buffers and Buffer Supports

5.3.1.15.1 Requirement was revised in ASME A17.1-2013/CSA B44-13 to permit other than spring buffers that are permitted by requirements in Parts 2 and 3 of the Code. This requirement was revised in ASME A17.1-2016/CSA

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B44-16 to change "bumpers" to "buffers" to correctly identify the permitted equipment.

5.3.1.16 Car and Counterweight Guide Rails and Guide Fastenings. Where guide-rail sections other than those specified in 2.23.3 are used, the allowable deflection of the guide rail is limited by these requirements to prevent the safety device from disengaging from the rail during application with full load.

5.3.1.17 Driving Machines, Sheaves, and Their Supports. See Diagram 5.3.1.17 of typical private residence hydraulic elevator.

5.3.1.17.2 Driving Machines: General Requirements

5.3.1.17.2(a) Types of Driving Machines. Requirement 5.3.1.17.2(a) was revised in ASME A17.1-2019/CSA B44:19 to allow use of rack-and-pinion driving machines in all jurisdictions.

5.3.1.17.2(b)(1) Materials for Sheaves and Drums and Minimum Diameter. Requirement 5.3.1.17.2(b)(1) was revised in ASME A17.1-2019/CSA B44:9 to allow use of rack-and-pinion driving machines in all jurisdictions.

5.3.1.17.2(c) Fastening of Driving Machines and Sheaves to Underside of Overhead Beams. Cast iron is an alloy of iron, carbon, and silicon that is cast in a mold and is hard, nonmalleable, and brittle, with low tensile strength. Being brittle, it will not withstand the forces applied.

5.3.1.17.2(e) Friction Gearing, Clutch Mechanisms, or Couplings. Use of other than a solid connection would allow a runaway condition in the case of a connection failure.

5.3.1.17.2(i) Manual Operation. Manual operation is required on private residence elevators since car designs are too small to accommodate a top emergency exit. There is no other way for a trapped passenger to be removed from the car. Manual operation devices must be capable of moving any load up to and including rated load. A manual operating device is required even if the elevator is equipped with a backup power source (e.g., UPS or standby generator).

5.3.1.17.2(j) Car-Top-Mounted Machine or Controller. Requirement 5.3.1.17.2(j) was revised in ASME A17.1-2019/CSA B44:19 to update references.

5.3.1.18 Terminal Stopping Devices. A normal terminal stopping device slows down and stops an elevator automatically at or near a terminal landing independent of the function of the car switch, push button, lever, or other manual device used to actuate a control.

The final terminal stopping device automatically causes the power to be removed from an electric elevator driving-machine motor and brake independent of the functioning of the normal terminal stopping device or the operating device after the car has passed a terminal landing.

5.3.1.18.1 Stopping Devices Required. Alternate and independent but equivalent means for stopping a winding-drum or sprocket-and-chain-type driving machine at the terminal landings is required. Machine limit devices operated by the driving machine are difficult to set and reset because of cable stretch directly related to capacity and loading. Pit depths and overhead space requirements in a private residence are minimal, requiring the final terminal stopping devices to be precisely located.

The stopping device operated by the driving machine may be indirectly connected to the machine by a belt, rope, or chain. This type of connection has been provided on private residence elevators for more than 80 yr.

5.3.1.19 Operating Devices and Control Equipment

5.3.1.19.2 Control and Operating Circuit Requirements

5.3.1.19.2.1 Design and Installation

5.3.1.19.2.1(b) A tension-type spring, if broken, could cause the device to stay in the made position.

5.3.1.19.2.1(d) A majority of single-phase AC motors will continue to rotate in the same direction upon rapid operation of the reversing control as caused by maintaining the opposite direction control device in the made position when stopping at a landing.

5.3.1.19.2.2 Monitoring of the Car Door or Gate Switch Electric Contacts. A requirement was added in ASME A17.1-2010/CSA B44-10 to provide a means within the controller design to detect the bridging of a car gate contact. A number of accidents have occurred in which people, especially children, have been killed by the actions of persons disabling a car gate or door safety contact on manually operated car doors or gates. A number of suggestions have been made in the past, such as self-closing doors, alarms, and signs, but all were rejected by the Committee as being too inconvenient or alarming to users. This requirement allows a proper level of latent and inherent safety to be reached without requiring graphic signs and warnings or any actions on the part of the user.

Requirement 5.3.1.19.2.2 was revised in ASME A17.1-2019/CSA B44:19 to make it clear that if the landing door or gate is not cycled at a landing, then the elevator will accept calls. The requirement is for the controller to check for a condition where the landing door is cycling but the car door or gate is not cycling, which could indicate the car door or gate contact is faulty.

5.3.1.19.4 Electrical Equipment and Wiring

5.3.1.19.4(b) The specified electrical equipment is required to be certified as complying with CSA B44.1/ASME A17.5, Elevator and Escalator Electrical Equipment. This will minimize the risk of electricity as a source of electric shock and as a potential ignition source of fires.

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5.3.1.19.9 Remote Operation Indicator. Requirement 5.3.1.19.9 was added in ASME A17.1-2019/CSA B44:19 to provide additional requirements when the controller is located remotely from the driving machine. It is important for someone working on the equipment to be able to determine the location and travel direction of the car when it is not visible from the location of the elevator controller to aid in inspection, testing, and maintenance.

Requirement 5.3.1.19.9 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definition of "normal building power."

5.3.1.20 Emergency Signaling Devices. This requirement was revised in ASME A17.1-2016/CSA B44-16 to clarify the functions of the two devices listed and to separate the requirements for each into two designated paragraphs. The new requirements use performance-based language to allow greater flexibility for the design of devices.

Requirements 5.3.1.20.1 and 5.3.1.20.2 were revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definition of "normal building power" and language used for the source of emergency or standby power.

5.3.1.22 Maintenance Documentation. Requirement 5.3.1.22 was added in ASME A17.1-2019/CSA B44:19 to provide requirements for owner's manuals and Maintenance Control Programs. User instructions are needed for safe operation and proper maintenance of the elevator and they need to be on the premises.

5.3.2 Private Residence Hydraulic Elevators

See Diagram 5.3.2.

5.3.2.2 Driving Machines, Sheaves, and Supports for Direct-Plunger and Roped-Hydraulic Driving Machines

5.3.2.2.2 A pressure switch is required. This device adds a means of protection should the plunger be obstructed in its descent. See also Handbook commentary on referenced requirements.

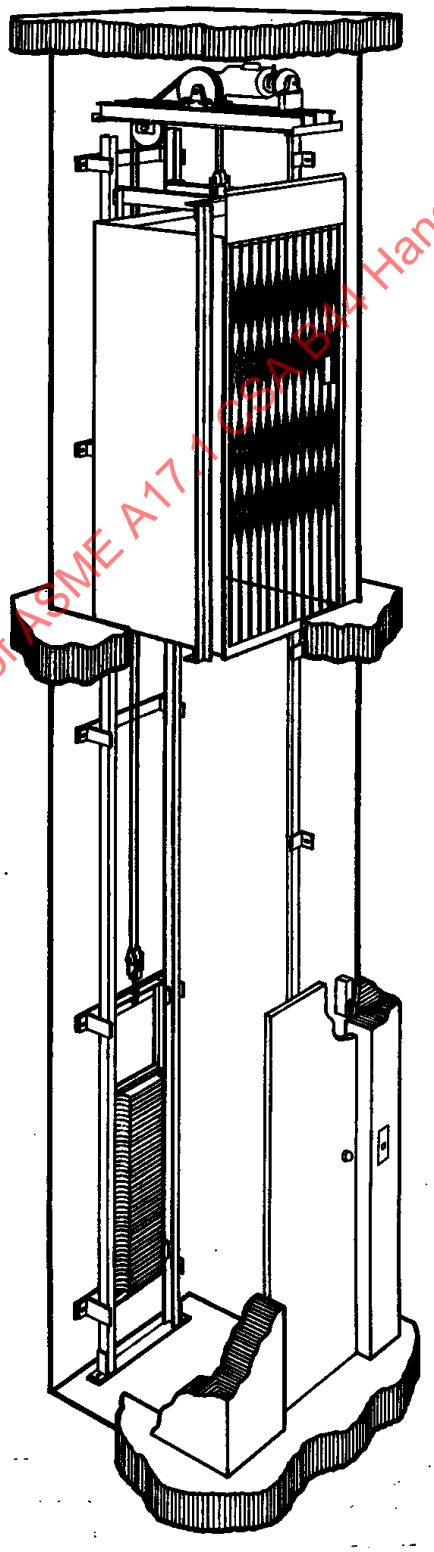
5.3.2.3 Terminal Stopping Devices. Compliance with 3.25 for the requirements for terminal stopping devices is required.

Private residence elevators are limited to a maximum speed of 0.20 m/s or 40 ft/min, thus the exception to the requirements for terminal speed-reducing devices.

5.3.2.4 Anticreep Leveling Devices. The requirements are similar to those specified in 3.19.3 and 3.26.4. They have been modified and are compatible with the electrical protective devices required on a private residence elevator.

Requirement 5.3.2.4.4 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definition of "main line power."

Diagram 5.3
Typical Private Residence Elevator With Traction Driving Machine



GENERAL NOTE: Courtesy of Sedgwick Lifts, Inc.

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Diagram 5.3.1.1.1
Typical Detail of Under-Platform Pressure Switch

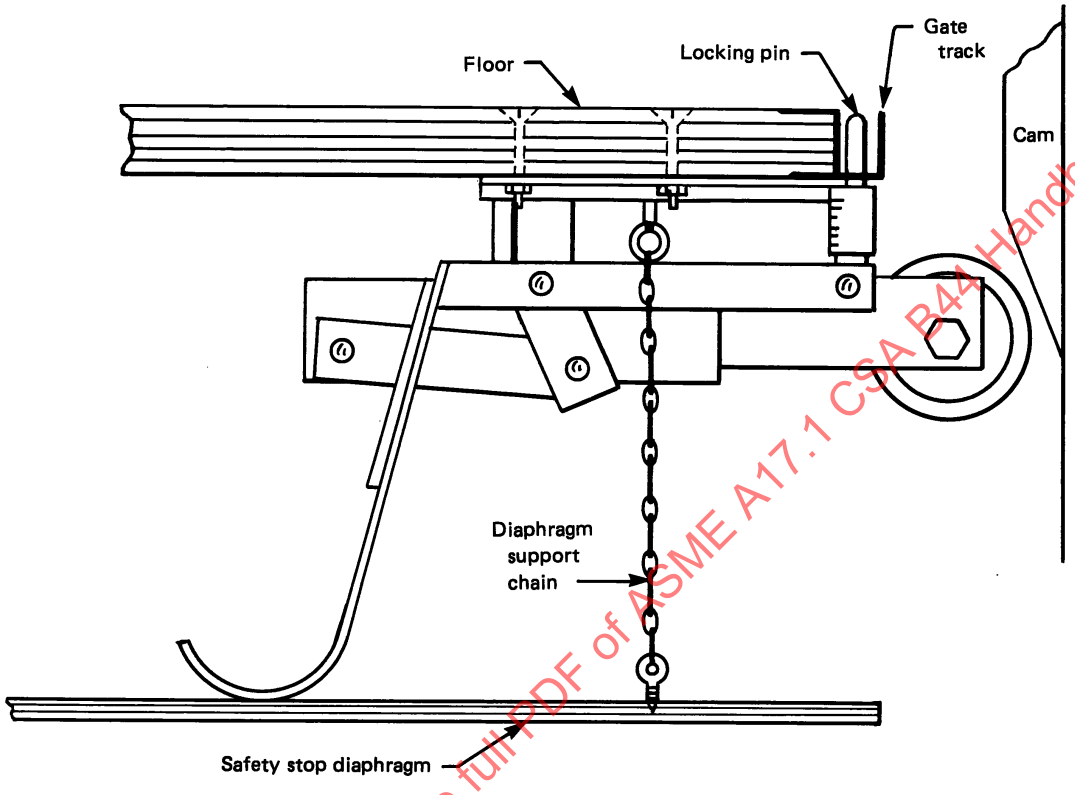
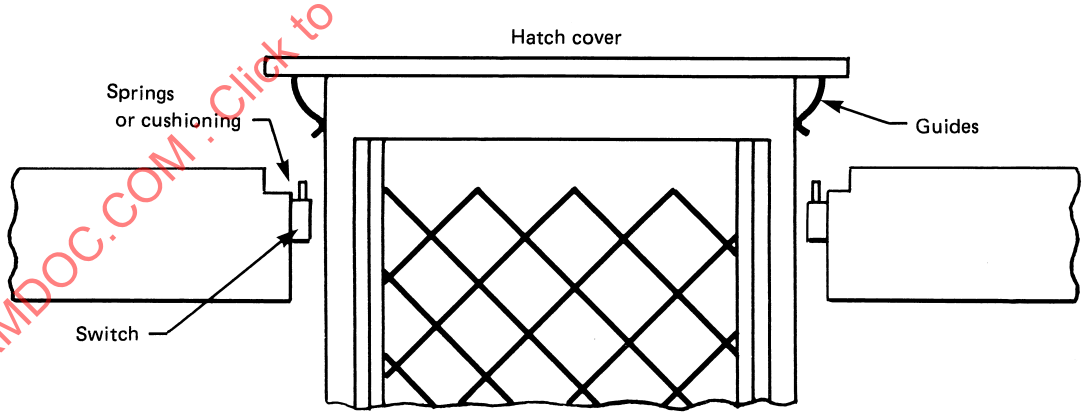


Diagram 5.3.1.1.2
Typical Detail of Hatch Cover Arrangement



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Diagram 5.3.1.7.2
Guarding by Enclosing Within Guide or Track

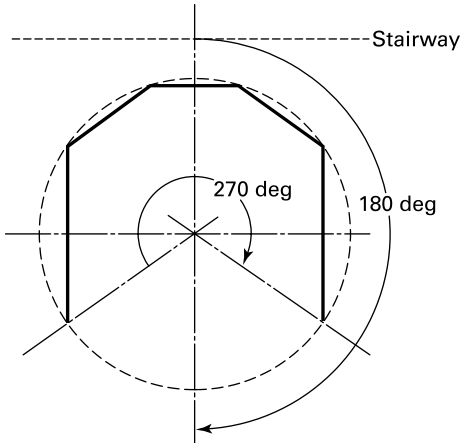
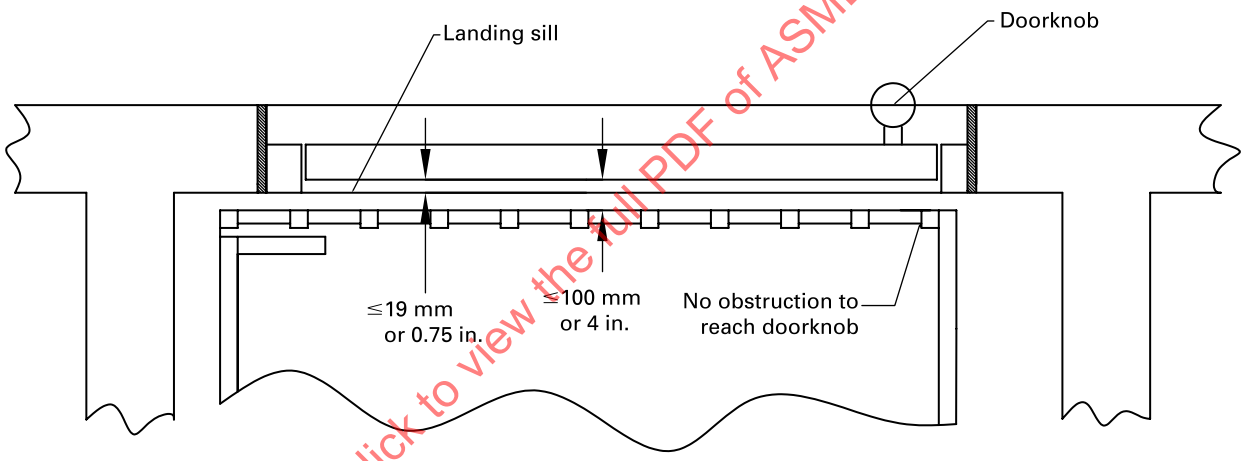
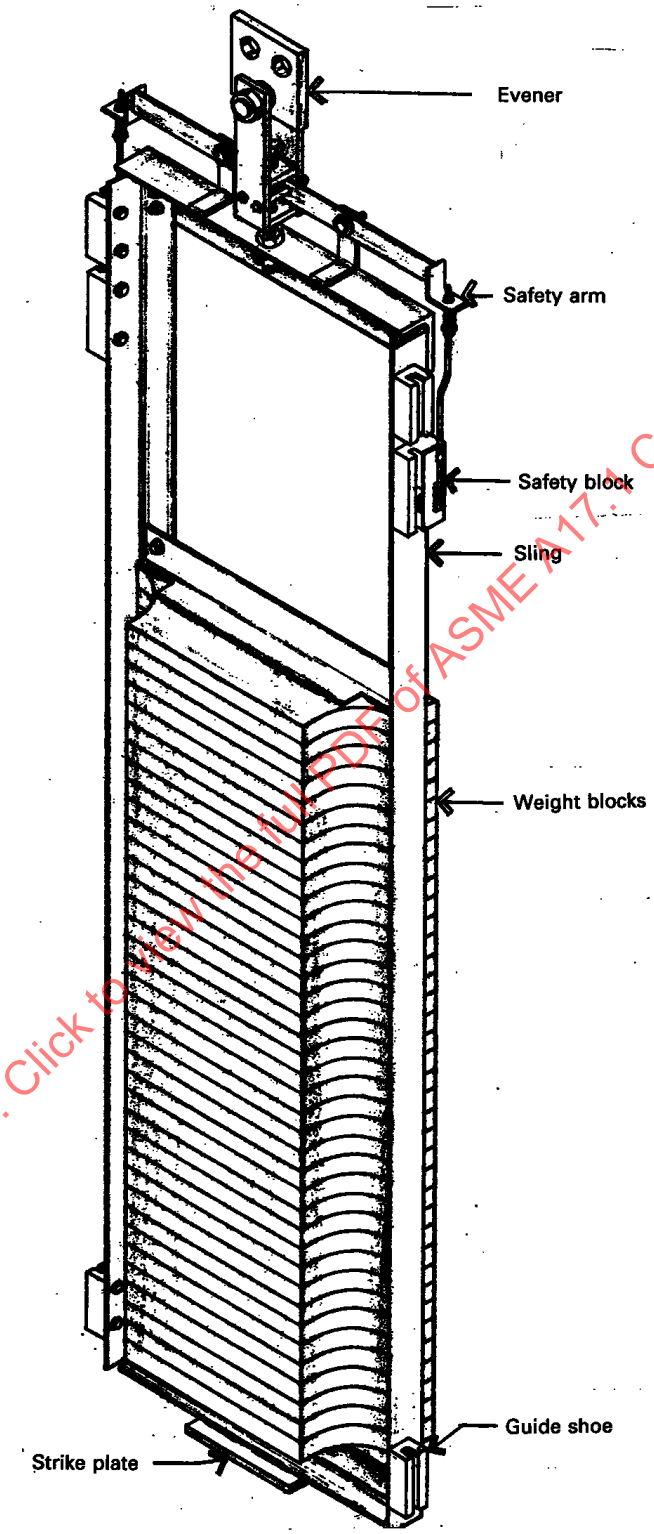


Diagram 5.3.1.8.2
Clearances at Landing Sill



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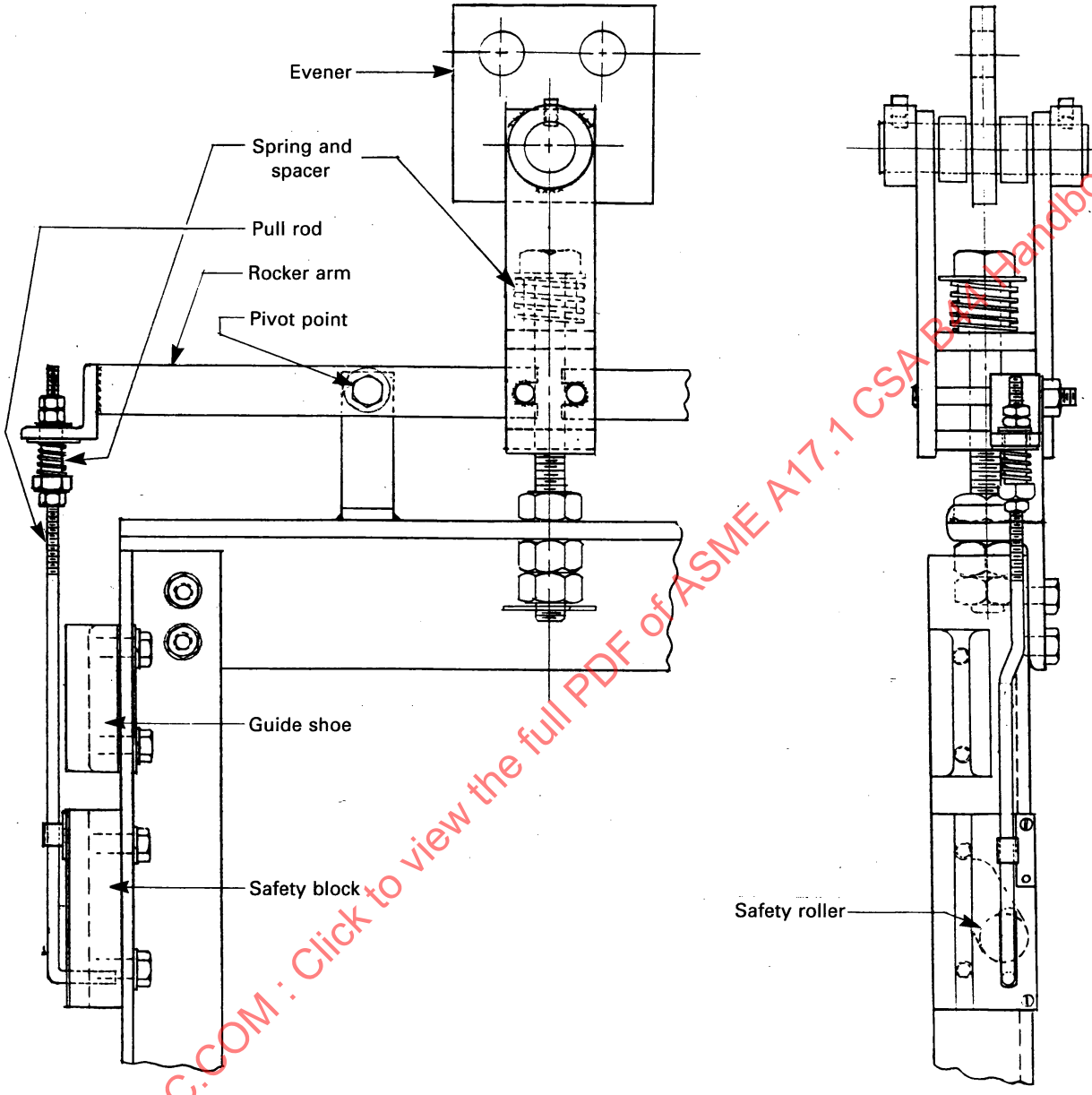
Diagram 5.3.1.12(a)
Typical Private Residence Elevator Counterweight With Safety



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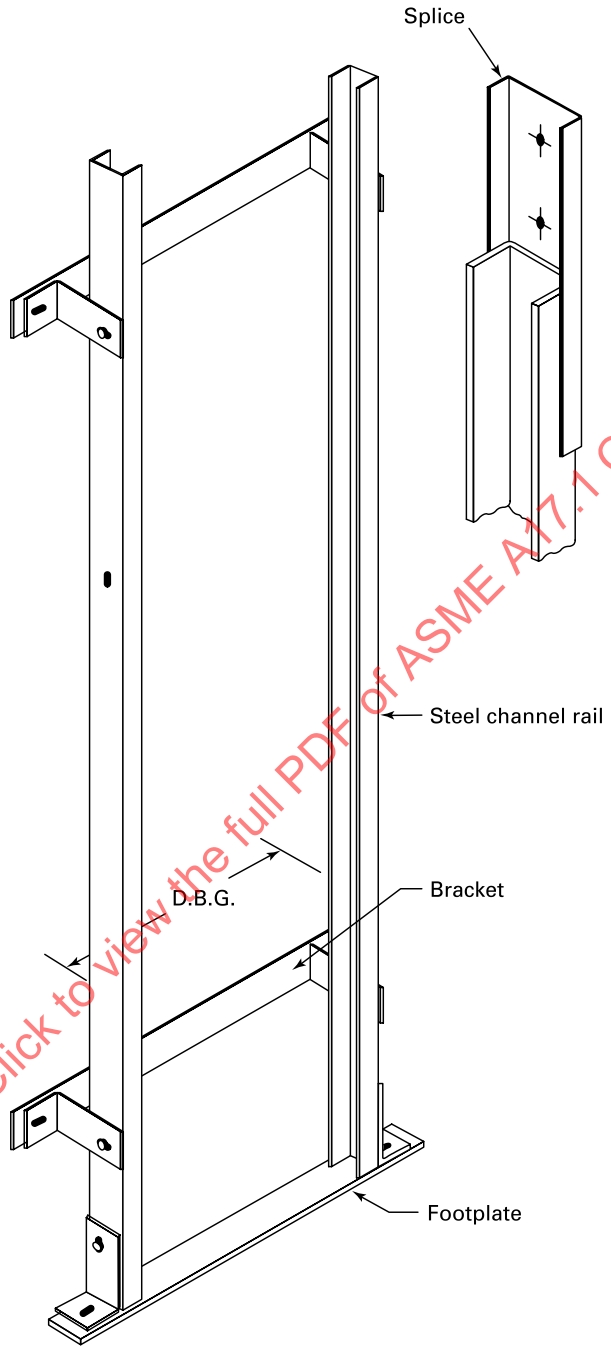
Diagram 5.3.1.12(b)
Typical Private Residence Elevator Counterweight Safety



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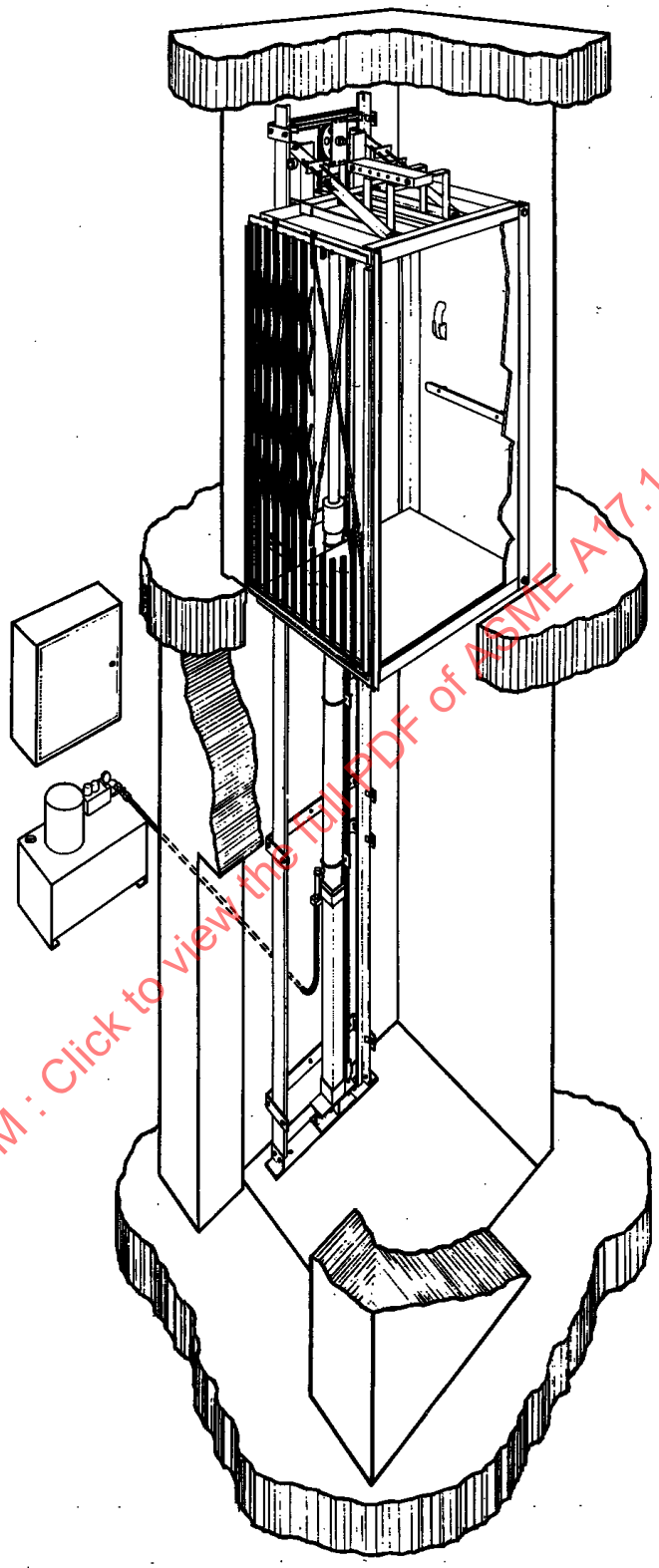
Diagram 5.3.1.17
Typical Private Residence Elevator Guide-Rail System



GENERAL NOTE: Courtesy of Sedgwick Lifts, Inc.

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Diagram 5.3.2
Typical Hydraulic Private Residence Elevator



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SECTION 5.4
PRIVATE RESIDENCE INCLINED ELEVATORS

NOTE: Throughout Section 5.4, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

Section 5.4 applies to elevators installed in or at a private residence. It also applies to similar elevators installed in buildings other than private residences as a means of access to a private residence in that building provided the elevator is installed so that it is not accessible to the general public or to other occupants of the building. A private residence is defined in ASME A17.1/CSA B44 as "a separate dwelling or separate apartment in a multiple dwelling that is occupied only by the members of a single family unit" (see Section 1.3). This definition may not be identical to that used by the building code.

ASME A17.1/CSA B44 does not permit the installation of a private residence elevator in locations other than described above even if the elevator is key operated. The rationale for 5.4 is best described by the introduction to ASA A17.1.5-1953 when requirements for private residence elevators were first added to A17.1.

> This Part of the Code has been developed in response to demands for a separate section of Rules to cover the installation in a private residence of a small electric power passenger elevator or inclined lift which serves only the members of a single family. These elevators or inclined lifts are installed primarily for the convenience of elderly persons or invalids who are unable to walk up or down stairs. In such cases, equipment of very low speed and small capacity meets the requirements. Such elevators and lifts, while usually installed in single-family private residences, may be installed within a separate apartment in a multiple dwelling.
>
> It is frequently necessary to install such elevators in open stairwells, as the construction of the building does not provide space to permit installing a standard type of enclosed hoistway inside the building.
>
> Due to their limited size, speed, load, and rise, and the fact that their use is limited to the members of a single family and is under the control of the head of the family, adequate safety of operation can be secured without requiring that such equipment meet the standards set up in other parts of this Code for equipment installed in buildings of other types which is used by the general public and is thus subjected to much more severe and frequent service. The Rules of this Part of the Code have, therefore, been developed to set up minimum standards for equipment of the type described which, if conformed to, should result in adequate safety of operation and use.
>
> It should be noted that the Rules of this Part of the Code do not apply to all power elevators installed in private residences, but only to those which meet the definition for Private Residence Elevator as given in this Code and which are installed in a Private Residence as defined in this Code. All other elevators in private residences, even when the latter terms conform to the definition in this Code, are required to comply with all the Rules of the other Parts of this Code.

Section 5.4 was reformatted in ASME A17.1-2013/CSA B44-13 to remove requirements that no longer apply and add new requirements based on new technology and evolution of elevators. Reformatting avoids redundancy by referencing Secton 5.3 to provide consistency for private residence elevator systems.

5.4.1 Runway Protection

The requirements protect against or move pinch and snag points outside the reach of passengers. The building code should also be consulted, as there may be a requirement for a fire-resistive hoistway (runway) enclosure.

5.4.2 Landing Enclosures and Gates (Where Required)

5.4.2.1 Landing Enclosures. Provides protection from falling or entering the elevator runway.

5.4.2.4 Clearance Between Landing Doors or Gates and Landing Sills and Car Doors or Gates. Diagram 5.3.1.7.2 illustrates the required clearances between the hoistway doors or gates and landing sills and car doors or gates.

5.4.4 Car Enclosures, Car Doors, and Gates

5.4.4.2 Car Doors or Gates

5.4.4.2.4 Latching of Swinging Gates. This requirement is intended to prohibit movement of the car when the car door is open, as the open door would result in severe damage to the elevator.

5.4.4.3 Use of Glass or Plastics. See Handbook commentary on 2.14.1.8.

5.4.6 Capacity

If any of the requirements are exceeded, the entire installation must comply with all the requirements in Section 5.1.

5.4.6.2 Shelves or Benches. See Diagram 5.1.13.1.

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5.4.8 Suspension Means

Welded link chain is not permitted, as there is no visual indication of impending failure at a weld. In addition, there appears to be no practical way to detect an impending failure due to fatigue. Hairline cracks indicating a fatigue situation can appear at any moment. Any chain failure could result in a life-threatening exposure.

5.4.13 Terminal Stopping Devices

5.4.13.1 Terminal Stopping Devices. A normal terminal stopping device slows down and stops an elevator automatically at or near a terminal landing independent of the function of the car switch, push button, lever, or other manual device used to actuate a control.

The final terminal stopping device automatically causes the power to be removed from an electric elevator driving-machine motor and brake independent of the functioning of the normal terminal stopping device or the operating device after the car has passed a terminal landing.

SECTION 5.5
POWER SIDEWALK ELEVATORS

NOTE: Throughout Section 5.5, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

A sidewalk elevator is an elevator of the freight type for carrying material that operates between a landing of a sidewalk or other areas exterior to a building and the floors below a sidewalk or grade elevation. Being an elevator of the freight type, it must be used primarily for carrying freight in which only the operator and persons necessary for unloading and loading the freight are permitted to ride. Passengers are not permitted to ride on a sidewalk elevator.

See Diagram 5.5.

5.5.1 Electric Sidewalk Elevators

5.5.1.1 Construction of Hoistways and Hoistway Enclosures. Sidewalk elevators must comply with the requirements in Section 2.1, except as modified by 5.5.1.1(a) through 5.5.1.1(e).

The requirements of the local building code should also be reviewed since they may have additional requirements. If the hoistway is required by the building code to be enclosed with fire-resistive construction, then all hoistway openings in that construction must be provided with fire-resistive protective assemblies with an hourly rating as specified in the building code (see Section 1.3).

5.5.1.2 Pits. Due to the nature of their operation, sidewalk elevator hoistways are exposed to the weather; therefore, means must be provided to automatically remove water from the pit.

5.5.1.4 Vertical Clearances and Runbys. These requirements reflect the possible use of a car top and incorporate the necessary clearances when provided. Requirements are also included for vertical lifting covers when provided.

5.5.1.5 Horizontal Car and Counterweight Clearances. These requirements are similar to those for electric elevators with clarification of clearances where adjacent openings are provided.

5.5.1.8 Equipment in Hoistways and Machine Rooms. Sidewalk elevator hoistways and pits are subjected to water, thus the requirement to locate switches a minimum of 600 mm or 24 in. above the floor. For the same reason, the use of electrical metallic tubing (EMT) is prohibited. Water corrodes EMT quickly, allowing the wire to get wet and deteriorate, resulting in equipment malfunction.

5.5.1.11 Protection of Hoistway Landing Openings

5.5.1.11.1 Vertical Openings. Requirement 2.11.2.1 is not applicable as it applies only to passenger elevators. Hoistway entrance panels are not allowed to be perforated.

5.5.1.11.2 Horizontal Openings in Sidewalks and Other Areas Exterior to the Building. The requirements in 5.5.1.11.2(a) are intended to provide a safe area for pedestrian traffic when the elevator is at the upper landing.

The requirements in 5.5.1.11.2(c) ensure that an area that could entrap pedestrians is not created.

The public is protected by requiring hinged metal doors or vertical lifting covers [5.5.1.11.2(d)]. When closed, they must be capable of safely supporting a static load of not less than 1 460 kg/m^2 or 300 lb/ft^2, which is the normal load that would be encountered with traffic moving over the door or cover. When opened, the doors or covers will form a barricade around the opening. Requirement 5.5.1.11.2(e) addresses a potential tripping hazard. Requirement 5.5.1.11.2(g) addresses the need to keep as much water as possible from entering the hoistway. Requirement 5.5.1.11.2(h) ensures that doors or covers of sidewalk elevators, which might be exposed to vehicular traffic, are designed to support anticipated loads. See Diagram 5.5.1.11.2.

5.5.1.11.3 Hinged-Type Swing Sidewalk Doors. See Diagram 5.5.1.11.3.

5.5.1.11.4 Vertical Lifting Sidewalk Covers. See Diagram 5.5.1.11.4.

5.5.1.12 Hoistway Door Locking Devices and Electric Contacts, and Hoistway Access Switches. The modifications to the requirements in Section 2.12 are to provisions that pertain only to passenger elevators.

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5.5.1.14 Car Enclosures, Car Doors and Gates, and Car Illumination. Car tops are permitted for sidewalk elevators subject to the limitations of this requirement and 5.5.1.4, 5.5.1.11.4, and 5.5.1.25.3, which ensure the necessary safety requirements.

Lighting fixtures are usually located on the bow iron, which can be damaged when it strikes the door. Requirement 5.5.1.14.3 permits the lighting to be exterior to the car, provided that the required illumination levels are provided.

5.5.1.15 Car Frames and Platforms. Requirements are included for conditions that are unique to sidewalk elevators.

5.5.1.16 Capacity and Loading. Requirements in Section 2.16 for carrying passengers are not referenced, as passengers are not permitted on sidewalk elevators.

5.5.1.23 Driving Machines and Sheaves. The smaller-diameter sheave has proved satisfactory for sidewalk elevators.

5.5.1.25 Operating Devices and Control Equipment

5.5.1.25.2 Operation Through Openings in Sidewalk or Other Area Exterior to the Building. This requirement was revised in ASME A17.1b-2009/CSA B44b-09 to provide necessary precautions for safe operation of sidewalk elevators through the sidewalk opening from on the car in a manner that will permit authorized personnel to safely ride and operate sidewalk elevators through sidewalk openings. This requirement was deemed necessary as it had been found that building owners and operators were using sidewalk elevators in this manner without the necessary safety features that are included in this proposal.

Requirement 5.5.1.25 was revised and 5.5.1.25.5 was added in ASME A17.1-2022/CSA B44:22 to exclude remote interaction operation (RIO) for sidewalk elevators until such time that the Committee can develop specific requirements and limitations for the use of RIO.

5.5.1.25.3 Top-of-Car Operating Devices and Stop Switch. Requirements reflect the safest possible use of a car top.

5.5.1.25.4 Maximum Rated Speed. When the car is fully enclosed, there is no need to limit car speed. Also, see 5.5.1.25.2 and 5.5.1.25.3 for additional speed limitation requirements.

SECTION 5.6
ROOFTOP ELEVATORS

NOTE: Throughout Section 5.6, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

This Section was developed in response to a request for elevators to bring passengers and freight to rooftop heliports. Where a roof is used for a heliport, the FAA places severe restrictions on obstruction such as elevator hoistways.

5.6.1 Electric Rooftop Elevators

5.6.1.2 Pits. A means must be provided to automatically remove water from a pit as the hoistway is exposed to the weather when the car is at the top landing. Also, see Handbook commentary on 5.5.1.2.

5.6.1.4 Vertical Clearances and Runbys. Since there is no need for a person to ride on top of the car when the rise is less than 6.1 m or 20 ft, there is no need for additional car top clearance. The car top clearance is measured when the bow iron or stanchion is in contact with the door to ensure that adequate space is provided.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to delete references to 2.4.10, 2.4.11, and 2.4.12, which no longer exist. Top-of-car clearance requirements were added to replace the former refuge-space requirements intended to protect a person on top of the car. A separate refuge space is no longer specified in the Code because the clearances necessary for refuge space are now incorporated into the top-of-car clearances for both electric and hydraulic elevators.

5.6.1.8 Equipment in Hoistways and Machine Rooms. Additional requirements are included because the elevator equipment is exposed to the weather. Also, see Handbook commentary on 5.5.1.8.

5.6.1.11 Protection of Hoistway Landing Openings

5.6.1.11.2 Horizontal Openings in Rooftops. See Handbook commentary on 5.5.1.11.2.

5.6.1.11.3 Hinged-Type Rooftop Doors. See Handbook commentary on 5.5.1.11.3. Additional requirements are incorporated to address ramps provided for handicapped wheelchair and stretcher access to the elevator.

5.6.1.11.4 Vertical Lifting Rooftop Covers. See Handbook commentary on 5.5.1.11.4. Additional requirements are incorporated to address ramps provided for handicapped access to the elevator.

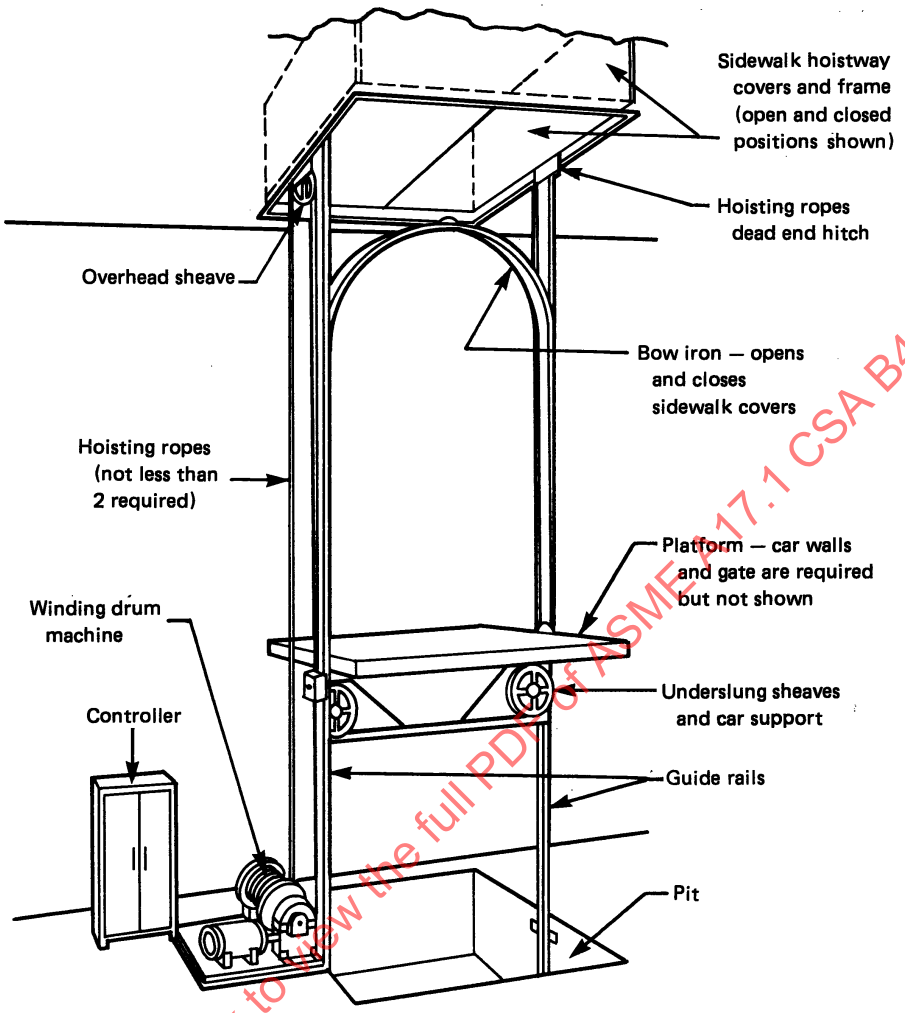
5.6.1.11.5 Setting of the Door. The intent of this requirement is to locate the roof door in such a way that any water on the roof flows away from the opening.

5.6.1.12 Hoistway Door Locking Devices and Electric Contacts and Hoistway Access Switches. See Handbook commentary on 5.5.1.12.

5.6.1.14 Car Enclosures, Car Doors and Gates, and Car Illumination. Weatherproof electric equipment is required as the elevator is exposed to the elements when at the top landing.

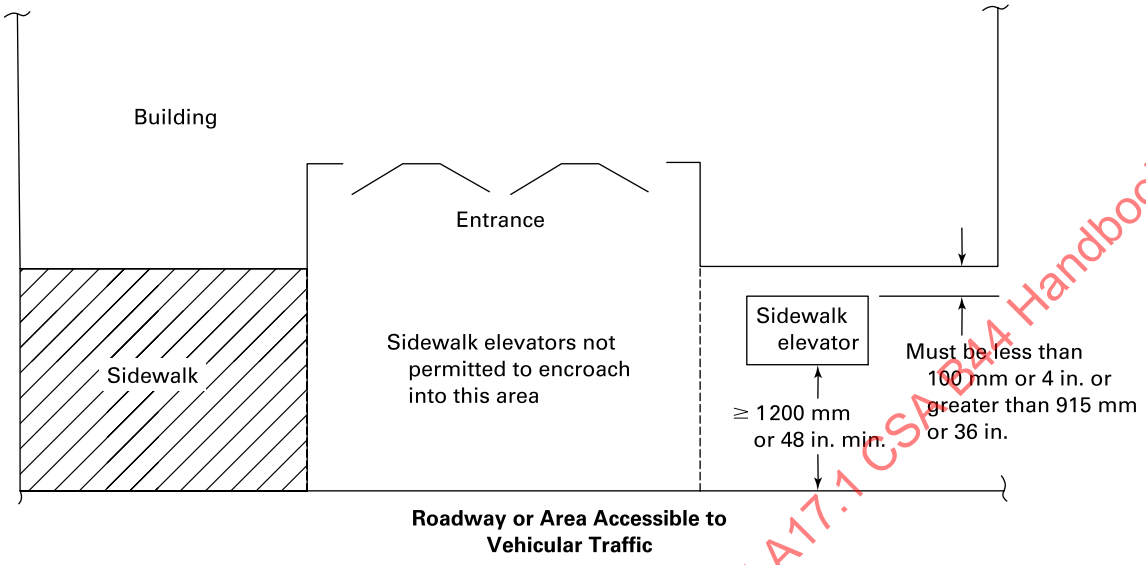
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Diagram 5.5
Typical Sidewalk Elevator Layout



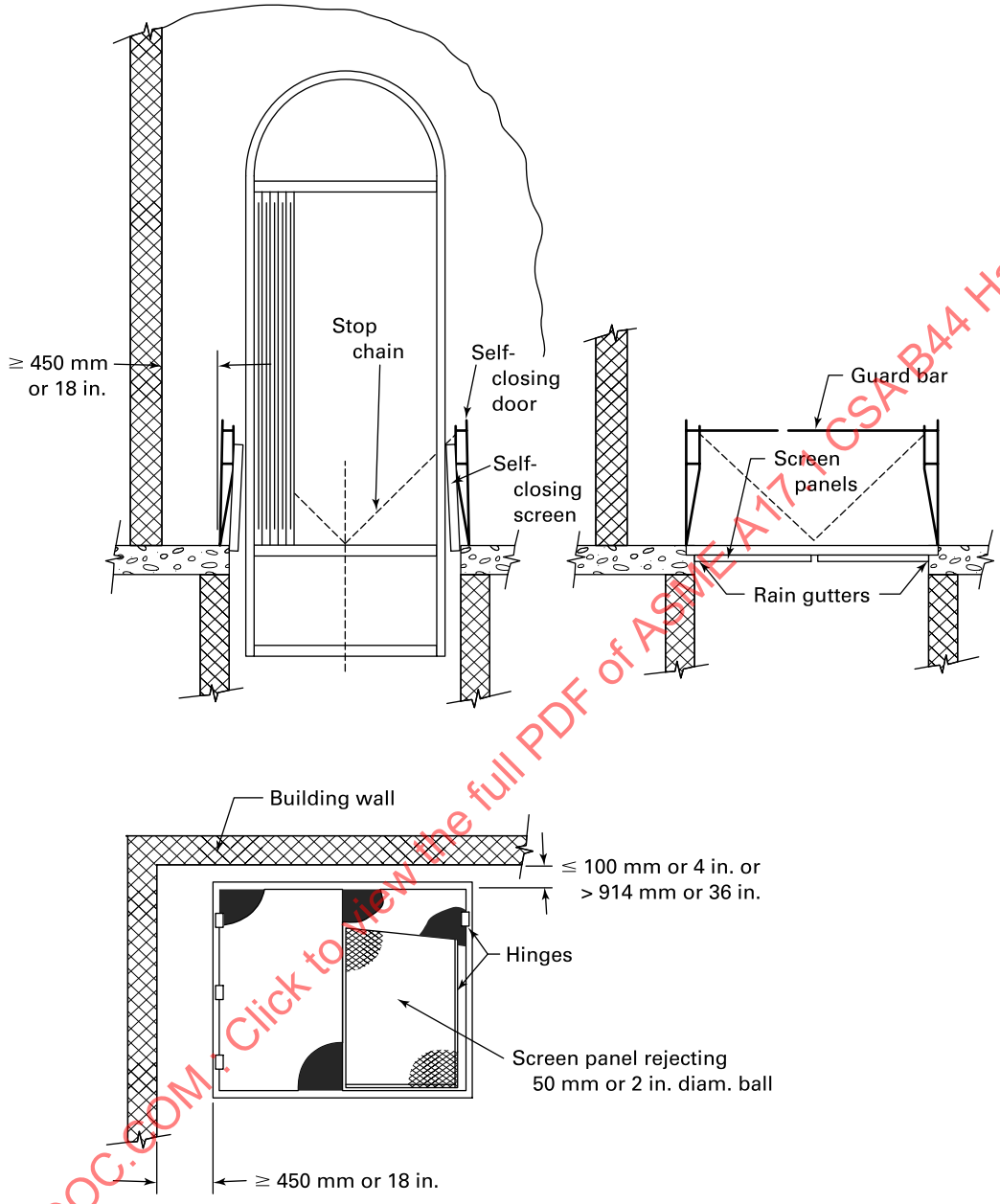
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Diagram 5.5.1.11.2
Sidewalk Elevator Location



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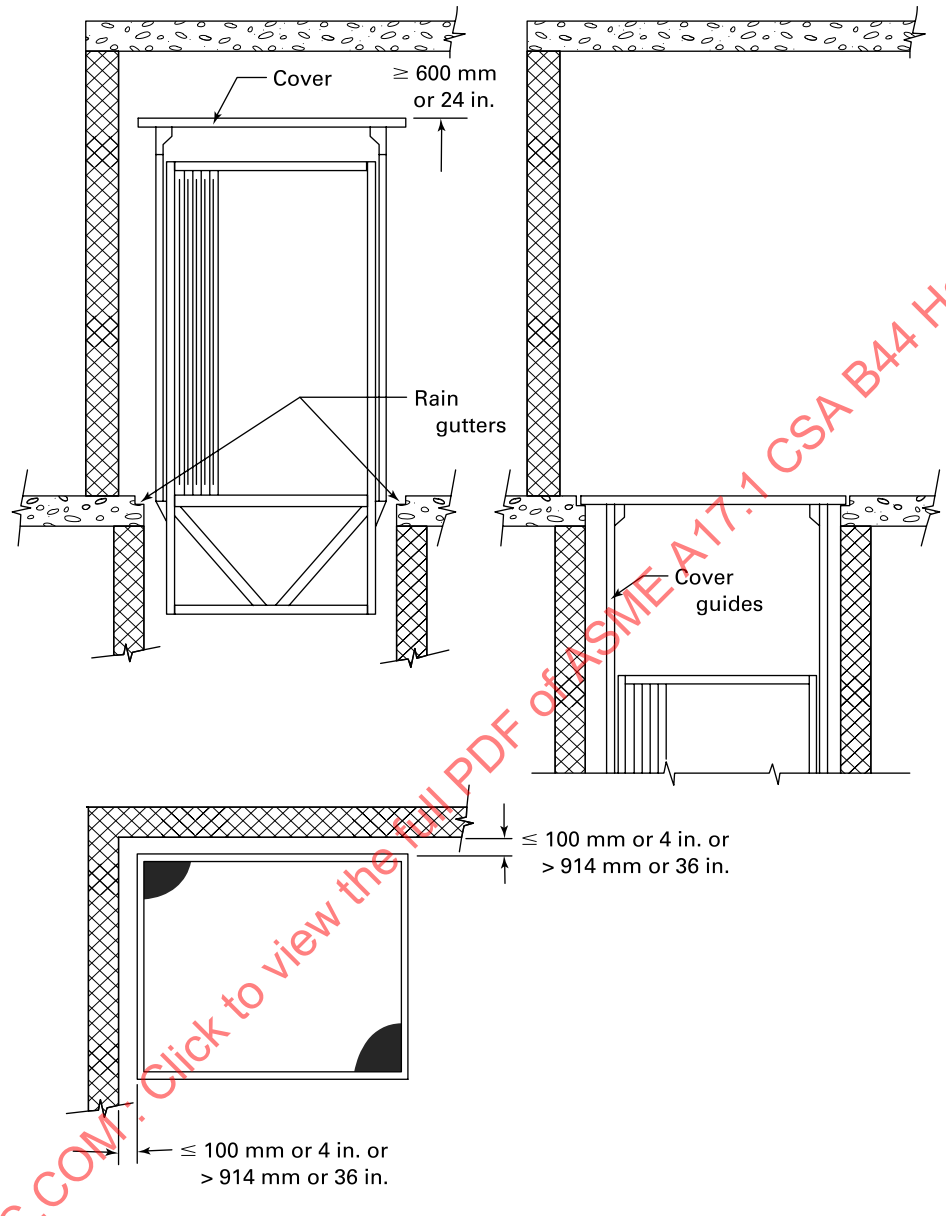
Diagram 5.5.1.11.3
Requirements for Hinged-Type Sidewalk Doors



GENERAL NOTE: Courtesy of Gillespie Corp.

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Diagram 5.5.1.11.4
Requirements for Vertical Lifting Sidewalk Covers



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5.6.1.15 Car Frames and Platforms

5.6.1.15.1 Platforms. These requirements provide for the safe operation of equipment arranged to travel above the level of the roof for freight loading and unloading. See Handbook commentary on 5.5.1.15.

5.6.1.15.2 Bow Irons and Stanchions. See Handbook commentary on 5.5.1.15.2.

5.6.1.23 Driving Machines and Sheaves. See Handbook commentary on 5.5.1.23.

5.6.1.24 Terminal Stopping Devices. Requirements provide protection of the equipment from the elements.

5.6.1.25 Operating Devices and Control Equipment. ASME A17.1a-2002 and CSA B44 Update No. 1-02 allowed the rooftop elevator to service the rooftop as well as an unlimited number of landings below. Prior edition limited service to the rooftop and one landing below. It was felt that many buildings, particularly health care institutions, are designed or will be designed to have elevator service to a rooftop helipad on which a medivac helicopter will land and from which the patient will have to be transported to one or more trauma centers on floors below the rooftop. The reason given for the original limitation was "to gain experience" with this application before allowing service to multiple levels below. Experience has proven this application viable, and such limitation is no longer necessary.

A requirement was also added for protection of the equipment from the elements [5.6.1.25.2(c)].

Requirement 5.6.1.25 was revised and 5.6.1.25.6 was added in ASME A17.1-2022/CSA B44:22 to exclude remote interaction operation (RIO) for rooftop elevators until such time that the Committee can develop specific requirements and limitations for the use of RIO.

5.6.1.25.4 Maximum Rated Speed. The operating speed is not limited until the bow-iron or stanchion is in contact with the door.

SECTION 5.7
SPECIAL PURPOSE PERSONNEL ELEVATORS

NOTE: Throughout Section 5.7, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

Elevators covered by this Section are limited to rated loads of 454 kg or 1,000 lb or less, rated speeds of 0.76 m/s or 150 ft/min or less, and a platform area of 1.208 m^2 or 13 ft^2 or less (see 5.7.12.2). By definition, special purpose personnel elevators are to be used only by authorized personnel (see Section 1.3).

Section 5.7 does not apply in jurisdictions enforcing NBCC. In those jurisdictions, special purpose personnel elevators should comply with the requirements in CAN/CSA B311, Safety Code for Manlifts.

5.7.1 Construction of Hoistways and Hoistway Enclosures

5.7.1.1 Hoistways and Hoistway Enclosures. Where a hoistway is adjacent to an area where people may come in contact with an elevator, such as a passageway, stairway, elevator landing, or walkway, the hoistway must be enclosed to a height of 2 130 mm or 84 in. above the floor or stair tread. Above that height, the hoistway may be unenclosed. A landing may be composed of nothing more than an adjacent metal grating a few feet wide. If a person is expected to be on this platform, the hoistway must be guarded at that location. Hoistway enclosures up to 2 130 mm or 84 in. may be of the openwork type as long as the openwork rejects a ball 25 mm or 1 in. in diameter (see Diagram 5.7.1.1). When a fire-resistive enclosure (floor or wall) is penetrated, the construction must comply with the local building code or one of the following model building codes. It is likely that the entire hoistway will need to be fire-rated if the elevator penetrates a fire-resistive floor or wall. Most of the building codes in the United States are based on one of the following model building codes:

(a) International Building Code (IBC)

(b) NFPA 5000®, Building Construction and Safety Code

The IBC is the model building code that is widely adopted in the United States. It is published by the International Code Council (ICC). The National Fire Protection Association (NFPA) publishes NFPA 5000®. To the author's knowledge, no major jurisdiction in the United States or Canada had adopted NFPA 5000® as of the publication of this Handbook.

5.7.1.2 Floor Over Hoistway. This requirement was revised in ASME A17.1-2016/CSA B44-16 because it is not practical or necessary to provide a floor over the hoistway in the types of structures served by special purpose personnel elevators. The revision also harmonizes the requirement with those in CAN/CSA B311-02.

5.7.2 Pits

A pit must be provided. The ASME A17.1/CSA B44 Code does not require a minimum bottom car clearance, only the runby is addressed. The small cross-sectional area of the hoistway precludes providing a refuge area in the pit under a car resting on its fully compressed buffers. This requirement was revised in ASME A17.1-2016/CSA B44-16 to specify pit-related requirements for special purpose personnel elevators.

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5.7.3 Location and Enclosing of Counterweights

5.7.3.1 Counterweight Coming Down to Floors or Passing Floors or Stairs. A counterweight runway adjacent to a floor or stairway must be enclosed to a height of 2 130 mm or 84 in. above that floor or stairway tread by a solid or openwork enclosure. A landing may be comprised of nothing more than a metal platform a few feet wide that is adjacent to the hoistway. If a person is expected to be on this platform, the hoistway must be guarded at that location. The openwork enclosure must reject a ball 25 mm or 1 in. in diameter. There must be at least 100 mm or 4 in. between the outside of the enclosure and the closest member of the counterweight assembly. Above 2 130 mm or 84 in., the counterweight runway need not be enclosed. The local building code or one of the model building codes should be consulted if the counterweight runway passes through a fire-resistive enclosure (floor or wall). See Handbook commentary on 5.7.1.1.

5.7.3.2 Access to Enclosed Counterweights and Ropes. This requirement refers to counterweights that may be enclosed throughout their full run and to counterweights that are partially enclosed throughout a significant portion of the counterweight runway. The electrical contact on the access door ensures that the elevator will not run when servicing or inspecting the counterweight. The self-locking key tumbler lock with Group 1 security ensures that only elevator personnel can get into the counterweight runway for inspection or maintenance purposes. This requirement was revised in ASME A17.1-2016/CSA B44-16 to establish security requirements.

5.7.4 Vertical Clearances and Runby

5.7.4.2 Top-of-Car Clearance. A rack-and-pinion elevator will travel in the up position only to the point where the rack teeth are terminated. This requirement was revised in ASME A17.1-2016/CSA B44-16 to encompass all drive types.

5.7.4.3 Top Counterweight Clearances. This requirement was added in ASME A17.1-2016/CSA B44-16 to specify the minimum top counterweight clearance. Gravity stopping affect is not considered due to the car speed limitation of 0.76 m/s or 150 ft/min.

5.7.7 Overhead Machinery Beams and Supports

5.7.7.1 Securing of Machinery Beams and Type of Supports. Cast iron is an alloy of iron, carbon, and silicon that is cast in a mold and is hard, nonmalleable, and brittle. Being brittle, it will not withstand the forces applied.

5.7.8 Hoistway Doors and Gates

5.7.8.1 Where Required. Each entrance must be protected by a door or gate to its full height or 2 030 mm or 80 in., whichever is less. Openwork entrances are permissible as long as they reject a ball 25 mm or 1 in. in diameter. The local building code should also be checked to see if a fire-resistive entrance is required.

5.7.8.3 Access to Hoistways for Emergency and Inspection Purposes. Hoistway door unlocking devices are required at the top and bottom landing for access to the hoistway for emergency, inspection, and maintenance purposes. These devices must be of a design to prevent unlocking of the door with common tools, such as with a screwdriver. They must be kept on the premises in a location readily available only to authorized or emergency personnel.

5.7.8.6 Distance Between Hoistway Doors or Gates and Landing Sills and Car Doors or Gates. Compliance ensures that no one can stand between the car door or gate and hoistway door or gate, and that no one can stand on the landing sill with the hoistway door or gate closed and the car at a remote location in the hoistway.

5.7.9 Locking Devices for Hoistway Doors or Gates

There is no difference in the exposure of a special purpose elevator compared to a passenger elevator in terms of rise or number of openings. The use of mechanical locks and electric contacts where there is no electrical confirmation of the locking action is not permitted except under very limited conditions. The limitations cover freight elevators not permitted to carry passengers, with manual doors, a rise not over 4 570 mm or 15 ft, and any landing whose landing sill is within 1 525 mm or 60 in. of the pit floor, regardless of the elevator rise. [See Diagram 2.12.3.1(b).] These limitations provide a short fall distance in the event of inadvertent access to the open hoistway. With mechanical locks and electric contacts, door opening is possible as an elevator in flight passes a landing during the period the unlocking cam rides on the mechanical lock roller arm. In the event the locking arm does not return to the closed position after the elevator leaves the landing, the door will remain unlocked and can be opened with the car at any position, in which case a dangerous fall hazard is created.

5.7.10 Car Enclosures, Car Doors and Gates, and Car Illumination

5.7.10.4 Emergency Exits. As this type of elevator is not used by the general public, an emergency exit is not required. If one is provided, it must conform to the specified requirements. The exit size must be large enough for use, and the exit cover must be equipped with a switch or contact that will not allow the car to

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move if the exit cover is open. A written emergency evacuation procedure is required by 8.6.10.4.

5.7.12 Capacity and Loading

5.7.12.2 Limitation of Load, Speed, and Platform Area. As this elevator is permanently installed in a wide variety of structures and locations to provide vertical transportation for authorized personnel and their equipment only, such elevators are limited in load, speed, and platform area.

The speed and capacity provisions have been increased since this type of equipment was first recognized by ASME A17.1. The maximum allowed speed was increased in ASME A17.1a-1991 because it is recognized that on tall structures it would be more efficient to decrease travel time. The maximum capacity was also increased. As the elevator is used to move equipment, the ASME A17 Committee recognized a need to provide a means of moving heavy equipment safely. It was determined the previous limit was not practical.

If these requirements cannot be met, then the elevator must conform to the applicable requirements in Part 2 or Part 3, or Section 4.1 or Section 4.2 of ASME A17.1/CSA B44.

5.7.13 Car Safeties and Governors

5.7.13.1 Car Safeties and Governors for Traction and Winding-Drum-Type Elevators. See Diagram 5.7.13.1. This requirement was revised in ASME A17.1-2016/CSA B44-16 to conform to the 0.76 m/s or 150 ft/min maximum rated car speed for special purpose personnel elevators.

5.7.13.2 Car Safeties and Governors for Rack-and-Pinion-Type Elevators. A rack-and-pinion-type elevator typically uses a safety device controlled by a pinion, which is permanently engaged in the rack. In the event of overspeed, a centrifugal device engages and screws a cone brake into action, bringing the car to a gradual stop. These safeties are usually sealed and require that they be returned to the manufacturer for calibration and maintenance at scheduled intervals. See 8.6.6.1 for maintenance requirements.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to reflect rack-and-pinion requirements and to reference 4.1.17. See Handbook commentary on 4.1.17.

5.7.13.3 Opening of Brake and Motor Control Circuits on Safety Application. In addition to these requirements, the speed governor should be located where it can be easily serviced.

5.7.14 Suspension Ropes

See Diagram 5.7.14 for examples of typical traction and winding-drum roping arrangements.

5.7.14.1 Types Permitted. Only wire rope that is specifically designed and constructed for suspending elevator cars and counterweights can be used. Suspension means other than wire rope, such as chain, are prohibited.

5.7.14.5 Arrangement of Wire Ropes on Winding Drums. This requirement ensures that when the elevator or counterweight has reached its limit of travel, the wire rope will not become separated from the winding drum.

5.7.14.6 Lengthening, Splicing, Repairing, or Replacing Suspension Means. The design strength of the wire rope is severely weakened when spliced. Splicing also increases the diameter of the rope at the splice. This increase in diameter would adversely affect the relationship between the sheave groove and rope.

All ropes must be replaced at one time to ensure uniform rope life. If one rope has excessive wear, the cause of the wear should be determined before replacing a full set of ropes. Replacement of the entire set of ropes when any single worn or damaged rope has to be replaced is required.

5.7.15 Counterweight Guiding and Construction

5.7.15.1 Guiding. Counterweights, if used, must be guided by the use of guide rails, which must conform to the requirements of 5.7.17.

5.7.16 Car and Counterweight Buffers

The requirements in 5.7.16 were redefined in ASME A17.1-2016/CSA B44-16 by drive type. The requirements for car buffers for rack-and-pinion drives were revised, and a requirement that did not take into consideration the kinetic energy of the rack-and-pinion machine was deleted. The rotational kinetic energy is additive to the translative kinetic energy of the car.

Requirement 5.7.16 was editorially revised in ASME A17.1-2022/CSA B44:22.

5.7.17 Car Guide Rails and Guide-Rail Fastenings

Guide rails other than the T-shaped type may be used on special purpose personnel elevators. Some other types of shapes used are

(a) round rail
(b) angle rail
(c) rack rail

5.7.18 Driving Machines and Sheaves

Winding-drum machines are required to conform to the rise and speed limitations specified in 2.24.1 (see 5.7.12.2). Special purpose personnel elevators with winding-drum machines are permitted to transport authorized personnel.

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This requirement was revised in ASME A17.1-2016/CSA B44-16 to reference the rack-and-pinion machine requirements in Section 4.1 and to add requirements for traction and winding-drum drives.

5.7.19 Operating Devices and Control Equipment

This requirement was reformatted in ASME A17.1-2016/CSA B44-16 using "positive" Code language. Exceptions were deleted, and 5.7.19.1 through 5.7.19.9 were added, incorporating requirements from Part 2.26 that apply to special purpose personnel elevators.

In general, the requirements of 5.7.19 were organized to parallel those in Section 2.26, as indicated by the last digit(s) of the paragraph designations (e.g., 2.26.2.1 and 5.7.19.2.1 both address slack-rope switch requirements). Where numbers skip (e.g., 5.7.19.2.15 is followed by 5.7.19.2.18), 5.7.19 has no requirement parallel to that in Section 2.26. For example, the following paragraph designators are not used:

(a) 5.7.19.2.16, 5.7.19.2.22, 5.7.19.2.31, and 5.7.19.2.32 are not used because of the car speed limitations of special purpose personnel elevators.

(b) 5.7.19.2.21 is not used because use of special purpose personnel elevators is limited to authorized personnel and material.

(c) 5.7.19.2.25 is not used because there are no existing requirements for special purpose personnel elevators to have blind hoistway emergency doors.

The devices covered in 5.7.19.2.33 through 5.7.19.2.39 are not required because of the limitations of special purpose elevators, but, where provided, they must conform to the referenced requirements of 2.26.2.

For rack-and-pinion safety devices, a single switch functions as both the car-safety overspeed switch and the speed governor switch. This change carries forward exceptions taken to Part 2 requirements within the 2016 Code.

In addition to the above revisions, 5.7.19.2.15 was revised to eliminate conflict with 5.7.19.2.28, and requirements were added for stop switches in remote machine rooms and control rooms; car door contacts and interlocks; ascending car overspeed protection; and unintended car movement.

The title of requirement 5.7.19.7 was revised in ASME A17.1-2022/CSA B44:22 to align with the referenced 2.26.7.

5.7.20 Operation

5.7.20.1 Types of Operation. Continuous-pressure operation is operation by means of buttons or switches, in the car and at the landing, any one of which may be used to control the movement of the car as long as the button or switch is manually maintained in the actuating position.

Single automatic operation is automatic operation by means of one button in the car for each landing served and one button at each landing, so arranged that if any car or landing button has been actuated, the actuation of any other car or landing button will have no effect on the operation of the car until its response to the first button has been completed.

5.7.21 Emergency Signal and/or Communication.

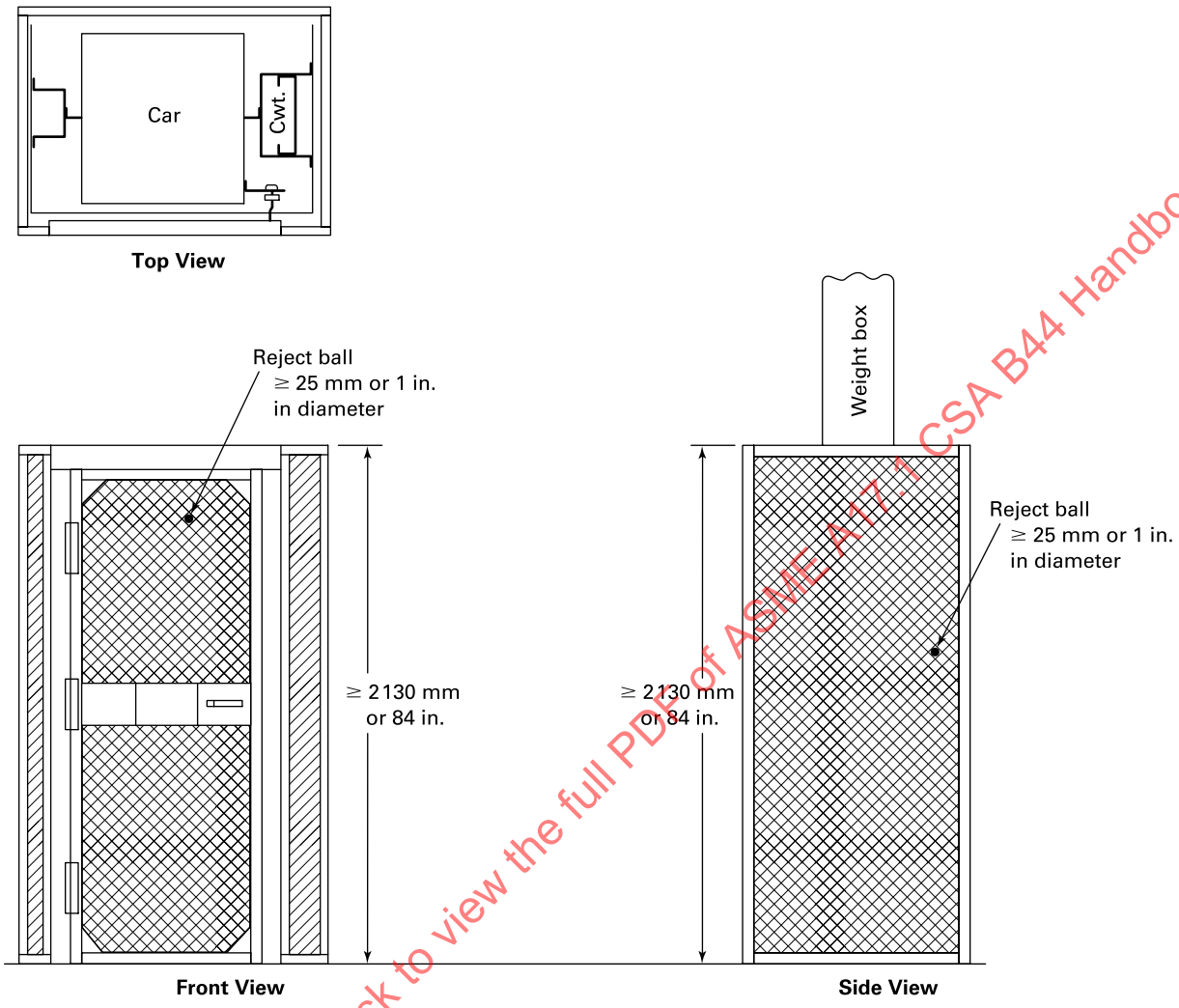
Requirement 5.7.21 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definitions for "normal building power" and "auxiliary power supply."

5.7.22 Layout Drawings

This requirement was revised in ASME A17.1-2016/CSA B44-16 to reference rack-and-pinion requirements.

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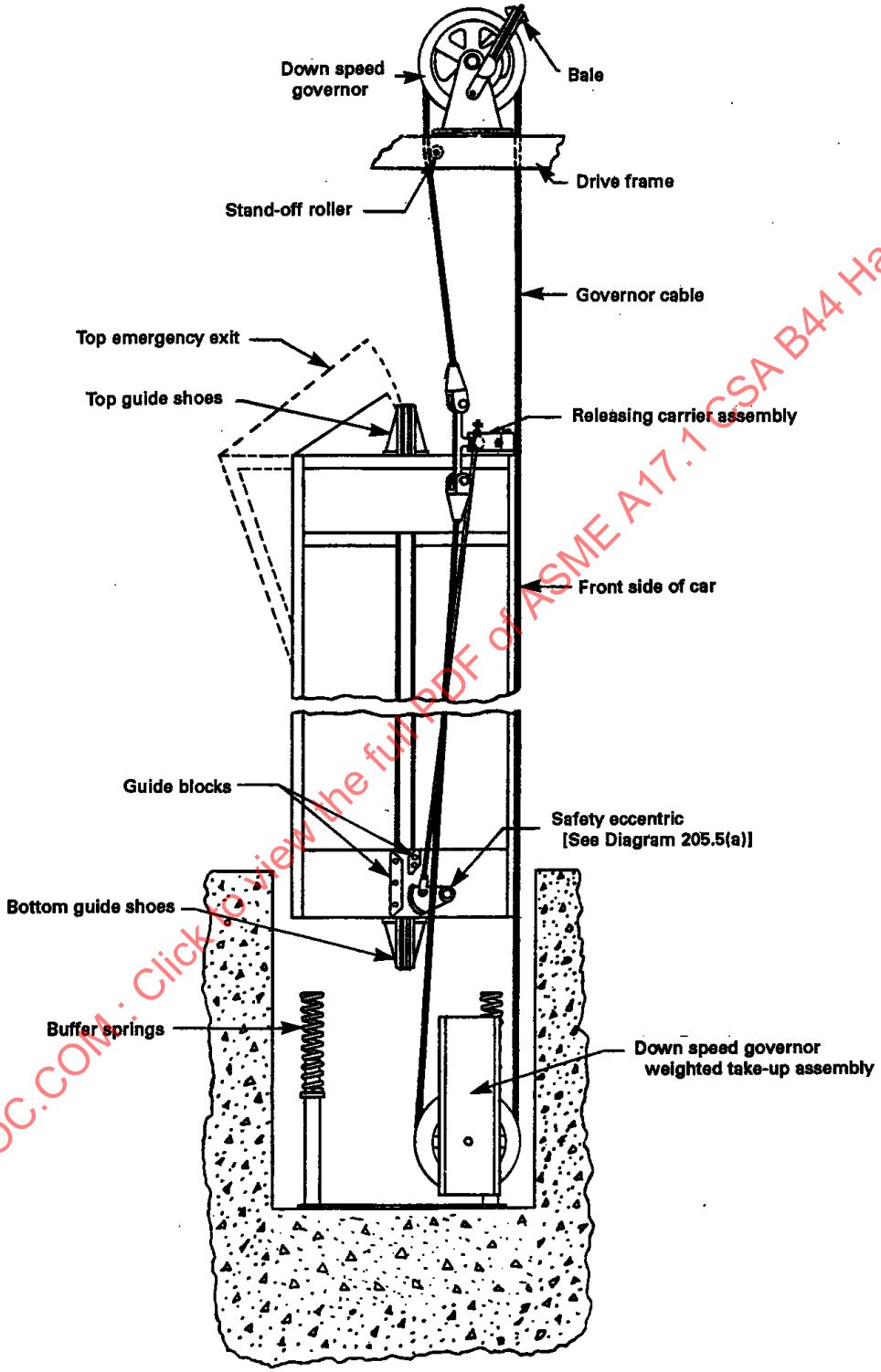
Diagram 5.7.1.1
Typical Hoistway Enclosure



GENERAL NOTE: Courtesy of Sidney Manufacturing Co.

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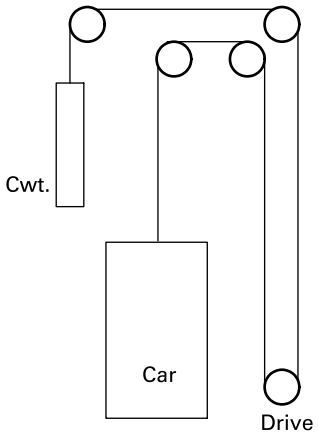
Diagram 5.7.13.1
Cutaway View Governor, Releasing Carrier, and Type A Safety



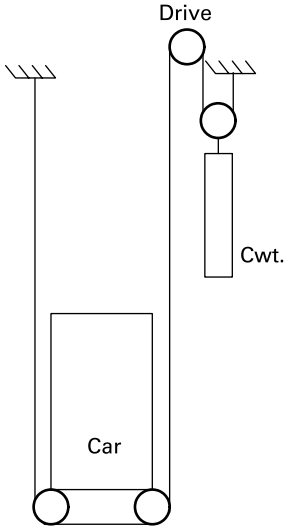
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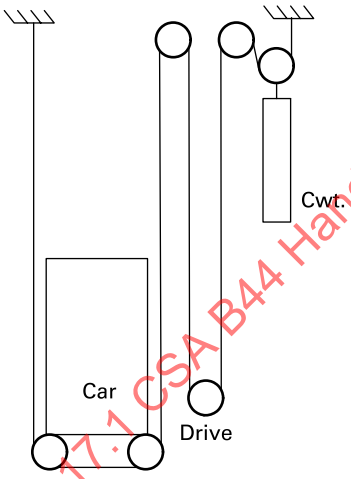
Diagram 5.7.14
Typical Traction and Winding-Drum Roping Arrangements



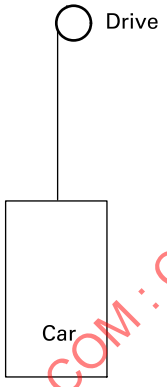
(a) Traction Drive at Bottom or Some Intermediate Point—Used Where it Is Impractical to Have the Drive at the Top.



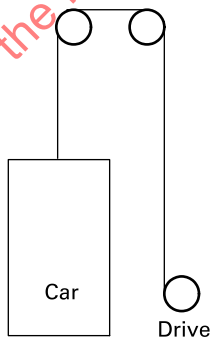
(b) Traction Drive at the Top and to the Side. Used for Low Overhead When Drive Can Be Located at the Top Landing.



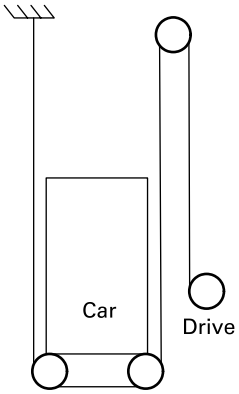
(c) Traction Drive at the Bottom and to the Side. Similar but With the Drive at the Bottom.



(d) Overhead Drum Drive. No Counterweight Required.



(e) Drum Drive at Bottom. Same Travel and Speed as Shown to Left.



(f) Drum Drive at Bottom With Secondary Sheaves. Used for Low Overhead.

GENERAL NOTE: Courtesy of Viola Industries.

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SECTION 5.8
MARINE ELEVATORS

NOTE: The name of this type of elevator was revised in ASME A17.1-2010/CSA B44-10 from Shipboard Elevators to Marine Elevators to align with the terminology used by AHJs.

Throughout Section 5.8, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

5.8.1 Electric Marine Elevators

5.8.1.1 Hoistway Enclosures. This requirement addresses the need to construct a hoistway with sufficient strength to resist being struck by a moving object as a result of vessel movement. The requirement also addresses the different construction materials used in maritime construction. The use of an expanded metal hoistway enclosure when the hoistway is within one compartment can be compared to an observation elevator hoistway with an atrium.

5.8.1.2 Separate Counterweight Hoistways. See Handbook commentary on 5.8.1.1.

5.8.1.3 Protection of Space Below Hoistway. Counterweight safeties must be provided because the space below the counterweight could be the vessel's hull and could also be occupied.

5.8.1.5 Top Emergency Exits. Special provisions are made to allow a passenger to escape from a stalled elevator in a vessel using the top emergency exit. These are provided as a person in a stalled elevator in a sinking vessel must be given an escape route.

5.8.1.6 Illumination of Cars. Not all of the electrical requirements on a vessel are covered by the NEC® or CSA C22.1, Canadian Electrical Code. Compliance with IEEE 45, Recommended Practice for Electric Installations on Shipboard, in addition to NFPA 70® or CSA C22.1, is specified.

5.8.1.7 Traction Driving Machines. These provisions are required because the elevator may be required to move at a substantial incline. The movement of the vessel will change the incline at which the elevator will be operating.

5.8.1.9 Special Conditions. These requirements, in addition to those in Sections 2.14 through 2.28, apply to marine elevators. Elevators on a vessel must be capable of operating safely as the vessel moves.

5.8.1.10 Handrails. As the vessel moves, the elevator moves. The handrail gives the passengers a means of steadying themselves.

5.8.1.11 Flooring. As the vessel moves, the elevator moves. Floors must be slip resistant to allow a secure foothold.

5.8.2 Hydraulic Shipboard Elevators

5.8.2.1 Storage Tanks. These requirements address the potential of an oil spill, which would be dangerous on a vessel. Storage tanks must be capable of withstanding the moving environment encountered on a vessel.

5.8.2.2 Special Conditions. These requirements, in addition to those in Part 3, apply to hydraulic marine elevators. Elevators on a vessel must be capable of operating safely as the vessel moves.

5.8.2.3 Handrails. As the vessel moves, the elevator moves. The handrail gives the passengers a means of steadying themselves.

5.8.2.4 Flooring. As the vessel moves, the elevator moves. Floors must be slip resistant to allow a secure foothold.

5.8.3 Rack-and-Pinion Marine Elevators

5.8.3.1 Special Conditions. These requirements, in addition to those in Section 4.1, apply to rack-and-pinion marine elevators. Elevators on a vessel must be capable of operating safely as the vessel moves.

5.8.3.2 Handrails. As the vessel moves, the elevator moves. The handrail gives the passengers a means of steadying themselves.

5.8.3.3 Flooring. As the vessel moves, the elevator moves. Floors must be slip resistant to allow a secure foothold.

SECTION 5.9
MINE ELEVATORS

NOTES:

(1) The author expresses his appreciation to Albert Saxer for his contributions to Section 5.9.

(2) Throughout Section 5.9, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of those requirements, readers are advised to review the Handbook commentary on all referenced requirements.

A mine elevator is an elevator permanently installed in a mine hoistway (see Section 1.3) and used to provide access to a mine for personnel, materials, equipment, and supplies.

A mine elevator must be designed and installed in conformance with Part 2, except where those requirements are modified by Section 5.9. Although mine elevators are very similar to high-rise, high-speed elevators, a mine environment is more hostile to the equipment. Fire and emergencies are also handled differently. Mine elevators are also regulated by the Code of Federal Regulations, Title 30. See Diagram 5.9.

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Section 5.9 was revised in ASME A17.1-2019/CSA B44:19 to recognize that the severe operating environments that exist in mine applications also contribute to their designation as a "special application elevator."

The scope of Section 5.9 was revised in ASME A17.1-2022/CSA B44:22 to include rack-and-pinion elevators.

Section 5.9 does not apply in jurisdictions enforcing NBCC. Mine elevators are covered separately by Canadian Federal Regulations.

5.9.1 Construction of Hoistways and Hoistway Enclosures

5.9.1(a) Fire-resistive construction and other specific construction requirements are not applicable.

5.9.1(b) Projections, recesses, and setbacks are not applicable (see Section 1.3, definition of "mine hoistway").

5.9.2 Pits

It is important to be aware of water accumulation in the elevator pit. Elevator operation is inhibited if the power to this alarm is interrupted to prevent a silent failure. In some conditions, the best solution is to position the bottom landing above the mine level and locate the pit equipment at the mine floor level.

Requirement 5.9.2 was revised in ASME A17.1-2019/CSA B44:19 to add requirements for guarding of pits and elevator equipment to protect workers from potential hazards that can exist because mine elevator hoistways are typically not enclosed.

Requirement 5.9.2.2 was revised in ASME A17.1-2022/CSA B44:22 to reference the railing requirements in Section 2.10.

5.9.4 Vertical Clearances and Runbys for Cars and Counterweights.

Requirement 5.9.4 was revised in ASME A17.1-2019/CSA B44:19 to revise the vertical clearance requirements and update references to align with changes previously made in Part 2 to remove the term "refuge space."

5.9.5 Horizontal Car and Counterweight Clearances

Mine hoistways are often round or present an irregular surface (Diagram 5.9.5). Fascia plates are not practical because of high airflow, so a car door interlock is provided. In the event the car runs on to the compressed buffer, entrapped miners may force the car doors open to evacuate the car. Fascia is provided at the bottom landing to prevent them from falling into the pit. Elsewhere in the hoistway, the car top exit panel would be used to evacuate the car. Also, see Handbook commentary on 5.9.12.

5.9.7 Machinery Space, Machine Rooms, Control Spaces, and Control Rooms

Fire-resistive construction is not applicable.

The title of Requirement 5.9.7 was revised in ASME A17.1-2019/CSA B44:19 to align the title with Section 2.7.

5.9.8 Equipment in Hoistways, Machinery Spaces, Machine Rooms, Control Spaces, and Control Rooms

The title of Requirement 5.9.8 was revised in ASME A17.1-2019/CSA B44:19 to align the title with Section 2.8.

5.9.8.1 Hoistway and Car Wiring. The requirements address the conditions that may be encountered in a mine hoistway.

5.9.8.2 Sprinklers are not used in mines. Pipes, ducts, etc., must be run in the elevator hoistway, since it is usually the only vertical shaft available for this purpose.

5.9.10 Guarding of the Equipment and Standard Railing

The title of 5.9.10 was revised in ASME A17.1-2019/CSA B44:19 to align with the language in Section 2.10.

5.9.11 Protection of Hoistway Openings

Glass doors are not suitable in a mine environment. Mine hoistways are not required to be fire resistive; therefore, fire-rated doors are not required.

5.9.12 Hoistway Door Locking Devices and Electric Contacts, and Hoistway Access Switches

Mine hoistways are often round or irregular. A car door interlock is necessary since environmental conditions make fascia plates impractical. A car door interlock prevents the car door from being opened when the car is between landings.

Cars are provided with a car door interlock, modified to suit the environment, conforming to 2.14.4.2. Therefore, anytime the car is outside the unlocking zone, the car doors are locked. See also Handbook commentary on 5.9.5.

5.9.14 Car Enclosures, Car Doors and Gates, and Car Illumination

Environmental conditions in a mine require frequent inspections of the hoistway to ensure that safe operating conditions exist.

Access to the car top by passengers (miners) is necessary for emergency evacuation. The requirements for the car top access panel were modified to require the panel to be hinged or retained in a track. Therefore, the safety chain is not required.

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5.9.14.1 Car Top Access Panel

5.9.14.1(b) This requirement establishes a maximum closing and opening force to minimize strain to personnel manually opening or closing the car top access panel. A panel once fully opened is required to resist accidental closing to prevent potential injury to persons accessing the elevator through that panel.

5.9.14.1(c) This requirement ensures the emergency stop switch is conveniently accessible from the car top access panel.

5.9.14.3 Car Top Protection

5.9.14.3(d) This requirement was revised in ASME A17.1-2016/CSA B44-16 to recognize that mine elevators operate in blind hoistways several hundred feet deep. Passengers may need to be rescued from disabled elevators, and the car top may need to be removed to facilitate passenger rescue with an auxiliary personnel hoist operated from an overhead location on the surface.

5.9.14.4 This requirement permits the use of a car top platform. It also requires a standard car top railing.

5.9.14.5 Miners wear cap lamps that will provide auxiliary lighting when normal car lighting fails.

5.9.15 Car Frames and Platforms

5.9.15.1 Corrosion Protection. Environmental conditions in a mine are corrosive.

5.9.17 Car and Counterweight Safeties

Mine environmental conditions such as accumulation of ice on the guide rails, or ground movement causing misalignment of the guide rails can cause inadvertent actuation of the counterweight safeties. Many times the rail surfaces are exposed to high humidity and rail surfaces develop a coating of "rust" that may dramatically impact safety slide distance.

5.9.17.2 This requirement was revised in ASME A17.1-2004 to require safety-operated switches to be installed on both the car and the counterweight, if counterweight safeties are furnished. The accumulation of ice on the counterweight guide rails and brackets can cause accidental application of the safety. Without the switch, the machine would continue to run in the up direction with the safety applied.

These revisions eliminate unnecessary repetition by using the correct references.

5.9.17.3 See Handbook commentary on 5.9.17.2.

5.9.17.4 Access to the elevator is not readily available to release the car safeties when the car is in the "blind" mine hoistway.

5.9.17.5 Access to the car or counterweight is not readily available to release the safeties in the "blind" hoistway. See also Handbook commentary on 5.9.17.2.

5.9.17.6 Pit conditions, such as falling ice or debris, could foul compensating ropes or sheaves, thus making tie-down impractical.

Requirement 5.9.17.6 was moved to 5.9.21 in ASME A17.1-2019/CSA B44:19 to include it in the correct section to align with Part 2.

5.9.18 Speed Governors

5.9.18.1 Governor Rope Tension Sheaves. Vast changes in temperature and humidity occur in a mine hoistway. This can result in both stretching and shrinkage of the governor rope. Means must be provided to ensure the tension frame operates as intended.

5.9.20 Suspension Means and Their Connections

Requirement 5.9.20 was revised in ASME A17.1-2019/CSA B44:19 to recognize that other suspension means are available and to align with Part 2.

5.9.20.1 Suspension and Compensating Means and Governor Ropes. ASME A17.1a-2008/CSA B44a-08 added requirements for corrosion-resistant ropes in mines where equipment may be subjected to a hostile environment. Although many mine elevator hoistways are suitable for use of standard wire ropes, others are extremely wet. Standard ropes corrode rapidly, which can result in an unsafe condition caused by corrosion fatigue and embrittlement. Corrosion does not include surface discoloration from rust that can be cleaned with a wire brush, provided the rope does not show evidence of pitting, loss of cross-sectional area, or diametral reduction.

5.9.20.2 Prohibited Suspension Means Devices. Requirement 5.9.20.2 was added in ASME A17.1-2022/CSA B44:22 to prohibit the use of auxiliary devices permanently attached to the suspension means, as these devices might cause localized corrosion due to the mine environment or interfere with the ability to examine the suspension means.

5.9.21 Counterweights

Language from Requirement 5.9.17.6 was added in Requirement 5.9.21 in ASME A17.1-2019/CSA B44:19 to include it in the correct section to align with Part 2.

5.9.22 Buffers and Bumpers

Buffer switches are necessary on oil buffers, since mine environmental conditions often cause the buffers to corrode and become stuck in compressed or partially compressed position, if the car or counterweight overtravels.

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Requirement 5.9.22 was revised in ASME A17.1-2019/CSA B44:19 to remove reduced stroke buffers. Mine elevator hoistways are provided with deep pits to address water accumulation and other environmental conditions. Reduced stroke buffers are not needed.

5.9.26 Operating Devices and Control Equipment

This requirement was revised in ASME A17.1a-2005 to require an emergency stop switch to be located in the elevator car. Environmental conditions in a mine can cause ice to collect on rails and brackets, causing false safety application, derailments of counterweights, or displacement of ropes from sheave groves. An emergency stop switch in the car will permit passengers to shut the car down if a problem occurs. The misuse of the emergency stop switch is not an issue with mine elevators.

This requirement was further revised in ASME A17.1-2016/CSA B44-16 to clarify that inspection operation is not permitted to be used to transport miners when defects are present that prevent automatic elevator operation. However, inspection operation may be used by elevator personnel to evacuate miners from the mine during a mine emergency or to rescue miners from a disabled mine elevator. This revision also requires a push-to-stop configuration for the emergency stop switch in the car, with guarding to prevent inadvertent operation. If the switch is inadvertently actuated, it will cause the elevator to be in a safe state. Protection against inadvertent switch movement is necessary because mine elevators are typically crowded with personnel during shift change, and mine personnel are required to wear safety apparatus that could contact the switch and cause a rated-speed emergency stop.

Requirement 5.9.26 was reformatted in ASME A17.1-2019/CSA B44:19 for clarity.

Requirement 5.9.26 was revised and 5.9.26.3 was added in ASME A17.1-2022/CSA B44:22 to exclude remote interaction operation (RIO) for mine elevators until such time that the Committee can develop specific requirements and limitations for the use of RIO.

5.9.27 Emergency Operations and Signaling Devices

Firefighters' service is not required in a mine. Emergency equipment must be available at all times. Emergency procedures are well defined. A fire in a mine is a very different problem from that in a building.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to specify that emergency or standby power shall be capable of operating the elevator at rated load for a minimum of 4 h. Mine elevators are exposed to extreme elements that present health and safety hazards to elevator passengers when power is interrupted. Mine elevators operate in blind hoistways and typically provide the primary means of escape during a mine emergency since stairs are not typically available.

Requirement 5.9.27 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definitions for "normal building power" and "emergency or standby power."

5.9.29 Identification

Requirement 2.29.2 does not apply, as mine elevators are typically two-stop installations. Landings on multiple stop elevators are identified by reference to the mining level depth of the landing, not by floor numbers.

5.9.30 Sway Control Guides

Requirement 5.9.30 was added in ASME A17.1-2019/CSA B44:19 to align with the numbering in Part 2.

5.9.31 Welding

Requirement 5.9.30 was renumbered as 5.9.31 in ASME A17.1-2019/CSA B44:19 to align with the numbering in Part 2.

5.9.32 Elevators Under Construction or Disassembly

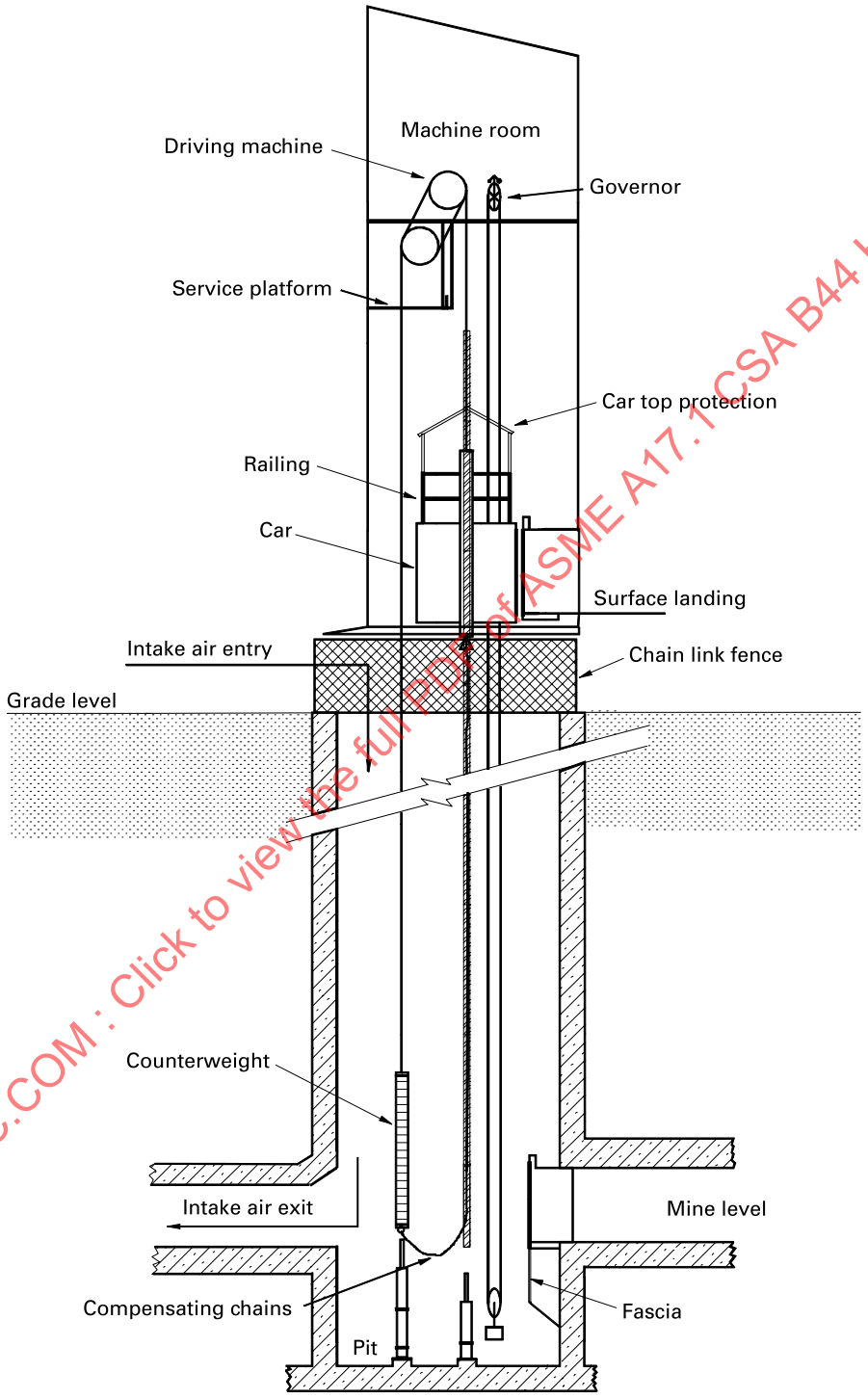
Requirement 5.9.32 was added in ASME A17.1-2022/CSA B44:22 to prohibit mine elevators that are being constructed or disassembled from being used by anyone but elevator personnel.

5.9.33 Rack-and-Pinion Elevators

Requirement 5.9.33 was added in ASME A17.1-2022/CSA B44:22 to provide requirements for rack-and-pinion mine elevators.

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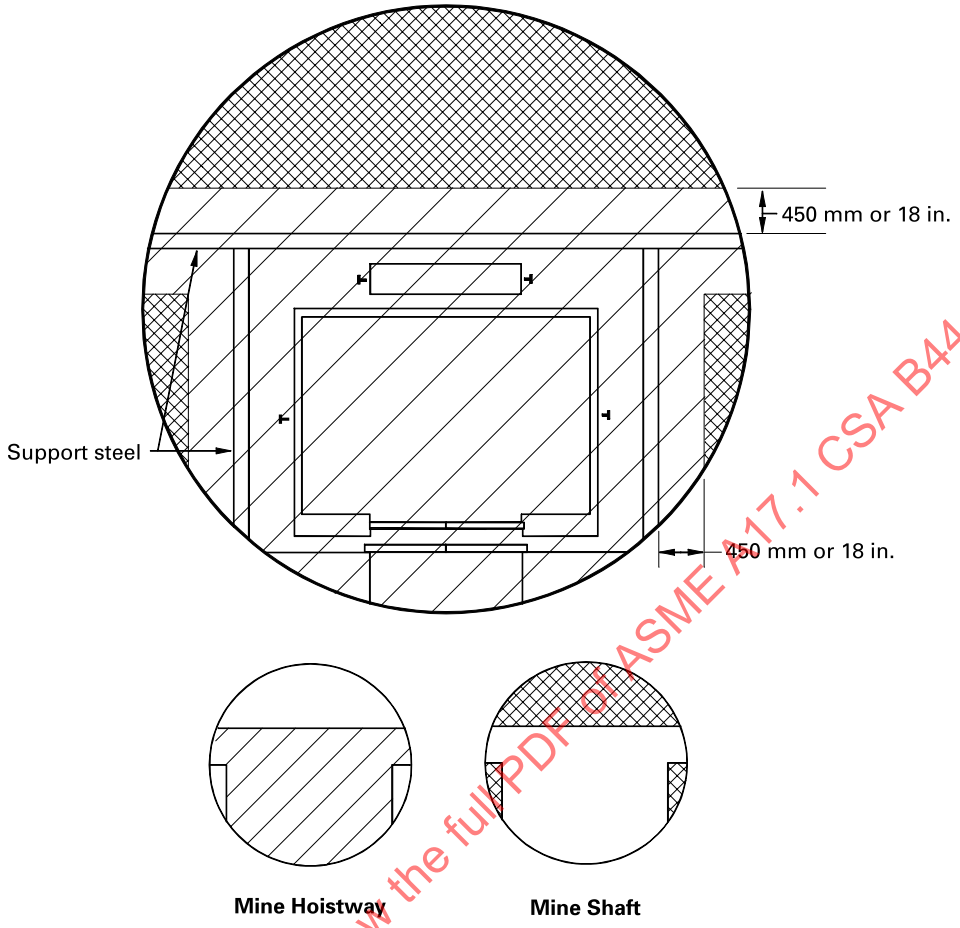
Diagram 5.9
Typical Mine Elevator Layout



GENERAL NOTE: Courtesy of US DOL MSHA/Thomas Barkand.

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Diagram 5.9.5
Mine Shaft and Mine Elevator Hoistway



GENERAL NOTE: Courtesy of US DOL MSHA/Thomas Barkand.

SECTION 5.10
ELEVATORS USED FOR CONSTRUCTION

NOTE: Throughout Section 5.10, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of those requirements, readers should review the Handbook commentary on all relevant referenced requirements.

An elevator used for construction is defined as an elevator being used temporarily only for construction purposes.

Existing elevators used for construction must also comply with requirements of Section 5.10, which are applicable throughout the period the elevator is used for construction. After that period, requirements for alterations (see Section 8.7) would apply.

Section 5.10 does not apply to the design, construction, installation, operation, inspection, testing, maintenance, alteration, or repair of structures and hoists that are not a permanent part of the building; are installed inside or outside of buildings during construction, alteration, or demolition; and are used to raise and lower workers and other personnel connected with or related to a building project and/or for the transportation of materials. The requirements relating to that type of equipment are contained in

(a) ANSI/ASSE A10.4, Safety Requirements for Personnel Hoists and Employee Elevators, or

(b) ANSI/ASSE A10.5, Safety Requirements for Material Hoists, or

(c) CSA Z185, Safety Code for Personnel Hoists, or

(d) CSA Z256, Safety Code for Material Hoists

Elevators used for construction must be located where the general public will not come in contact with the equipment. This elevator is for use of construction personnel and not the general public. Elevator entrances must open into lobbies separated from areas accessible to the general public. This is especially important in buildings that are undergoing renovation and in new buildings that are partially occupied.

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Section 5.10 does not, nor do any requirements in ASME A17.1/CSA B44, apply to line jacks, false cars, shafters, moving platforms, and similar equipment used for installing an elevator. Information on this type of equipment can be located in the *Elevator Industry Field Employees' Safety Handbook*. See Part 9 of this Handbook for procurement information.

5.10.1 Electric Elevators Used for Construction

5.10.1.1 Construction of Hoistways and Hoistway Enclosures

5.10.1.1.1 Hoistway Enclosures

5.10.1.1.1(a) These requirements are similar to those that apply to special purpose personnel elevators. Fire-resistive construction is not required because the building is usually open from floor to floor during construction.

5.10.1.1.1(b) This requirement provides protection from objects falling down the hoistway.

5.10.1.1.1(c) This requirement protects personnel in the adjacent hoistways while they are working and affords a means of protection to the occupants of the elevator. Screening used for separation may remain in place after the elevator is placed in general service (i.e., elevator conforms to Parts 2 or 3). Screening must not restrict the use of side emergency exits when provided.

However, the original intent of the requirement is that the separation is removed once the elevator is placed in general use.

5.10.1.1.2 Working Requirements in the Hoistway. Conformance with these requirements will protect the occupants of the elevator from material falling in the hoistway and/or interfering with the necessary running clearances.

5.10.1.3 Location and Guarding of Counterweights. Counterweights located in the hoistway of the elevator they serve facilitate the inspection and maintenance of the counterweight and its ropes. When counterweights are located in a separate hoistway, as permitted by 2.3.3, the requirements provide access for inspection and maintenance. Requirement 5.10.1.3.3 also recognizes that a separate counterweight hoistway can be temporary as long as it complies with the requirements of 5.10.1.1.1.

5.10.1.5 Horizontal Car and Counterweight Clearances. A 100 mm or 4 in. clearance between the car landing sill and hoistway landing sill is permitted because the permanent sills may not be installed.

5.10.1.6 Protection of Spaces Below Hoistways. The space below the hoistway can be secured by the use of a temporary fence or partition as long as it will not be accessible when the elevator is in use.

5.10.1.7 Machine Rooms and Machinery Spaces. This requirement provides for a machinery area protected from the elements. It also requires that the machinery area be secured to protect nonelevator personnel from accidental exposure to the elevator equipment.

5.10.1.7.2 Machine Room and Machinery Space Floors. A floor is not required at the top of the hoistway when the elevator machine is located below or at the side of the hoistway, and where elevator equipment can be serviced and inspected from outside the hoistway or from the top of the car. When an elevator machine is located over the hoistway, a floor is not required below secondary deflecting sheaves if the elevator equipment can be serviced and inspected from the top of the car or from outside of the hoistway. A floor provides a platform that makes servicing the elevator equipment less hazardous. The requirement also recognizes that wood floors may be necessary, as the machinery room as well as the building floors may not be in place at this time.

5.10.1.8 Machinery and Sheave Beams, Supports, and Foundations. The Note recognizes the temporary use of this equipment and provides for same.

5.10.1.9 Hoistway Doors and Gates. Every landing needs a door or gate. The doors may be constructed of wood and have a wire mesh vision panel. Mechanical means are acceptable (see 5.10.1.9.5) for a slower speed car (≤ 1.75 m/s or ≤ 350 ft/min) to lock hoistway doors or gates in the closed position. It is the responsibility of the operator to close and latch the door before moving the car. On high-speed (> 1.75 m/s or > 350 ft/min) applications, the exposure is greater and interlocks or combination mechanical locks and electric contacts are required.

The requirement also has a provision that allows the elevator hoistway to be locked from the landing when the car is taken out of service.

5.10.1.10 Car Enclosure, Car Doors and Gates, and Car Illumination

5.10.1.10.1 Enclosures Required. Car enclosure requirements permit both temporary and permanent enclosures. See Diagram 5.10.1.10.1.

5.10.1.10.4 Top Emergency Exits.

5.10.1.10.4(e) This requirement recognizes that all loads cannot be carried totally within the car. The term "authorized personnel" refers to persons who have been instructed in the operation of the equipment and designated to use the equipment.

5.10.1.10.7 Car Emergency Signal. The signaling device could be an audible signal, i.e., an alarm bell or a two-way means of communication such as a permanently or temporarily installed intercom or walkie-talkie.

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5.10.1.10.8 Car Doors or Gates. The car door or gate could be either permanent or temporary.

5.10.1.11 Car Frames and Platforms. This requirement recognizes that temporary car platforms may be used and allows them to be constructed of wood without protection against fire.

5.10.1.12 Rated Load and Speed

5.10.1.12.1 Rated Load. Capacity is calculated on 90 kg or 200 lb per passenger to allow for the fact that most passengers will be carrying tools and/or other equipment.

5.10.1.12.3 Speed. The limitation on car speed is due to the temporary nature of the hoistway, car enclosure, hoistway door locks, etc. Elevators with higher speeds are required to comply with Part 1, 2, or 4 of ASME A17.1/CSA B44.

5.10.1.15 Ascending Car Overspeed and Unintended Car Movement Protection. It is not deemed necessary to add ascending car overspeed and unintended car movement protection to an existing elevator unless the elevator has been or is in the process of being altered and said requirements will be mandated by Section 8.7.

5.10.1.16 Suspension Means. The factor of safety of suspension wire ropes is the same as freight elevators since they are not used by the general public. Elevators used for construction are typically used as freight elevators to carry construction material.

5.10.1.21 Operating Devices and Control Equipment

5.10.1.21.1 Applicable Requirements. The requirement recognizes that not all of the requirements of Section 2.26 can practically be enforced on elevators used for construction. Requirement 5.10.1.21.1(c) recognizes that elevators used for construction are not going to be used by the disabled, thus the landing accuracy required by 2.26.11 is not required.

Requirement 5.10.1.21.1 was revised in ASME A17.1-2022/CSA B44:22 to exclude remote interaction operation (RIO) for elevators used for construction until such time that the Committee can develop specific requirements and limitations for the use of RIO.

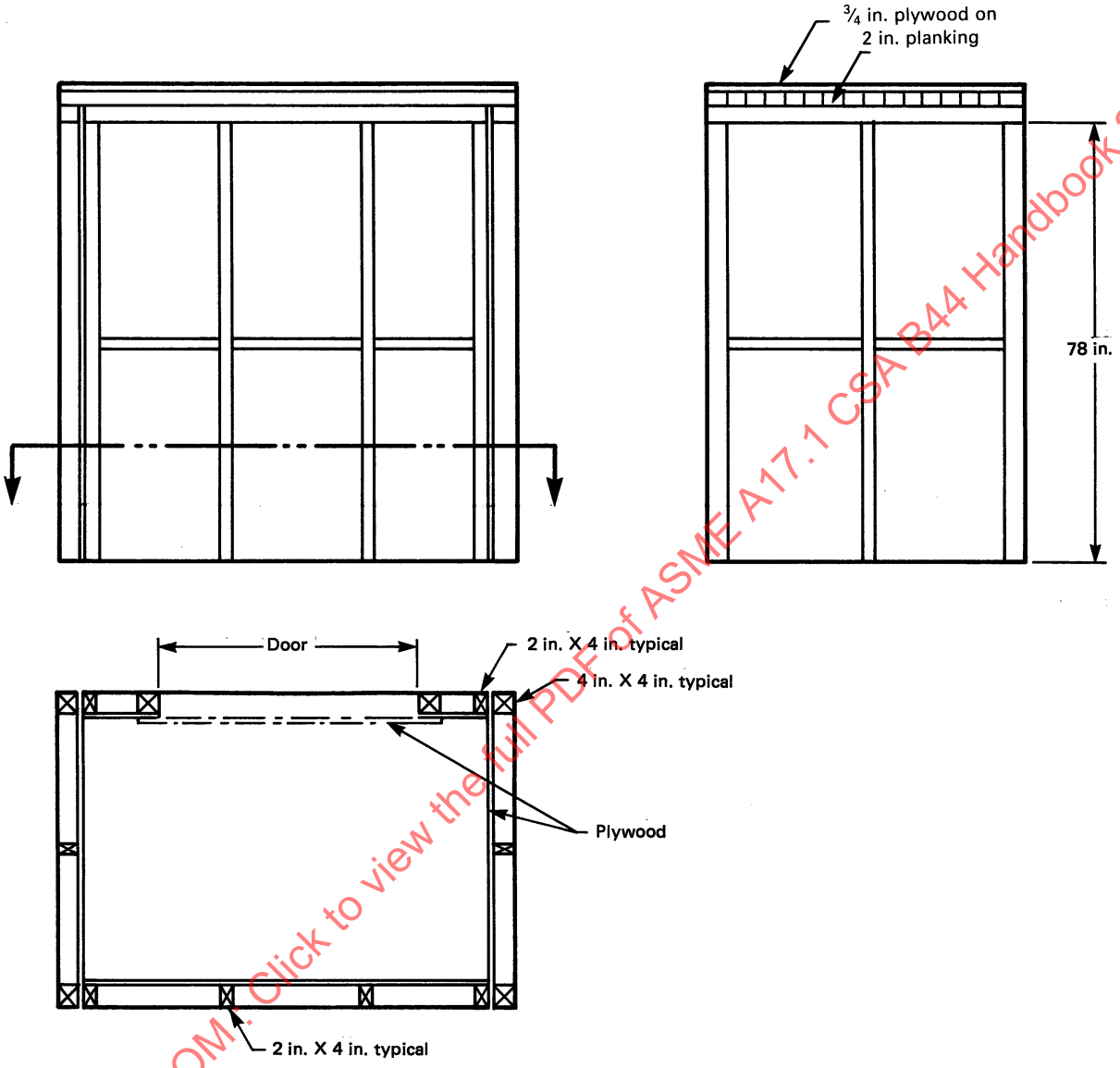
5.10.1.21.3 Temporary Wiring. This requirement recognizes and allows temporary wiring as long as it conforms to the requirements of Article 305 of the NEC® or Section 76 of CSA C22.1. Permanent wiring must also conform to the NEC® or CSA C22.1.

Permanent electric elevator equipment is required to be certified as complying with CSA B44.1/ASME A17.5. This will minimize the risk of electricity as a source of electric shock and as a potential ignition source of fires.

5.10.1.23 Capacity and Data Plates or Signs. This requirement recognizes that a temporary data and capacity plate may be provided. The permanent (final) data and capacity plate may not contain correct information on the elevator used for construction, hence the requirement for the temporary plates.

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Diagram 5.10.1.10.1
Typical Temporary Car Enclosure



GENERAL NOTE: Attachment of temporary car to platform is not shown.

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SECTION 5.11
WIND TURBINE TOWER ELEVATORS

In ASME A17.1-2016/CSA B44-16, Section 5.11 was revised and Nonmandatory Appendix W deleted to eliminate information that is provided in ASME A17.8/CSA B44.8. For more information on wind turbine tower elevators, see ASME A17.8/CSA B44.8 or the 2013 edition of the ASME A17.1/CSA B44 Handbook by Edward A. Donoghue, CPCA.

Section 5.11 was editorially revised in ASME A17.1-2019/CSA B44:19 to update the references to ASME A17.8/CSA B44.8 to correctly reflect the binational nature of the standard.

SECTION 5.12
OUTSIDE EMERGENCY ELEVATORS

Section 5.12 was first introduced in ASME A17.1-2013/CSA B44-13. It requires outside emergency elevators to comply with ASME A17.7/CSA B44.7.

Guidance on the use of the global essential safety requirements ensures that the unique operating environment of outside emergency elevators is taken into consideration. The risk assessment ensures that the viewpoint of firefighters is taken into consideration. Operating instructions ensure that emergency personnel and elevator personnel are provided with appropriate information.

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Part 6
Escalators and Moving Walks

NOTES:
(1) The author expresses his appreciation to Davis L. Turner for his contributions to Part 6.
(2) For educational information on safely using escalators, contact the Elevator/Escalator Safety Foundation at www.eesf.org, and National Elevator Industry, Inc., at www.neii.org.

SECTION 6.1
ESCALATORS

Escalators are designed and installed for transporting people only. They are not to be used for moving heavy, bulky, crude objects, which may result in overloading or damage that could contribute to the failure of parts, scratching of skirts, congestion, or jam-ups that could cause an unsafe condition. It is the author's opinion that the use of a stationary escalator as a stairway is a violation of the building codes. Escalators typically have a 203 mm or 8 in. riser and a 406 mm or 16 in. tread. Building code requirements for a stair specify that the greatest riser height within a flight of stair shall not exceed the smallest by more than 9.5 mm or $^{3}/_{8}$ in. and that the maximum riser height in nonresidential construction shall not exceed 178 mm or 7 in. Escalator steps in transition do not comply with the uniform riser requirement. Other stairway characteristics described in the building code preclude classification of escalators as "stairs" or "stairways." For example, escalators lack a nonslip design and adequate rounded bull nosing, and the leading edge of the escalator step is not readily identifiable by personnel due to its inherent design of horizontal parallel lines, which may not provide sufficient visual contrast for a user.

6.1.1 Protection of Floor Openings

6.1.1.1 Protection Required. Escalators passing through fire-rated floor assemblies must have their openings protected against the passage of flame, heat, and/or smoke. Without such protection, a fire has a clear path of travel from one floor to another. Not all escalator openings pass through fire-rated floor assemblies. In these cases, opening protection is not required. For example, an escalator serving two floors within an atrium does not require fire protection.

The building code is an ordinance that sets forth requirements for building design and construction. Where such an ordinance has not been enacted, compliance with one of the following model codes is required:

(a) International Building Code (IBC)

(b) NFPA 5000®, Building Construction and Safety Code

(c) National Building Code of Canada (NBCC)

Most building codes in the United States are based on one of the model building codes. The IBC is the model building code most widely adopted in the United States. It is published by the International Code Council (ICC). The National Fire Protection Association (NFPA) publishes NFPA 5000®. To the author's knowledge, no major jurisdiction in the United States or Canada had adopted NFPA 5000® as of the publication of this Handbook. The model building code used in Canada is the NBCC, which is promulgated by National Research Council of Canada.

Most building codes recognize that it is not necessary to fully enclose an escalator in the same way as one would enclose a stair since escalators are normally not part of a required means of egress. Chart 6.1.1.1 (excerpts from NFPA 101®, Life Safety Code®) describes several methods used in completely sprinklered buildings. In such cases, escalators are not used as exits, which permit them to be unenclosed from floor to floor.

Even if an escalator opening is not required to be fully enclosed, the floor opening must be protected against falls where applicable in accordance with the building code requirements.

Fall protection design features are controlled by building codes and are the responsibility of the architect and building owners. The elevator industry does not have the expertise to evaluate the needs of floor opening protection and should not undertake the design responsibility of providing such protection.

The prime reason for the moving handrail and the height-of-handrail requirement in 6.1.3.4.5 is to provide support for passengers using the escalator. The moving handrails are not intended to provide protection as would a barricade or guard.

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6.1.2 Protection of Trusses and Machine Spaces Against Fire

6.1.2.1 Protection Required. The sides and undersides of escalator trusses and machinery spaces must be enclosed in noncombustible or limited-combustible materials to protect the trusses from heat during a fire in the vicinity immediately outside the truss. NFPA 101®-2021, defines "limited-combustible" and "noncombustible" as follows:

> *(a) limited-combustible:* refers to a building construction material not complying with the definition of noncombustible (see 4.6.13) that, in the form in which it is used, has a potential heat value not exceeding 8 141 kJ/kg or 3,500 Btu/lb where tested in accordance with NFPA 259, Standard Test Method for Potential Heat of Building Materials, and includes
>
> *(1)* materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of 3.2 mm or $\frac{1}{8}$ in., that has a flame spread index not greater than 50 when tested in accordance with ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials, or ANSI/UL 723, Standard for Test for Surface Burning Characteristics of Building Materials, and
>
> *(2)* materials, in the form and thickness used, having neither a flame spread index greater than 25 nor evidence of continued progressive combustion, and of such composition that surfaces that would be exposed by cutting through the material on any plane would have neither a flame spread index greater than 25 nor evidence of continued progressive combustion when tested in accordance wth ASTM E84 or ANSI/UL 723.
>
> *(b) noncombustible:* refers to a material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors, when subjected to fire or heat. Materials that are reported as passing ASTM E136, Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C, are considered noncombustible materials. Materials that are reported as complying with the pass/fail criteria of ASTM E136 when tested in accordance with the test method and procedure in ASTM E2652, Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-Shaped Airflow Stabilizer, at 750 °C are also considered noncombustible materials.

Compliance with this requirement will assist in containing a fire that may start within the truss. It can be met simply by applying gypsum drywall or an equally noncombustible or limited-combustible material on the outside of the truss and machinery space. No hourly rating is required. A truss or machinery space suspended in an approved fire-rated ceiling assembly, where the truss is exposed within that assembly, does not meet this requirement. The truss and machinery space sides and undersides must be separately enclosed within the rated ceiling assembly. Noncombustible or limited-combustible material is not required between multiple escalators in a single wellway. Dampers in the noncombustible or limited-combustible material enclosing the truss must be provided with fire links, which will close the opening when there is a fire.

6.1.3 Construction Requirements

See Diagrams 6.1.3(a) and 6.1.3(b).

6.1.3.1 Angle of Inclination. Limiting the angle of inclination to 30 deg without a tolerance of 1 deg due to field conditions is impractical. Most escalators are designed to be installed at a 30 deg angle of inclination. Construction practices are such that a precise dimension cannot be guaranteed. A maximum 1 deg tolerance is therefore necessary and is considered safe. An angle of inclination above this gives the impression that the escalator is too steep and could cause dizziness in some passengers.

The angle of inclination varies on curved (spiral) escalators depending on where along the step width it is measured. The centerline was selected as the location to measure the angle because it is closest to the location where most passengers stand.

6.1.3.2 Geometry. The handrail clearances reduce entrapment and shear exposure and position the handrail to facilitate its use. These clearances must be maintained wherever the handrail is exposed. Components of the handrail guard are not subject to this requirement. See Diagrams 6.1.3(a), 6.1.3(b), and 6.1.3.2.

6.1.3.3 Balustrades

6.1.3.3.1 Construction. Glass balustrades require gaps up to 5 mm or $\frac{3}{16}$ in. between glass panels to allow for expansion. This condition is allowed. Raised or depressed areas of molding, including dynamic skirt covers more than 6.4 mm or $\frac{1}{4}$ in. high, could snag clothing, packages, and parts of the body.

6.1.3.3.2 Strength. This requirement specifically states that balustrades shall be designed to resist specified forces. There is no ASME A17.1/CSA B44 Code requirement to field test the design. Conformance with the design requirement may be verified by examining the manufacturer's design criteria. This requirement simply means that the balustrade has been designed to "resist" the applied load and when the load is removed, there is no permanent deformation or damage.

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Some enforcement authorities and consultants have argued that the International Building Code (IBC) handrail requirements also apply to escalator handrails. IBC Chapter 10 applies to the means of egress as stated in Section 1001.1. IBC 1003.7 prohibits escalators from being used as a component of a required means of egress. Thus, IBC Sections 1012.1 and 1012.3 do not apply to escalators.

According to ICC staff, it was never the intent that IBC Section 1607.7 be applied to escalators. The purpose of concentrated loads requirements for a stationary handrail was to make sure the handrail did not come off the wall or break when someone grabbed it when falling on a stairway. While people do walk down escalators, the graspable handrail moves with the person who is standing. In order to be moveable, there is not a practical way the handrail can meet the IBC force requirements.

IBC Section 1009.11 refers to IBC 1607.7 for a handrail on stairways. While stairways and escalators may look similar, they are not used the same way. ICC staff concluded handrail load requirements referenced by the IBC code are contained in ASME A17.1/CSA B44.

Compliance with the requirement provides rider stability and support when entering, exiting, or riding an escalator.

6.1.3.3.3 Use of Glass or Plastic. See Handbook commentary on 2.14.1.8 for additional information on glass and plastics.

6.1.3.3.4 Interior Low Deck. Requirements provide a maximum angle of the interior deck profile that help prevent a rider from slipping while attempting to walk on the interior decking. ASME A17.1-2004 and CSA B44-04 clarified where the dimension is measured for escalators equipped with dynamic skirts. It also specified the minimum strength for inner deck dynamic skirt covers, which have a different support arrangement (cantilevered) than a conventional inner deck-skirt assembly.

See Diagrams 6.1.3.3.4(a) through 6.1.3.3.4(c).

6.1.3.3.5 Loaded Gap Between Skirt and Step. See Handbook commentary on 6.1.3.3.9.

6.1.3.3.6 Skirt Panels. Research has substantiated that the loaded gap requirements in 6.1.3.3.5, and the Step/Skirt Index requirements in 6.1.3.3.9 provide optimum protection against accidental entrapment of a foot, finger, clothing, shoes, sneakers, etc., between escalator skirts and the steps. See Diagrams 6.1.3.3.6(a) and 6.1.3.3.6(b).

6.1.3.3.7 Dynamic Skirt Panels. The requirement provides the same protection as required on escalators with skirts. Dynamic skirt panels are required to be smooth to prevent any possibility of the vertical face of the panel from snagging a passenger, clothing, packages, etc. Additional requirements are intended to

(a) provide the same protection at the dynamic skirt panel entry point as is required for the handrail entry

(b) reduce the risk of entrapment between dynamic skirt panel components

(c) ensure synchronization between the step and the dynamic skirt panel

(d) minimize the risk of entrapment between the dynamic skirt panel and the dynamic skirt panel cover

See Diagrams 6.1.3.3.4(a) through 6.1.3.3.4(c) and Diagrams 6.1.3.3.7(a) through 6.1.3.3.7(c).

6.1.3.3.8 Dynamic Skirt Panel Loaded Gap. The requirement minimizes the risk of entrapment between the dynamic skirt panel and step.

See Diagrams 6.1.3.3.4(a), 6.1.3.3.4(b), and 6.1.3.3.7(a).

6.1.3.3.9 Step/Skirt Performance Index. This requirement and the following commentary apply to escalators with conventional skirts, not to escalators with dynamic skirts. As there is no sliding motion between the step and dynamic skirt panel along the incline, the performance index is not applicable. In 1997, National Elevator Industry, Inc. (*NEII*®) contracted with Arthur D. Little (ADL) to develop an Escalator Step/Skirt Performance Index. Index requirements resulted from research conducted as part of this comprehensive study. The Index, ranging from zero to one, represents the relative potential for entrapment of objects in the step-to-skirt gap. A lower Index represents lower potential for entrapment.

Index values were established from the following criteria:

(a) the nominal estimated Index value based on ASME A17.1c-1999

(b) the desired Index value for a reduced entrapment potential for hands

(c) the desired Index value for a reduced entrapment potential for leg calf

The Step/Skirt Index value was based on estimates of the two primary escalator parameters in ASME A17.1c-1999 and earlier editions of the Code. The loaded gap parameter (the value of the step-to-skirt gap) under a spreading force of 110 N or 25 lbf and skirt coefficient of friction parameters were estimated due to ambiguity or nonexistent ASME A17.1/CSA B44 Code requirements. The prior ASME A17.1/CSA B44 specification of 4.8 mm or $^{3}/_{16}$ in. maximum step-to-skirt clearance does not address additional parameters of skirt stiffness and step dead band movement identified in the ADL study. These contribute to the loaded gap index parameter, and so were estimated. This additional gap value is nominally 1.27 mm or 0.05 in., resulting in a total gap of 6.1 mm or 0.24 in. An additional gap increase due to ASME A17.1/CSA B44-specified skirt stiffness of 1.6 mm or 0.06 in. at 667 N or 150 lbf, or 0.25 mm or 0.01 in. at 111.2 N or 25 lbf increases the total gap to a value of 6.35 mm or 0.25 in. loaded gap.

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ASME A17.1c-1999 and earlier editions of the Code specify that the skirt be "made from a low coefficient of friction material or treated with a friction reducing material." A conservative coefficient of friction of 0.4 between the skirt and polycarbonate (the friction test sample) is estimated based upon ADL tests in both the lab and field.

The estimated loaded gap of 6.35 mm or 0.25 in. and a polycarbonate coefficient of friction of 0.4 results in an Index of 0.4 for escalators that comply with the requirements in ASME A17.1c-1999 and earlier editions of the Code. However, it is also possible that an existing escalator could have an Index as high as 0.7 and still comply with the prior Code requirements.

The ADL study included a series of highly stressed tests to try to induce entrapments of shoes and artificial body parts (referred to as Sawbones parts). These tests indicate that an Index of 0.15 is needed for low entrapment potential of all objects studied, including the leg calf that had the highest incidents of entrapment. One method of complying with the requirements is to provide escalators with an Index of 0.15 or below. However, this low Index value may not realistically be achieved and maintained on all existing and new escalator designs; thus, additional design options are needed.

Skirt deflector devices installed in compliance with 6.1.3.3.10 should be effective in the prevention of leg calf entrapments and they are mandatory for escalators with an Index above 0.15. However, skirt deflectors may not be as effective in the prevention of other entrapments such as those involving hands and shoes. Therefore, an Index value up to 0.25 is required, when used in conjunction with skirt deflector devices.

An Index of 0.2 is clearly a valid threshold based on Sawbones hand entrapment tests (ADL report Figure 5-2 and Table 5-1). However, other factors show this Index value to be conservative. First, the Index was derived from severe test conditions with test sample placement into the gap and maximum expected entrapping force applied. Second, the leg calf entrapments at these low index values were sometimes actually pinches that were classified as entrapments. Third, the object coefficient of friction with stainless steel for the test sample Sawbones hand and calf of 0.8 is significantly higher than that for real skin at 0.5. This makes the entrapment of Sawbones hand samples significantly more likely than real hands at the same loaded gap.

Estimation can be made of the effect of Sawbones sample coefficient of friction as compared to real skin coefficient of friction on the Index. For Sawbones hand tests, the ADL study showed a low entrapment potential below an object Index of 0.4, with object coefficient of friction of 0.8 and loaded gap of 4.1 mm or 0.16 in. The index curves show that an object Index of 0.4 and a low entrapment potential are maintained when the coefficient of friction is decreased from 0.8 (Sawbones skin) to 0.5 (real skin) while the loaded gap is increased from 4.1 mm or 0.16 in. to 5.8 mm or 0.23 in. Thus, the loaded gap (5.8 mm or 0.23 in.) at which real hand entrapment potential diminishes is larger than the loaded gap (4.1 mm or 0.16 in.) associated with diminished Sawbones hand entrapment potential. The Index of an escalator will be measured with a polycarbonate test sample with an assumed coefficient of friction of 0.4. Using this test sample, a Sawbones hand Index of 0.4 with a loaded gap of 4.1 mm or 0.16 in. would be reduced to a measured Index of 0.2. In like manner, a real hand Index of 0.4 with a loaded gap of 5.8 mm or 0.23 in. would be reduced to a measured Index of 0.35. Therefore, an escalator with a loaded gap of 5.8 mm or 0.23 in. and an Index of 0.35 has a low real hand entrapment potential. A real hand would have the same low entrapment potential at an Index of 0.35 as the test Sawbones hand at an Index of 0.2.

Similar analysis can be made for the leg calf. Low entrapment potential exists for the Sawbones calf below object Index of 0.2, with object coefficient of friction of 0.8 and loaded gap of 1.6 mm or 0.06 in. Equivalently low entrapment potential exists for the real calf at object Index of 0.2 with object coefficient of friction decreased to 0.5 and loaded gap increased to 3.3 mm or 0.13 in. The equivalent measured Index is 0.1 for Sawbones and 0.16 for real calves. Entrapment potential is low for real calves at an Index of 0.16 or below.

The above assumptions provided the basis for the following index recommendations:

ASME A17.1c-1999 and earlier editions of the Code reflect an Index of 0.4 nominal.

The ADL study indicates low entrapment potential with an Index of 0.2 for Sawbones hand that translates to an Index of 0.35 for a real hand. The ADL study indicates low entrapment potential with an Index of 0.1 for Sawbones calf that translates to an Index of 0.16 for a real calf. These are conservative numbers due to the severity of testing and the conservative classification of calf entrapments.

Because the nominal ASME A17.1/CSA B44 Index of 0.4 is reasonably close to the low hand entrapment potential, a maximum Index of 0.4 is required for escalators installed under ASME A17.1d-2000 and earlier editions. A lower entrapment potential is desired for the future. Therefore, a maximum Index of 0.25 was required beginning with ASME A17.1a-2002 and CSA B44 Update No. 1-02. This allowed sufficient time for manufacturers to design for and achieve the desired Index. These Index thresholds, when used in conjunction with the required skirt deflector devices, will significantly reduce the entrapment potential on existing and new escalators. An Index of 0.15 or below will allow an escalator to be installed without skirt deflector devices.

Even though the Index provides a comprehensive measure of entrapment potential, a requirement for a loaded gap in ASME A17.1/CSA B44 requirement is desirable. The loaded gap parameter provides an additional

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margin of control of escalators that rely heavily on low coefficient of friction that can be difficult to maintain in the field. In addition, the loaded gap parameter provides a sound means of monitoring step band wear and need for correction. A loaded gap of 5 mm or 0.2 in. is required for escalators installed under ASME A17.1d-2000 and later editions of the Code.

Prior to ASME A17.1-2000d and CSA B44-00, Code requirements for step-to-skirt gap and skirt treatment were redundant; they were replaced by 6.1.3.3.5 and 6.1.3.3.9. If the old requirements had been maintained, they would have been misleading, as compliance with the old requirements would not have ensured compliance with the new loaded gap and step/skirt performance index requirements.

6.1.3.3.10 Skirt Deflector Devices. Deflector systems are an uncomplicated method of deflecting the feet of riders away from the step/skirt panel interface and can be secured in various manners depending on the design. The requirements prevent the use of common flat or Phillips head screws, which can be easily removed by nonelevator personnel.

6.1.3.3.10(a)(1) This dimension is consistent with the ASME A17 Committee's expressed previous consensus, and the majority, but not all, of what has been safely applied in other parts of the world. The requirements prevent footwear, etc., from being caught.

6.1.3.3.10(a)(2) Based on historical experience with use of these types of devices, this should provide sufficient clearance and angle to prevent footwear from catching between the step nose and horizontal protrusion. The required clearance is also the value stipulated in European Standard EN 115, Clause 5.1.5.6, on deflector device application. EN 115, Clause 5.1.5.6 was added a number of years ago specifically for deflectors; thus it would be logical to accept the experience obtained in other parts of the world. The 25 mm or 1 in. dimension is also the historical value deemed necessary in ASME A17.1/CSA B44, requirement 6.1.3.3.6(a). The 10 deg angle at this clearance is sufficient based on international history for installations at a 25 mm or 1 in. height.

6.1.3.3.10(a)(3) Based on historical experience, this should provide sufficient clearance and angle to take care of the change in elevation at the comb and allow passage of footwear.

6.1.3.3.10(a)(4) This is a reasonable value, which could withstand the force exerted by an adult's foot. Test plate area is specified; similar to requirements for the step fatigue test, combplate, etc.

6.1.3.3.10(b)(1) To minimize restriction of usable step area.

6.1.3.3.10(b)(2) The requirement that the flexible part be capable of bending to above the 10 deg line covers the concern of easy withdrawal of a foot.

6.1.3.3.10(b)(3) Although this would apply only to a very small area of contact at the step nose, requirements have been included to prevent damage. For example, to avoid the possibility of a brush providing a flat stepping surface by extending over two or more step cleats.

6.1.3.3.10(b)(4) Any step contact with continuous flexible elements could potentially cause damage to the elements.

6.1.3.3.11 Guard at Ceiling Intersection. A solid guard must be provided in the intersecting angle of each outside top of the balustrade and the point of penetration of the ceiling or soffit. It is not required on high-deck escalators where the side of the penetration at the ceiling or soffit is more than 600 mm or 24 in. from the centerline of the handrail, or on low-deck escalators where the centerline of the handrail is more than 350 mm or 14 in. from the centerline of the soffit. The vertical edge of the guard must be a minimum of 350 mm or 14 in. and be flush with the face of the wellway. The leading edge or the exposed edge of the guard should be vertical and must be rounded. The thickness of the guard is not required to be 25 mm or 1 in., but the exposed vertical edge of the guard must present a minimum width of 25 mm or 1 in. and be rounded with a minimum radius of 12 mm or ½ in. The material used for the guard should be solid without holes or openings passing through it. Glass or plastic can be used for the guards as long as they conform to the requirements of 6.1.3.3.3. This guard protects escalator passengers, if they are leaning off to the side of an up-traveling escalator, from the possibility of trapping their heads or arms in the angle where the escalator and ceiling or soffit meet. See Diagram 6.1.3.3.11.

6.1.3.3.11(c) Prevents objects or persons from being placed in the area between parallel panels and experiencing uncontrolled descent down the length of the incline.

Requirement 6.1.3.11 was revised in ASME A17.1-2022/CSA B44:22 to add a reference to new Figures I-13 and I-14 in Nommandatory Appendix I. The figures were added to clarify the requirements for escalator ceiling intersection guards.

6.1.3.3.12 Antislide Devices. Antislide devices, sometimes referred to as baggage stops, discourage pranksters from using the escalator deck as an amusement slide. They also discourage passengers from resting packages on the deck while traveling on the escalator. See Diagrams 6.1.3.3.12(a) and 6.1.3.3.12(b). The requirements were revised in ASME A17.1a-2002 and CSA B44 Update No. 1-02 to clarify that

(a) the maximum distance between antislide devices is to be measured along the direction of travel

(b) the maximum clear space on high deck balustrades is no greater than 300 mm or 12 in. wide

(c) no requirement for minimum spacing of the devices in the direction of travel is intended

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(d) no requirement for maximum height of devices is intended

There is no limitation on shape or configuration of devices (other than height).

6.1.3.3.13 Deck Barricades. Deck barricades discourage people, especially small children, from walking or going up or down the low-deck exterior balustrade from the ground level. See Diagram 6.1.3.3.13. Barricade attachment fasteners are required to be tamper resistant to discourage and/or prevent the removal of some or all of the fasteners and/or the barricade itself, which would create a dangerous falling hazard.

6.1.3.3.13(c) Prevents objects or persons from being in the area between parallel panels and experiencing uncontrolled decent down the length of the incline.

6.1.3.4 Handrails

6.1.3.4.1 Type Required. A handrail not moving in the same direction or speed would have a tendency to pull passengers backward or forward, causing them to lose their balance. It is not necessary for the handrail to move at exactly the same speed as the step since passengers can easily adjust the position of their hands to compensate for minor differences in speeds. The minimum handrail driving force is necessary to ensure that the handrail continues to operate under a passenger load.

6.1.3.4.2 Extension Beyond Combplates. This requirement allows passengers to grab hold of a handrail before they step on to the escalator and allows them to continue to hold on to the handrail until they have completely stepped off the moving portion of the escalator. The moving handrail extending beyond the exit point also has the tendency to immediately move the passenger away from the exit, thus reducing bunching at this location.

6.1.3.4.3 Guards. Hand or finger guards provide protection for the curious, especially children, who want to explore the area where the handrail enters the balustrade. Also see Handbook commentary on 6.1.6.3.12, Handrail Entry Device, for additional information.

6.1.3.4.4 Splicing. Although field splicing of escalator handrails is rare, it is done occasionally.

6.1.3.4.5 Vertical Height. The specification of maximum height ensures that handrails will be accessible to a majority of users of the escalator. All manufacturers of escalators provide handrail heights, which are below this maximum value, based on the manufacturer's internal studies.

Requirement 6.1.3.4.5 was revised in ASME A17.1-2022/CSA B44:22 to increase the maximum height of the balustrade to 1 100 mm or 43 in. The change was made to increase stability while riding the escalator and to deter misuse.

6.1.3.4.6 Handrail Clearance. Provides a limitation of a dimension that, if excessive, can permit fingers to become caught. See Diagram 6.1.3.2.

6.1.3.5 Steps

6.1.3.5.1 Material and Type. A step frame is the supporting structure of an escalator step to which the tread and riser sections are fastened. A concern addressed by this requirement is the potential of non-fire-rated escalator components spreading a fire.

6.1.3.5.1(a) While the flame spread index for magnesium complies with Code requirements, input and comments from firefighters show that the temperature at which magnesium burns makes magnesium fires nearly impossible, and in fact dangerous, to fight with conventional means. Special techniques and equipment are required to combat fires with magnesium content. Operating conventional water hose lines to combat a fire involving magnesium will cause the hydrogen and oxygen to separate and react violently with the magnesium.

With myriad materials available for escalator step construction, the Committee felt it prudent to follow the advice of firefighters and exclude magnesium as a suitable material, thus the "exception" in the requirement. See Material Safety Data Sheet (MSDS) for magnesium.

6.1.3.5.1(c) The limit of step tipping is included, as this is a factor that if not controlled, can produce a dangerous condition for passengers.

6.1.3.5.2 Dimensions of Steps. The minimum dimension of the step tread assures that there is adequate area for persons to stand. The maximum dimension of the step riser assures that a person can walk up the step if necessary. No manufacturer in the United States currently makes a step less than 597 mm or 23.5 in. wide. The wider the step, the more room the passenger has to avoid contact with the skirt, especially if an adult and a small child are standing on the same step. See Diagram 6.1.3.5.2.

6.1.3.5.3 Cleated Step Risers. See Handbook commentary on 6.1.3.5.5 and Diagram 6.1.3.5.3.

6.1.3.5.4 Clearance Between Steps. See Diagram 6.1.3.5.4.

6.1.3.5.5 Slotting of Step Treads. Slotting of step treads and risers provides protection against entrapment of a foot or finger and articles of clothing such as shoes, sneakers, etc., as the step makes the transition from the incline to the horizontal. See also Handbook commentary on 6.1.3.6.1.

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6.1.3.5.6 Step Demarcation. Demarcation requirements resulted from suggestions by the accessibility community. A study by the Metropolitan Atlanta Rapid Transit Authority (MARTA) found that yellow is a preferred color, particularly for site-impaired individuals. The accessibility community also felt yellow was appropriate.

Marking on the back of treads is effective in assisting boarding passengers to recognize separation between adjacent steps. It is in clear view as a passenger approaches an escalator and boards, but it does not provide a distraction from the boarding area as step nose markings do when the steps move away from the landing. This is most prevalent on an up escalator as the strobe effect of marks emerging from under the comb cause a passenger's eyes to seek a more stable environment by following markings up an incline.

When traveling down, a step's nose markings tend to merge into a solid line of color extending down the incline. This can produce a pattern confusing to passengers looking down an incline and cause them to become disoriented. Neither of these conditions occurs when markings are at the back of steps since they are hidden from a passenger's view on the incline.

It is imprudent to attempt to place an insert into the nose of the step. This area plays a critical part in strength and dimensional stability of a modern one-piece die-cast step used today by most escalator manufacturers. Although doable, it would likely increase areas that could develop problems resulting in a step failure. Additionally, any insert must have a surface that would provide physical and dimensional characteristics identical to the parent step surface.

Nose markings would most likely be painted to offset these problems. However, paint on any step surface is subject to wear and dirt that would diminish the intended effect as well as alter friction characteristics of the step treads. None of these problems are experienced when a marking insert is placed on the back of the step tread.

Addition of this marking on step noses will do more to reduce safety than promote it. The only condition for which nose markings are more effective is for persons who are walking up or down an escalator. This is a dangerous practice for any person and more so for physically disabled individuals. Depth of step treads and varying riser heights are difficult to negotiate and could conceivably cause a walking passenger to stumble and possibly fall.

Prior to the 2007 edition of the Code, the requirement read, "There shall be demarcation lines on the sides of the step." In the broad literal sense, this could include both the side along the tread and side along the riser. While this is not prohibited and is done in some cases, it has not always been the practice, or intention, to require demarcation along the step side riser. This requirement was reworded in ASME A17.1-2007/CSA B44-07 to clarify that the requirement applies to the step tread rather than the riser.

Prior to ASME A17.1-2007/CSA B44-07, step demarcation lights were required. The yellow demarcation strips at the back of the steps along with the illumination requirement for steps (6.1.7.2) eliminated the need for demarcation lights.

6.1.3.5.7 Step Fatigue Tests. See Handbook commentary on 8.3.11.

6.1.3.5.8 Step Wheels. There have been a number of instances where the trailing wheels have become separated from the step. Although the front of the step is still attached to the step chain, the other end can pivot down into the escalator interior. If the wheels were located inside the step, then when the step is pivoted down it would be stopped by the step wheel track located below. However, if the wheels are located outside the width of the step, the wheel support track is located beyond the edge of the step and there is nothing to prevent the step from pivoting into the escalator interior. If this happens, passengers standing on the step could fall into the escalator interior and be seriously hurt. This requirement is intended to prevent that condition.

6.1.3.6 Entrance and Egress Ends

6.1.3.6.1 Combplates. The combplate is the section of the floor plate nearest the step. It normally has replaceable comb segments made of brittle material such as plastic or aluminum. Comb teeth must be brittle and break rather than bend. A bent comb tooth could cause a steep wreck, piling the steps up at the comb. The comb teeth are so arranged that the cleats of the step treads will pass between them with minimum clearance. This arrangement allows the steps to move under the combplate, allowing passengers to move safely from the step onto the floor. Because the comb segments are not an integral part of the combplate assembly, worn or damaged comb segments can be replaced readily without disturbing the balance of the comb segments.

6.1.3.6.1(d) This requirement ensures that the combs and combplate do not drag on the steps when a passenger is standing on them.

6.1.3.6.2 Distinction Between Comb and Step. A significant number of falls occur on boarding an escalator. This requirement is important, as it requires a visual aid for passengers to assist in boarding the moving steps of the escalator. This is intended to reduce the hazard by calling attention to that area.

6.1.3.6.3 Adjacent Floor Surfaces. This requirement addresses a potential tripping hazard. This requirement applies to the difference in elevation between the landing plate and the adjacent building floor, not between the comb and landing plate. There always will be a difference

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in elevation between the comb and landing plate due to the following factors:

(a) combplate thickness required to meet current deflection criteria

(b) allowance for combplate deflection

(c) step tail or nose swing — the tail or nose moves in an arc as the step begins its travel through the turn-around

(d) a small amount of additional running clearance to allow for manufacturing tolerance and wear-in of parts

(e) possible increased combplate thickness necessitated by requirements for combplates

Floor height variations usually occur when buildings are renovated and different floor materials are used than were present when the escalator was originally installed.

6.1.3.6.4 Safety Zone. The safety zone ensures there is adequate space for passengers when they exit an escalator. If bunching occurs at the exit of an escalator, there will be no space for passengers exiting the escalator. This presents a serious safety hazard to those passengers on the escalator. See Diagram 6.1.3.6.4.

6.1.3.6.5 Flat Steps. Entering passengers require adequate time to position their feet before the steps change their direction of movement from horizontal to the incline. Exiting passengers require adequate time to prepare to step off the escalator; however, excessive time can cause a lack of concentration. Measurement of the flat step distance is from the line of intersection where the top of the comb tooth passes below the top of the step tread, not from the root of the comb teeth. This represents the point where a passenger can first contact the step tread when boarding.

If more than four flat steps are used, when starting an escalator utilizing the key-operated starting switches located on the newels it is very difficult to see if any passengers are either on or boarding the escalator. See Diagram 6.1.3.6.5.

6.1.3.7 Trusses or Girders. The truss is the structural foundation of the escalator. Attached to and/or within the truss are the various components that form the escalator. Structural steel is used to make the truss and may differ from one manufacturer to another since escalator trusses may be made of round tubing, angle iron, square tubing, or in some cases, combinations of these materials.

The purpose of the requirement is to prevent any part of the running gear or passengers on the running gear from falling through the truss to the space below.

6.1.3.9 Rated Load. This requirement contains design parameters. There is no Code requirement to test the design in the field. Conformance with these design requirements may be verified by examining the manufacturer's design criteria. The length of the horizontal projection of the truss varies on curved (spiral) escalators as a function of the truss with width. The centerline was selected as the location to measure the length because it represents the average length between the inside minimum and the outside maximum. The following four types of rated load must be considered:

(a) 6.1.3.9.1 Structural rated load is the live load an escalator truss must support.

(b) 6.1.3.9.2 Machinery rated load is the live load on the steps that the escalator machine is required to move.

(c) 6.1.3.9.3 Brake rated load. An escalator machine brake must meet the following two conditions:

(1) Stop the down-running escalator with the brake rated load on the steps at a retardation rate not exceeding 0.91 m/s^2 or 3 ft/sec^2. This is often referred to as the "dynamic brake rated load."

(2) Hold the escalator in the stopped position with the brake rated load on the steps. This is often referred to as the "static brake rated load."

(d) 6.1.3.9.4 Step. Step load accounts for weight of a passenger at any point on the step tread.

In ASME A17.1-2010/CSA B44-10, the static brake rated load was increased by 33% in consideration of the possible but unlikely situation where a fully loaded stopped escalator would undergo additional forces if all of the passengers were to walk up or down the escalator, or the escalator were to become overcrowded as additional passengers attempted to board the stopped escalator. Since the brake system contains sufficient capacity to balance and decelerate a load at the prescribed 0.91 m/s^2 or 3 ft/sec^2, which is significantly greater than the static brake rated load, it was agreed to increase the static brake load. The structural rated load, machinery rated load, and dynamic brake rated load remained unchanged.

As the method of determining the various rated loads for the escalator evolved over the years, the factors and values became inconsistent with sound engineering and physics practices. Various formulae were restructured to clarify and accurately reflect design requirements.

Requirement 6.1.3.9 was revised in ASME A17.1-2019/CSA B44:19 to clarify the language regarding safety factors. Revisions were made to applicable escalator requirements to correct and clarify that required factors of safety are minimum values and the loads from which the factors of safety are calculated are fixed values. See also Handbook commentary on 6.1.3.10.

6.1.3.10 Design Factors of Safety. Requirements for reinforced concrete structures are not specified in ASME A17.1/CSA B44. It is suggested that the normal design criteria for concrete structures be followed in providing supports for escalators. The design of the structure is to be based on static loading.

The intent of the requirements in 6.1.3.10.2 through 6.1.3.10.4 is to ensure that the drive will safely support a loaded escalator. While the limiting mode of failure is ultimate strength and logically the initial design could be tested to ensure the safety factor is

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achieved, this does not mean that fatigue, etc., should be neglected in the design. Whether the American Gear Manufacturers Association (AGMA) standards or escalator manufacturers' internal standard is used in drive design, other modes of failure need to be considered. Such standards should include consideration of the endurance limit of a component in regard to the maximum stress that can be varied or reversed indefinitely without producing fracture of the component material.

Requirement 6.1.3.10 was revised in ASME A17.1-2019/CSA B44:19 to clarify the language regarding safety factors. Previous Code language pertaining to the calculations of factors of safety for escalator and moving walk systems contained ambiguities leading to confusion and different calculation approaches by designers. The previous Code language left open to interpretation whether analysis of the driving machine parts and power transmission members should be based on a stationary condition, i.e., not in motion, or an operating condition, i.e., with motion at constant velocity/speed (not accelerating), and whether consideration of system losses and other applied loads encountered on the components during operation were to be considered.

Application of system losses and any additional loads imposed on the system while operating in the upward (lifting) direction are intended to be included with the machinery rated load for assessment of factors of safety on driving machine parts and power transmission systems of escalators and moving walks. Previous requirements pertaining to factors of safety on escalator and moving walk drive machine parts and power transmission members were revised to address ambiguities and confusion on the application of system losses and any additional loads imposed on the systems. Revisions were also made to applicable escalator and moving walk requirements to correct and clarify that required factors of safety are minimum values and the loads from which the factors of safety are calculated are fixed values.

6.1.3.10.1 This requirement was revised in ASME A17.1-2016/CSA B44-16 to specify ANSI/AISC 360-05, Specification for Structural Steel Buildings, and a more recent edition of CAN/CSA-S16.1, Limit States Design of Steel Structures, to be consistent with changes to the seismic sections of the Code.

6.1.3.11 Chains. Cast iron is a commercial alloy of iron, carbon, and silicon that is cast in a mold; is hard, brittle, and nonmalleable; has a low tensile strength; and is capable of being hammer welded.

6.1.3.12 Headroom. Requirement 6.1.3.12 was revised in ASME A17.1-2019/CSA B44:19 to add a width requirement for the headroom. Previous language only required a minimum headroom.

6.1.3.15 Water Accumulation. Since water accumulation can adversely affect safe operation of an escalator, provision is made for removal. The performance-based requirements stipulate a means to continuously prevent the accumulation of groundwater and runoff that does not require human intervention.

Where the water is discharged is not addressed in the Code. This typically would be addressed in the applicable building code or plumbing code.

6.1.4 Rated Speed

6.1.4.1 Limits of Speed. Prior to ASME A17.1-2010/CSA B44-10, any change in the speed of the escalator was prohibited. A proportion of escalator accidents are related to passengers falling. A problem could occur if speed were unintentionally varied during operation with passengers on the steps. This in fact could be hazardous due to games played walking or running against the direction of operation, even though this is intensively discouraged. In such a case, misgauging of the speed could result in a fall anywhere along the escalator travel. Past practice in some applications permitted escalators to operate at two different speeds at different times, typically 0.46 m/s or 90 ft/min and 0.61 m/s or 120 ft/min. The change from one speed to the other was not permitted unless the escalator was first stopped, the speed connections changed, and the escalator then restarted.

Variable frequency acceleration to provide controlled starts or Wye-delta motor control is not prohibited.

As of ASME A17.1-2010/CSA B44-10, escalator speed is permitted to be changed provided there are no passengers using the escalator. Reducing the speed when there are no passengers riding the escalator is an energy conservation measure. Rigid performance parameters are provided to minimize any possibility of speed change when passengers are riding the escalator and to ensure that the rate of change of speed of the escalator is sufficiently gradual so as not to cause loss of balance should a passenger bypass the detection means, yet sufficiently rapid to attain full speed when an approaching passenger is detected.

On curved (spiral) escalators, tangential speed varies as a function of the step width. The centerline was selected as the location to measure the speed for consistency with the other requirements, and because it is closest to the location where passengers are most likely to stand while riding the escalator.

6.1.5 Driving Machine, Motor, and Brake

6.1.5.1 Connection Between Driving Machine and Main Drive Shaft. This requirement addresses the connection between the driving machine and the main drive shaft and not the number of driving machines permitted per escalator. This requirement does not say, nor was it ever intended to say, that the escalator shall be driven

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by only one machine. A fluid coupling is prohibited. A fixed connection is required.

6.1.5.2 Driving Motor. It is not always safe to shut down multiple escalators when circumstances require the stopping of one unit. See Handbook commentary on 6.1.5.1.

6.1.5.3 Brakes. The escalator brake maximum stopping rate provides a smooth stopping action for all passenger loadings. The nameplate indicating the required brake torque will provide a means for periodically checking the brake performance, eliminating the practice of checking the brake by persons carrying weights on a moving escalator, which if not performed carefully, could be unsafe. The maximum deceleration rate is based on a test of high-speed pedestrian conveyors, conducted by the Engineering Physics Department of the Royal Aeronautical Establishment in Farnsborough, England. It also is the normal acceleration and deceleration rate of the San Francisco and the Washington Metro transit vehicles.

Prior to 1937, only an electrically released mechanically applied brake was required on the escalator drive machine (Rule 612a in the 1925 and 1931 editions of A17.1). In 1937, A17.1 recognized that a dangerous runaway condition could develop should the connection between the drive machine and the main drive shaft part, and a new requirement was established. Rule 512f in A17.1-1937 required a brake on the main drive shaft to prevent such a runaway condition. When A17.1 was extensively revised in 1955, Rule 804.3 continued the requirement of the previous Rule 512f, except that the main drive shaft brake was required only when a chain connected the machine to the main drive shaft. This change acknowledged the fact that a damaged or worn gear connection would not produce the runaway condition that a worn or broken drive chain could.

A chain that drives the step chains could permit a runaway condition if they both were to break. A difference exists, however, in the fact that there are two separate chains. Unlike the conventional escalator chain drive, where one link exists that, in failing, immediately produces an unsafe condition, now both independent chains must fail. This introduces a concept of redundancy of equipment to provide safety in operation — a concept widely accepted today. Brake systems in automobiles and control systems in air and space vehicles are examples of its application. If each system in a redundant design is capable of individually fulfilling all the demands imposed on it, and the failure of either system is detected and acted upon, a high degree of safety is achieved. The two drive chains referred to above constitute a redundant design if each can safely support the total escalator loads and if a device is present that would cause the escalator machine brake to stop the unit should either one of the chains break. This would fulfill the original intent by effectively preventing a runaway condition. Safety of operation, the prime objective of ASME A17.1/CSA B44, is achieved without the use or need of an auxiliary brake in this particular design.

6.1.5.3.1 Escalator Driving-Machine Brake

6.1.5.3.1(a) A braking control system that applies the brake, without intentional delay, with a force that varies as necessary to decelerate the escalator as specified in 6.1.5.3.1(c) but not necessarily the maximum braking force, is an acceptable means of complying with this requirement.

Requirement 6.1.5.3.1(a) was revised in ASME A17.1-2019/CSA B44:19 to allow the use of motor controlled dynamic braking. See also Handbook commentary on 6.1.5.3.4.

6.1.5.3.1(c) A restriction on deceleration was considered in the up direction but was rejected for two basic reasons. First, there was an absence of history of falls on escalators traveling up attributable to escalator stopping. It is reasonable to assume that up-running escalators carrying passengers would stop for the same reasons that down-running escalators would stop. The lack of falls due to the up-running escalator stopping is the result of the geometry of the escalator step and handrail and dynamic interaction of the passenger body, the escalator itself, and the forces of gravity.

The second reason is the complexity of accomplishing a stop combined with the normal force that is produced by gravity. Such a stop would require using the motor to bring the escalator to a halt while traveling in the up direction. This technology is used in elevator control and is well known to the industry, but its complexity and necessary safeguards are not justified by the experience of escalator operation.

The ASME A17 Committee realizes there is a degree of risk when an up-running escalator is decelerated too quickly. When a down-running escalator is decelerated too quickly, there also is a much greater risk of fall and more serious injury as well as an additional risk of causing others to fall. In weighing the consequences of complexity versus degree of risk, the ASME A17 Committee felt the requirement as written was the proper choice. See Diagram 6.1.5.3.1(c).

ASME A17.1-2004 and CSA B44-04 were revised from requiring a 0.91 m/s^2 or 3 ft/sec^2 maximum to a 0.91 m/s^2 or 3 ft/sec^2 average deceleration. This does not change the escalator stopping performance as prescribed and measured by past certification procedures. The past practice of plotting velocity versus time over the duration of the stop, best fitting a line to the data, and determining the slope/deceleration from the line nets the same average deceleration for both terms. Likewise, a determination of the average deceleration based on the initial velocity (rated speed) and the stopping distance will verify the stopping performance. The difference occurs only with

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more sophisticated equipment readily available today that is capable of measuring/calculating instantaneous deceleration peaks and valleys present in mechanical systems. While peaks above 0.91 m/s^2 or 3 ft/sec^2 do exist, research has shown that short-duration, limited-amplitude peaks reflect what was probably intended by the original requirement. This is consistent with current inspection techniques and provides compatibility with current measurement technology and equipment.

The values used reflect values established and used by inclined elevators. They are also applicable for escalators.

6.1.5.3.1(d) The purpose of providing a brake torque nameplate, as required since the stopping requirement outlined in 6.1.5.3.1(d) and 6.1.6.3.6 were established in ASME A17.1-1983, was to replace a potentially dangerous, difficult, and unsafe type test from being performed when a new model escalator was released. This test only confirmed compliance with the basic brake requirement, which required a fully loaded escalator to stop. Since this was performed only for a new model installation, the brake setting was not required to be checked in this manner during the life of an escalator. Instead, the brake torque was measured from time to time and adjusted to meet the manufacturer's specification, if it was known.

When stopping requirements were further defined in ASME A17.1-1983 and CSA B44-1985, maintaining brake torque became critical. As a result, ASME A17.1/CSA B44 requires a nameplate that displays the manufacturer's specified brake torque. The brake nameplate was modified in ASME A17.1-2000 and CSA B44-00 to include the minimum distance from the skirt-switch to the combplate and the minimum stopping distance. With current requirements, inspectors and maintenance personnel alike know the correct brake torque and are able to check the brake and adjust if necessary.

Manufacturers develop brake torque values through engineering analysis of data unique to a given model and confirm these results with empirical testing. These tests involve using test weights, encoders, recording devices, and circuit modifications to the controller. This equipment is usually found and best used in a test facility. Because it is both costly and bulky, it does not lend itself to be used in field application.

When a new model escalator is released, manufacturers can be asked to produce their analysis in the same manner that other design calculations such as truss analyses are requested. This permits verification of the brake calculations. Reliable periodic brake checks can be made by measuring existing torque against that shown on the nameplate data.

Prior to ASME A17.1a-2005 and CSA B44-04 Update No. 1, the brake data plate requirement specified the minimum distance that the skirt switch electrical protective device could be located from the combplate to ensure meeting the stopping requirement in the skirt electrical protective device rule (i.e., the maximum stopping distance of the escalator, which inherently occurs under a loaded condition). In essence, the data plate expressed maximum stopping distance in terms of skirt switch location. Over time, additional electrical protective devices have been added with the same requirement that the escalator is to stop before an activating step reaches the combplate, and are not specifically covered on the data plate. The Code was revised to specify the maximum stopping distance data on the brake data plate. This clearly provides inspection and compliance information with respect to all electrical protective devices by providing a stopping distance requirement.

The data plate is required to be located on the machine brake. If the data plate is not readily visible, a duplicate nameplate is required.

Requirement 6.1.5.3.1(d) was revised in ASME A17.1-2022/CSA B44:22 to add conformance to 8.13.1 which provides detailed requirements for data plates. See Handbook commentary on 8.13.1.

6.1.5.3.1(d)(5) See Handbook commentary on 6.1.6.3.16.

6.1.5.3.2 Main Drive Shaft Brake. This requirement was revised in ASME A17.1-2016/CSA B44-16 to permit duplicate and monitored power transmission chains in lieu of a main shaft brake to ensure brake function. Duplication of a system, component, or part with monitoring of the function of each is a fundamental and long-accepted practice to ensure reliability and safety. It is reasonable to allow this approach to ensure the level of safety in escalator drive systems that utilize power transmission chains between the main shaft and the driving machine and brake.

See also Handbook commentary on 6.1.5.3.

6.1.5.3.3 Requirement 6.1.5.3.3 was revised in ASME A17.1-2019/CSA B44:19 to add a requirement that motor controlled dynamic braking also be certified to the requirements in 8.3.1 and 8.3.6. See also Handbook commentary on 6.1.5.3.4.

6.1.5.3.4 Escalator Driving Machine Motor Controlled Dynamic Braking. Requirement 6.1.5.3.4 was added in ASME A17.1-2019/CSA B44:19 to provide requirements for motor controlled dynamic braking. Advances in electric motor control technology have provided for improvements to braking/stopping performance of escalators. Possible improvements from dynamic braking with variable frequency control of the motor include constant and precisely controlled deceleration rates regardless of load, optimizing the stopping process to include a jerk rate in addition to a deceleration rate, and enabling up direction stopping performance equal to down direction stopping performance regardless of escalator load. Previous brake requirements prohibited these possible improvements and therefore were revised.

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6.1.5.3.5 Auxiliary Brake. Requirement 6.1.5.3.4 was added in ASME A17.1-2022/CSA B44:22 to provide an additional means to bring an escalator to a controlled stop in the event of an overspeed situation resulting from a malfunctioning machine brake. The combination of the machine brake and auxiliary brake during an overspeed situation reduces the potential hazard of a higher-than-normal deceleration when stopping. In addition, the auxiliary brake is required to apply after each stop to mechanically exercise the brake components to enhance reliability.

6.1.6 Operating and Safety Devices

6.1.6.2 Starting and Inspection Control Switches

6.1.6.2.1 It is important that an individual who is starting an escalator has a clear, unobstructed view of that escalator to ensure that no one is on the steps before the escalator is started. Only key-operated-type starting switches are permissible for starting the escalator. Automatic starting by the use of mats, etc., violates the intent of this requirement. Starting an escalator with passengers on the step is an unsafe practice. This has occurred with automatic starting operations due to misuse of the automatic starting means.

The starting switches must be located such that the escalator steps are within sight. The starting switch must also be within reach of the emergency stop button (6.1.6.3.1). All persons who start an escalator must also be trained in the proper procedure as required by 8.6.11.6. A closed-circuit TV camera used to view the steps does not comply with the intent of the requirements.

6.1.6.2.2 Inspection Control. The intent is to prevent accidents through inadvertent starting/running of escalators by elevator personnel when attempting to position escalators in order to check, adjust, or repair components by providing a switch for use during maintenance and repairs that will prevent the escalator from running except under constant-pressure operation.

6.1.6.3 Electrical Protective Devices

6.1.6.3.1 Emergency Stop Buttons. Specifying the exact location of the emergency stop button ensures that at the time of an emergency, precious time will not be lost hunting for stop buttons. The location also gives the user of an emergency stop button a clear, unobstructed view of the escalator. A cover is required to prevent accidental contact. The alarm is to discourage unauthorized/unnecessary use and to alert passengers.

The basic premise of remotely stopping escalators is unsafe. Introducing the human element in the decision process is the weak link. Using TV monitors to supervise the conditions on a remote escalator does not provide for objective and safe control of the unit. Unlike devices that respond to a specific condition and then stop the escalator, a person sitting in a room full of TV monitors and controls is susceptible to fatigue, emotional stress, inattentiveness, carelessness, and other factors that can result in unnecessary or erroneous stops. This type of job is a monotonous one, particularly susceptible to these problems.

While some contract specifications call for remote stopping in certain facilities such as fixed guideway transit and passenger rail systems, elaborate measures are required to reduce the probability of accidents. Most local AHJs do not allow it, and suppliers have recommended against its use.

6.1.6.3.1(a) In jurisdictions enforcing NBCC, remote stop buttons are permitted only where there is a clear view of the escalator.

Requirement 6.1.6.3.1(a) was revised in ASME A17.1-2019/CSA B44:19 to clarify the location of the stop button.

6.1.6.3.1(c) Requirement 6.1.5.3.1(c) was revised in ASME A17.1-2019/CSA B44:19 to require the emergency stop buttons to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

6.1.6.3.2 Escalator Speed-Monitoring Device. Prior to ASME A17.1-2010/CSA B44-10, speed governors or speed-monitoring devices were not required when low-slip squirrel cage induction motors were provided. While ASME A17.1/CSA B44 does not specifically require a low-slip squirrel cage induction motor, this type of motor has been commonly provided. When an AC induction motor exceeds synchronous speed (an amount equal to its design slip), a braking action takes place electrically that prevents excessive overspeed.

The distinction between low and high slip is that an escalator motor must be of low-slip characteristics, or speed loss would occur under load in the up direction. A low-slip motor cannot overspeed beyond 140%. Since sufficient speed cannot be reached to trip the governor, an overspeed governor would have been superfluous.

Advances in drive control technologies can now result in the use of other power control devices. For example, soft-start and energy-saving devices do not vary in frequency but, because of their location between the motor and contactor, still have the potential to interrupt power to the motor without affecting a stop (removing power from the brake), resulting in a potential overspeed situation. In addition, improvements in control and monitoring technology utilized today enable more precise overspeed detection, so the overspeed detection magnitude has been reduced from 40% to 20% to further minimize impact of an overspeed situation.

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The squirrel cage induction motor's exception has been eliminated due to the increasingly common practice of providing power management systems that bypass the function of a fail-safe brake and permit an overspeed condition.

Requirement 6.1.6.3.2 was revised in ASME A17.1-2022/CSA B44:22 to add removal of power to the auxiliary brake (6.1.5.3.5) where provided. See Handbook commentary on 6.1.5.3.5.

6.1.6.3.3 Broken Step-Chain Device. Requirement 6.1.6.3.3 was revised in ASME A17.1-2019/CSA B44:19 to require the broken step-chain device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

6.1.6.3.4 Drive-Chain Device. The main drive shaft brake is provided when the escalator machine is connected to the main drive shaft by a chain. If the chain becomes disconnected from the sprockets, the machine brake is not capable of stopping or holding the unbalanced load. Chain failure is the only condition currently addressed in the Code. However, a chain that comes off the sprocket represents another condition that produces the same result as a broken chain. This requirement covers other conditions occurring to the drive chain that would permit the escalator to run uncontrolled in the down direction.

The term “device” is consistent with the terminology in Part 6 and is more descriptive of the equipment to perform the required function.

Requirement 6.1.6.3.4 was revised in ASME A17.1-2022/CSA B44:22 to add application of the auxiliary brake [6.1.5.3.5(b)] where provided. See Handbook commentary on 6.1.5.3.5.

Requirement 6.1.6.3.4 was revised in ASME A17.1-2016/CSA B44-16 to permit duplicate and monitored power transmission chains in lieu of a main shaft brake to ensure brake function. Duplication of a system, component, or part with monitoring of the function of each is a fundamental and long-accepted practice to ensure reliability and safety. It is reasonable to allow this approach to ensure the level of safety in escalator drive systems that utilize power transmission chain between the main shaft and the driving machine and brake.

6.1.6.3.5 Stop Switch in Machinery Spaces. The stop switch or main line disconnect switch provides the means to ensure that an escalator cannot be started by the starting switch while working in the machinery space.

6.1.6.3.6 Escalator Skirt Obstruction Device. In the event that someone's shoe, sneaker, finger, foot, etc., becomes entrapped between the skirt and step, the skirt obstruction device would act to stop the escalator. Skirt obstruction devices are required only in the area where the step approaches the upper and lower combplate areas. This is due to the fact that steps are extending and retracting and have more of a tendency toward entrapment in this area. During the rest of the escalator travel, entrapment usually can be caused only by deliberately forcing an object between the step and skirt. The skirt obstruction devices must be located no less than the distance specified on the brake data plate [6.1.5.3.1(d)(5)] from the combplate. See Diagram 6.1.6.3.6.

The skirt obstruction device is permitted to be automatically reset if it operates no more than one time in a 24-h period. This is to minimize unnecessary service calls and unnecessary downtime due to nuisance trips of the device. If the skirt obstruction device operates more than once in a 24 h period, it must be manually reset by elevator personnel after the cause of the operation is determined.

The requirement does not establish a specific force value to operate the switch. The performance requirement places the responsibility on the designer to accomplish compliance.

Requirement 6.1.6.3.6 was revised in ASME A17.1-2019/CSA B44:19 to require the escalator skirt obstruction device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

6.1.6.3.7 Escalator Egress Restriction Device. An up-running escalator would bunch people at a closed rolling shutter or a closed door at the egress end if the escalator were allowed to continue running. People traveling on the escalator would not be able to descend because it would still be running in the up direction. See also commentary on rolling shutters in Chart 6.1.1.1.

Requirement 6.1.6.3.7 was revised in ASME A17.1-2019/CSA B44:19 to require the escalator egress restriction device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

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6.1.6.3.8 Reversal Stop Device. In the event of the reversal of an ascending escalator, the power shall be removed from the escalator drive-machine motor and brake. The escalator speed-monitoring device (6.1.6.3.2) may be designed to monitor both overspeed and underspeed and would satisfy the requirements for the reversal stop device.

6.1.6.3.9 Step Upthrust Device. The requirement is written in performance language and requires

(a) stopping prior to the affected step reaching the combplate

(b) actuation at or prior to the point of tangency

(c) maximum stop roller displacement prior to actuating

The step upthrust device is required at the lower end, as an object trapped between two steps would cause the lower step to resist transition to level, causing the device to operate and stop the escalator.

The step upthrust device is permitted to be automatically reset if it operates no more than one time in a 24-h period. This is to minimize unnecessary service calls and unnecessary downtime due to nuisance trips of the device. If the step upthrust device operates more than once in a 24-h period, it must be manually reset by elevator personnel after the cause of the operation is determined.

See Diagram 6.1.6.3.9.

Requirement 6.1.6.3.9 was revised in ASME A17.1-2019/CSA B44:19 to require the step upthrust device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

6.1.6.3.10 Disconnected Motor Safety Device. This requirement is essential when a nonpositive drive connects the escalator motor to the machine. A separate device is required in the event a governor is not used on this equipment.

6.1.6.3.11 Step Level Device. A downward displaced step entering the combplate, as a result of a missing wheel, its tire, or a failure of the end frame where the wheel fastens to the step or pallet, can be hazardous. The step level device must be positioned such that when activated, it will bring the displaced step to a stop before it enters the comb. These devices will prevent the escalator from running under a condition of downward displacement.

Requirement 6.1.6.3.11 was revised in ASME A17.1-2019/CSA B44:19 to require the step level device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

6.1.6.3.12 Handrail Entry Device. Objects caught in the area where the handrail reenters the balustrade can produce bodily injury and/or damage to the escalator equipment. A switch in this area should prevent or limit the extent of injury or damage in the event of this occurring.

The handrail entry device is permitted to be automatically reset if it operates no more than one time in a 24-h period. This is to minimize unnecessary service calls and unnecessary downtime due to nuisance trips of the device. If the handrail entry device operates more than once in a 24-h period, it must be manually reset by elevator personnel after the cause of the operation is determined.

Requirement 6.1.6.3.12 was revised in ASME A17.1-2019/CSA B44:19 to require the handrail entry device to initiate motor controlled dynamic braking where provided and to align the language with other similar sections. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

6.1.6.3.13 Comb-Step Impact Devices. Escalator step wrecks can occur from a variety of circumstances, some of which may not be detected, and some that may be detected by other safety devices. When these occur, steps continue to be drawn into the pileup until an existing safety device is haphazardly tripped or someone pushes the stop button. This requirement is intended to detect the first step to impact the comb and stop the escalator as a direct result of the impact. Because steps can strike the comb from below as well as entering, both vertical and horizontal impact detection is necessary.

6.1.6.3.14 Step Lateral Displacement Device. The tension in the step chain of curved (spiral) escalators will attempt to straighten the chain out if there is a failure in the side guiding system. This will force the steps against the skirt, producing an unsafe condition if the escalator continues to operate.

Requirement 6.1.6.3.14 was revised in ASME A17.1-2019/CSA B44:19 to require the step lateral displacement device to initiate motor controlled dynamic braking where provided and to align the language with other similar sections. It was also revised to permit dynamic braking to bypass the normal methods to remove power from

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the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

6.1.6.3.16 Dynamic Skirt Panel Obstruction Device. This requirement minimizes the risk of entrapment between the dynamic skirt panel and the dynamic skirt panel cover. The dynamic skirt panel obstruction device was added in ASME A17.1a-2008/CSA B44a-08 to detect objects caught between the dynamic skirt panel and the dynamic skirt panel cover in the transition zone. The function is similar to the skirt obstruction device of requirement 6.1.6.3.6. Like the skirt obstruction device, this device removes power from the driving-machine motor and brake. The escalator should stop before the step attached to the dynamic skirt panel reaches the combplate. Without this requirement, the device may be placed at a distance from the combplate less than the maximum stopping distance. The result would be that the object caught between the panel and panel cover could impact at the point where the panel enters the balustrade. There is no similar device or requirement for moving walks.

Requirement 6.1.6.3.16 was revised in ASME A17.1-2019/CSA B44:19 to require the dynamic skirt panel obstruction device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

6.1.6.4 Handrail Speed-Monitoring Device. There is a need to stop an escalator if the speed of the handrail deviates by 15% or more. While a speed deviation of less than 15% would also not comply with 6.1.3.4.1, it would not be enough to necessitate stopping the escalator right away. A delay is necessary so that the escalator is not stopped every time someone pulls on the handrail.

A handrail not moving in the same direction or speed has a tendency to pull passengers backward or forward, causing them to lose their balance. It is not necessary for the handrail to move at exactly the same speed as the step since passengers can easily adjust the position of their hands to compensate for minor differences in speeds.

The handrail speed-monitoring device is permitted to be automatically reset if it operates no more than one time in a 24-h period. This is to minimize unnecessary service calls and unnecessary downtime due to nuisance trips of the device. If the handrail speed-monitoring device operates more than once in a 24-h period, it must be manually reset by elevator personnel after the cause of the operation is determined.

Requirement 6.1.6.4 was revised in ASME A17.1-2019/CSA B44:19 to require the handrail speed-monitoring device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

Requirement 6.1.6.4 was revised in ASME A17.1-2022/CSA B44:22 to make it mandatory for the device to retain the status of the timer and count of events if power is interrupted.

6.1.6.5 Missing Step and Missing Dynamic Skirt Devices. This requirement will prevent an escalator from continuing to run if a step is missing. It will prevent a void from a missing step to emerge from under the comb. This requirement was adopted because of the seriousness of the injury that results from stepping into the gap of a missing step, and the fact that a passenger may not see the gap until starting to step into it. In ASME A17.1-2004 and CSA B44-04, the requirement was expanded to include a missing dynamic skirt panel.

Requirement 6.1.6.5 was revised in ASME A17.1-2019/CSA B44:19 to require the missing step and missing dynamic skirt devices to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

6.1.6.6 Tandem Operation. See Diagram 6.1.6.6.

Requirement 6.1.6.6 was revised in ASME A17.1-2019/CSA B44:19 to require the electrical interlocks for tandem operation to initiate motor controlled dynamic braking where provided and to align the language with other similar sections. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

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6.1.6.7 Escalator Braking-Distance Monitor. This requirement was added in ASME A17.1-2016/CSA B44-16 to require that a device be provided to monitor the stopping distance every time the escalator is stopped, to ensure correct brake operation. The minimum and maximum stopping-distance requirements are already described in the Code.

6.1.6.8 Escalator Smoke Detectors. Smoke detectors are not required in wellways by ASME A17.1/CSA B44. Some building codes do require smoke detectors in wellways and adjacent areas. When a smoke detector is used to stop a moving escalator, these requirements must be adhered to. This requirement was adopted because if smoke detectors were set to stop the escalator, certain events were deemed necessary to permit the escalator to stop safely.

Requirement 6.1.6.8 was revised in ASME A17.1-2019/CSA B44:19 to require the escalator smoke detectors to initiate motor controlled dynamic braking where provided and to align the language with other similar sections. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

6.1.6.9 Signs

6.1.6.9.1 Caution Signs. The sign (Figure 6.1.6.9.1) cautions people on how to use an escalator properly and indicates that it is for the transportation of people only. Most accidents are caused by improper use of an escalator. A pictograph reduces the problems caused by language barriers.

6.1.6.9.2 Signs or Graphics Relating to Safety. Additional signs relating to safety may be provided since during the normal walking flow of people entering an escalator, there is only sufficient time to read and comprehend the required sign (6.1.9.3.1). To properly board an escalator, it is important to continue to walk without stopping or otherwise causing abrupt bodily contact with others. For this reason, a sign that is well outside the normal boarding traffic flow is permitted. Additional signs within the boarding area that may obstruct passenger flow are prohibited. Due to escalators being installed in many different locations, there is no consensus on what the additional sign should say. Some of the most frequently used messages are “No Luggage or Carts,” “No Bare Feet,” “No Strollers,” “No Wheelchairs,” “Handicapped-Use Elevator.”

The Code has, therefore, provided some broad guidelines and a message to building owners, etc., to consider anything peculiar to the building site that requires further unique messages.

6.1.6.9.3 Additional Signs or Graphics. Signs or graphics not related to safety that might obstruct passenger flow, access to handrails, or view of the required sign (6.1.9.3.1) are not permitted. Manufacturer's identification, signs or graphics on step risers, and handrail markings are permitted.

6.1.6.10 Control and Operating Circuits. This requirement provides for protection against singular failures in the control room and/or operating circuits resulting in an unsafe condition.

6.1.6.10.4 Requirement 6.1.6.10.4 was revised in ASME A17.1-2019/CSA B44:19 to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.1.5.3.4.

6.1.6.11 Electrically Powered Safety Devices. Requirement 6.1.6.11 was revised in ASME A17.1-2019/CSA B44:19 to address changes to allow motor controlled dynamic braking. The changes are to clarify that stopping performance monitoring is as critical as the handrail speed monitor or missing step in preventing the electrical protective devices that are permitted to use dynamic braking from being ineffective. See also Handbook commentary on 6.1.5.3.4.

6.1.6.12 Installation of Capacitors or Other Devices or Means to Make Electrical Protective Devices Ineffective. This mandates that the electrical protective devices always be operative and that they may not be bypassed except as provided for in ASME A17.1/CSA B44.

The title in requirement 6.1.6.12 was revised in ASME A17.1-2022/CSA B44:22 to pick up other means to make electrical protective devices ineffective. See Handbook commentary on 2.26.14.

6.1.6.13 Completion or Maintenance of Circuit. The requirement is written in a manner such that failure of any circuit associated with an electrical protective device will cause the device to operate. This is a basic principle of fail-safe design. The intent of 6.1.6.13 is that the contactors used to interrupt the power to the escalator motor and brake shall not be energized to perform this function.

Requirement 6.1.6.13 was revised in ASME A17.1-2019/CSA B44:19 to clarify that these requirements do not apply to motor controlled dynamic braking. See also Handbook commentary on 6.1.5.3.4.

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6.1.6.14 Escalator Manual Reset. An external power failure should not result in any safety device requiring manual reset to lose its indication of a malfunction.

6.1.6.15 Contactors and Relays for Use in Critical Operating Circuits. This requirement specifies the requirements for single failure protection, i.e., redundancy, in the design of specific control and operating circuits (6.1.6.10.1) and requires the checking of that redundancy (6.1.6.10.3). This may require the use of two relays instead of one in these circuits, and the checking of the operation of these relays.

When electromechanical relays and contactors are being checked for operation, specifically drop-out operation, by utilizing contacts on the relays or contactors themselves, care must be taken that the contact used for monitoring the state of the contact used in the critical circuit is a true and correct representation of the critical circuit contact.

The required operation of the monitoring contact is specified, and it is clarified that springs in the design of the relay, contactor, or contact design may be used, but that spring failure shall not cause the monitoring contact to indicate an open critical circuit contact if the critical circuit contact is not open.

6.1.7 Lighting, Access, and Electrical Work

6.1.7.1 Lighting of Machine Room and Truss Interior. The requirements ensure that a source of illumination and power is provided in machine rooms for elevator personnel. Machinery spaces in the truss, either at the end or on the incline, do not require permanent lighting, as it is impractical to locate a light fixture that will provide lighting to all work areas.

6.1.7.1.2 Truss Interior. The requirement for a duplex receptacle in the truss interior is to allow for the use of a drop cord light for inspection and maintenance inside the truss.

6.1.7.2 Lighting of Escalator. Step treads must be illuminated properly in order to reduce a tripping hazard.

6.1.7.3 Access to Interior. The removal of escalator steps is considered a reasonable means of access to the interior of an escalator.

6.1.7.3.1 The use of terrazzo, stone, concrete, or other similar floor coverings that are excessively heavy, would be a hazard for maintenance and inspection personnel to lift. This type of material also tends to crack, resulting in a tripping hazard. Access plates must be securely fastened to prevent accidental opening.

6.1.7.3.2 Gravity alone is not sufficient to secure means of fastening access plates.

6.1.7.4 Electrical Equipment and Wiring. Requirement 6.1.7.4 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definition for "main line power."

6.1.7.4.1 See Handbook commentary on 2.26.4.1.

6.1.7.4.2 The specified electric equipment is required to be certified as complying with CSA B44.1/ASME A17.5. This will minimize the risk of electricity as a source of electric shock and as a potential ignition source for fires. See Handbook commentary on 2.26.4.2.

6.1.7.4.3 This requirement was revised in ASME A17.1-2016/CSA B44-16 to specify that electromagnetic interference testing of escalator and moving walk control circuits shall be done in accordance with an ISO standard rather than a European (EN) standard. The revision is not due to any known deficiencies with the current products or the previous EN standard; similar revisions have been made previously to the requirements for elevator controls (see 2.26.4.4).

See also Handbook commentary on 2.26.4.3.

6.1.8 Outdoor Escalators

The Code requires outdoor escalators to be covered (see 6.1.8.2). Experience shows that outdoor escalators must be protected from weather. Escalators installed outdoors without any cover were usually shut down when it rained; however, many have since been covered. It was also observed that when it rained or snowed on an uncovered escalator, passengers tended to run up or down the steps; this is considered unsafe.

This requirement was revised in ASME A17.1-2007/CSA B44-07. It is performance based, requiring escalators to be protected from the elements. Since rain and snow seldom fall straight down, a cover alone is not considered adequate protection.

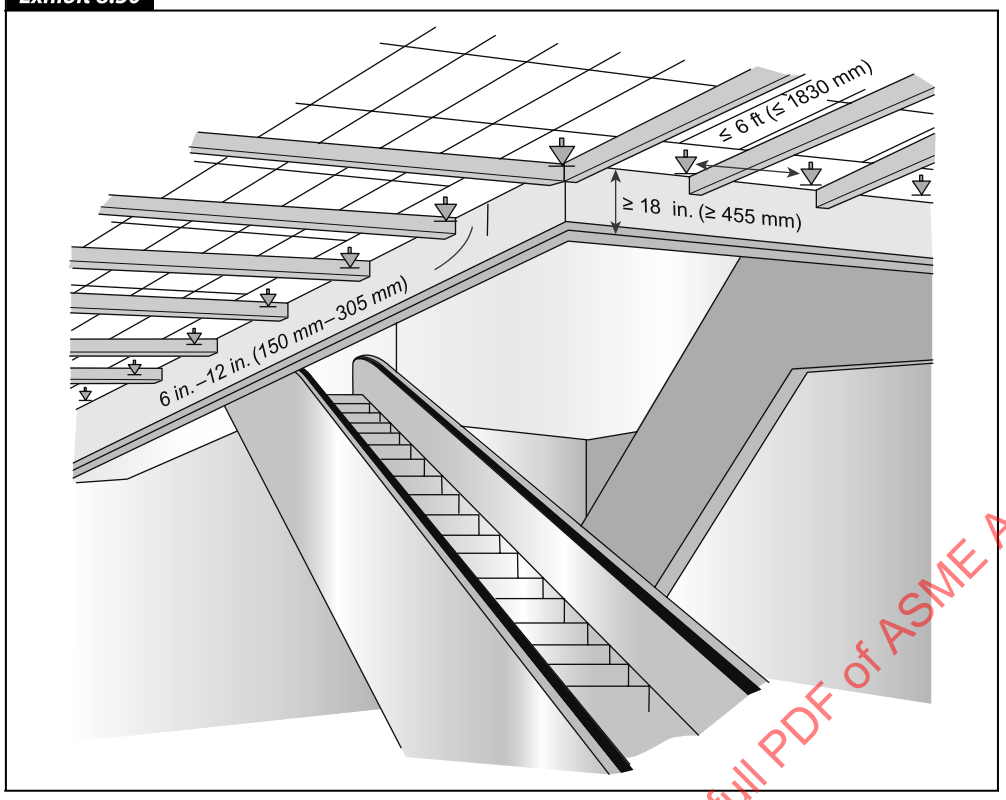
6.1.8.2 Precipitation. Skirt deflectors and other devices must be protected so they do not present a hazard to riders when subjected to inclement weather. See Diagram 6.1.8.2.

6.1.8.2.2 The ASME A17 Committee recognizes that not all sources of water, such as those from hurricanes or flooding, can be drained. However, groundwater, water from shoes (e.g., rain and snow), and runoff that might accumulate in the equipment are to be drained. See Handbook commentary on 6.1.3.15.

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Chart 6.1.1.1
Excerpts from NFPA *101*®-2021, Life Safety Code® Handbook

Exhibit 8.30



Sprinklers around an escalator opening.

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Chart 6.1.1.1
Excerpts from NFPA *101*®-2018, Life Safety Code® Handbook (Cont'd)

8.6.9.6 Any escalators and moving walks serving as a required exit in existing buildings shall be enclosed in the same manner as exit stairways. *(See 7.1.3.2.)*

Where used as an exit, an escalator must be completely enclosed with fire-rated construction, including entrance and discharge doors. It is rare to find an escalator enclosed in such a manner. Escalators located within the required means of egress in existing buildings that maintain compliance with the *Code* usually make use of one of the provisions of 8.6.9.7 to avoid creating an unprotected vertical opening. By doing so, they are classified as exit access. Note that 7.2.7 prohibits escalators from constituting any part of the required means of egress in new buildings. Thus, in new construction, an escalator can be installed but is not recognized as satisfying the requirements for exit access, exit, or exit discharge.

8.6.9.7 Any escalators and moving walks not constituting an exit shall have their floor openings enclosed or protected as required for other vertical openings, unless otherwise permitted by one of the following:

(1) The requirement of 8.6.9.7 shall not apply to escalators in large open areas, such as atriums and enclosed shopping malls.

(2)* In existing buildings protected throughout by an approved automatic sprinkler system in accordance with Section 9.7, escalator and moving walk openings shall be permitted to be protected in accordance with the method detailed in NFPA 13 or in accordance with a method approved by the authority having jurisdiction.

(3) In new buildings protected throughout by an approved automatic sprinkler system in accordance with Section 9.7, escalator and moving walk openings shall be permitted to be protected in accordance with the method detailed in NFPA 13 or in accordance with a method approved by the authority having jurisdiction, and the opening shall not connect more than four contiguous stories unless otherwise permitted by Chapters 11 through 43.

(4) In buildings protected throughout by an approved automatic sprinkler system in accordance with Section 9.7, escalator and moving walk openings shall be permitted to be protected by rolling steel shutters appropriate for the fire resistance rating of the vertical opening and complying with all of the following:
   (a) The shutters shall close automatically and independently of each other upon smoke detection and sprinkler operation.
   (b) A manual means of operating and testing the operation of the shutters shall be provided.
   (c) The shutters shall be operated not less than once a week to ensure that they remain in proper operating condition.
   (d) The shutters shall operate at a speed not to exceed 30 ft/min (0.15 m/s) and shall be equipped with a sensitive leading edge.
   (e) The leading edge shall arrest the progress of a moving shutter and cause it to retract a distance of approximately 6 in. (150 mm) upon the application of a force not exceeding 20 lbf (90 N) applied to the surface of the leading edge.
   (f) The shutter, following the retraction specified in 8.6.9.7(4)(e), shall continue to close.
   (g) The operating mechanism for the rolling shutter shall be provided with standby power complying with the provisions of *NFPA 70*.

A.8.6.9.7(2) The intent is to place a limitation on the size of the opening to which the protection applies. The total floor opening should not exceed twice the projected area of the escalator or moving walk at the floor. Also, the arrangement of the opening is not intended to circumvent the requirements of 8.6.7.

As with any opening through a floor, the openings around the outer perimeter of the escalators should be considered as vertical openings.

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Chart 6.1.1.1
Excerpts from NFPA *101*®-2018, Life Safety Code® Handbook (Cont'd)

The provisions of 8.6.9.7 provide that new escalators (which are not permitted to be part of the means of egress) and existing escalators not serving as exits (see 8.6.9.6) need not be enclosed if certain provisions are met.

The sprinkler–draft curtain method is detailed in NFPA 13, *Standard for the Installation of Sprinkler Systems*. It consists of surrounding the escalator opening, in an otherwise fully sprinklered building, with an 18 in. (455 mm) deep draft stop located on the underside of the floor to which the escalator ascends. This draft stop serves to delay the heat, smoke, and combustion gases developed in the early stages of a fire on that floor from entering into the escalator well. A row of closely spaced automatic sprinklers located outside the draft stop also surrounds the escalator well. As sprinklers along this surrounding row are individually activated by heat, their water discharge patterns combine to create a water curtain. A typical installation is shown in Exhibit 8.30. In combination with the sprinkler system in the building, this system should delay fire spread effectively and allow time for evacuation.

Prior editions of the *Code* detailed several methods that permitted the use of unenclosed escalators in completely sprinklered buildings where the escalators were not used as exits. In addition to the sprinkler–draft curtain or rolling shutter methods, the authority having jurisdiction might consider one of the following when evaluating existing buildings:

1. Sprinkler-vent method
2. Spray nozzle method
3. Partial enclosure method

Sprinkler-Vent Method. Under the conditions specified, escalator or moving walk openings are permitted to be protected by the sprinkler-vent method, which consists of a combination of an automatic fire or smoke detection system, an automatic exhaust system, and an automatic water curtain. This combination of fire protection and system design is required to meet the criteria of the following eight items and to be approved by the authority having jurisdiction.

1. The exhaust system should be capable of creating a downdraft through the escalator or moving walk floor opening. The downdraft should have an average velocity of not less than 300 ft/min (1.5 m/s) under normal conditions for a period of not less than 30 minutes. This requirement can be met by providing an air intake from the outside of the building above the floor opening. The test of the system under normal conditions requires that the velocity of the downdraft be developed when windows or doors on the several stories normally used for ventilation are open. The size of the exhaust fan and exhaust ducts must be sufficient to meet such ventilation conditions. Experience indicates that fan capacity should be based on a rating of not less than 500 $ft^3/min/ft^2$ (8.3 $m^3/s/m^2$) of moving stairway opening to obtain the 300 ft/min (1.5 m/s) velocity required. If the building is provided with an air-conditioning system arranged to be automatically shut down in the event of fire, the test condition should be met with the air-conditioning system shut down. The 300 ft/min (1.5 m/s) downdraft through the opening provides for the testing of the exhaust system without requiring the expansion of air that would be present under actual fire conditions.

2. Operation of the exhaust system for any floor opening should be initiated by an approved device on the involved story and should use one of the following means, in addition to a manual means, for operating and testing the system:

- **a.** Heat detectors (fixed-temperature, rate-of-rise, or a combination of both)
- **b.** Waterflow in the sprinkler system
- **c.** Approved supervised smoke detection located so that the presence of smoke is detected before it enters the stairway

3. Electric power supply to all parts of the exhaust system and its control devices should be designed and installed for maximum reliability. The electric power supply provision of NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*,[41] can be used as a guide to design and installation features that help to ensure maximum reliability.

4. Any fan or duct used in connection with an automatic exhaust system should be of the approved type and should be installed in accordance with the applicable standards in Chapter 2 and Annex D.

5. Periodic tests should be performed on the automatic exhaust system, at least quarterly, to maintain the system and the control devices in good working condition.

6. The water curtain should be formed by open sprinklers or by spray nozzles located and spaced to form a complete and continuous barrier along all exposed sides of the floor opening and to reach from the ceiling to the floor. Water discharge for the water curtain should be not less than approximately 3 gal/min/lineal ft (0.6 L/s/lineal m) of water curtain, measured horizontally around the opening.

7. The water curtain should operate automatically from thermal-response elements of a fixed-temperature type. These elements should be located with respect to the ceiling/floor opening so that the water curtain actuates upon the advance of heat toward the escalator or moving walk opening.

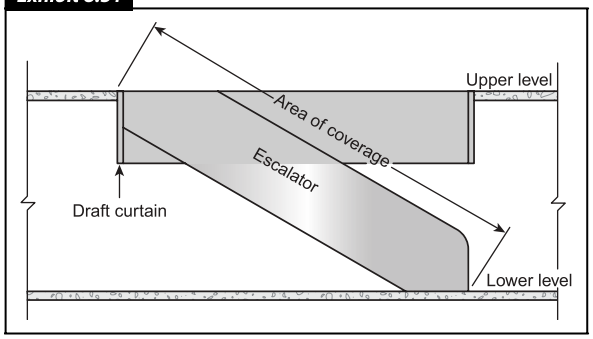
8. Every automatic exhaust system (including all motors, controls, and automatic water curtain system) should be electrically supervised in an approved manner that is similar to that specified for automatic sprinkler system supervision.

Spray Nozzle Method. Under the conditions specified, escalator openings are permitted to be protected by the spray nozzle method, which consists of a combination of an automatic fire or smoke detection system and a system of high-velocity water spray nozzles. This combination of fire protection and system

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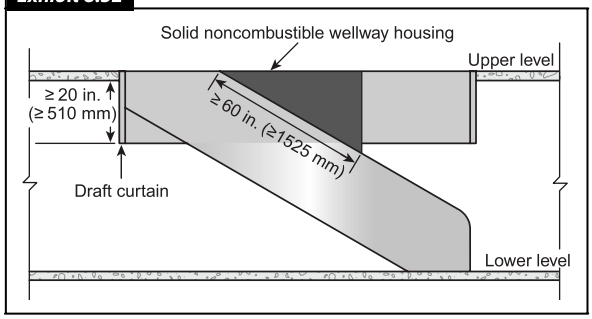
Chart 6.1.1.1
Excerpts from NFPA *101*®-2018, Life Safety Code® Handbook (Cont'd)

Exhibit 8.31



Area of coverage for spray nozzle method of protecting escalator openings.

Exhibit 8.32



The draft curtain and wellway housing method of protecting vertical openings.

design should meet the following eight criteria and be approved by the AHJ.

1. Spray nozzles should be of the open type and should have a solid conical spray pattern with discharge angles between 45 degrees and 90 degrees. The number of nozzles, their discharge angles, and their location should be such that the escalator or moving walk opening between the top of the wellway housing and the treadway will be completely filled with dense spray on operation of the system.

2. The number and size of nozzles and water supply should be sufficient to deliver a discharge of 2 gal of water/ft^2/min (1.4 L of water/m^2/s) through the wellway with the area perpendicular to the treadway. See Exhibit 8.31.

3. Spray nozzles should be located to take full advantage of the cooling and counterdraft effects. They should be positioned so that the centerline of spray discharge is as closely in line as possible with the slope of the escalator or moving walk, not more than an angle of 30 degrees from the top slope of the wellway housing. Nozzles should also be positioned so that the centerline of discharge is at an angle of not more than 30 degrees from the vertical sides of the wellway housing.

4. Spray nozzles should discharge at a minimum pressure of 25 lb/in.^{2} (172 kPa). Water supply piping is permitted to be taken from the sprinkler system, provided that an adequate supply of water is available for the spray nozzles and that the water pressure at the sprinkler farthest from the supply riser is not reduced beyond the required minimum. Water supply taken from the sprinkler system is designed to provide protection from life hazards in the wellway opening during the exit period but is not to be relied on to provide an effective floor cutoff.

5. Control valves should be readily accessible to minimize water damage.

6. A noncombustible or limited-combustible draft curtain should be provided that extends at least 20 in. (510 mm) below and around the opening, and a solid noncombustible wellway housing at least 60 in. (1525 mm) long, measured parallel to the handrail and extending from the top of the handrail enclosure to the soffit of the stairway or ceiling above, should also be provided at each escalator floor opening. Where necessary, spray nozzles should be protected against mechanical damage or tampering that might interfere with proper discharge. See Exhibit 8.32.

7. The spray nozzle system should operate automatically from thermal-response elements of the fixed-temperature type and be located with respect to the ceiling/floor opening so that the spray nozzle system actuates upon the advance of heat toward the escalator opening. Supervised smoke detection located in or near the escalator opening is permitted to be used to sound an alarm. The spray nozzle system should also be provided with manual means of operation. It is not desirable to have smoke detectors activate the spray nozzles; safeguards against accidental discharge must be provided to prevent both panic and property damage.

8. Control valves for the spray nozzle system and approved smoke detection or thermostatic devices should be electrically supervised in accordance with the applicable provisions of 9.7.2.

Partial Enclosure Method. Under the conditions specified, escalator or moving walk openings are permitted to be protected by a partial enclosure, or so-called kiosk, designed to provide an effective barrier to the spread of smoke from floor to floor. This method of fire protection should meet the following two criteria and be approved by the AHJ.

1. Partial enclosure construction should provide fire resistance equivalent to that specified for stairway enclosures in the same building, with openings therein protected by approved, self-closing fire doors. The openings are also permitted to be of approved wired-glass and metal frame construction with wired-glass panel doors.

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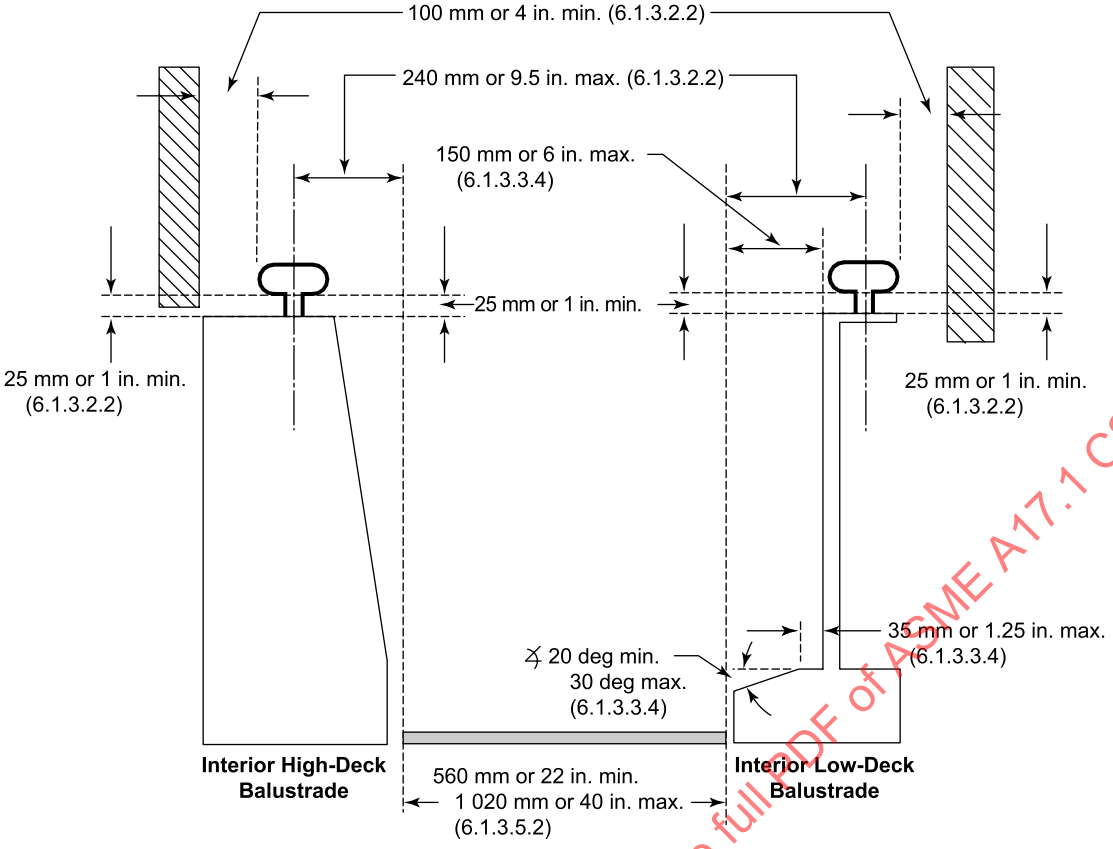
Chart 6.1.1.1
Excerpts from NFPA *101*®-2018, Life Safety Code® Handbook (Cont'd)

2. Fire doors are permitted to be equipped with an electric opening mechanism, which opens the door automatically upon the approach of a person. The mechanism should return the door to its closed position upon any interruption of electric current supply, and it should be adjusted so that the pressures generated by a fire will not cause the door to open.

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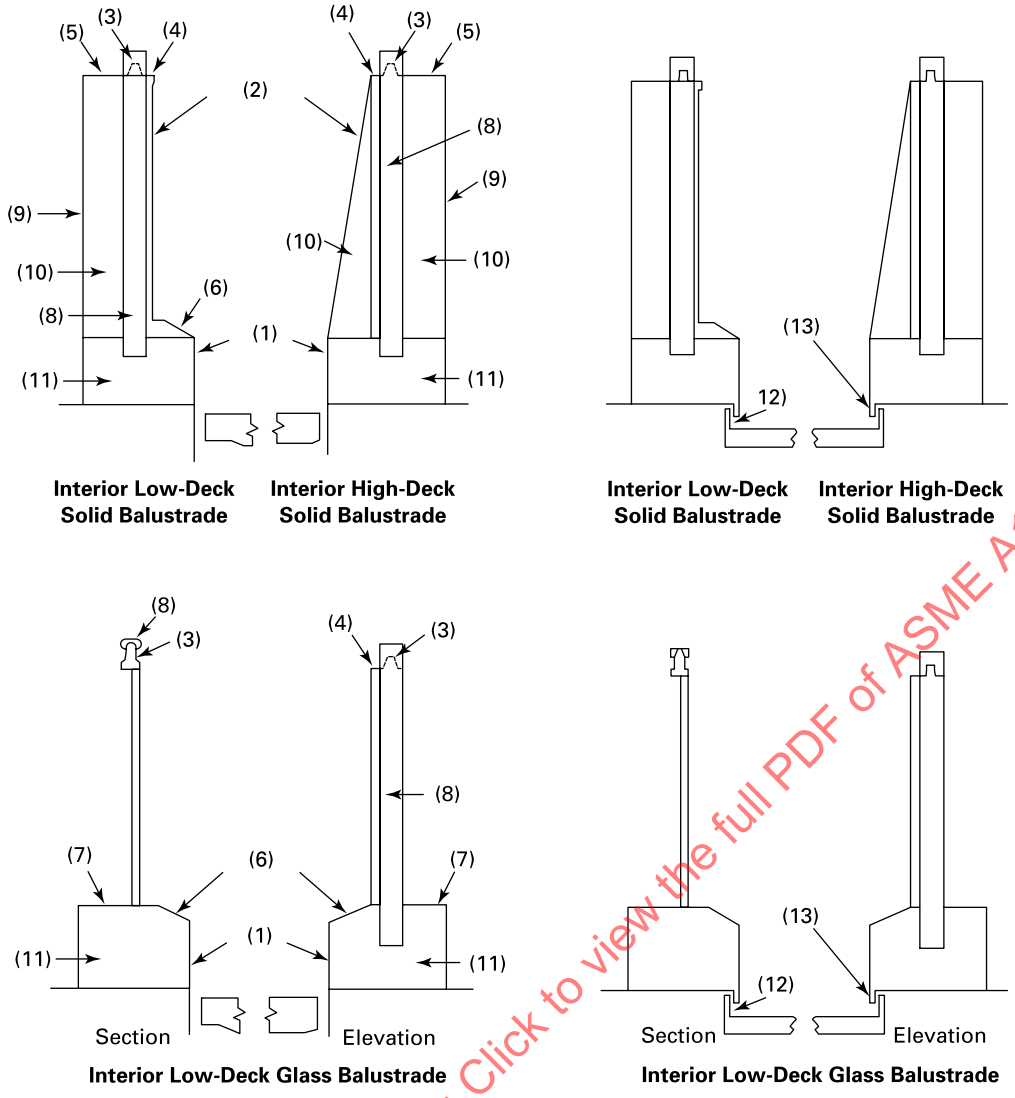
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Diagram 6.1.3(a)
Relationship of Escalator Parts



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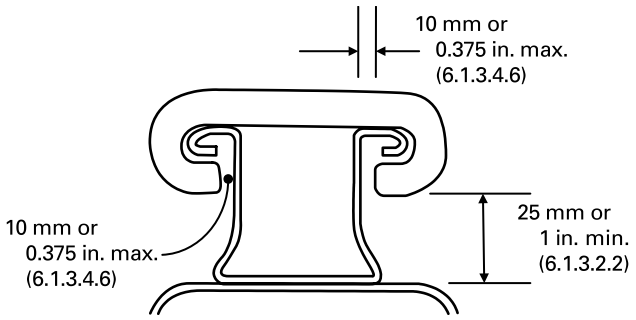
Diagram 6.1.3(b)
Escalator Nomenclature



LEGEND:
(1) Skirt panel
(2) Interior panel
(3) Handrail stand
(4) High-deck interior
(5) High-deck exterior
(6) Low-deck interior
(7) Low-deck exterior
(8) Handrail
(9) Exterior panel
(10) Newel
(11) Newel base
(12) Dynamic skirt panel
(13) Dynamic skirt panel cover

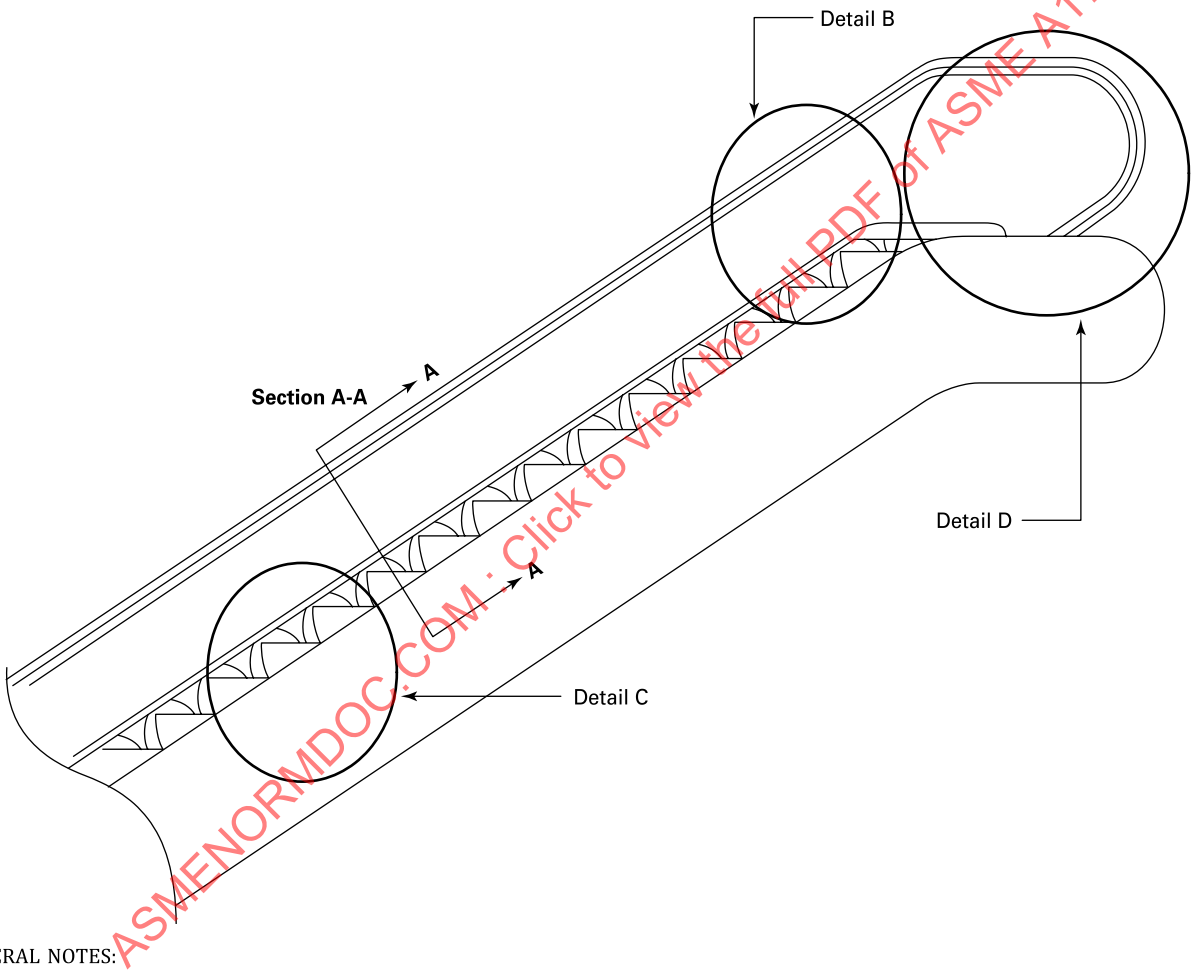
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Diagram 6.1.3.2
Handrail



GENERAL NOTE: Courtesy of Davis. L Turner.

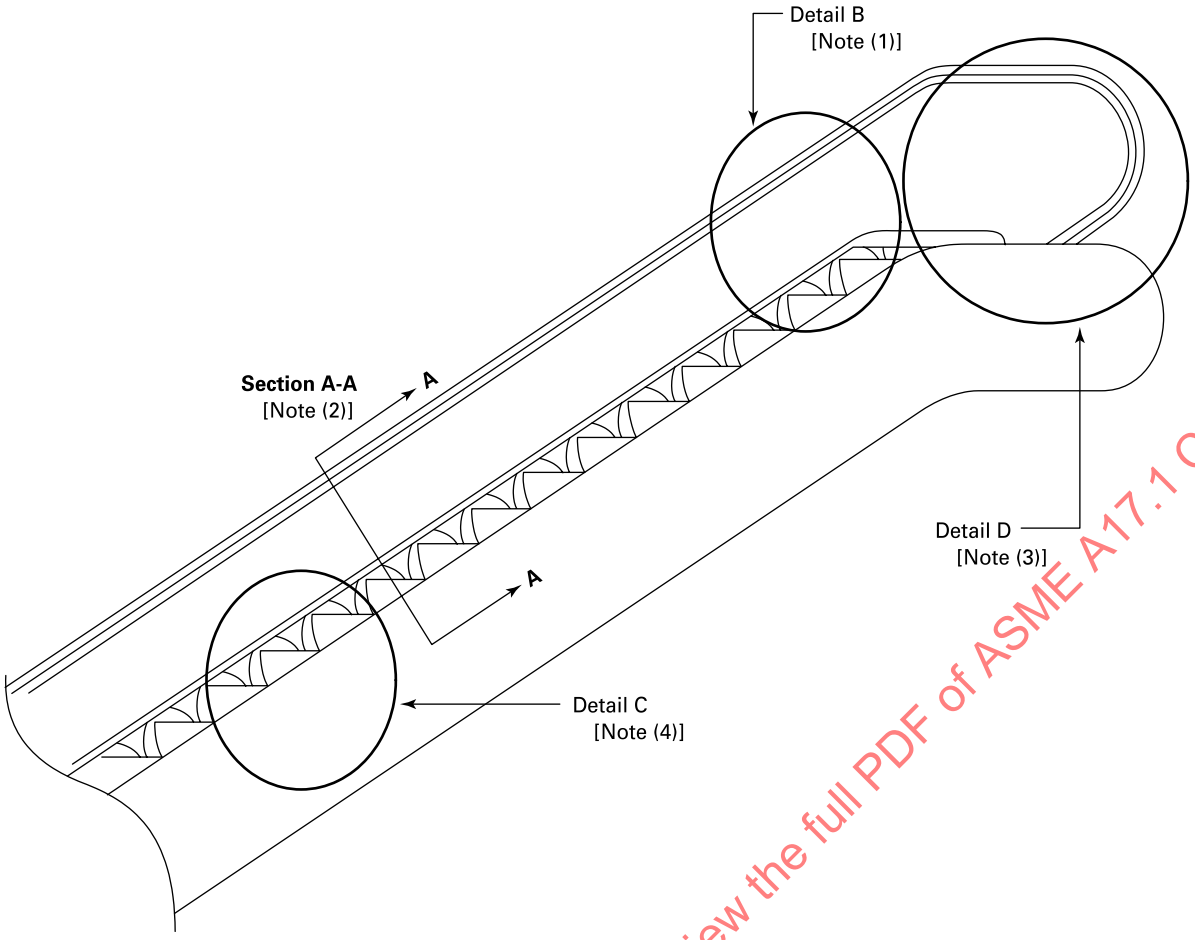
Diagram 6.1.3.3.4(a)
Dynamic Escalator Skirt Panels



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co.
(b) Diagrams 6.1.3.3.4(a) through 6.1.3.3.4(c) and Diagrams 6.1.3.3.7(a) through 6.1.3.3.7(c) show some of the requirements introduced in the 2004 Code related to dynamic skirt panels that *move with the steps* in place of stationary skirt panels.

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Diagram 6.1.3.3.4(b)
Dynamic Escalator Skirt Panels



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co.
(b) Diagrams 6.1.3.3.4(a) through 6.1.3.3.4(c) and Diagrams 6.1.3.3.7(a) through 6.1.3.3.7(c) show some of the requirements introduced in the 2004 Code related to dynamic skirt panels that *move with the steps* in place of stationary skirt panels.

NOTES:
(1) Detail B:

Requirement	Purpose
6.1.3.3.8 Dynamic skirt panel and step loaded gap requirement	Add safety requirement to minimize gap between dynamic skirt panel and step

(2) Section A-A:

Requirement	Purpose
6.1.3.3.7(f) Dynamic skirt panel and dynamic skirt panel cover gap requirement	Add gap requirement to interface between dynamic skirt panel and nonmoving cover
6.1.3.3.4(d) Strength requirement on dynamic skirt panel cover + interior deck	Add a strength requirement for this assembly with new support arrangement
6.1.3.3.4(a) Width from dynamic skirt panel to vertical face of interior panel	Comply with existing rules for construction of escalator

(3) Detail D:

Requirement	Purpose
6.1.3.3.7(c) Dynamic skirt panel entry guarding and max. gap requirement	Add safety requirement for dynamic skirt panel entry area

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Diagram 6.1.3.3.4(b)
Dynamic Escalator Skirt Panels (Cont'd)

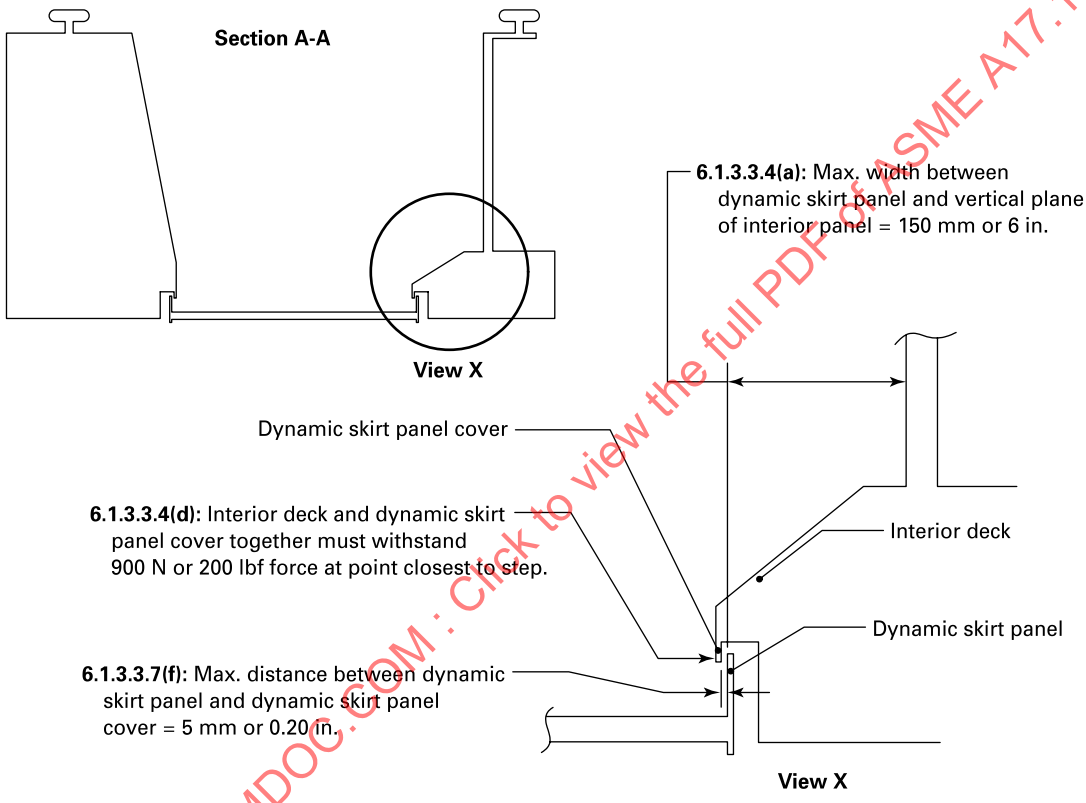
NOTES (Cont'd)

Requirement	Purpose

(4) Detail C:

Requirement	Purpose
6.1.3.3.7(a) Dynamic skirt panel vertical height requirement	Add safety requirement consistent with existing requirement for skirt height
6.1.3.3.7(d) Clearance between dynamic skirt panels requirement	Add safety requirement for gap between dynamic skirt panels

Diagram 6.1.3.3.4(c)
Dynamic Escalator Skirt Panels



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co.
(b) Diagrams 6.1.3.3.4(a) through 6.1.3.3.4(c) and Diagrams 6.1.3.3.7(a) through 6.1.3.3.7(c) show some of the requirements introduced in the 2004 Code related to dynamic skirt panels that *move with the steps* in place of stationary skirt panels.

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Diagram 6.1.3.3.6(a)
Skirt Assembly

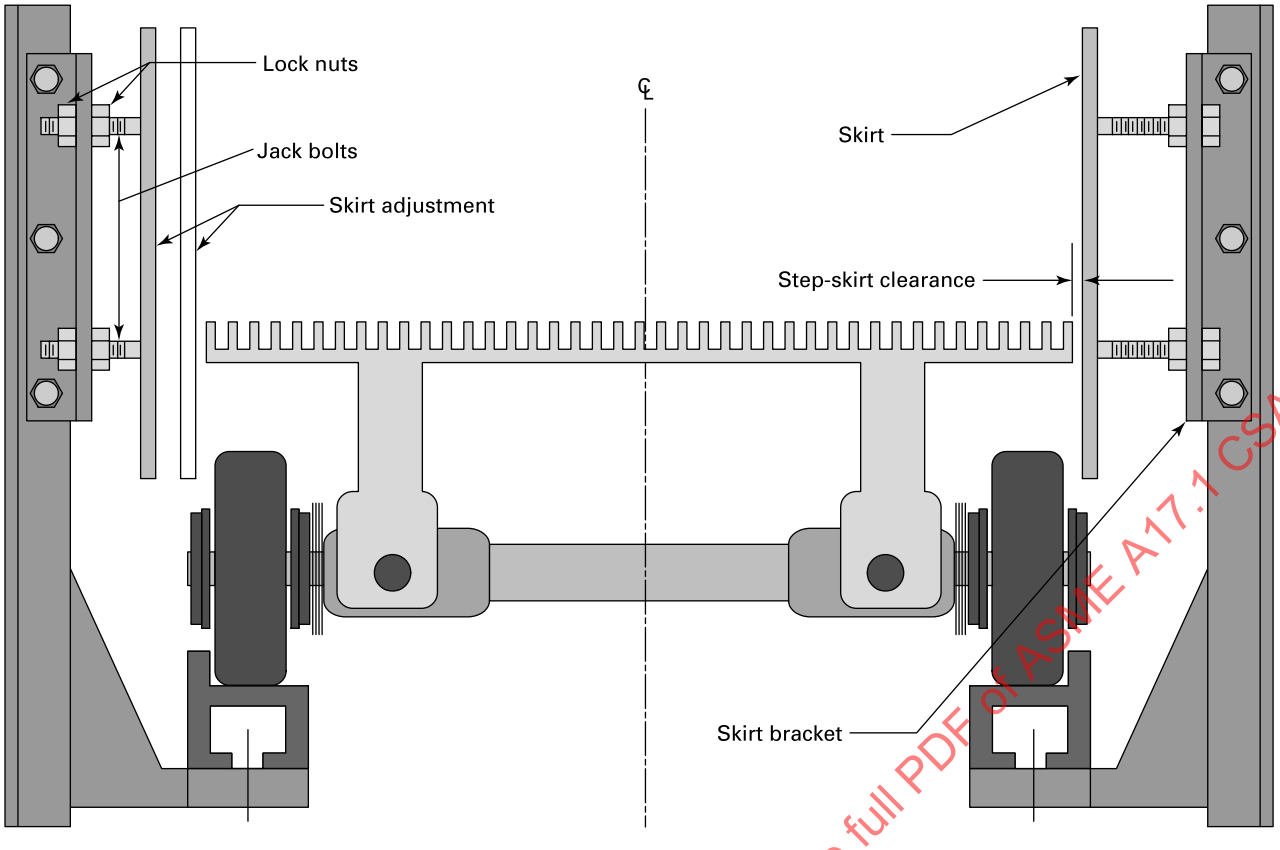
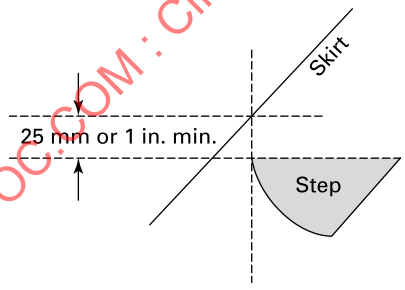
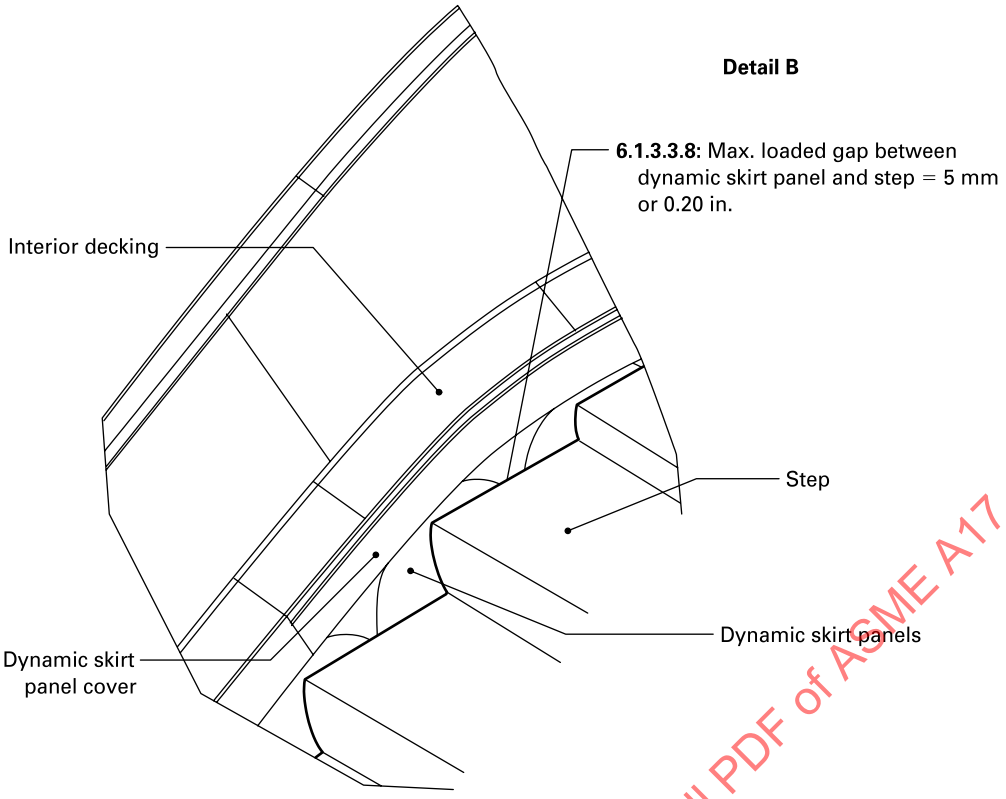


Diagram 6.1.3.3.6(b)
Skirt Panel — Step Nose



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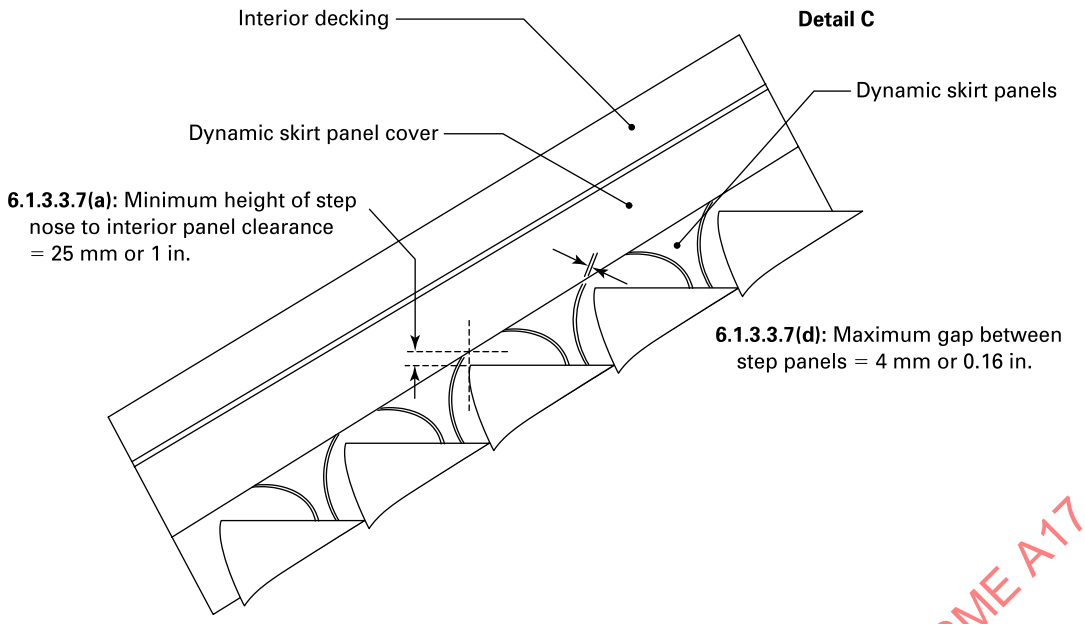
Diagram 6.1.3.3.7(a)
Dynamic Escalator Skirt Panels



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co.
(b) Diagrams 6.1.3.3.4(a) through 6.1.3.3.4(c) and Diagrams 6.1.3.3.7(a) through 6.1.3.3.7(c) show some of the requirements introduced in the 2004 Code related to dynamic skirt panels that *move with the steps* in place of stationary skirt panels.

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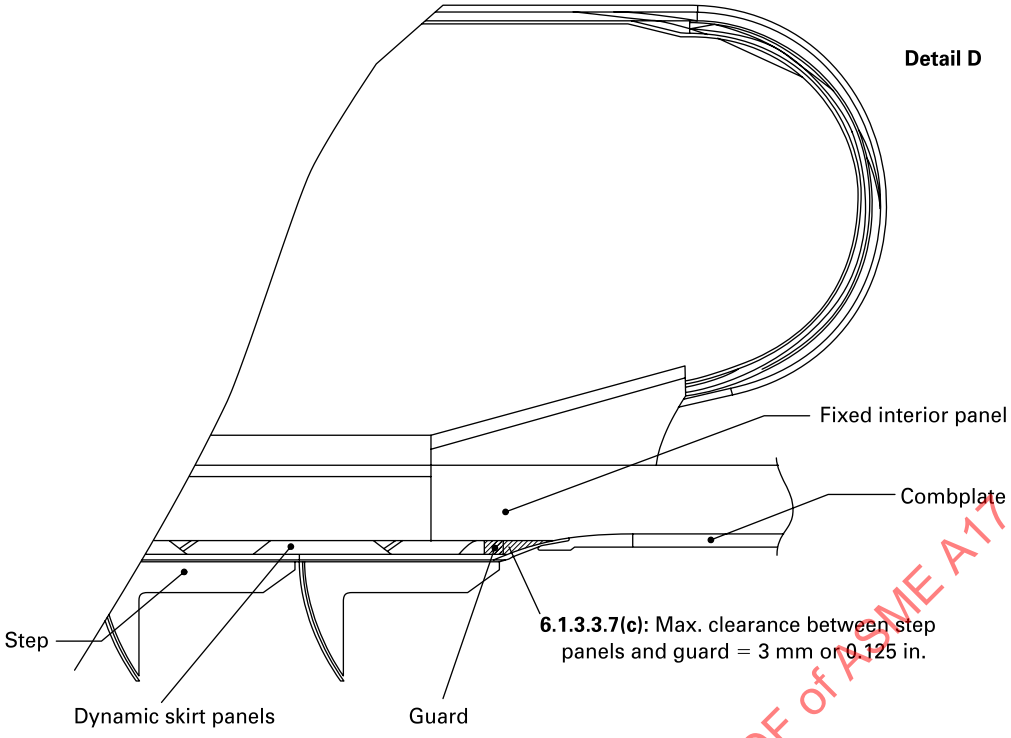
Diagram 6.1.3.3.7(b)
Dynamic Escalator Skirt Panels



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co.
(b) Diagrams 6.1.3.3.4(a) through 6.1.3.3.4(c) and Diagrams 6.1.3.3.7(a) through 6.1.3.3.7(c) show some of the requirements introduced in the 2004 Code related to dynamic skirt panels that *move with the steps* in place of stationary skirt panels.

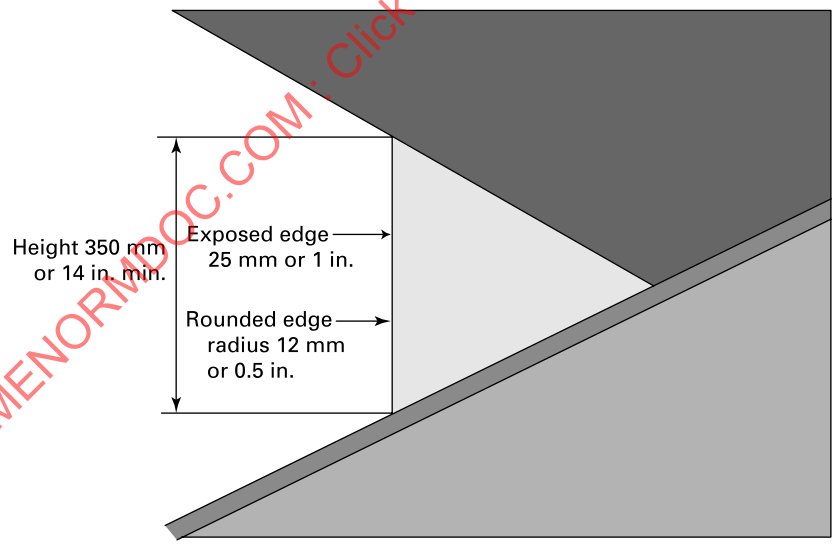
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Diagram 6.1.3.3.7(c)
Dynamic Escalator Skirt Panels



GENERAL NOTES:
(a) Courtesy of Otis Elevator Co.
(b) Diagrams 6.1.3.3.4(a) through 6.1.3.3.4(c) and Diagrams 6.1.3.3.7(a) through 6.1.3.3.7(c) show some of the requirements introduced in the 2004 Code related to dynamic skirt panels that *move with the steps* in place of stationary skirt panels.

Diagram 6.1.3.3.11
Ceiling or Soffit Guard



GENERAL NOTE: Courtesy of Davis L. Turner.

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Diagram 6.1.3.3.12(a)
High Deck Balustrade Antislide Devices

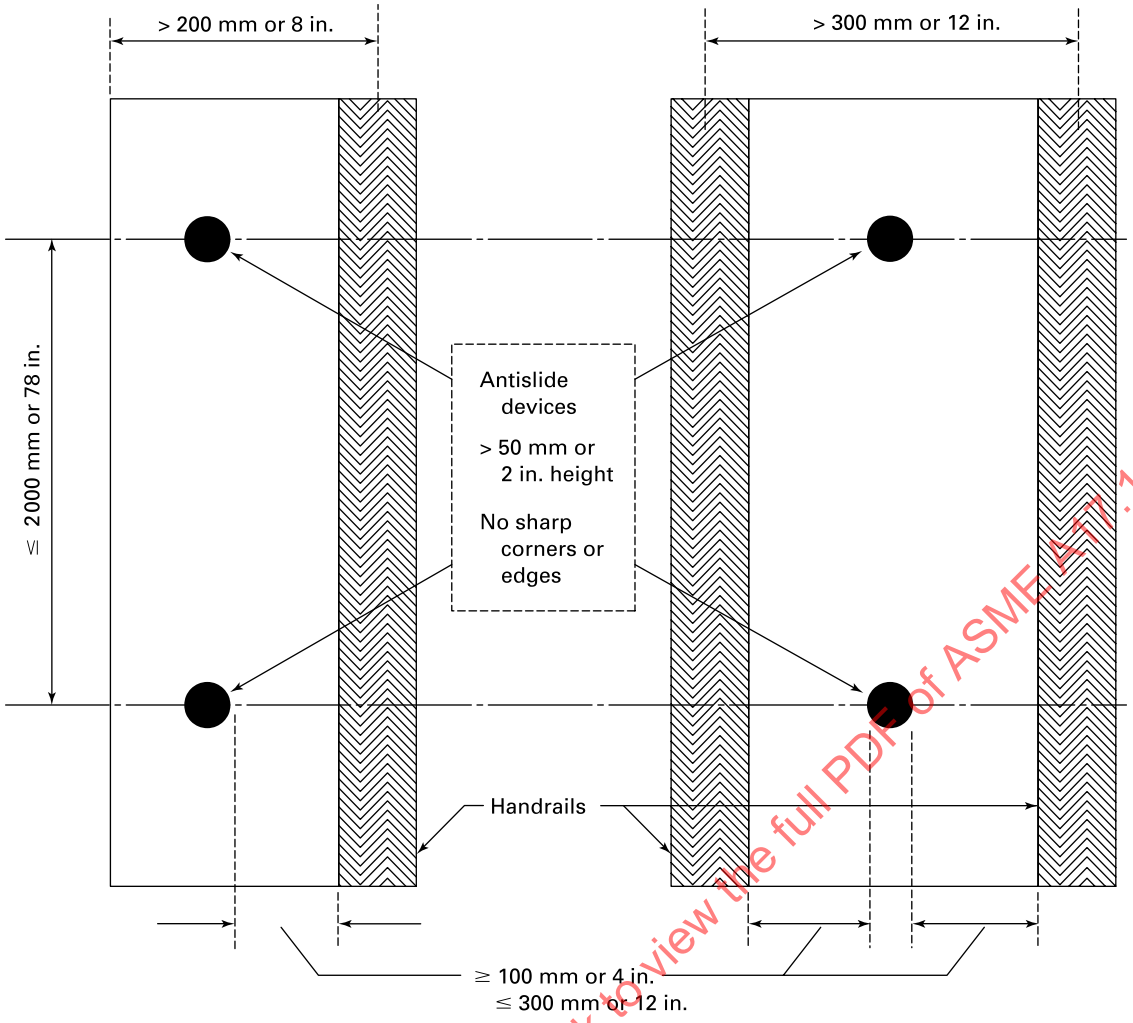
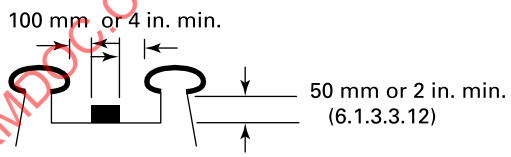


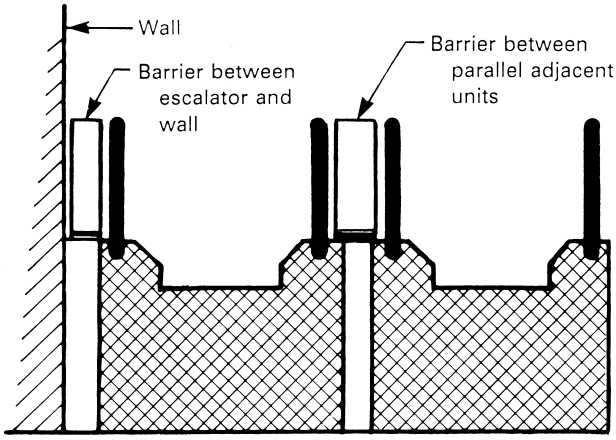
Diagram 6.1.3.3.12(b)
Antislide Devices

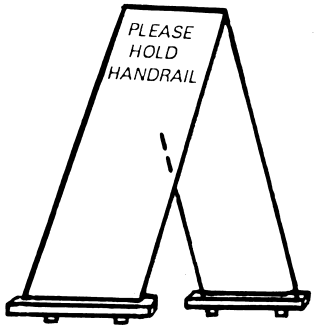


GENERAL NOTE: Courtesy of Davis L. Turner.

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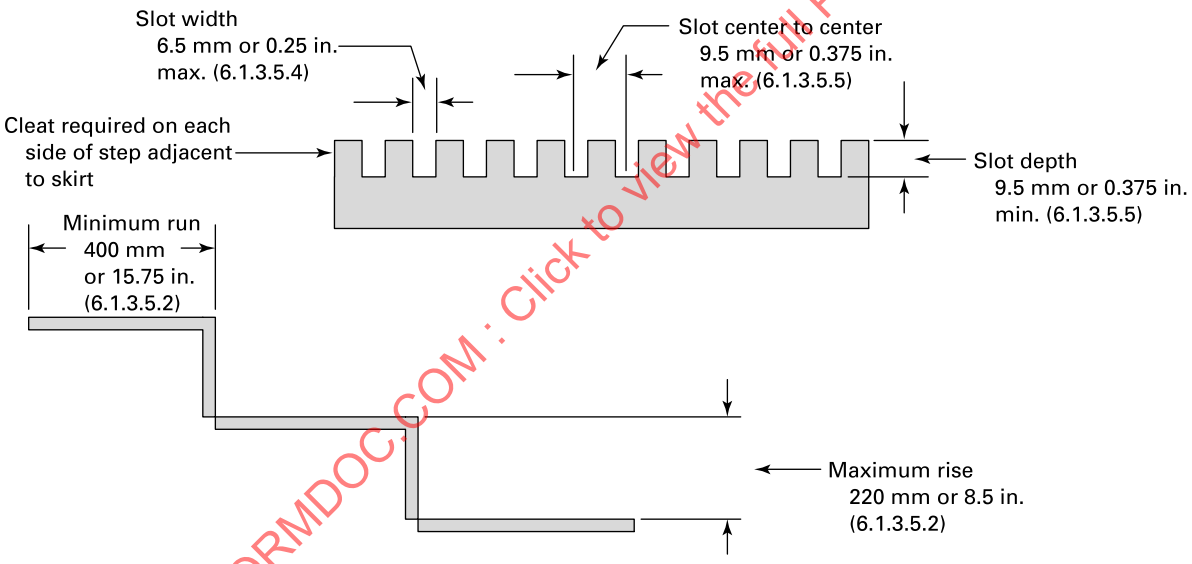
Diagram 6.1.3.3.13
Deck Barricade





Typical Design
(Other Designs Acceptable)

Diagram 6.1.3.5.2
Escalator Step Tread



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Diagram 6.1.3.5.3
Cleated Riser

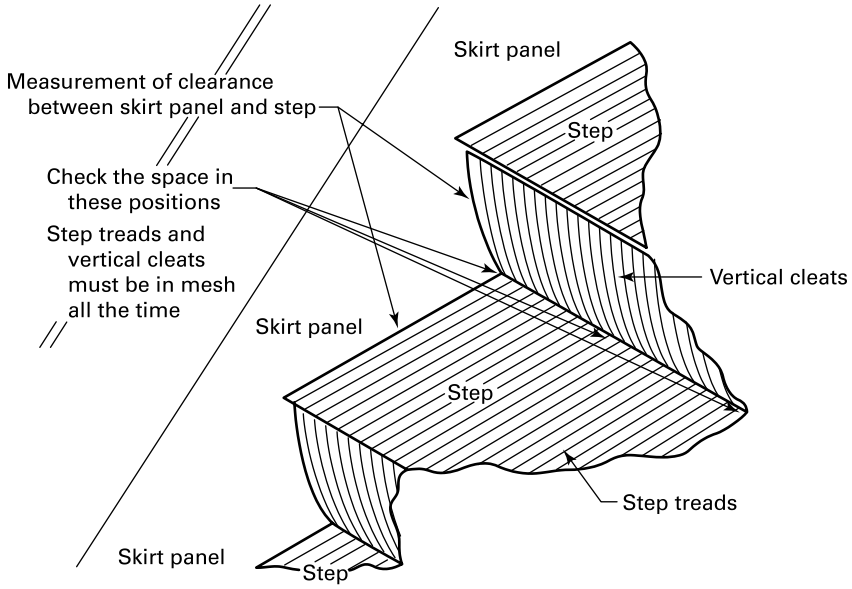
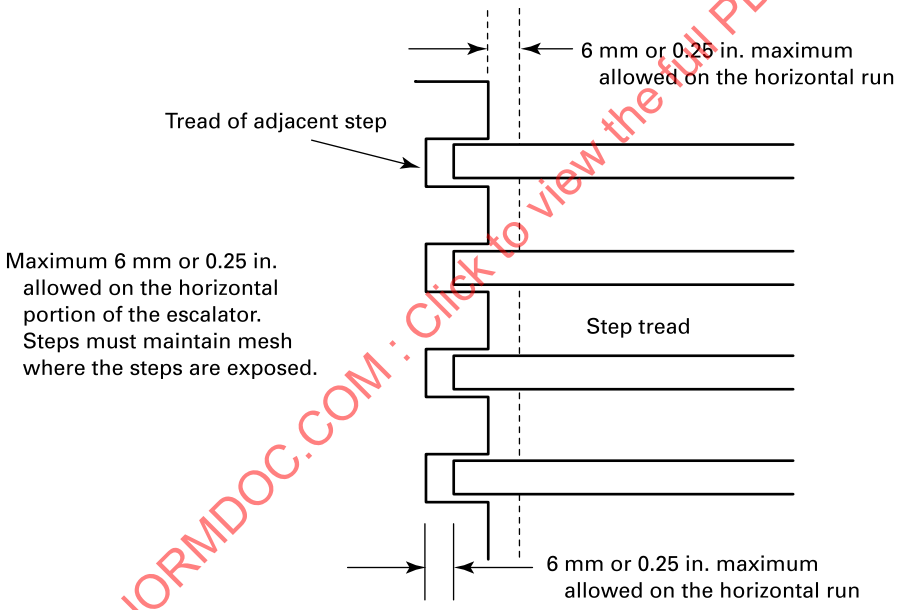


Diagram 6.1.3.5.4
Clearance Between Escalator Steps



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Diagram 6.1.3.6.4
Safety Zone

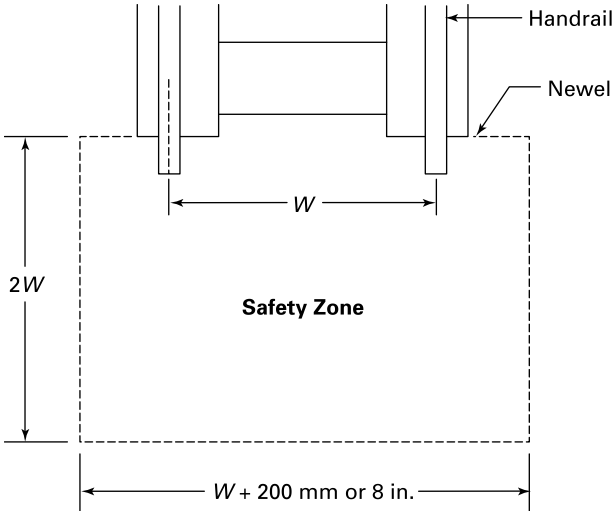
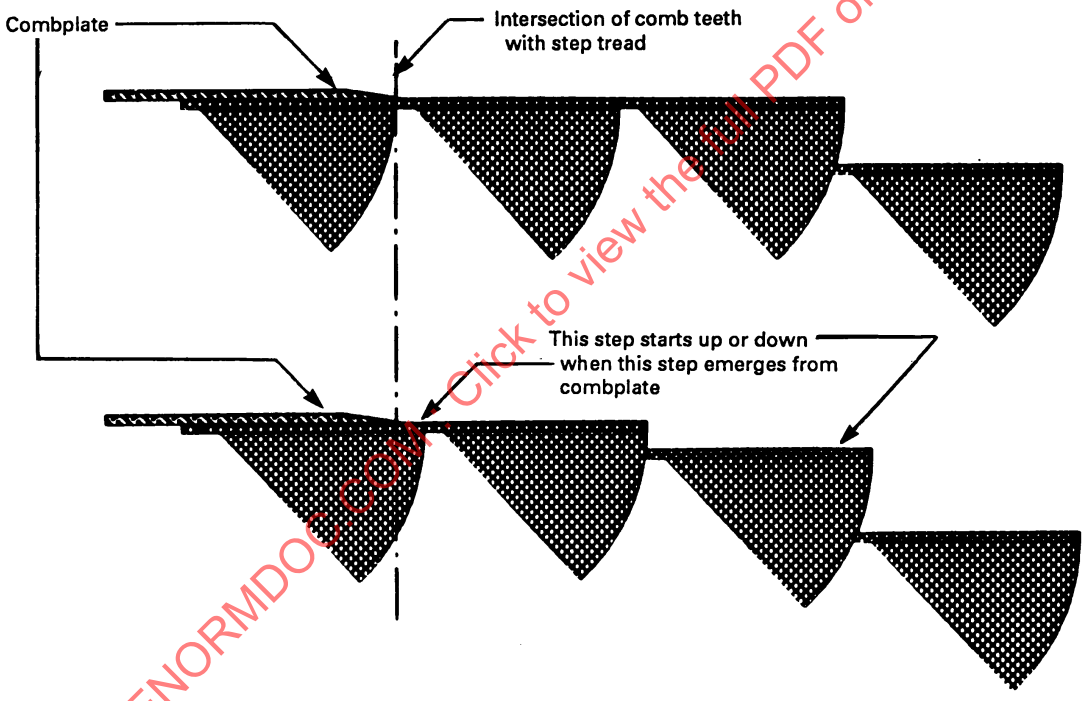
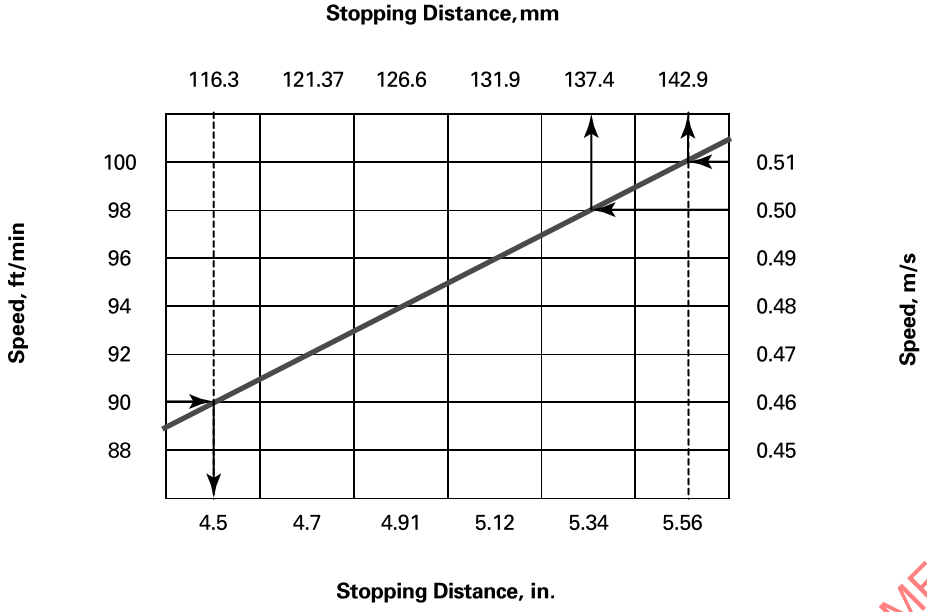


Diagram 6.1.3.6.5
Two Flat Steps



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Diagram 6.1.5.3.1(c)
Escalator and Moving Walk Stopping Distances



GENERAL NOTES:

(a) Courtesy of Davis L. Turner.

(b) The example shows escalator stopping distance in both SI and Imperial units. An escalator operating at 0.5 m/s has a minimum stopping distance of 137.4 mm and a maximum deceleration of 0.91 m/s^2; likewise, an escalator operating at 90 ft/min has a minimum stopping distance of 4.5 in. and a maximum deceleration of 3 ft/sec^2.

(c) Conversion of SI units to Imperial units results in slight discrepancies between the values shown on the graph; the stopping distance values given in millimeters are based on speed given in millimeters per second, whereas the stopping distance values given in inches are based on speed given in feet per minute.

(d) Calculations:

(*SI Units*)

$$s = \frac{v^2}{2a} \times 1\,000$$

(Imperial Units)

$$s = \frac{v^2}{2a} \times \frac{1}{300}$$

where

a = average deceleration, 0.91 m/s^2 or 3 ft/sec^2

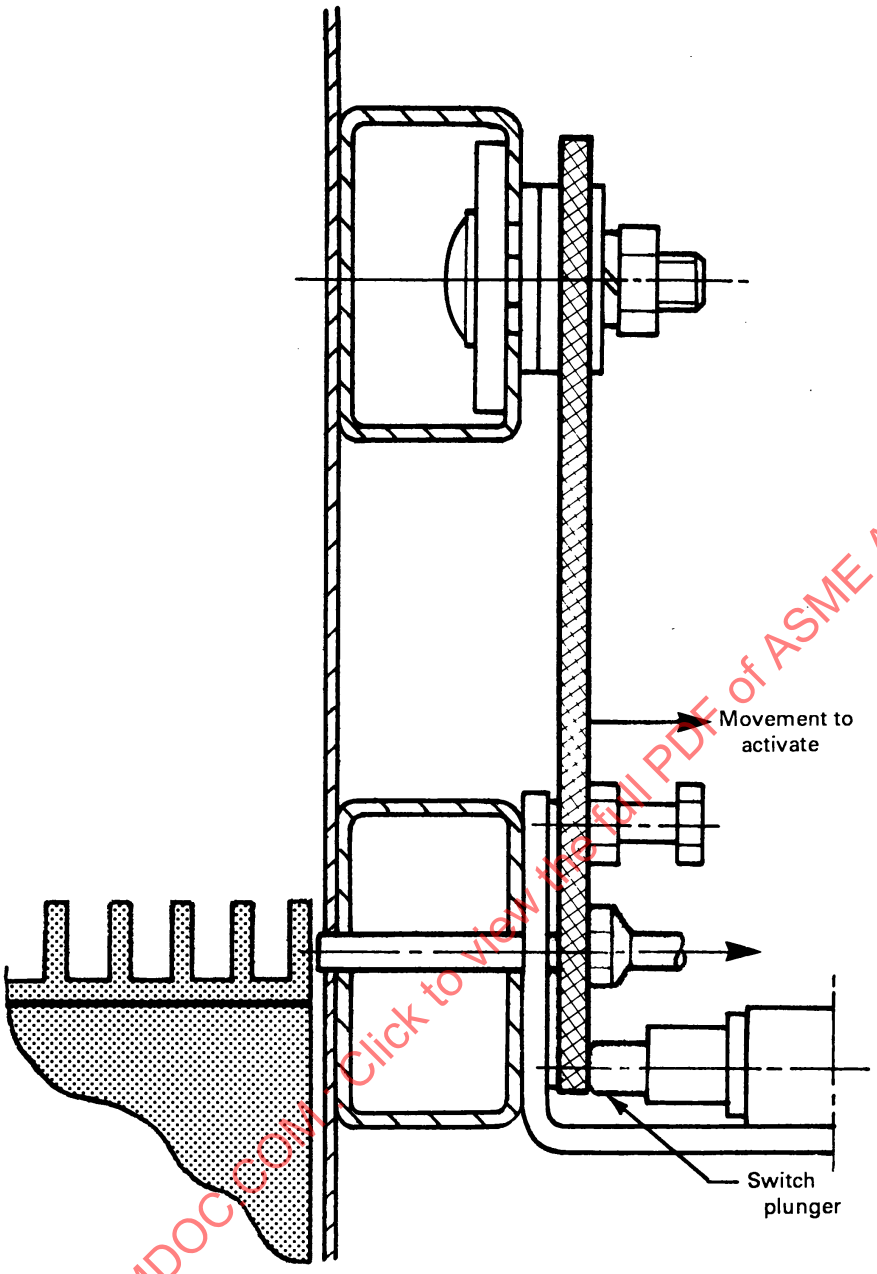
s = stopping distance, mm or in.

v = escalator or moving walk speed, m/s or ft/min =

Speed, m/s (ft/min)	Stopping Distance at 0.91 m/s^2, mm (3 ft/sec^2, in.)
0.40 (90)	87.9 (4.50)
0.42 (92)	96.9 (4.70)
0.44 (94)	106.3 (4.91)
0.46 (96)	116.3 (5.12)
0.48 (98)	126.6 (5.34)
0.50 (100)	137.4 (5.56)
0.52	148.6

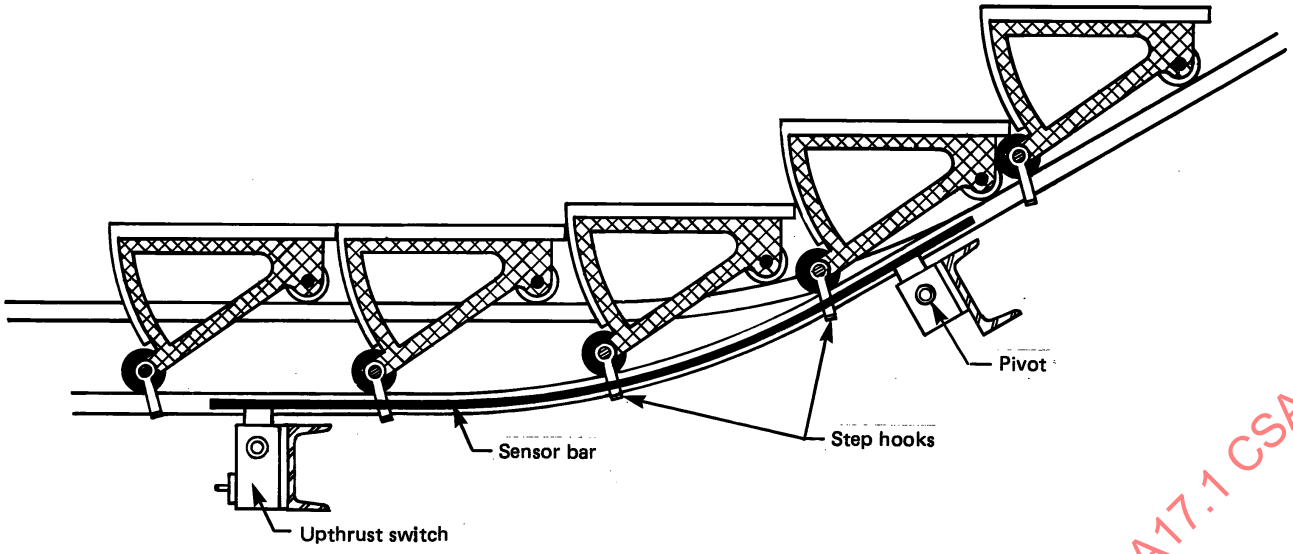
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Diagram 6.1.6.3.6
Typical Escalator Skirt Obstruction Device



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Diagram 6.1.6.3.9
Typical Step Upthrust Device



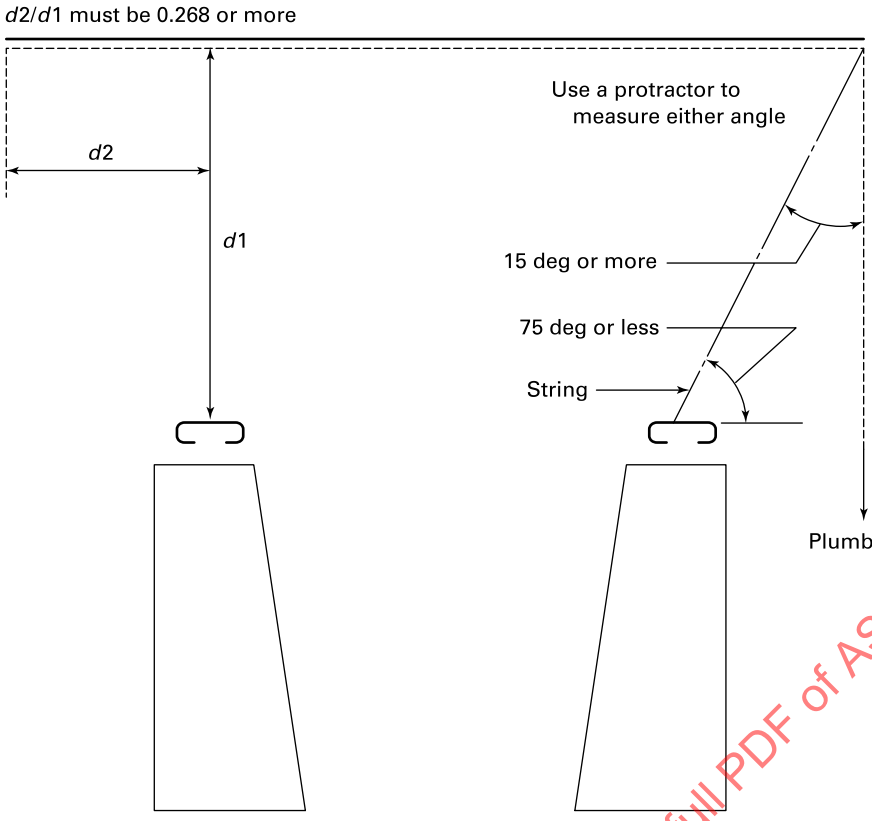
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Diagram 6.1.6.6
Typical Tandem-Operated Escalator Installation

GENERAL NOTE: Courtesy of Schindler Elevator Co.

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Diagram 6.1.8.2
Outdoor Escalator Cover



Two Methods for Checking Compliance With 6.1.8.2 Cover Requirement

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SECTION 6.2
MOVING WALKS

Moving walks are for transporting people only, not for moving heavy, bulky, crude objects or carts, which may cause overloading or damage that could contribute to failure of parts, scratching of skirts, congestion, or jam-ups that could cause an unsafe condition.

6.2.1 Protection of Floor Openings

6.2.1.1 Protection Required. Moving walks passing through fire-rated floor assemblies must have their openings protected against the passage of flame, heat, and/or smoke. If not, fire has a clear path of travel from one floor to another. Typically, moving walks do not pass through fire-rated floor assemblies, and in these cases, no protection of the opening is required. An example of this type of construction is a moving walk serving two floors within an atrium.

The building code is an ordinance that sets forth requirements for building design and construction; where such an ordinance has not been enacted, compliance with one of the following model codes is required:

(a) International Building Code (IBC)

(b) NFPA 5000®, Building Construction and Safety Code

(c) National Building Code of Canada (NBCC)

Most building codes in the United States are based on one of the model building codes. The IBC is the model building code most widely adopted in the United States. It is published by the International Code Council (ICC). The National Fire Protection Association (NFPA) publishes NFPA 5000®. To the author's knowledge, NFPA 5000® has not been adopted by any major jurisdiction at this time. The model building code used in Canada is the NBCC, which is promulgated by National Research Council of Canada.

Building codes recognize that moving walks do not need to be fully enclosed, since moving walks are not normally part of a required means of egress. Chart 6.1.1.1 (excerpts from NFPA 101®) describes several methods that are utilized in completely sprinklered buildings where the moving walks are not used as exits, which permit them to be unenclosed between floors. The reader is cautioned to check building code requirements before proceeding to use any of the methods described in Chart 6.1.1.1.

6.2.2 Protection of Supports and Machine Spaces Against Fire

6.2.2.1 Protection Required. The sides and undersides of moving walk trusses and machinery spaces must be enclosed in noncombustible or limited-combustible materials to protect the trusses from heat during a fire in the vicinity immediately outside the truss. The Life Safety Code, NFPA 101®-2021 defines "limited-combustible" and "noncombustible" as follows:

> *(a) limited-combustible:* refers to a building construction material not complying with the definition of noncombustible (see 4.6.13) that, in the form in which it is used, has a potential heat value not exceeding 3,500 Btu/lb (8141 kJ/kg), where tested in accordance with NFPA 259 and includes
>
> *(1)* materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of (3.2 mm) $\frac{1}{8}$ in. that has a flame spread index not greater than 50 when tested in accordance with ASTM E84 or ANSI/UL 723 and
>
> *(2)* materials, in the form and thickness used, having neither a flame spread index greater than 25 nor evidence of continued progressive combustion, and of such composition that surfaces that would be exposed by cutting through the material on any plane would have neither a flame spread index greater than 25 nor evidence of continued progressive combustion in accordance with ASTM E84 or ANSI/UL 723
>
> *(b) noncombustible:* refers to a material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors, when subjected to fire or heat. Materials that are reported as passing ASTM E136, Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C are considered noncombustible materials. Materials that are reported as complying with the pass/fail criteria of ASTM E136 when tested in accordance with the test method and procedure in ASTM E2652, Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-Shaped Airflow Stabilizer, at 750°C are also considered noncombustible materials.

Compliance with this requirement will assist in containing a fire that may start within the truss. It can be met simply by applying gypsum drywall or an equally noncombustible or limited-combustible material on the outside of the truss and machinery space. No hourly rating is required. A truss or machinery space suspended in an approved fire-rated ceiling assembly, where the truss is exposed within that assembly, does not meet this requirement. The truss and machinery space sides and undersides must be separately enclosed within the rated ceiling assembly. Noncombustible or limited-combustible material is not required between multiple moving walks in a single wellway. Dampers in the noncombustible or limited-combustible material enclosing the truss must be provided with fire links, which will close the opening when there is a fire.

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6.2.3 Construction Requirements

See Diagrams 6.2.3(a) and 6.2.3(b).

6.2.3.1 Angle of Inclination. An angle of inclination above those specified by this requirement is considered too steep for safe use. A larger angle of inclination may cause foot strain and/or dizziness in some riders. See Diagram 6.2.3.1.

Requirement 6.2.3.1 was revised in ASME A17.1-2022/CSA B44:22 to require the angle to be measured from the floor surface along the path of the moving walk as opposed to the landing plate. This change accounts for the fact that moving walks are not always located on a horizontal floor surface but may be installed on an inclined floor surface. This will prevent the moving walk from having an excessive angle of inclination.

6.2.3.2 Geometry. The handrail clearances reduce entrapment and shear exposure and position the handrail to facilitate its use. These clearances must be maintained wherever the handrail is exposed. Components of the handrail guard are not subject to this requirement. See Diagram 6.2.3(b).

Requirement 6.2.3.2.2 was revised in ASME A17.1-2022/CSA B44:22 to increase the maximum height of the balustrade to 1 100 mm or 43 in. The change was made to increase stability while riding the moving walk and to deter misuse.

6.2.3.3 Balustrades

6.2.3.3.1 Construction. Glass balustrades require gaps of about 5 mm or $^{3}/_{16}$ in. between glass panels to allow for expansion. This condition is allowed. Raised or depressed areas of molding more than 6.4 mm or $^{1}/_{4}$ in. high could snag clothing, packages, and parts of the body.

6.2.3.3.2 Strength. This requirement specifically states that the balustrades shall be designed to resist the forces specified. There is no ASME A17.1/CSA B44 requirement to test the design in the field. Conformance with the design requirement may be verified by examining the manufacturer's design criteria. This requirement simply means that the balustrade has been designed to "resist" the applied load and when the load is removed, there is no permanent deformation or damage.

Compliance with this requirement provides riders stability and support when entering, exiting, or riding the moving walk.

6.2.3.3.3 Use of Glass or Plastic. See Handbook commentary on 2.14.1.8 for additional information on glass and plastics.

6.2.3.3.4 Interior Low Deck. The requirements provide a maximum angle of the interior deck profile that assists in preventing a rider from slipping while attempting to walk on the interior decking.

6.2.3.3.5 Skirtless Balustrade. Vertical dimension ensures that the balustrade would not have a knife edge. It should be smooth to avoid snagging clothing or footwear. Excessive deflection could contribute to objects getting caught between the balustrade and treadway. See Diagram 6.2.3.3.5.

6.2.3.3.6 Skirt Panels. The deflection requirement for the skirt panel in combination with the clearance requirement provides the best protection against accidental entrapment of a foot, finger, clothing, shoes, sneakers, etc., between the skirt and the pallet. Entrapment incidents rarely occur on a moving walk as the walkway surface is moving in a parallel directionto the skirt. Vertical dimension ensures that the balustrade would not have a knife edge. It should be smooth to avoid snagging clothing or footwear. Excessive deflection could contribute to objects getting caught between the balustrade and treadway. See Diagram 6.2.3(a).

6.2.3.3.7 Guard at Ceiling Intersections. A solid guard must be provided in the intersecting angle of each outside top of the balustrade and the point of penetration of the ceiling or soffit. It is not required on high deck moving walks where the side of the penetration at the ceiling or soffit is more than 600 mm or 24 in. from the centerline of the handrail or on low deck moving walks where the centerline of the handrail is more than 350 mm or 14 in. from the centerline of the soffit. The vertical edge of the guard must be a minimum of 350 mm or 14 in. and be flush with the face of the wellway. The leading edge or the exposed edge of the guard should be vertical and must be rounded. The material used for the guard should be solid without holes or openings passing through it. Glass or plastic can be used for the guards as long as they conform to the requirements of 6.2.3.3.3. This guard protects moving walk passengers, if they are leaning off to the side of an up-traveling moving walk, from the possibility of trapping their heads or arms in the angle where the moving walk and ceiling or soffit meet. See Diagram 6.1.3.3.11.

6.2.3.3.8 Deck Barricades. Deck barricades discourage people, especially small children, from walking or going up or down the low deck exterior balustrade from the ground level. See Diagram 6.1.3.3.13. Barricade attachment fasteners are required to be tamper resistant to discourage and/or prevent the removal of some or all of the fasteners and/or the barricade itself, which would create a dangerous falling hazard.

6.2.3.3.8(c) Prevents objects or persons from being in the area between parallel panels and experiencing uncontrolled descent down the length of the incline.

6.2.3.4 Handrails

6.2.3.4.1 Type Required. A handrail not moving in the same direction or speed would have a tendency to pull passengers backward or forward, causing them to

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lose their balance. It is not necessary for the handrail to move at exactly the same speed as the pallet since passengers can easily adjust the position of their hands to compensate for minor differences in speeds. The minimum handrail driving force is necessary to ensure that the handrail continues to operate under a passenger load.

6.2.3.4.2 Extension Beyond Combplates. This requirement allows passengers to grab hold of a handrail before they step on to the moving walk and allows them to continue to hold on to the handrail until they have completely stepped off the moving portion of the moving walk. The moving handrail extending beyond the exit point also has the tendency to immediately move the passenger away from the exit, thus reducing bunching at this location. See Diagram 6.2.3.4.2.

6.2.3.4.3 Guards. Hand or finger guards provide protection for the curious, especially children, who want to explore the area where the handrail enters the balustrade. Also see Handbook commentary on 6.2.6.3.10 for additional information.

6.2.3.4.4 Splicing. Although field splicing of moving walk handrails is rare, it is done occasionally.

6.2.3.4.5 Handrail Clearance. This requirement provides a limitation of a dimension that, if excessive, can permit fingers to become caught. See Diagram 6.2.3(b).

6.2.3.5 Pallet-Type Treadway. A pallet-type treadway is a treadway consisting of closely coupled intermeshing pallets or small platforms, with the exposed surface of each being grooved. Diagram 6.2.3.5 illustrates a pallet-type treadway.

6.2.3.5.1 Slotting of Treadway. The safety principles of the slots in the tread are the same for moving walks and escalators. Therefore, the dimensions are the same. See Diagram 6.2.3.5.1. See Handbook commentary in 6.1.3.5.5.

Requirement 6.2.3.5.1 was revised in ASME A17.1-2022/CSA B44:22 to update the slot width in the treadway for consistency.

6.2.3.5.2 Intermeshing Pallets. The intermeshing of adjacent pallet slots protects against entrapment of a foot or finger and articles of clothing such as shoes and sneakers. See also Handbook commentary on 6.2.3.8.

6.2.3.5.3 Alignment of Pallet Tread Surfaces. Since people have a tendency to walk on the moving walk, no abrupt changes in the walk surface should occur, which could create tripping hazards.

6.2.3.5.4 Pallet Fatigue Tests. See Handbook commentary on 8.3.11.

6.2.3.5.5 Material and Type. A concern addressed by the requirement is the potential of moving walk components spreading a fire.

6.2.3.5.5(a) While the flame spread index for magnesium complies with Code requirements, input and comments from firefighters show that the temperature at which magnesium burns makes magnesium fires nearly impossible, and in fact dangerous, to fight with conventional means. Special techniques and equipment are required to combat fires with magnesium content. Operating conventional water hose lines to combat a fire involving magnesium will cause the hydrogen and oxygen to separate and react violently with the magnesium.

With myriad materials available for moving walk pallet construction, the Committee felt it prudent to follow the advice of firefighters and exclude magnesium as a suitable material, thus the "exception" in the requirement. See Material Safety Data Sheet (MSDS) for magnesium.

6.2.3.5.6 Pallet Wheels. There have been a number of instances where the wheels have become separated from the pallet. Although the one end of the pallet is still attached to the pallet chain, the other end can pivot down into the moving walk interior. If the wheels were located inside the pallet, then when the pallet pivoted down it would be stopped by the pallet wheel track located below. However, if the wheels are located outside the width of the pallet, the wheel support track is located beyond the edge of the pallet and there is nothing to prevent the pallet from pivoting into the moving walk interior. If this happens, passengers standing on the pallet could fall into the moving walk interior and be seriously hurt. This requirement is intended to prevent that condition.

6.2.3.6 Belt-Type Treadway. A belt-type treadway is a treadway consisting of an integral belt of uniform width and thickness made or spliced in one continuous piece, forming a loop. The particular design determines the belt thickness. A belt-type treadway is illustrated in Diagram 6.2.3.6(a). Some earlier moving walk designs utilized a belt-pallet-type treadway. A belt-pallet-type treadway consists of a continuous integral belt supported on coupled pallets. The pallets may not be ordinarily visible to a person standing on the treadway. A belt-pallet-type treadway is illustrated in Diagram 6.2.3.6(b).

6.2.3.6.2 Slotting of Treadway. Slotting is required for proper combing and safe footing. The fact that the tread is a belt or pallet does not change the dimensional requirements.

Requirement 6.2.3.6.2 was revised in ASME A17.1-2022/CSA B44:22 to add a reference to Figure I-10 in Nonmandatory Appendix I for consistency with the reference in 6.2.3.5.1 for pallet-type treadways.

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6.2.3.8 Entrance and Egress Ends

6.2.3.8.1 Combplates. The combplate is the section of the floor plate nearest the pallet or belt. It normally has replaceable comb segments made of brittle material such as plastic or aluminum. Comb teeth must be brittle and break rather than bend. A bent comb tooth could cause a pallet wreck, piling the pallets up at the comb. The comb teeth are so arranged that the cleats of the pallet or belt treads will pass between them with minimum clearance. This arrangement allows the pallets to move under the combplate, allowing passengers to move safely from the pallet onto the floor. Because the comb segments are not an integral part of the combplate assembly, worn or damaged comb segments can be replaced readily without disturbing the balance of the comb segments.

6.2.3.8.1(d) This requirement ensures that the combs and combplate do not drag on the pallets when a passenger is standing on them.

6.2.3.8.2 Distinction Between Comb and Treadway. A significant number of falls occur on boarding a moving walk. This requirement is important in that it requires a visual aid for passengers to assist in boarding the moving walk. This is intended to reduce the hazard by calling attention to that area.

6.2.3.8.3 Adjacent Floor Surfaces. This requirement addresses a potential tripping hazard. This requirement applies to the difference in elevation between the landing plate and the adjacent building floor, not between the comb and landing plate. There always will be a difference in elevation between the comb and landing plate due to the following factors:

(a) combplate thickness required to meet current deflection criteria

(b) allowance for combplate deflection

(c) pallet tail or nose swing — the tail or nose moves in an arc as the pallet begins its travel through the turnaround

(d) a small amount of additional running clearance to allow for manufacturing tolerance and wear-in of parts

(e) possible increased combplate thickness necessitated by proposed requirements for combplates

Floor height variations usually occur when buildings are renovated and different floor materials are used than were present when the moving walk was originally installed.

6.2.3.8.4 Safety Zone. The safety zone ensures there is adequate space for passengers when they exit a moving walk. If bunching occurs at the exit of a moving walk, there will be no space for passengers exiting the moving walk. This presents a serious safety hazard to those passengers on the moving walk. See Diagram 6.1.3.6.4.

6.2.3.9 Supporting Structure. The truss is the structural foundation of the moving walk. Attached to and/or within the truss are the various components that form the moving walk. Structural steel is used to make the truss and may differ from one manufacturer to another since moving walk trusses may be made of round tubing, angle iron, square tubing, or in some cases, combinations of these materials.

The purpose of the requirement is to prevent any part of the running gear or passengers on the running gear from falling through the truss to the space below. Belt deflection requirements are illustrated in Diagrams 6.2.3.9(b) and 6.2.3.9(c).

6.2.3.10 Rated Load. This requirement contains design parameters. There are no Code requirements to test the design in the field. Conformance with these design requirements may be verified by examining the manufacturer's design criteria.

The following four types of rated load must be considered:

(a) 6.2.3.10.1 Structural rated load is the live load a moving walk must support.

(b) 6.2.3.10.2 Machinery rated load is the live load on the pallets or treadway that the moving walk machine is required to move.

(c) 6.2.3.10.3 Brake Rated Load. The moving walk machine brake must meet the following two conditions:

(1) Stop the moving walk with the brake rated load on the pallets or treadway at a retardation rate not exceeding 0.91 m/s^2 or 3 ft/sec^2. This is often referred to as the "dynamic brake rated load."

(2) Hold the moving walk in the stopped position with the brake rated load on the pallets or treadway. This is often referred to as the "static brake rated load."

(d) 6.2.3.9.4 Pallet. Pallet load accounts for weight of a passenger at any point on the pallet.

As the method of determining the various rated loads for a moving walk evolved over the years, the factors and values became inconsistent with sound engineering and physics practices. Formulae were restructured to clarify and accurately reflect design requirements.

Requirement 6.2.3.10 was revised in ASME A17.1-2019/CSA B44:19 to clarify the language regarding safety factors. Revisions were made to applicable moving walks requirements to correct and clarify that required factors of safety are minimum values and the loads from which the factors of safety are calculated are fixed values. See also Handbook commentary on 6.2.3.11.

6.2.3.11 Design Factors of Safety. Requirements for reinforced concrete structures are not specified in ASME A17.1/CSA B44. It is suggested that the normal design criteria for concrete structures be followed in providing supports for moving walks. The design of the structure is to be based on static loading.

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The intent of the requirements in 6.2.3.10.2 through 6.2.3.10.4 is to ensure that the drive will safely support a loaded moving walk. While the limiting mode of failure is ultimate strength and logically the initial design could be tested to ensure the safety factor is achieved, this does not mean that fatigue, etc., should be neglected in the design. Whether the AGMA standards or moving walk manufacturers' internal standard is used in drive design, other modes of failure need to be considered. Such standards should include consideration of the endurance limit of a component in regard to the maximum stress that can be varied or reversed indefinitely without producing fracture of the component material.

Requirement 6.2.3.11 was revised in ASME A17.1-2019/CSA B44:19 to clarify the language regarding safety factors. Previous Code language pertaining to the calculations of factors of safety for escalator and moving walk systems contained ambiguities leading to confusion and different calculation approaches by designers. The previous Code language left open to interpretation whether analysis of the driving machine parts and power transmission members should be based on a stationary condition, i.e., not in motion, or an operating condition, i.e., with motion at constant velocity/speed (not accelerating), and whether consideration of system losses and other applied loads encountered on the components during operation were to be considered.

Application of system losses and any additional loads imposed on the system while operating in the upward (lifting) direction are intended to be included with the machinery rated load for assessment of factors of safety on driving machine parts and power transmission systems of escalators and moving walks. Previous requirements pertaining to factors of safety on escalator and moving walk drive machine parts and power transmission members were revised to address ambiguities and confusion on the application of system losses and any additional loads imposed on the systems. Revisions were also made to applicable escalator and moving walk requirements to correct and clarify that required factors of safety are minimum values and the loads from which the factors of safety are calculated are fixed values.

6.2.3.11.1 This requirement was revised in ASME A17.1-2016/CSA B44-16 to specify ANSI/AISC 360-05 and a more recent edition of CAN/CSA-S16.1, to be consistent with changes to the seismic sections of the Code.

6.2.3.12 Chains. Cast iron is a commercial alloy of iron, carbon, and silicon that is cast in a mold. It is hard, brittle, and nonmalleable, with low tensile strength.

6.2.3.13 Headroom. Requirement 6.2.3.13 was revised in ASME A17.1-2019/CSA B44:19 to add a width requirement for the headroom. Previous language only required a minimum headroom.

6.2.3.18 Water Accumulation. Since water accumulation can adversely affect safe operation of a moving walk, provision is made for removal. The performance-based requirement stipulates a means to continuously prevent the accumulation of groundwater and runoff that does not require human intervention.

Where the water is discharged is not addressed in the Code. This typically would be addressed in the applicable building code or plumbing code.

6.2.4 Rated Speed

6.2.4.1 Limits of Speed. Prior to ASME A17.1-2010/CSA B44-10, any change in the speed of the moving walk was prohibited. A proportion of moving walk accidents are related to passengers falling. A problem could occur if moving walk speed were unintentionally varied during operation with passengers on the treadway. This in fact could be hazardous, due to games played while walking or running against the direction of operation; this activity, however, is intensively discouraged. In such a case, misgauging of the speed could result in a fall anywhere along the moving walk travel. Past practice in some applications permitted moving walks to operate at two different speeds at different times, typically 0.46 m/s or 90 ft/min and 0.61 m/s or 120 ft/min. The change from one speed to the other was not permitted unless the moving walk was first stopped, the speed connections changed, and the walk then restarted. Variable frequency acceleration to provide controlled starts or Wye-delta motor control is not prohibited.

As of ASME A17.1-2010/CSA B44-10, moving walk speed is permitted to be changed provided there are no passengers using the moving walk. Reducing the speed when there are no passengers riding the moving walk is an energy conservation measure. Rigid performance parameters are provided to minimize any possibility of speed change when passengers are riding the moving walk and to ensure that the rate of change of speed of the moving walk is sufficiently gradual so as not to cause loss of balance should a passenger bypass the detection means. However, the speed change should be sufficiently rapid to attain full speed when an approaching passenger is detected and before the passenger reaches the moving treadway.

6.2.5 Driving Machine, Motor, and Brake

6.2.5.1 Connection Between Driving Machine and Main Drive Shaft. This requirement addresses the connection between the driving machine and the main drive shaft and not the number of driving machines permitted per moving walk. This requirement does not say, nor was it ever intended to say, that the moving walk shall be driven by only one machine. A fluid coupling is prohibited. A fixed connection is required.

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6.2.5.2 Driving Motor. It is not always safe to shut down multiple moving walks when circumstances require the stopping of one unit. See Handbook commentary on 6.1.5.1.

6.2.5.3 Brakes. The moving walk brake maximum stopping rate provides a smooth stopping action for all passenger loadings. The name plate indicating the required brake torque will provide a means for periodically checking the brake performance and eliminating the practice of checking the brake by persons carrying weights on a moving walk, which could be unsafe if not performed carefully. The maximum deceleration rate is based on a test of high-speed pedestrian conveyors conducted by the Engineering Physics Department of the Royal Aeronautical Establishment in Farnsborough, England. It is also the normal acceleration and deceleration rate of the San Francisco and Washington Metro transit vehicles. See also, Handbook commentary on 6.1.5.3.

6.2.5.3.1 Moving Walk Driving-Machine Brake

6.2.5.3.1(a) A braking control system that applies the brake, without intentional delay, with a force that varies as necessary to decelerate the moving walk as specified in 6.2.5.3.1(c) but not necessarily the maximum braking force, is an acceptable means of complying with this requirement.

Requirement 6.2.5.3.1(a) was revised in ASME A17.1-2019/CSA B44:19 to allow the use of motor controlled dynamic braking. See also Handbook commentary on 6.1.5.3.4.

6.2.5.3.1(c) A restriction on deceleration was considered in the up direction, but was rejected for two basic reasons. First, there was absence of history of falls on moving walks traveling up attributable to moving walk stopping. It is reasonable to assume that up-running moving walks carrying passengers would stop for the same reasons that down-running ones would stop. The lack of falls due to the up-running moving walk stopping is the result of the geometry of the moving walk pallets, the handrail and the dynamic interaction of the passenger body, the moving walk itself, and the forces of gravity.

The second reason is the complexity of accomplishing a stop combined with the normal force, which is produced by gravity. Such a stop would require using the motor to bring the moving walk to a halt while traveling in the up direction. This technology is used in elevator control and is well known to the industry, but its complexity and necessary safeguards are not justified by the experience of moving walk operation.

The ASME A17 Committee realizes there is a degree of risk when an up-running moving walk is decelerated too quickly. When a down-running moving walk is decelerated too quickly, there is a much greater risk of fall and more serious injury as well as an additional risk of causing others to fall. In weighing the consequences of complexity versus degree of risk, the ASME A17 Committee felt that the requirement as written was the proper choice.

ASME A17.1-2004 and CSA B44-04 were revised from requiring a 0.91 m/s^2 or 3 ft/sec^2 maximum to a 0.91 m/s^2 or 3 ft/sec^2 average deceleration. This does not change the moving walk stopping performance as prescribed and measured by past certification procedures. The past practice of plotting velocity versus time over the duration of the stop, best fitting a line to the data, and determining the slope/deceleration from the line nets the same average deceleration for both terms. Likewise, a determination of the average deceleration based on the initial velocity (rated speed) and the stopping distance will verify the stopping performance. The difference occurs only with more sophisticated equipment readily available today that is capable of measuring/calculating instantaneous deceleration peaks and valleys present in mechanical systems. While peaks above 0.91 m/s^2 or 3 ft/sec^2 do exist, research has shown that short-duration, limited-amplitude peaks reflect what was probably intended by the original requirement. This is consistent with current inspection techniques, what is or is not significant to the human body, and provides compatibility with current measurement technology and equipment.

The values used reflect values established and used by inclined elevators. They are also applicable for moving walks.

6.2.5.3.1(d) The purpose for providing a brake torque nameplate, as required since the stopping requirement outlined in 6.2.5.3.1(d) and 6.2.6.3.6 were established in ASME A17.1-1983, was to replace a potentially dangerous and difficult type test from being performed when a new model moving walk was released. This test only confirmed that the basic brake requirement, requiring the fully loaded moving walk to stop, was complied with. Since this was performed only for a new model installation, the brake setting was not required to be checked in this manner during the life of the moving walk. Instead, the brake torque was measured from time to time and adjusted to meet the manufacturer's specification, if it was known.

When stopping requirements were further defined in ASME A17.1-1983, and maintaining brake torque became more critical, the Code required a brake torque nameplate that displayed the manufacturer's specified brake torque. Nameplate requirements were modified in ASME A17.1-2000 and CSA B44-00 to include the minimum distance from skirt switch to comb-plate, and minimum stopping distance. With current requirements, inspectors and maintenance personnel alike know correct brake torque and are able to check the brake and adjust if necessary.

Manufacturers develop brake torque values for each moving walk model to fulfill ASME A17.1/CSA B44 requirements through engineering analysis. Results are confirmed by tests. These tests involve using test

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weights, encoders, recording devices, and control circuit modifications to the controller. This equipment is usually found and best used in a test facility. Because it is both costly and bulky, it does not lend itself to periodic use on each moving walk installation.

When a new model moving walk is released, manufacturers can be asked by AHJs to produce their analysis in the same manner that other design calculations such as truss analyses are requested. This permits verification to the accuracy of the brake calculations. Reliable brake checks can then be made by measuring existing torque against nameplate data.

Prior to ASME A17.1a-2005 and CSA B44-04 Update No. 1, the brake data plate requirement specified the minimum distance the skirt switch electrical protective device could be located from the combplate to ensure meeting the stopping requirement in the skirt electrical protective device rule (i.e., the maximum stopping distance of the moving walk, which inherently occurs under a loaded condition). In essence, current data plates express maximum stopping distance in terms of skirt switch location. Over time, additional electrical protective devices have been added with the same requirement that a moving walk is to stop before an activating pallet reaches the combplate, and are not specifically covered on the data plate. The Code was revised to specify maximum stopping distance data on the brake data plate. This provides inspection and compliance information with respect to all electrical protective devices by defining a stopping distance requirement.

Requirement 6.2.5.3.1(d)(5) was added in ASME A17.1-2016/CSA B44-16 to specify that additional maximum stopping-distance data be included on the data plate.

The data plate is required to be located on the machine brake. If the data plate is not readily visible, a duplicate nameplate is required.

Requirement 6.2.5.3.1(d) was revised in ASME A17.1-2022/CSA B44:22 to add conformance to 8.13.1 which provides detailed requirements for data plates. See Handbook commentary on 8.13.1.

6.2.5.3.3 Moving Walk Driving Machine Motor Controlled Dynamic Braking. Requirement 6.2.5.3.3 was added in ASME A17.1-2019/CSA B44:19 to provide requirements for motor controlled dynamic braking. Advances in electric motor control technology have provided for improvements to braking/stopping performance of escalators and moving walks. Possible improvements from dynamic braking with variable frequency control of the motor include constant and precisely controlled deceleration rates regardless of load, optimizing the stopping process to include a jerk rate in addition to a deceleration rate, and enabling up direction stopping performance equal to down direction stopping performance regardless of moving walk load. Previous brake requirements prohibited these possible improvements and therefore were revised.

6.2.6 Operating and Safety Devices

6.2.6.2 Starting and Inspection Control Switches

6.2.6.2.1 It is important that an individual who is starting a moving walk has a clear, unobstructed view of that moving walk to ensure that no one is on the walkway before the moving walk is started. Only key-operated-type starting switches are permissible for starting the moving walk. Automatic starting by the use of mats, etc., violates the intent of this requirement. Starting a moving walk with passengers on the pallet is an unsafe practice. This has occurred with automatic starting operations due to misuse of the automatic starting means.

The starting switches must be located such that the moving walk pallets are within sight. The starting switch must also be within reach of the emergency stop button (6.2.6.3.1). All persons who start a moving walk must also be trained in the proper procedure as required by 8.6.11.6. A closed-circuit TV camera used to view the treadway does not comply with the intent of the requirements.

6.2.6.2.2 Inspection Control. The intent is to prevent accidents through inadvertent starting/running of moving walks by elevator personnel when attempting to position moving walks in order to check, adjust, or repair components by providing a switch for use during maintenance and repairs that will prevent the moving walk from running except under constant-pressure operation.

6.2.6.3 Electrical Protective Devices

6.2.6.3.1 Emergency Stop Buttons. Specifying the exact location of the emergency stop button ensures that at the time of an emergency, precious time will not be lost hunting for the stop buttons. The location also gives the user of the emergency stop button a clear, unobstructed view of the moving walk. The cover is required to prevent accidental contact. The alarm is to discourage unauthorized/unnecessary use and to alert passengers.

The basic premise of remotely stopping moving walks is unsafe. Introducing the human element in the decision process is the weak link. Using TV monitors to supervise the conditions on a remote moving walk does not provide for objective and safe control of the unit. Unlike devices that respond to a specific condition and then stop the moving walk, a person sitting in a room full of TV monitors and controls is susceptible to fatigue, emotional stress, inattentiveness, carelessness, and other factors that can result in unnecessary or erroneous stops. This type of job is a monotonous one, particularly susceptible to these problems.

Although it is true that the major suppliers of moving walks have installed units with the capability of providing remote stopping as required by contract specifications, most of the moving walks running with this feature

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are operational. The fact is, most local authorities have not allowed it, and the suppliers have recommended against its use.

6.2.6.3.1(a) In jurisdictions enforcing NBCC, auxiliary stop buttons are permitted where there is a clear view of the moving walk.

Requirement 6.2.6.3.1(a) was revised in ASME A17.1-2019/CSA B44:19 to clarify the location of the stop button.

6.2.6.3.1(c) Requirement 6.2.5.3.1(c) was revised in ASME A17.1-2019/CSA B44:19 to require the emergency stop buttons to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.2.5.3.3.

6.2.6.3.2 Moving-Walk Speed-Monitoring Device. Prior to ASME A17.1-2010/CSA B44-10, speed governors or speed-monitoring devices were not required where low-slip squirrel cage induction motors were provided. While the Code does not specifically require a low-slip squirrel cage induction motor, this type of motor has been provided frequently. When an AC induction motor exceeds synchronous speed, a braking action takes place electrically that prevents excessive overspeed. The more the motor attempts to exceed synchronous speed, the more the braking action increases, preventing excessive overspeeding.

The distinction between the low and high slip is that the moving walk motor must be of low-slip characteristics or loss of speed would occur under load in the up direction. A low-slip motor cannot overspeed beyond 140%. Since sufficient speed cannot be reached to trip the governor, an overspeed governor would be superfluous.

Advances in drive control technology can now result in the use of other power control devices, such as soft starters and energy-saving devices, that do not vary in frequency but, because of their location between the motor and contactors, still have the potential to interrupt power to the motor without affecting a stop (removing power from the brake), resulting in a potential overspeed situation. In addition, improvements in control and monitoring technology enable more precise overspeed detection, so the overspeed detection magnitude has been reduced from 40% to 20% to further minimize impact of an overspeed situation.

The squirrel cage induction motor's exception has been eliminated due to the increasingly common practice of providing power management systems that bypass the function of a fail-safe brake and permit an overspeed condition.

6.2.6.3.3 Broken Step-Chain Device. Requirement 6.2.6.3.3 was revised in ASME A17.1-2019/CSA B44:19 to require the broken step-chain device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.2.5.3.3.

6.2.6.3.4 Drive-Chain Device. The main drive shaft brake is provided when the moving walk machine is connected to the main drive shaft by a chain. If the chain becomes disconnected from the sprockets, the machine brake is not capable of stopping or holding the unbalanced load. Chain failure is the only condition currently addressed in ASME A17.1/CSA B44. However, a chain that comes off the sprocket represents another condition that produces the same result as a broken chain. This requirement covers other conditions occurring to the drive chain that would permit the moving walk to run uncontrolled in the down direction.

The term "device" is consistent with the terminology in Part 6, and is more descriptive of the equipment to perform the required function.

6.2.6.3.5 Stop Switch in Machinery Spaces. The stop switch or main line disconnect switch provides the means to ensure that a moving walk cannot be started by the starting switch while working in the machinery space.

6.2.6.3.6 Moving Walk Egress Restriction Device. An up-running moving walk would bunch people, at a closed rolling shutter or a closed door at the egress end, if the moving walk was allowed to continue running. People traveling on the moving walk would not be able to come down the moving walk because it would still be running in the up direction. See also the commentary on rolling shutters in Chart 6.1.1.1.

Requirement 6.2.6.3.6 was revised in ASME A17.1-2019/CSA B44:19 to require the moving walk egress restriction device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.2.5.3.3.

6.2.6.3.7 Reversal Stop Device. In the event of the reversal of an ascending moving walk, the power shall be removed from the drive-machine motor and brake.

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The moving-walk speed-monitoring device (6.2.6.3.2) may be designed to monitor both overspeed and underspeed and would satisfy the requirements for the reversal stop device.

6.2.6.3.8 Disconnected Motor Safety Device. This requirement is essential when a nonpositive drive connects the moving walk motor to the machine. A separate device is required in the event a governor is not used on this equipment.

Requirement 6.2.6.3.8 was revised in ASME A17.1-2019/CSA B44:19 to require the moving walk disconnected motor safety device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.2.5.3.3.

Requirement 6.2.6.3.8 was revised in ASME A17.1-2022/CSA B44:22 to correct an apparent error created during the addition of dynamic braking requirements. Dynamic braking cannot stop the moving walk when the motor becomes disengaged from the gear reducer.

6.2.6.3.9 Pallet Level Device. A displaced pallet entering the combplate, as a result of a missing wheel, its tire, or a failure of the end frame where the wheel fastens to the pallet, can be hazardous. The pallet level device must be positioned such that when activated, it will bring the displaced pallet to a stop before it enters the comb. These devices will prevent the moving walk from running under a condition of downward displacement.

Requirement 6.2.6.3.9 was revised in ASME A17.1-2019/CSA B44:19 to require the moving walk pallet level device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.2.5.3.3.

6.2.6.3.10 Handrail Entry Device. Objects caught in the area where the handrail reenters the balustrade can produce bodily injury and/or damage to the moving walk equipment. A switch in this area should prevent or limit the extent of injury or damage in the event of this occurring.

The handrail entry device is permitted to be automatically reset if it operates no more than one time in a 24-h period. This is to minimize unnecessary service calls and unnecessary downtime due to nuisance trips of the device. If the handrail entry device operates more than once in a 24-h period, it must be manually reset by elevator personnel after the cause of the operation is determined.

Requirement 6.2.6.3.10 was revised in ASME A17.1-2019/CSA B44:19 to require the moving walk handrail entry device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.2.5.3.3.

6.2.6.3.11 Comb-Pallet Impact Devices. Moving walk pallet wrecks can occur from a variety of circumstances, some of which may not be detected, or be detectable, with the other safety devices. When these occur, pallets continue to be drawn into the pileup until an existing safety device is haphazardly tripped or someone pushes the stop button. This requirement is intended to detect the first pallet to impact the comb and stop the moving walk as a direct result of the impact. Because pallets can strike the comb from below as well as entering, both vertical and horizontal impact detection is necessary.

6.2.6.4 Handrail Speed-Monitoring Device. There is a need to stop a moving walk if the speed of the handrail deviates by 15% or more. While a speed deviation of less than 15% would also not comply with 6.1.3.4.1, it would not be enough to necessitate stopping the moving walk right away. A delay is necessary so that the moving walk is not stopped every time someone pulls on the handrail.

A handrail not moving in the same direction or speed has a tendency to pull passengers backward or forward, causing them to lose their balance. It is not necessary for the handrail to move at exactly the same speed as the pallet since passengers can easily adjust the position of their hands to compensate for minor differences in speeds.

The handrail speed-monitoring device is permitted to be automatically reset if it operates no more than one time in a 24-h period. This is to minimize unnecessary service calls and unnecessary downtime due to nuisance trips of the device. If the handrail speed-monitoring device operates more than once in a 24-h period, it must be manually reset by elevator personnel after the cause of the operation is determined.

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Requirement 6.2.6.4 was revised in ASME A17.1-2019/CSA B44:19 to require the handrail speed-monitoring device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.2.5.3.3.

Requirement 6.2.6.4 was revised in ASME A17.1-2022/CSA B44:22 to make it mandatory for the device to retain the status of the timer and count of events if power is interrupted.

6.2.6.5 Missing Pallet Device. This requirement will prevent a moving walk from continuing to run if a pallet is missing. It will prevent a void from a missing pallet to emerge from under the comb. This requirement was adopted because of the seriousness of the injury that results from stepping into the gap of a missing pallet, and the fact that a passenger would not see the gap until starting to step into it.

Requirement 6.2.6.5 was revised in ASME A17.1-2019/CSA B44:19 to require the missing pallet device to initiate motor controlled dynamic braking where provided. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.2.5.3.3.

6.2.6.6 Tandem Operation. See Diagram 6.1.6.6.

Requirement 6.2.6.6 was revised in ASME A17.1-2019/CSA B44:19 to require the electrical interlocks for tandem operation to initiate motor controlled dynamic braking where provided and to align the language with other similar sections. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.2.5.3.3.

6.2.6.7 Moving Walk Smoke Detectors. Smoke detectors are not required in wellways by ASME A17.1/CSA B44. Some building codes do require smoke detectors in wellways and adjacent areas. When a smoke detector is used to stop a moving walk, these requirements must be adhered to. This requirement was adopted because if smoke detectors were set to stop the moving walk, certain events were deemed necessary to permit the moving walk to stop safely.

Requirement 6.2.6.7 was revised in ASME A17.1-2019/CSA B44:19 to require the moving walk smoke detectors to initiate motor controlled dynamic braking where provided and to align the language with other similar sections. It was also revised to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.2.5.3.3.

6.2.6.8 Moving Walk Braking-Distance Monitor. This requirement was added in ASME A17.1-2016/CSA B44-16 to require that a device be provided to monitor the stopping distance every time the moving walk is stopped, to ensure correct brake operation. The minimum and maximum stopping-distance requirements are already described within the Code. (Note that the former 6.2.6.8 through 6.2.6.14 were redesignated as 6.2.6.9 through 6.2.6.15, respectively, as a result of this addition.)

6.2.6.9 Signs

6.2.6.9.1 Caution Signs. The sign (Figure 6.1.6.9.1) cautions people on how to use a moving walk properly and indicates that it is for the transportation of people only. Most accidents are caused by improper use of a moving walk. The pictograph reduces the problems caused by language barriers.

6.2.6.9.2 Signs or Graphics Relating to Safety. Additional signs relating to safety may be provided since during the normal walking flow of people entering a moving walk, there is only sufficient time to read and comprehend the required sign (6.1.9.3.1). To properly board a moving walk, it is important to continue to walk without stopping or otherwise causing abrupt bodily contact with others. For this reason, a sign that is well outside the normal boarding traffic flow is permitted. Additional signs within the boarding area that may obstruct passenger flow are prohibited. Due to moving walks being installed in many different locations, there is no consensus on what the additional sign should say. Some of the most frequently used messages are “No Luggage or Carts,” “No Bare Feet,” “No Strollers,” “No Wheelchairs,” “Handicapped-Use Elevator.” The Code has, therefore, provided some broad guidelines and a message to building owners, etc., to consider anything peculiar to the building site that requires further unique messages.

6.2.6.9.3 Additional Signs or Graphics. Signs or graphics not related to safety that might obstruct passenger flow, access to handrails, or view of the required sign (6.1.9.3.1) are not permitted.

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Manufacturer's identification, signs or graphics on step risers, and handrail markings are permitted.

6.2.6.10 Control and Operating Circuits. This requirement provides for protection against singular failures in the control and/or operating circuits resulting in an unsafe condition.

6.2.6.10.4 Requirement 6.2.6.10.4 was revised in ASME A17.1-2019/CSA B44:19 to permit dynamic braking to bypass the normal methods to remove power from the motor and driving-machine brake for those electrical protective devices that are permitted to use dynamic braking. This is only permitted based on the stopping performance monitoring of dynamic braking, which will remove the bypass when dynamic braking fails. See also Handbook commentary on 6.2.5.3.3.

6.2.6.11 Electrically Powered Safety Devices. Requirement 6.2.6.11 was revised in ASME A17.1-2019/CSA B44:19 to address changes to allow motor controlled dynamic braking. The changes are to clarify that stopping performance monitoring is as critical as the handrail speed monitor or missing step in preventing the electrical protective devices that are permitted to use dynamic braking from being ineffective. See also Handbook commentary on 6.2.5.3.3.

6.2.6.12 Installation of Capacitors or Other Devices or Means to Make Electrical Protective Devices Ineffective. This mandates that the electrical protective devices always be operative and that they may not be bypassed except as provided for in the Code.

The title in requirement 6.2.6.12 was revised in ASME A17.1-2022/CSA B44:22 to pick up other means to make electrical protective devices ineffective. See Handbook commentary on 2.26.14.

6.2.6.13 Completion or Maintenance of Circuit. The requirement is written in a manner such that failure of any circuit associated with an electrical protective device will cause the device to operate. This is a basic principle of fail-safe design. The intent of 6.2.6.13 is that the contactors used to interrupt the power to the moving walk motor or brake shall not be energized to perform this function.

Requirement 6.2.6.13 was revised in ASME A17.1-2019/CSA B44:19 to clarify that these requirements do not apply to motor controlled dynamic braking. See also Handbook commentary on 6.2.5.3.3.

6.2.6.14 Moving Walk Manual Reset. An external power failure should not result in any safety device requiring manual reset to lose its indication of a malfunction.

6.2.6.15 Contractors and Relays for Use in Critical Operating Circuits. This requirement specifies the requirements for single failure protection, i.e., redundancy, in the design of specific control and operating circuits (6.2.6.10.1) and requires the checking of that redundancy (6.2.6.10.3). This may require the use of two relays instead of one in these circuits, and the checking of the operation of these relays.

When electromechanical relays and contactors are being checked for operation, specifically drop out operation, by utilizing contacts on the relays or contactors themselves, care must be taken that the contact used for monitoring the state of the contact used in the critical circuit is a true and correct representation of the critical circuit contact.

The required operation of the monitoring contact is specified, and it is clarified that springs in the design of the relay, contactor, or contact design may be used, but that spring failure shall not cause the monitoring contact to indicate an open critical circuit contact if the critical circuit contact is not open.

6.2.7 Lighting, Access, and Electrical Work

6.2.7.1 Lighting of Machine Room and Truss Interior. The requirements ensure that a source of illumination and power is provided in machine rooms for elevator personnel.

6.2.7.1.2 Truss Interior. The requirement for a duplex receptacle in the truss interior is to allow for the use of a drop cord light for inspection and maintenance inside the truss.

6.2.7.2 Lighting of Treadway. Treadways must be illuminated properly in order to reduce a tripping hazard. Machinery spaces in the truss and at either end do not require permanent lighting, as it is impractical to locate a lighting fixture that will provide lighting to all work areas.

6.2.7.3 Access to Interior. The removal of pallets is considered a reasonable means of access to the interior of a moving walk.

6.2.7.3.1 The use of terrazzo, stone, or concrete, and other similar floor coverings that are excessively heavy, would be a hazard for maintenance and inspection personnel to lift. This type of material also tends to crack, resulting in a tripping hazard. Access plates must be securely fastened to prevent accidental opening.

6.2.7.3.2 Gravity alone is not considered a secure means of fastening access plates.

6.2.7.4 Electrical Equipment and Wiring

6.2.7.4.1 See Handbook commentary on 2.26.4.1.

6.2.7.4.2 The specified electric equipment is required to be certified as complying with CSA B44.1/ASME A17.5. This will minimize the risk of electricity as a source of electric shock and as a potential ignition source of fires. See Handbook commentary on 2.26.4.2.

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6.2.7.4.3 This requirement was revised in ASME A17.1-2016/CSA B44-16 to specify that electromagnetic interference testing of escalator and moving walk control circuits shall be done in accordance with an ISO standard rather than a European (EN) standard. The revision is not due to any known deficiencies with the current products or the previous EN standard; similar revisions have been made previously to the requirements for elevator controls (see 2.26.4.4).

See also Handbook commentary on 2.26.4.3.

6.2.8 Outdoor Moving Walks

The Code requires outdoor moving walks to be covered (6.2.8.2). Experience has shown that outdoor moving walks must be protected from the weather. Moving walks installed outdoors without any cover were usually shut down when it rained; many have since been covered.

This requirement was revised in ASME A17.1-2007/CSA B44-07. It is performance based and requires a moving walk to be protected from the elements. Since rain and snow seldom fall straight down, a cover alone is not adequate protection.

6.2.8.2 Precipitation

6.2.8.2.2 The ASME A17 Committee recognizes that not all sources of water, such as those from hurricanes or flooding, can be drained. However, groundwater, water from shoes (e.g., rain and snow), and runoff that might accumulate in the equipment are to be drained. See Handbook commentary on 6.2.3.18.

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Diagram 6.2.3(a)
Moving Walk Geometry

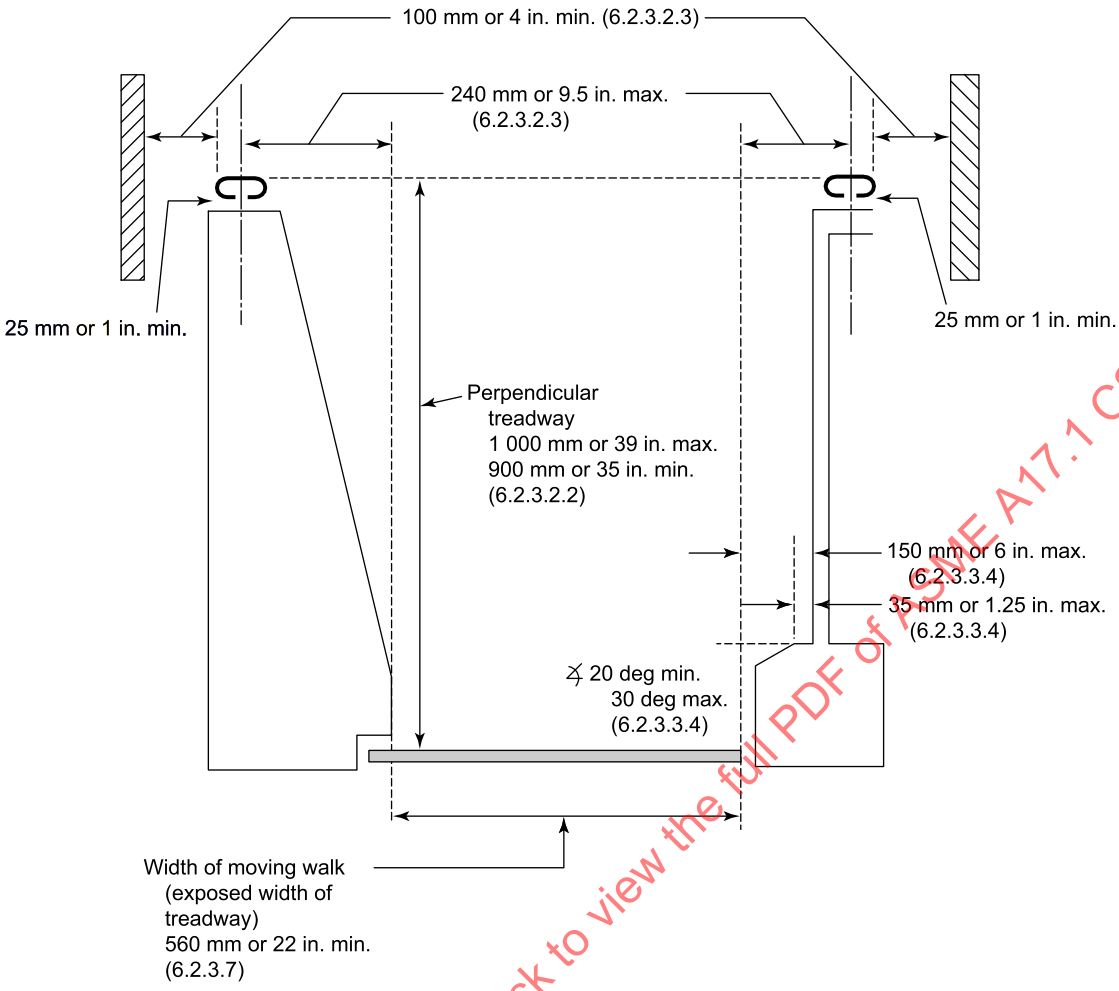
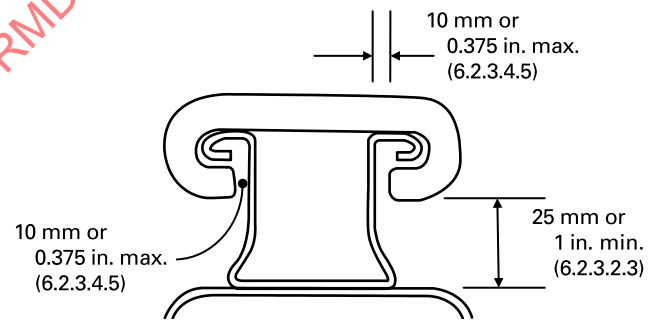


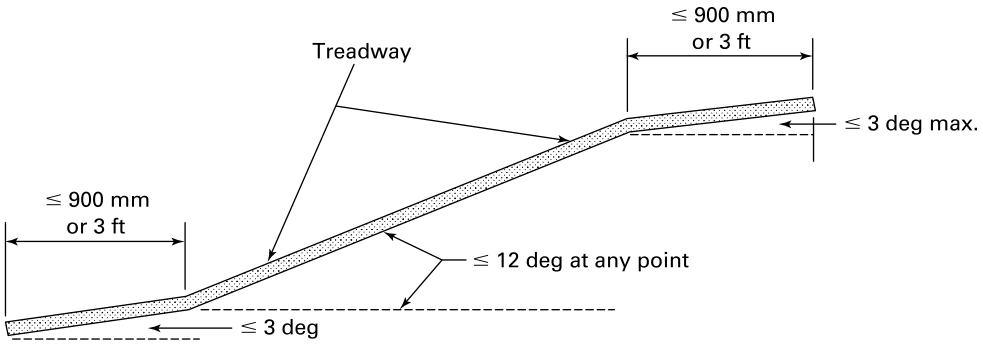
Diagram 6.2.3(b)
Handrail



GENERAL NOTE: Courtesy of Davis L. Turner.

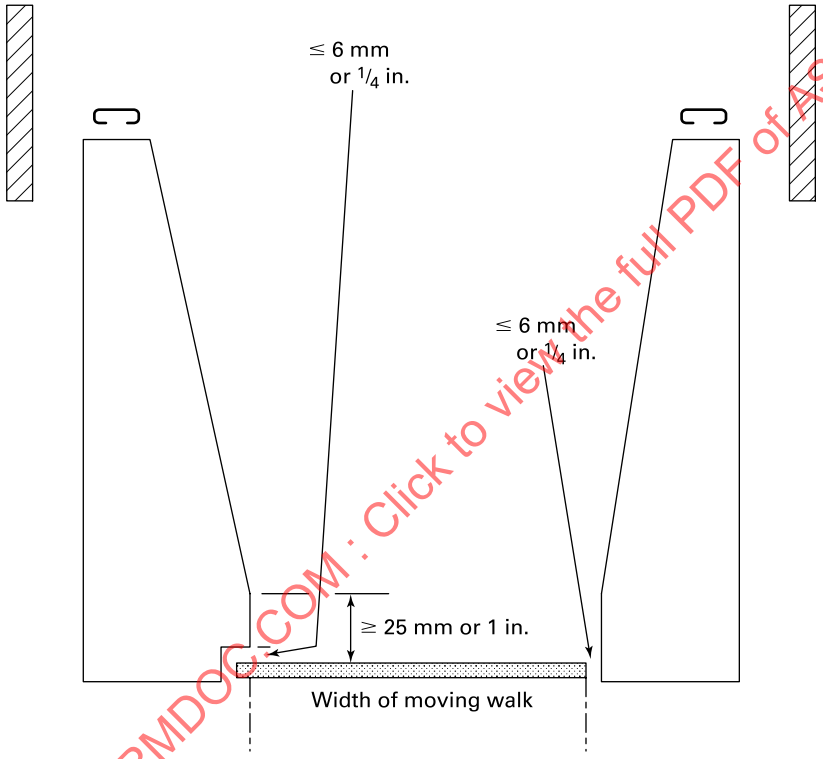
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Diagram 6.2.3.1
Maximum Treadway Angle



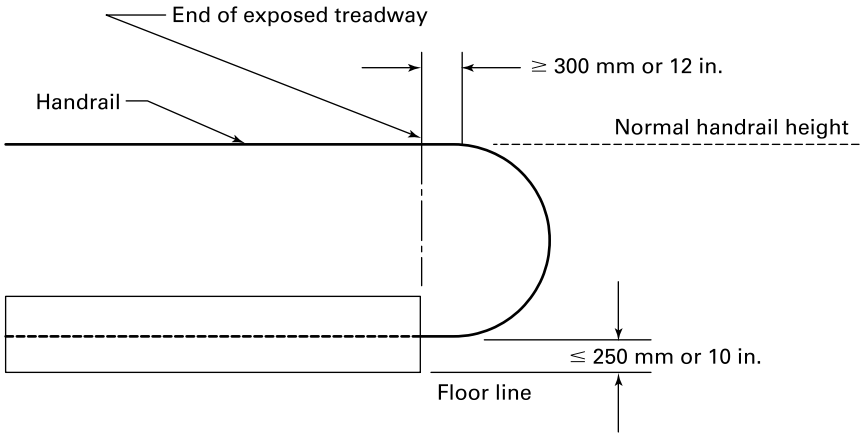
GENERAL NOTE: Courtesy of Zack McCain, Jr., P.E.

Diagram 6.2.3.3.5
Skirtless Balustrade Clearances



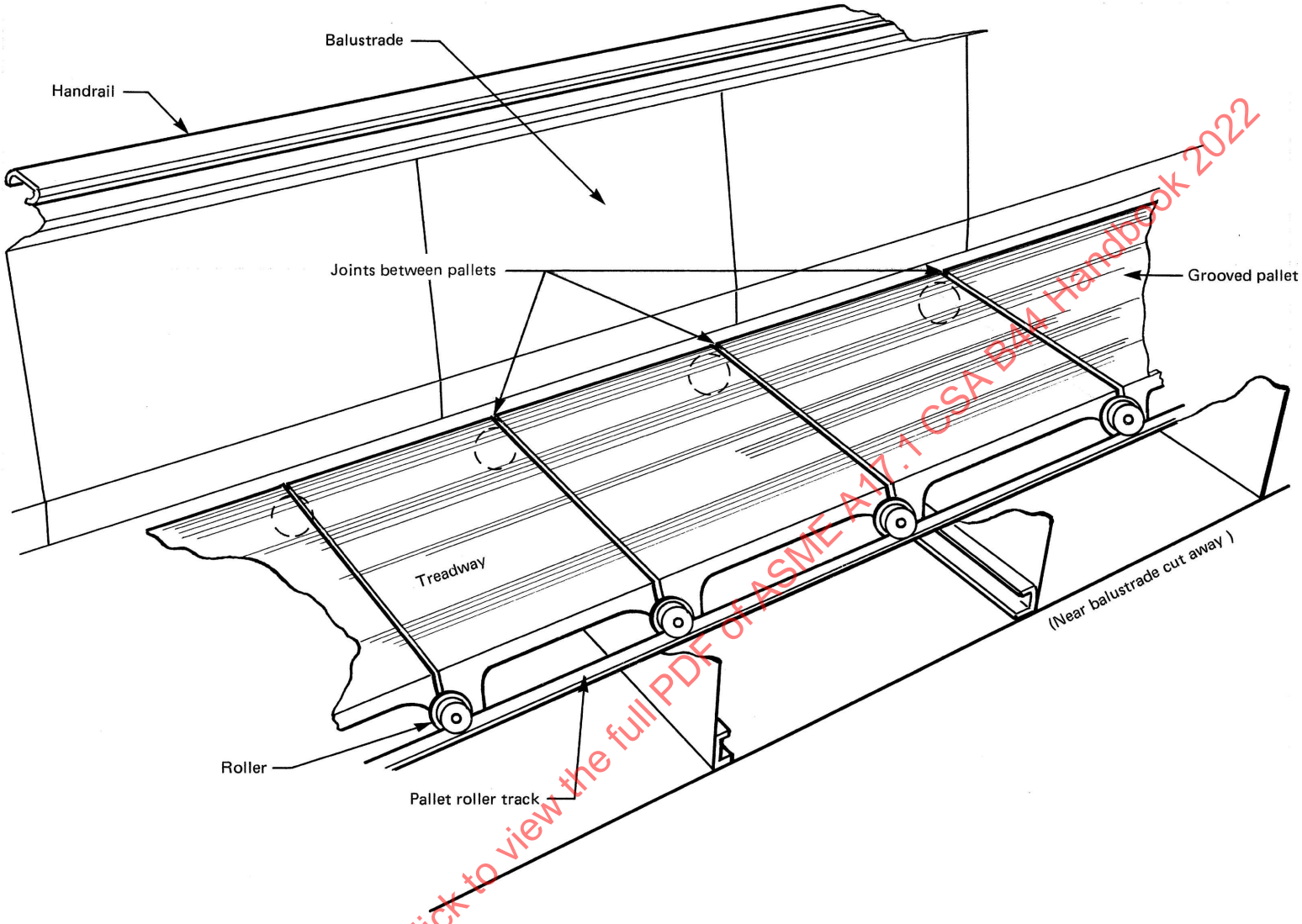
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Diagram 6.2.3.4.2
Moving Walk Handrail Extension



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Diagram 6.2.3.5
Pallet-Type Moving Walk



GENERAL NOTES:
(a) Courtesy of Charles Culp.
(b) Separate pallets, each with one pair of rollers at its trailing (or leading) edge, are coupled together to form a treadway. Joints between pallets are apparent in the treadway surface.

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Diagram 6.2.3.5.1
Moving Walk Treadway Slots

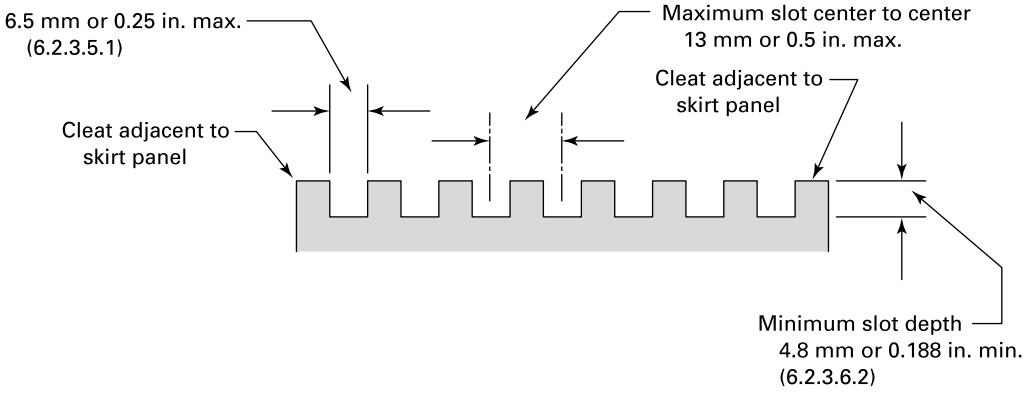
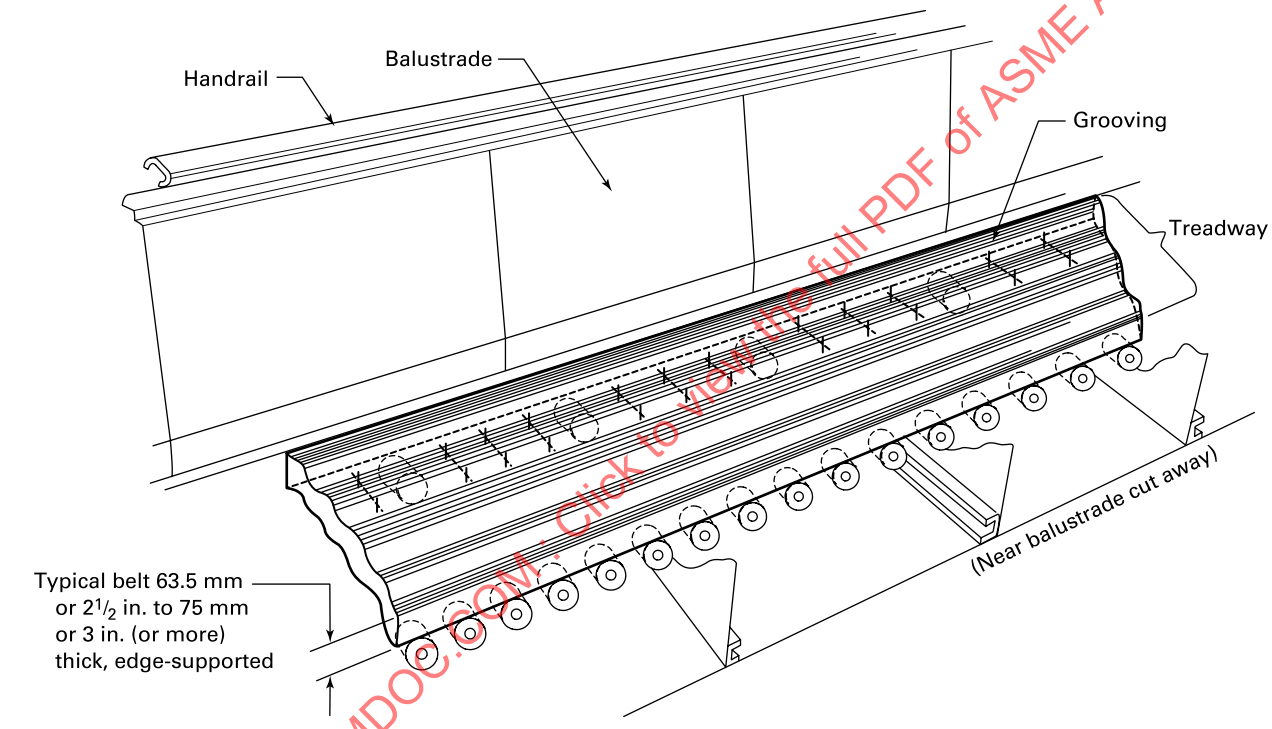


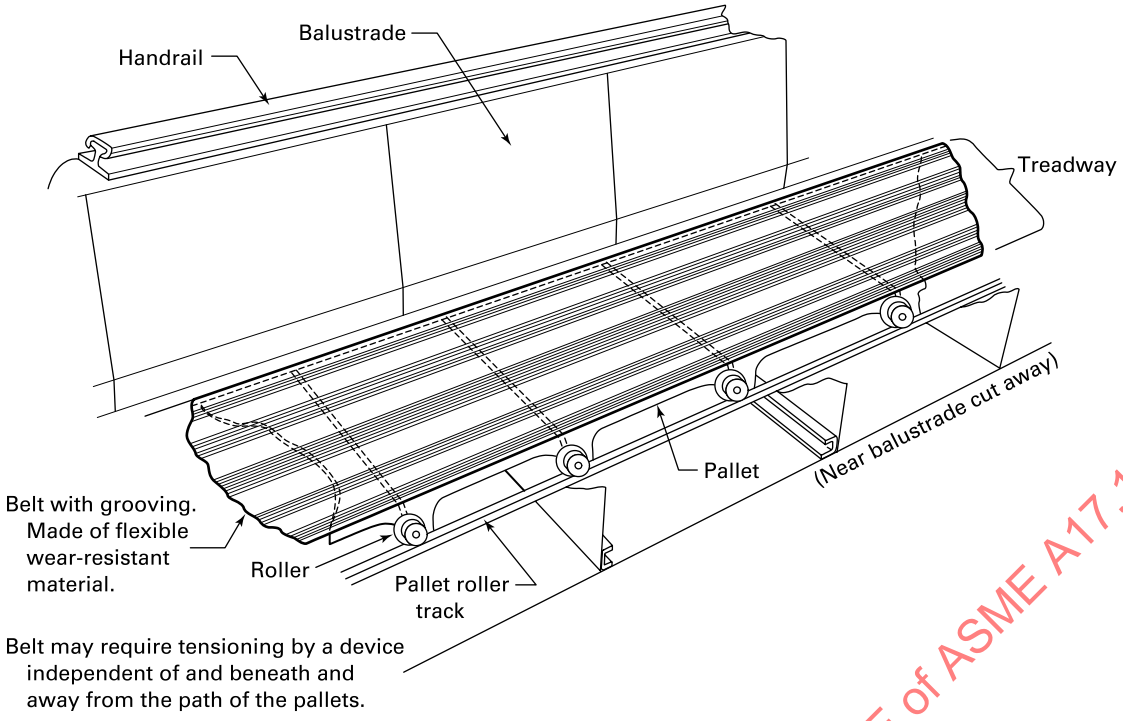
Diagram 6.2.3.6(a)
Belt-Type Moving Walk



GENERAL NOTE: Courtesy of Charles Culp.

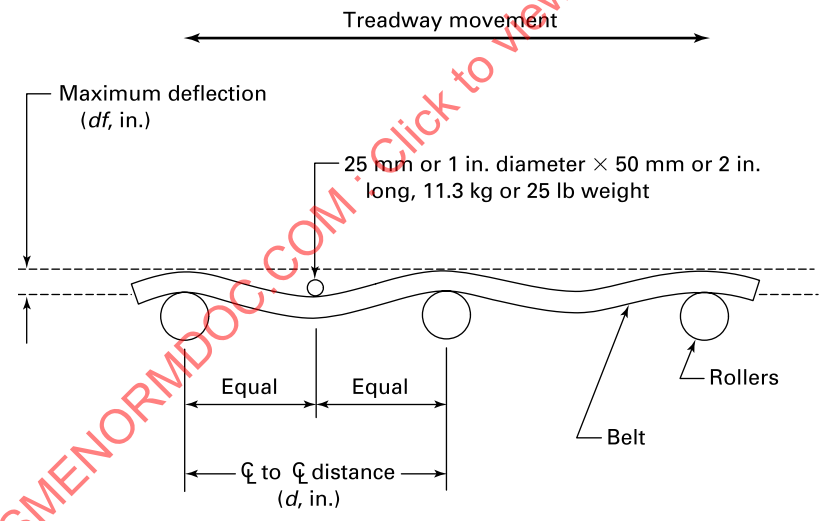
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Diagram 6.2.3.6(b)
Belt-Pallet-Type Moving Walk



GENERAL NOTE: Courtesy of Charles Culp.

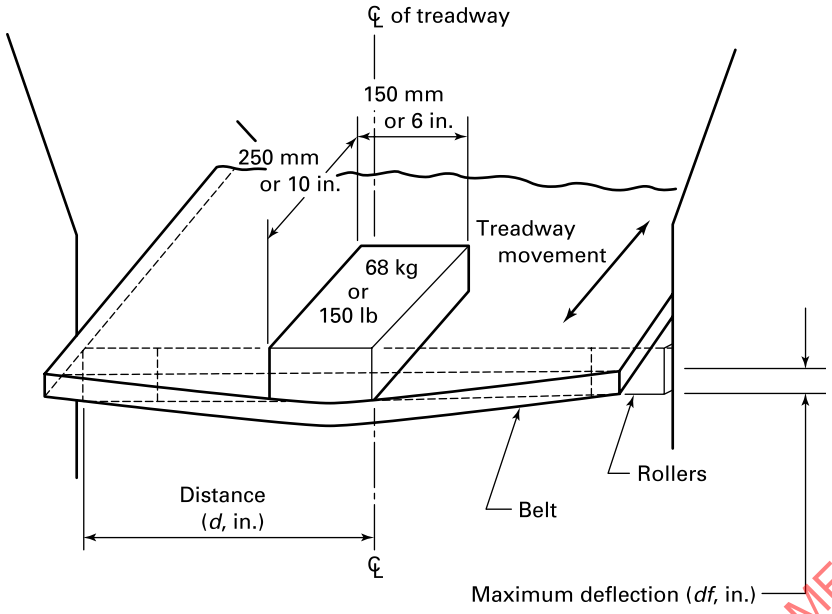
Diagram 6.2.3.9(b)
Belt Deflection With Roller Bed Support



GENERAL NOTE: Maximum deflection (df) = 0.094 in. + (0.004 × d).

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Diagram 6.2.3.9(c)
Belt Deflection With Edge Support



GENERAL NOTE: Maximum deflection (df) = $d \times 0.03$.

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Part 7
Dumbwaiters and Material Lifts

SCOPE

ASME A17.1/CSA B44 defines a dumbwaiter as "a hoisting and lowering mechanism equipped with a car of limited size that moves in guide rails and serves two or more landings."

ASME B20.1, Safety Standard for Conveyers and Related Equipment, defines a conveyor as "a horizontal, inclined, or vertical device for moving or transporting bulk material, packages, or objects in a path predetermined by the design of the device, and having points of loading and discharge, fixed or selective."

In response to questions concerning the difference between a "conveyor" and a "dumbwaiter," the ASME B20 Committee responded in Interpretation 7-1 in the following manner:

> Differences between a vertical reciprocating conveyor and a dumbwaiter are typically found in guides, hoistway construction, platform requirements, controls, and power mechanisms. The distinguishing features of a dumbwaiter are its limitation in capacity, size, door heights, and car clearances.

There are no practical differences between a dumbwaiter and a conveyor, except that a dumbwaiter is limited in size and a conveyor is not. See ASME A17.1, Inquiry 91-53.

A cursory reading of ASME A17.1/CSA B44 and ASME B20.1 definitions could lead one to conclude that Type A material lifts are vertical reciprocating conveyors [VRCs]; safety requirements for vertical reciprocating conveyors are published in ASME B20.1, and the scope of ASME A17.1/CSA B44 specifically excludes equipment covered in ASME B20.1. Additionally, one could argue that the ASME A17.1/CSA B44 Committee was established to address safe ways to move people, while the ASME B20 Committee deals with movement of inanimate objects. Therefore, provisions for material lifts should be excluded from ASME A17.1/CSA B44, as vertical reciprocating conveyors are already covered in ASME B20.1. There is no credible basis in the codes to lead someone to conclude that all VRCs are Type A material lifts and therefore should be subject to the ASME A17.1/CSA B44 Code requirements.

However, looking beyond the concise definitions to the history of the safety standards; equipment construction; and who is manufacturing, installing, and maintaining vertical reciprocating conveyors and material lifts will lead one to understand that they are uniquely different types of equipment and should be so treated by the ASME safety standards. First, it is important to understand that ASME A17.1/CSA B44 defines *material lift* as "an *elevator designed or modified for the purpose of transporting materials* that are manually or automatically loaded or unloaded and are not a vertical reciprocating conveyor ..." (emphasis added). ASME B20.1 specifically excludes "elevators"; vertical reciprocating conveyors utilize "carriers" (not "cars") that are positioned using conveyor-type structural steel components, not elevator "guide systems." Clearly, vertical reciprocating conveyors would not be "normally classified as an elevator."

Equipment covered by ASME A17.1/CSA B44, such as elevators, escalators, moving walks, etc., as well as all equipment covered by ASME B20, fall within the broad classification of conveyors; neither document covers, nor is intended to cover, all types of conveyors. ASME B20 limits itself to material handling conveyors that are not intended to convey operators or passengers. ASME B20 conveyors are usually used in industrial settings and are typically regulated/inspected by OSHA.

ASME A17.1/CSA B44 was developed from a need to ensure safety with equipment intended to convey people, either as passengers or operators, but also includes dumbwaiters, which do not carry passengers. This equipment is for the most part used in commercial buildings or homes where the general public is present; regulation and inspection of ASME A17.1/CSA B44 type equipment is handled by state/city elevator code authorities. ASME A17.1/CSA B44 specifically excludes all ASME B20 conveyors, amusement rides, and some specific types of people-conveying conveyors such as man-lifts and ski lifts. Both documents have stood the test of time in providing equipment installations that are safe for their intended purpose.

The differences between a freight elevator, a reciprocating conveyor conforming to ASME B20.1, a Type A or Type B material lift, and a dumbwaiter are highlighted in Chart 7.

The Scope was revised in ASME A17.1-2019/CSA B44:19 to prohibit hand dumbwaiters because they cannot comply with the equivalent minimum safety requirements for power dumbwaiters.

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Chart 7
Differences Between Freight Elevators, ASME B20.1 Reciprocating Conveyors, Type A Material Lifts, Type B Material Lifts, and Dumbwaiters

	Freight Elevator	B20.1 Reciprocating Conveyor	Type A Material Lift	Type B Material Lift	Dumbwaiter
Travel	Unlimited	Unlimited	Unlimited	5 000 mm or 16 ft 8 in. Penetrate one floor	Unlimited
Speed	Unlimited	Unlimited	Unlimited	0.15 m/s or 30 ft/min	Unlimited
Riders permitted (authorized material handlers)	Yes	No	No	Yes	No
Location	No restrictions	Only in areas with trained personnel [Note (1)]	No restrictions	Not accessible to the general public	No restrictions
Maximum size	No maximum	1 220 mm or 48 in. wide by 2 280 mm or 90 in. high No maximum depth	No maximum Enclosure walls must be 2 030 mm or 80 in. high	1 m^2 or 10.75 ft^2 by 1 220 mm or 48 in. high	
Operation	Automatic	Automatic	Automatic	Constant pressure push button hall station Cannot override car station	Automatic
Summary					
Limited travel	—	—	—	X	—
Limited speed	—	—	—	X	—
No riders	—	X	X	—	X
Restricted locations	—	X	—	X	—
Limited size	—	—	X	—	X
Restricted operation	—	—	—	X	—
Authorized persons	X	X	X	X	X

NOTE: (1) Per ASME B20.1-2015, para. 5.12(e) — personnel working on or near a conveyor shall be instructed as to the location and operation of pertinent stopping devices.

SECTION 7.1
POWER DUMBWAITERS WITHOUT AUTOMATIC TRANSFER DEVICES

NOTE: Throughout Section 7.1, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

The title and requirements in Section 7.1 were revised in ASME A17.1-2019/CSA B44:19 to delete hand dumbwaiters because they cannot comply with the equivalent minimum safety requirements for power dumbwaiters.

7.1.1 Construction of Hoistways and Hoistway Enclosures

Hoistways must be enclosed throughout their height. The fire resistance rating of the hoistway enclosure, including entrances and protective assemblies in other openings, should not be less than that required by the building code. Where there is no local building code, compliance with one of the following model codes is required:

(a) International Building Code (IBC)

(b) NFPA 5000®, Building Construction and Safety Code

(c) National Building Code of Canada (NBCC)

Most building codes in the United States are based on one of the model building codes. The IBC is the model building code most widely adopted in the United States. It is published by the International Code Council (ICC). The National Fire Protection Association publishes NFPA 5000®. To the author's knowledge, no major jurisdiction in the United States or Canada had adopted NFPA 5000® as of the publication of this Handbook. The model building code used in Canada is the NBCC, promulgated by National Research Council of Canada.

Fire-resistive construction retards the spread of fire, hot gases, and smoke from penetrating one floor or area to another. Use of nonfire-resistive construction is usually permitted by building codes when fire-resistive assemblies are not penetrated by a hoistway. Most local codes and model building codes generally require a hoistway enclosure be fire resistance rated for a minimum of 2 h, with entrances and other protective

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assemblies in the openings rated for a minimum of 1½ h. For specific types of construction, some codes allow a hoistway enclosure a fire resistance rating of less than 2 h with entrances and other opening protective assemblies rated accordingly. The term "opening protective assemblies" refers to access openings in the hoistway for maintenance and inspection (see 2.7.3.4).

7.1.2 Pits

7.1.2.3 Most dumbwaiter pits are shallow; thus, ambient illumination is usually acceptable.

7.1.3 Location and Guarding of Counterweights

Requirements of 2.3.1 have been made applicable to facilitate inspection and maintenance of counterweights and ropes. Compliance with 2.3.2 and 2.3.3 is not necessary since personnel will not be in the pit.

7.1.4 Vertical Car Clearances and Runbys for Cars and Counterweights

Compliance with Section 2.4 is not necessary since passengers are not carried.

7.1.4.3 Requires minimum clear space when a top-of-car operating device is provided.

7.1.5 Horizontal Car and Counterweight Clearances

Requirements for horizontal clearances are specified. Where the rated load is 227 kg or 500 lb or less, shifting loads in the car would not create the need for the same clearances required for elevators. Requirement 2.5.1.5 is for the protection of passengers and therefore not applicable.

7.1.6 Protection of Spaces Below Hoistway

Safeties and buffers are required regardless of rated load because of the impact on the hoistway or pit floor. ASME A17.1/CSA B44 does not require the counterweight frame to be designed or constructed to restrain the weights. There are also no requirements for constraints on guide rails or brackets or the strength of the hoistway wall. Since the dumbwaiter is often in an area accessible to the general public, concern is shown for the fact that even though the pit floor might sustain the impact loads, the falling car or counterweight might cause injury to people adjacent to or beneath the hoistway.

7.1.7 Machinery Spaces, Machine Rooms, Control Spaces, and Control Rooms

7.1.7.1 Separate machinery spaces are not always necessary.

7.1.7.3 Provisions are provided to prevent accidental contact with equipment.

7.1.7.4 Dumbwaiters are not required to have a permanent stair or ladder for access when the machinery spaces are within the hoistway. Obstructions that are easily removable, such as false ceilings or ceiling tiles, are permitted.

7.1.7.6

7.1.7.6.2 An electric contact is necessary to protect against moving equipment.

7.1.7.10 Control equipment and dumbwaiter machines are allowed to be located in the hoistway. This requirement was revised in ASME A17.1-2016/CSA B44-16 to require that dumbwaiter controllers located outside the hoistway be locked and accessible only to elevator personnel. The requirement for a locked cabinet was contained in CAN/CSA B44-94 but was not carried through at harmonization. Additionally, this revision provides consistency with NFPA 70, Section 620.71(A). Requiring a lock on the door prevents the public from being exposed to hazards that could result if unauthorized persons access the controller.

7.1.8 Electrical Equipment, Wiring, Pipes, Ducts, and HVAC in Hoistways and Machine Rooms

7.1.8.1 As dumbwaiter use in a fire is not essential, protecting interlock wiring from high temperature is not necessary; thus, SP-2-type wiring is not required.

7.1.8.2 Requirement similar to those for electric elevators except for the need to remove power prior to or upon application of a sprinkler, as there are no passengers on dumbwaiters.

7.1.11 Protection of Hoistway Openings

7.1.11.2 Types of Entrances

7.1.11.2.1

7.1.11.2.1(a) See Diagrams 2.11.2.1(a)(1) and 2.11.2.1(a)(2).
7.1.11.2.1(b) See Diagram 2.11.2.1(b).
7.1.11.2.1(c) See Diagram 2.11.2.1(c).
7.1.11.2.1(d) See Diagram 2.11.2.2(e)(2).
7.1.11.2.1(e) See Diagrams 2.11.2.1(d) and 2.11.2.2(f).

7.1.11.2.2

7.1.11.2.2(a) See Diagrams 2.11.2.1(d) and 2.11.2.2(f).
7.1.11.2.2(b) See Diagram 2.11.2.2(e)(2).
7.1.11.2.2(c) See Diagram 2.11.2.1(b).

7.1.11.3 Closing of Hoistway Doors. This requirement ensures the fire-resistance integrity of the hoistway. If the doors were allowed to remain open in a fire, the fire could enter the hoistway and thus be given a path to other portions of the building.

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7.1.11.3.2 Provisions include closing hoistway doors on hand-operated dumbwaiters when activated by smoke sensors in order to be compatible with building code requirements.

7.1.11.8 Hoistway Door Vision Panels. Requirements have been added for vision panels, if provided, per applicable requirements of 2.11.7.1.

7.1.11.10 Landings and Landing Sills. Requirements for illumination (2.11.10.2) are to provide adequate illumination for loading and unloading, and for hinged landing sills (2.11.10.3), if provided. This requirement does not prohibit the use of hinged car sills.

7.1.11.11 Horizontal Slide-Type Entrances. Requirement 2.11.11.1(b) is not applicable since it is for the protection of passengers.

7.1.11.12 Vertical Slide-Type Entrances. Requirements in 2.11.12 for vertical slide-type entrances suitable to dumbwaiter applications are referenced. See Diagram 7.1.11.12.

7.1.11.13 Swing-Type Entrances. Requirements in 2.11.13 that are not referenced are for the protection of riders.

7.1.12 Hoistway Door Locking Devices, Access Switches, and Unlocking Devices

7.1.12.1 Hoistway Door Locking Devices for Power Dumbwaiters

7.1.12.1.1 This requirement was revised in ASME A17.1-2016/CSA B44-16 to remove the permission for lock and contacts at floors with other than counter-height loading. The previous requirement allowed lock and contacts only when the fall hazard was restricted; however, that requirement appears to have been attempting to apply the rules for vertically sliding freight doors. Applying the same rule to a dumbwaiter with a maximum height of 1 220 mm or 48 in. results in a potential fall hazard of at least 3 350 mm or 132 in.

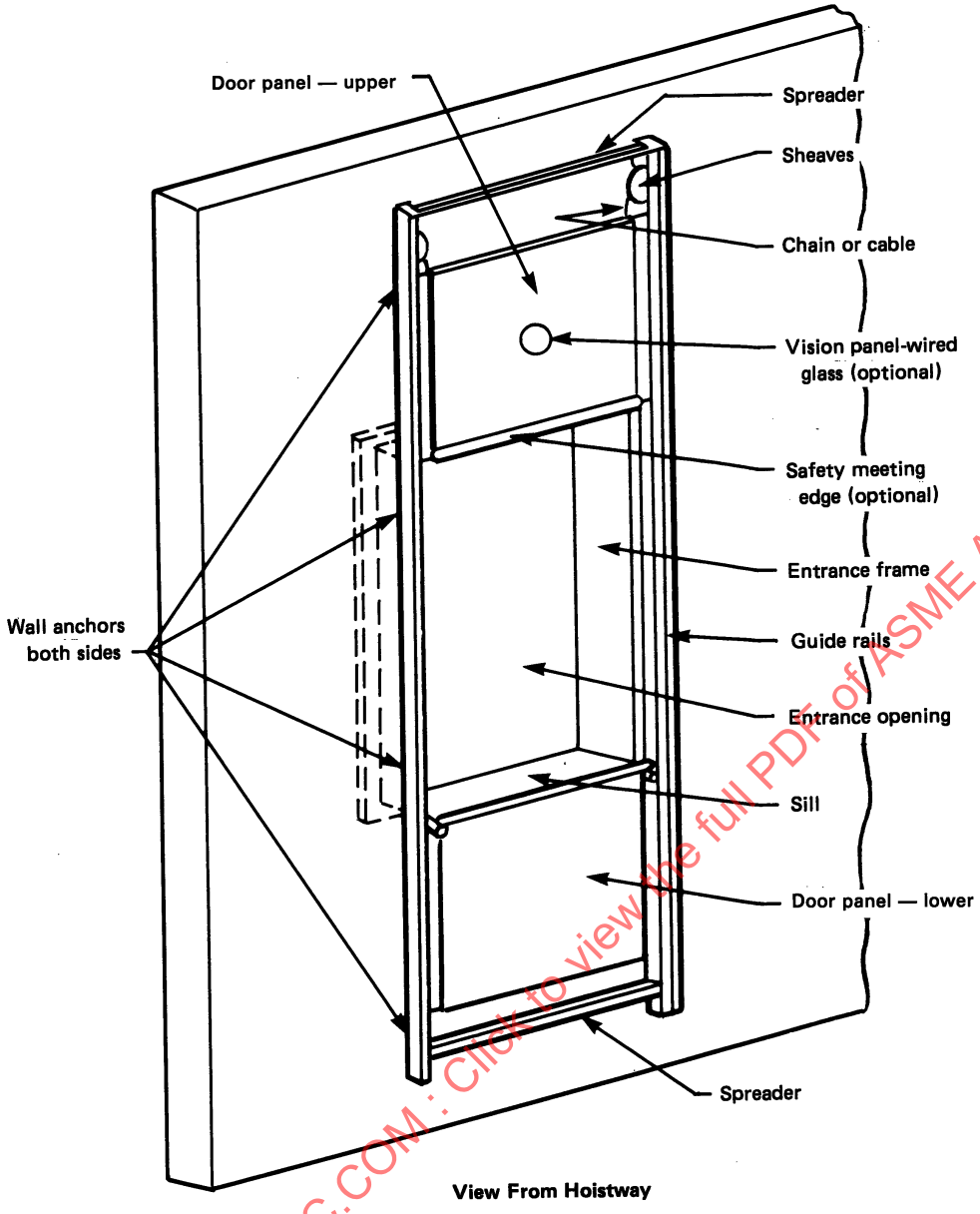
7.1.12.1.3 See Diagram 7.1.12.1.3. This requirement was revised in ASME A17.1-2016/CSA B44-16. The current interlock requirements for dumbwaiters with a rated speed greater than 0.5 m/s or 100 ft/min were maintained; these devices require a full interlock and a retiring cam. However, the revision added a requirement to allow dumbwaiters with a rated speed less than 0.5 m/s or 100 ft/min to move within a zone 75 mm or 3 in. above or below the landing with the doors closed but before they are locked. This revision allows a combination mechanical lock with electric contacts to be used with a fixed cam on dumbwaiters where space is limited. This locking method monitors the door-closed and door-locked condition and provides a greater level of safety than the previously allowed mechanical lock and contact.

7.1.12.3 Hoistway Door Unlocking Devices. This requirement allows a means for access to the hoistway even where access switches are provided.

7.1.12.4 Hoistway Access Switches. Hoistway door access switches are permitted. They provide a safe means for inspection and maintenance. On dumbwaiters, suspension means inspection is usually performed through the machine room access door rather than a hoistway door.

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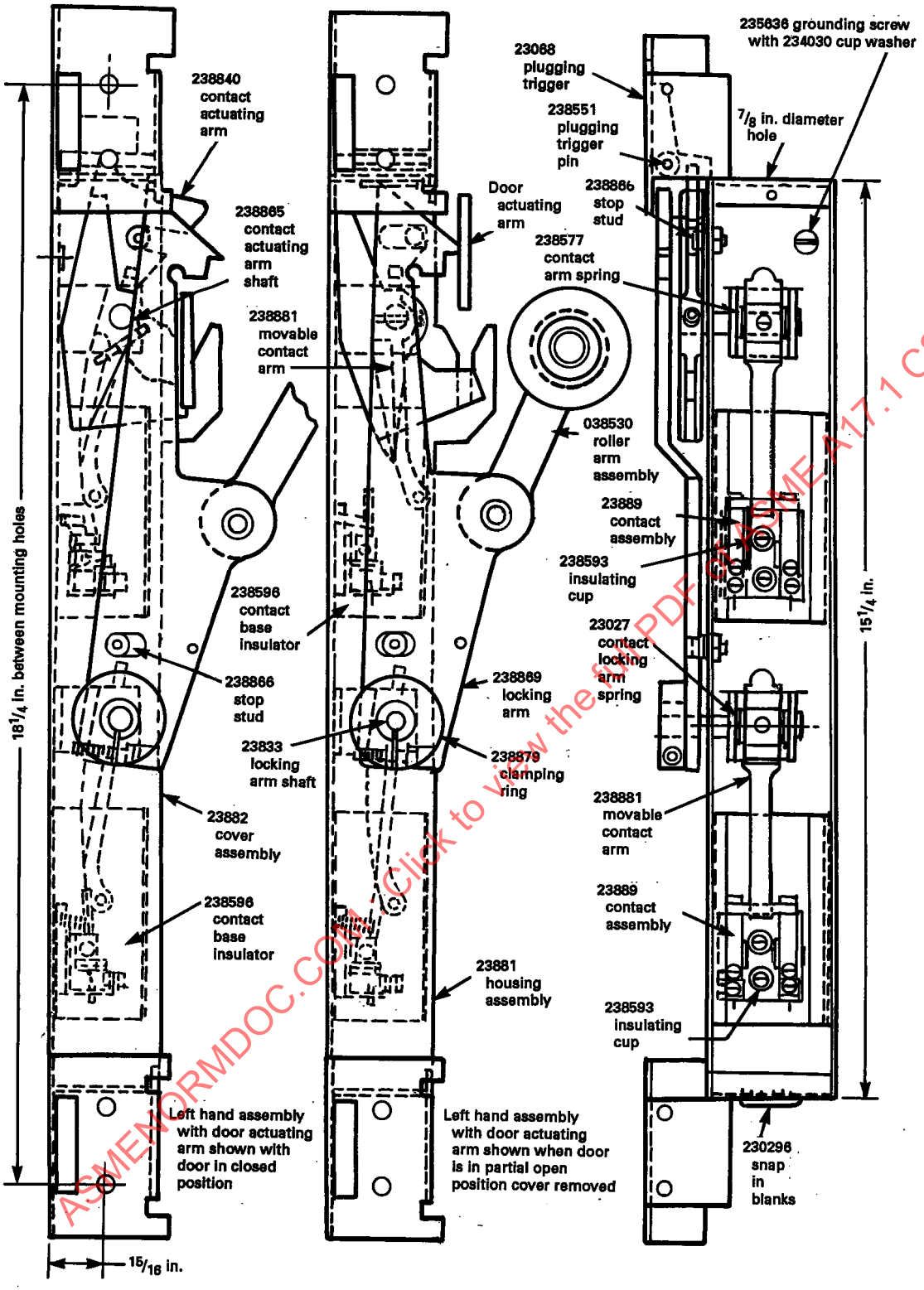
Diagram 7.1.11.12
Typical Dumbwaiter Vertical Biparting Door



GENERAL NOTE: Courtesy of The Peelle Co.

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Diagram 7.1.12.1.3
Typical Interlock for Dumbwaiter



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SECTION 7.2
ELECTRIC DUMBWAITERS WITHOUT AUTOMATIC TRANSFER DEVICES

NOTE: Throughout Section 7.2, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

In addition to the requirements in Section 7.2, the requirements in Section 7.1 apply to electric dumbwaiters without automatic transfer devices.

The title and requirements in Section 7.2 were revised in ASME A17.1-2019/CSA B44:19 to delete hand dumbwaiters because they cannot comply with the equivalent minimum safety requirements for power dumbwaiters.

7.2.1 Car Enclosures, Car Doors and Gates, and Car Illumination

7.2.1.1 Car Enclosures. Many of the requirements in Section 2.14 are not applicable because they are for the protection of passengers.

7.2.1.2 Car Doors and Gates. Car doors or gates are required. Car doors prevent the load from projecting from within the car.

7.2.1.3 Lighting Fixtures. Where lighting fixtures are provided in the car, conformance to the requirements of 2.14.7.3 and 2.14.7.4 will provide the necessary safety features.

7.2.2 Car Frames and Platforms

The requirements for car frames and platforms reference applicable portions of Section 2.13. Because of their smaller size, frames for dumbwaiter cars and platforms are not always necessary.

7.2.2.8 This requirement applies to leveling or inching operation. It is a performance-based requirement prohibiting an opening into the hoistway above or below a car during leveling or inching operation.

7.2.3 Capacity and Loading

7.2.3.1 Rated Load and Platform Area. ASME A17.1 requirements prior to the 1987 edition and CSA B44 requirements prior to the 2000 edition specified a maximum rated load of 226.8 kg or 500 lb and a minimum structural load based on the inside net platform area. ASME A17.1-1987 and CSA B44-00 and later editions recognized that, regardless of the posted rated load, a car is capable of being loaded to an extent based on its inside volume. Requiring a minimum rated load based on floor area, compatible with the structural capacity, is a more logical safety requirement. There is no maximum allowable capacity.

7.2.3.2 Capacity Plate. The capacity plate gives information on safe loading to the user. This requirement was revised in ASME A17.1-2016/CSA B44-16 to make the provisions for dumbwaiter plates consistent with those for elevator capacity plates.

7.2.3.3 Data Plate. The data plate is for the use of elevator personnel.

7.2.3.3.1 The requirement allows capacity information to be stand-alone or on a single plate that contains additional data. As most dumbwaiters are inspected from outside the hoistway, it is more convenient and safer to place the information in one location within a car.

7.2.4 Car and Counterweight Safeties

Car and counterweight safeties are necessary only where the hoistway is over occupiable space (7.1.6). Maximum stopping distances are specified; however, there is no need for minimum stopping distances since there are no passengers. These requirements address guide-rail shapes other than T-shaped. Persons should never be on top of or below a dumbwaiter car without safeties, unless means are provided to secure the car. See safety practices in *Elevator Industry Field Employees' Safety Handbook*. Procurement information for this document can be found in the Handbook commentary on Part 9.

Requirement 7.2.4.1 was revised in ASME A17.1-2022/CSA B44:22 to add safeties to dumbwaiters and their counterweights when only one suspension means is provided.

7.2.5 Speed Governors

Requirements for speed governors, if provided, are referenced. It would be inconsistent to require the governor rope to be 9.5 mm or $^{3}/_{8}$ in. in diameter when the suspension ropes may be less.

7.2.6 Suspension Means

(a) Welded link chain is prohibited as a suspension means because

(1) there appears to be no practical way of visually detecting an impending failure at the weld of a welded link proof-tested steel chain.

(2) there appears to be no practical way to detect an impending failure of such a chain due to fatigue. Hairline cracks develop quickly.

NOTE: (1) and (2) are important factors for safe operation, and place an undue burden of responsibility upon an inspector trying to determine when such chain is unsafe.

(3) there is literature published by some chain manufacturers that welded link proof-tested steel chain is not recommended for overhead lifting purposes or where its failure is likely to cause damage to property or persons.

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(4) the exposure of a substantial number of people from all walks of life to dumbwaiter usage in their normal everyday work environment subjects them to whatever hazards may exist around and in the entrances of such dumbwaiters. The fact that arms, hands, and even heads encroach into and through the entrance areas makes it imperative that a safe and adequate means of suspension exists at all times. Any chain failure could be disastrous.

(b) This requirement was revised in ASME A17.1-2016/CSA B44-16 to improve safety and to make terminology consistent by replacing the differing references to chain strength with "minimum ultimate tensile strength," the terminology used in the ASME B29 standards.

The only value for chain strength included in the ASME B29 standards is minimum ultimate tensile strength. As defined in the ASME B29 standards, the minimum ultimate tensile strength is the minimum force at which an unused, undamaged chain could fail when subjected to a single tensile loading test. Other values of chain strength, such as listed below, are not recognized by the ASME B29 standards.

(1) Average tensile strength is only a catalog value that is not defined in the ASME B29 standards, varies from manufacturer to manufacturer, and should not be used in the design of drive or suspension systems using chain.

(2) Rated breaking strength is not defined in the ASME B29 standards and is therefore not specific enough for use in elevator design.

(3) Ultimate tensile strength, although well-recognized terminology, is of little use for elevator design purposes. For its use, the specific failure mode of the chain (i.e., which component breaks in the given situation) would have to be known, and the ultimate strength of that component would need to be provided by the chain manufacturer.

Requirement 7.2.6.1.1 was revised in ASME A17.1-2022/CSA B44:22 to add a reference to the requirement for safeties when only one suspension means is provided.

NOTE: For elevator applications that involve lifting people, it may be prudent to have the chain manufacturers certify the minimum ultimate tensile strength of their chain.

7.2.6.2 Rope Data. The rope data tag is not permitted to be within the car. The crosshead data plate is permitted to be in the car.

7.2.6.3 Chain Data

7.2.6.3.1 and 7.2.6.3.2

7.2.6.3.1(d) and 7.2.6.3.2(c) These requirements were revised in ASME A17.1-2016/CSA B44-16 to update terminology for chain strength [see Handbook commentary in 7.2.6(b)].

7.2.6.5 Number of Ropes or Chains Required

7.2.6.5(b) This requirement was revised in ASME A17.1-2016/CSA B44-16 to update terminology for chain strength [see Handbook commentary in 7.2.6(b)].

7.2.6.8 Fastening of Suspension Means

7.2.6.8.1 *7.2.6.8.1(b)* U-bolt-type rope clips (clamps) are permissible, provided that the fastening develops at least 80% of the ultimate breaking strength of the rope. This requirement was revised in ASME A17.1-2016/CSA B44-16 to update terminology for chain strength [see Handbook commentary in 7.2.6(b)].

7.2.8 Bumpers and Buffers

Buffer stroke requirements are based on the fact that dumbwaiters do not carry passengers.

Requirement 7.2.8 was revised in ASME A17.1-2022/CSA B44:22 to clarify that solid bumpers are permitted and to include the necessary requirements.

7.2.8.1 Spring Buffers. Requirement 7.2.8.1 was revised in ASME A17.1-2022/CSA B44:22 to exclude 2.22.1.1.1 because 7.2.8.1 allows spring buffers to be used up to 1.5 m/s (300 ft/min). Also, the table reference was corrected.

7.2.8.2 Oil Buffers. Requirement 7.2.8.2 was revised in ASME A17.1-2022/CSA B44:22 to exclude 2.22.1.1.1 because 7.2.8.2 allows oil buffers to be used up to 1.5 m/s (300 ft/min). Also, the table reference was corrected.

7.2.8.3 Bumpers. Requirement 7.2.8.3 was added in ASME A17.1-2022/CSA B44:22 to clarify that solid bumpers are permitted and must comply with 2.22.2.

7.2.8.4 Elastomeric Buffers. Requirement 7.2.8.4 was added in ASME A17.1-2022/CSA B44:22 to clarify that elastomeric bumpers are permitted for lower speeds and must comply with 2.22.5.

7.2.9 Car and Counterweight Guide Rails, Guide-Rail Supports, and Fastenings

Other sizes and shapes for guide rails are permitted, provided that they meet the performance requirements of Section 2.23.

7.2.9.1 Guide-Rail Section. The allowable deflection of 6 mm or $\frac{1}{4}$ in. required by 2.23.5.1.1 relates to T-shaped guide rails and conventional elevator safeties. When other shapes of guide rails are used, the deflection must comply with this performance requirement.

7.2.10 Driving Machines and Sheaves

7.2.10.1 Power Dumbwaiters. The sheave and drum diameters are based on what is currently being used, with no history of any problem.

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7.2.10.2 Hand Dumbwaiters. This requirement was deleted in ASME A17.1-2019/CSA B44:19 because hand dumbwaiters cannot comply with the equivalent minimum safety requirements for power dumbwaiters.

7.2.10.3 Types of Driving Machines. See Diagrams 7.2.10.3(a) and 7.2.10.3(b).

7.2.11 Terminal Stopping Devices

Requirement 2.25.3.3 is not applicable to dumbwaiters. The final terminal limits must be in the hoistway. The "machine limit" for winding-drum machines required in 2.29.3.5 is not required. If the additional stopping device operated by the driving machines is provided, it must comply with 2.29.3.5.

The final terminal stopping device within the confines of the hoistway, in addition to the normal stopping means, provides an adequate level of redundancy and sufficient overtravel protection on a device designed solely to carry materials.

7.2.12 Operating Devices and Control Equipment

Requirements in Section 2.26 have been referenced, except for those requirements that are only for the protection of persons in the car. Broken rope, tape, and chain switches used in connection with normal terminal stopping devices are not necessary for dumbwaiters since final terminal stopping devices are now required. If the rope, tape, or chain breaks, the final terminal stopping device will still stop the dumbwaiter. The final terminal stopping device within the confines of the hoistway, in addition to the normal stopping means, provides an adequate level of redundancy and sufficient overtravel protection on a device designed solely to carry materials. Requirements are also added to reference 2.26.6 to prevent the continued rotation of the motor when it is reversed electrically. Where a top-of-car device is provided, indicating that maintenance or inspection may occur from the car top, car safeties must be provided. Electrical equipment is required to be certified as complying with CSA B44.1/ASME A17.5. This minimizes the risk of electricity as a source of electric shock and as a potential ignition source of fires. Dumbwaiter electrical equipment does not have to comply with EN 12016, Electromagnetic compatibility: Product family standard for lifts, escalators and moving walks. Immunity. Other referenced requirements are modified to reflect dumbwaiter conditions.

7.2.12.4 Hoistway access switch provides a means to access top of car when a car top operating station is provided.

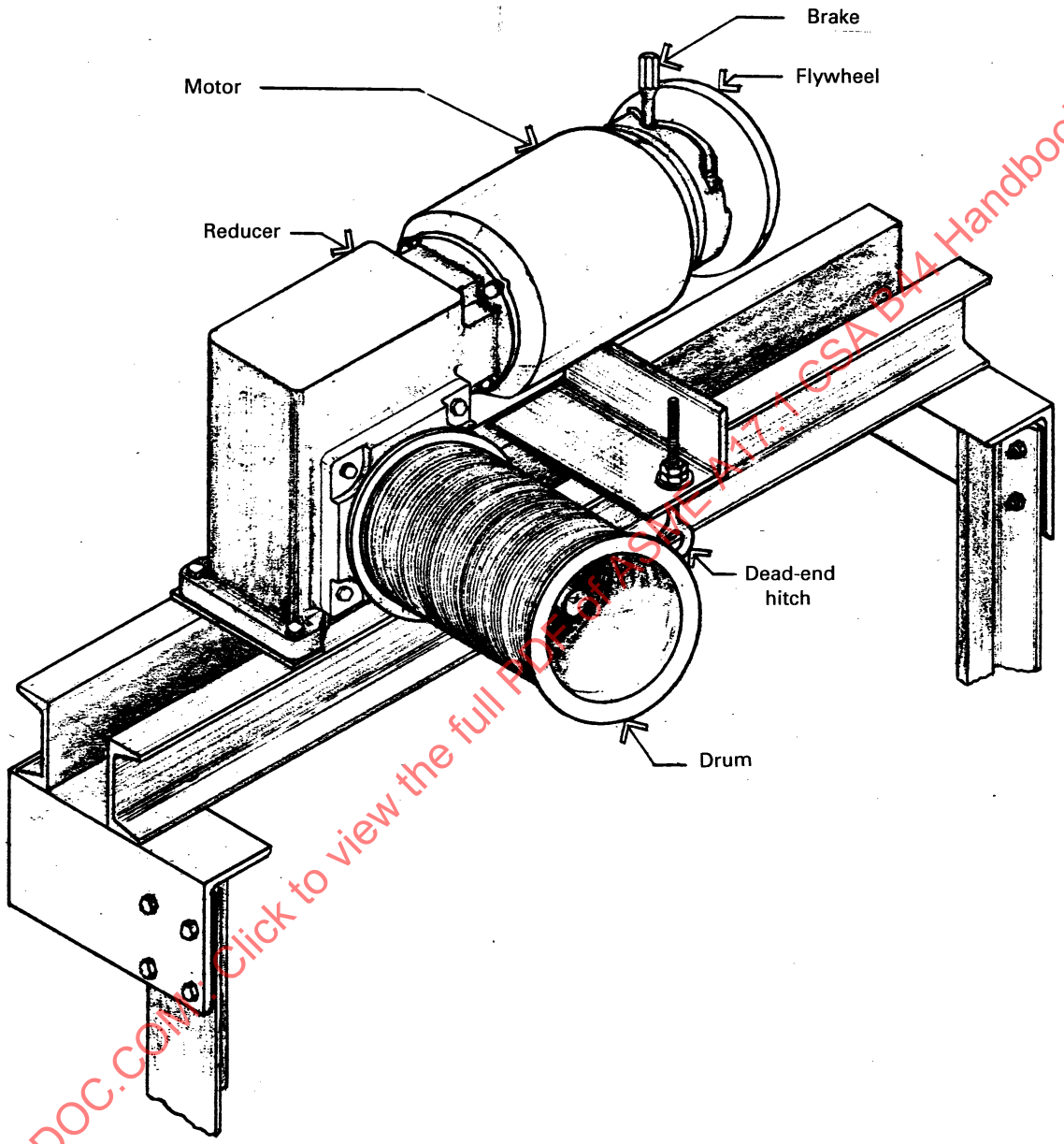
7.2.12.31 This requirement was added in ASME A17.1-2016/CSA B44-16 to provide a clear indication that door close contacts must be provided when operation with the door closed but not locked is permitted by 7.1.12.1.3(b)(2). It also confirms that the door close contacts are electrical protective devices and must meet all requirements for electrical protective devices, such as the requirements of 2.26.9.3, as applicable. The existing 7.2.12.31 through 7.2.12.38 were editorially redesignated as 7.2.12.32 through 7.2.12.39, respectively.

7.2.12.40 This requirement was added in ASME A17.1-2016/CSA B44-16 to clarify that fire service is not applicable to dumbwaiters and material lifts.

7.2.12.41 Requirement 7.2.12.41 was added in ASME A17.1-2022/CSA B44:22 to exclude remote interaction operation (RIO) on dumbwaiters without automatic transfer devices until such time that appropriate requirements are developed by the responsible ASME working group.

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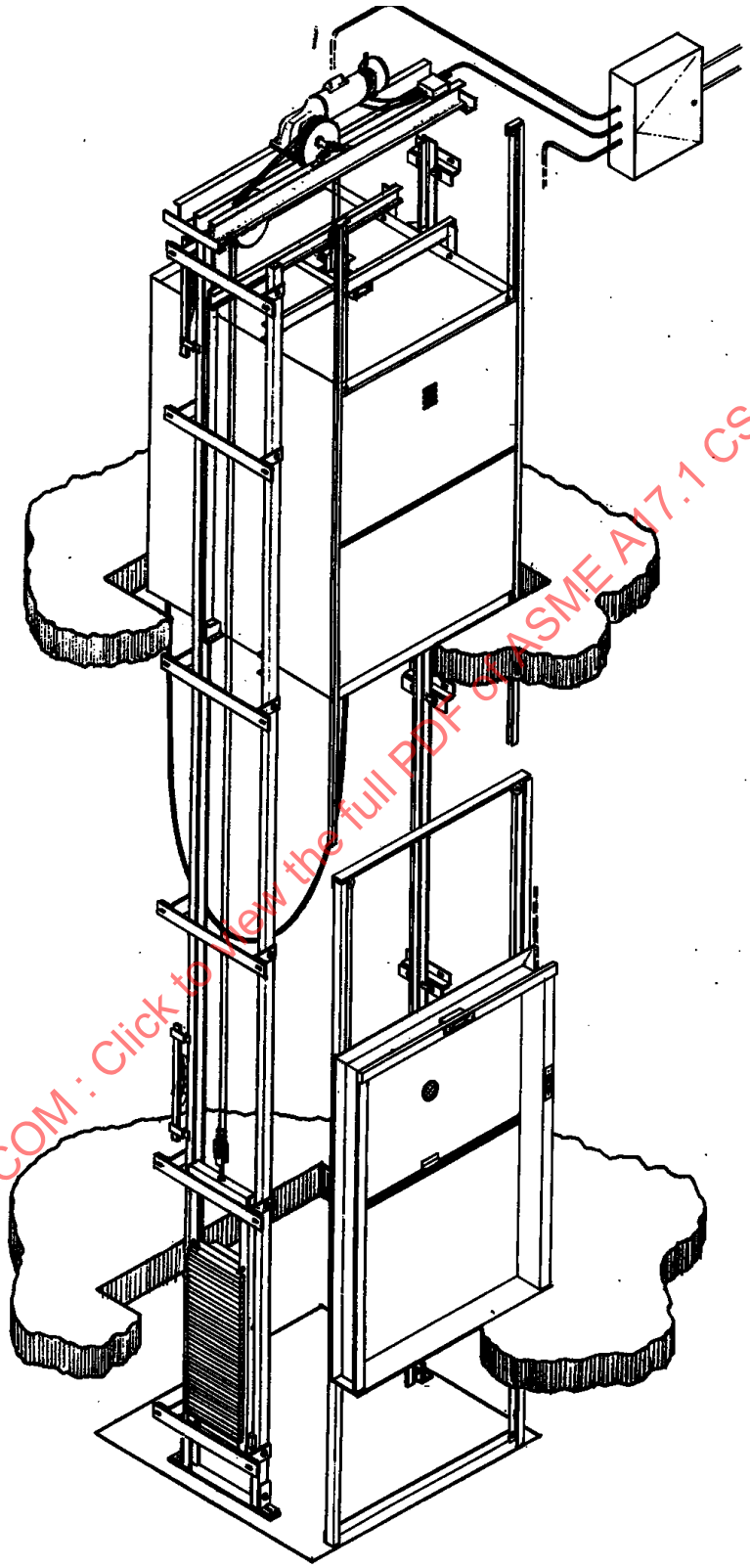
Diagram 7.2.10.3(a)
Typical Winding-Drum Machine — Dumbwaiter



GENERAL NOTE: Courtesy of Sedgwick Lifts, Inc.

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Diagram 7.2.10.3(b)
Typical Floor-Loading Traction Machine — Dumbwaiter



GENERAL NOTE: Courtesy of Sedgwick Lifts, Inc.

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SECTION 7.3
HYDRAULIC DUMBWAITERS WITHOUT AUTOMATIC TRANSFER DEVICES

NOTE: Throughout Section 7.3, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

In addition to the requirements in Section 7.3, the requirements in Section 7.1 apply to hydraulic dumbwaiters without automatic transfer devices.

7.3.11 Operating Devices and Control Equipment

7.3.11.3 Anticreep Leveling Devices

7.3.11.3.4 Requirement 7.3.11.2.4 was revised in ASME A17.1-2022/CSA B44:22 to be consistent with the new definition for "main line power."

7.3.11.10 This requirement was added in ASME A17.1-2016/CSA B44-16 to clarify that fire service is not applicable to dumbwaiters and material lifts.

SECTION 7.4
MATERIAL LIFTS WITHOUT AUTOMATIC TRANSFER DEVICES

NOTE: Throughout Section 7.4, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

The most obvious way to determine if one is looking at an ASME A17.1/CSA B44 Type A material lift or ASME B20 vertical reciprocating conveyors is to ask the manufacturer. Nobody should design, market, or install equipment without knowing what they are manufacturing or what safety standard their design is intended to meet. The key distinction between an ASME A17.1/CSA B44 Type A material lift and an ASME B20 vertical reciprocating conveyor lies in the fact that the material lift is simply an ASME A17.1/CSA B44 elevator (passenger or freight) design that has been modified to carry materials. The characteristics that typically may identify the equipment as an elevator include, but are not limited to, the following:

(a) "hoistway (shaft)" with entrance
(b) "T" type/"fixed guides"
(c) hoisting mechanism with elevator speed controls
(d) door mechanisms
(e) leveling devices
(f) safety devices
(g) electrical controls that mimic those found on elevators

Practically all these basic structural and electrical control features are different with vertical reciprocating conveyor's design, which utilizes industrial machine-type controls and basic conveyor components.

The comments that follow relate only to Type A material lifts unless otherwise specified. A new type of material lift called Type B was introduced in ASME A17.1-2000 and CSA B44-00. This lift was added as part of the harmonization process and closely matches the Canadian Freight Platform Lift contained in Section 15 of CSA B44-94.

7.4.2 Classification

7.4.2.2 This requirement provides limitations for Type B material lifts and was revised in ASME A17.1-2016/CSA B44-16 to remove the restriction for penetration of only one floor and to increase the travel limit to 7.6 m or 25 ft. The change to 7.6 m or 25 ft provides a practical limit for the operation of a device at 0.15 m/s or 30 ft/min as it would require holding the operating button for 50 s. Jurisdictions in Canada have permitted Type B material lifts to have a travel greater than 5 m or 16 ft for many years with no adverse consequences. Only authorized personnel can access and use Type B material lifts, which are commonly found in industrial buildings. These types of buildings can have floor spacing greater than 5 m or 16 ft as a result of the type of processing, storage, or manufacturing being performed. Also, industrial buildings are typically of slab-on-grade construction, with no provisions for elevator pits. Removing the one-floor penetration restriction allows greater application of this type of device when travel is increased to 7.6 m or 25 ft. These devices can already stop at intermediate landings and must meet fire-rated hoistway requirements when required by the building code. No additional hazards are foreseen by removing the floor-penetration restriction. The additional requirement of an interlock for this device reduces the risk of a fall that could result from increased travel as it ensures the doors are positively locked before the car leaves the landing zone.

7.4.3 Construction of Hoistways and Hoistway Enclosures

The building code (see Section 1.3) will dictate whether the hoistway must be of fire-resistive construction or non-fire-resistive construction.

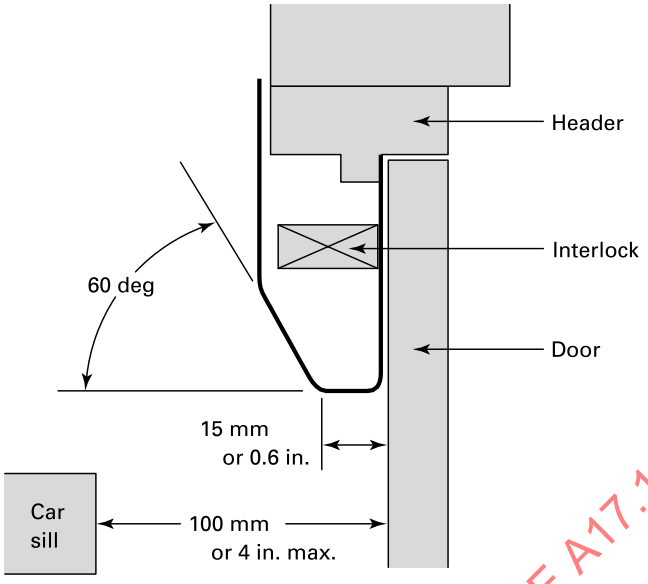
Requirement 7.4.3 was revised in ASME A17.1-2019/CSA B44:19 to clarify that glass hoistways are not permitted for material lifts. These lifts are often located in areas where damage is more likely and shifting loads could break the glass.

Table 7.4.3 Type B Material Lifts

A deviation for jurisdictions enforcing NBCC allows for vertically sliding doors and applicable clearance.

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Diagram 7.4.7.4
Beveling and Clearance Requirements



7.4.4 Pits

Requirement 7.4.4 was revised in ASME A17.1-2019/CSA B44:19 to clarify the requirements.

7.4.5 Location and Guarding of Counterweights

Where counterweights are exposed in service areas, they are required to be provided with guards or telltale (e.g., chain) warnings to warn personnel in the path of a descending counterweight.

7.4.6 Vertical Clearances and Runbys for Car and Counterweights

Requirements are provided for refuge space in the pit and in the overhead when appropriate conditions are present. As Type A material lifts do not carry passengers, less restrictive clearances and runbys are permitted.

7.4.6.1

7.4.6.1.3 and 7.4.6.1.4 Hoistway construction and machinery location in the hoistway may not provide adequate refuge space when the car is at the upper landing. Alternative methods to create the space are permitted.

7.4.6.1.4 Tighter tolerances are permitted on these relatively smaller cars on which passengers are not carried. The use of a single rail for both the car and counterweight necessitates tighter clearances.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to update the top car clearances to reflect requirements in 2.4.7. A separate refuge space is no longer specified in the Code since the clearances necessary for refuge space are now incorporated into the top-of-car clearances for both electric and hydraulic elevators.

7.4.7 Horizontal Car and Counterweight Clearances

7.4.7.4 Beveling and Clearance Requirements for Type B Material Lifts. See Diagram 7.4.7.4.

7.4.9 Machinery Spaces, Machine Rooms, Control Spaces, and Control Rooms

7.4.9.3 Requirement 7.4.9.3 was revised in ASME A17.1-2022/CSA B44:22 to remove the exception for 2.7.5.1, which was incorrectly included by a previous record.

7.4.10 Electrical Equipment in Hoistways and Machine Rooms

7.4.10.1 Type SF-2 wire is not required as firefighters' service is not required.

7.4.10.2 There is no need to remove power prior to or upon application of a sprinkler, as there are no passengers on a material lift.

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7.4.13 Protection of Hoistway Landing Openings

7.4.13.2

7.4.13.2.1 Emergency access doors to blind hoistways are not required for material lifts that do not carry people. Opening size is determined by material lift usage.

7.4.13.2.2 The requirements for passenger elevators are not applicable.

7.4.13.2.2(a) See Diagram 2.11.2.1(a)(1).
7.4.13.2.2(b) See Diagram 2.11.2.1(b).
7.4.13.2.2(c) See Diagram 2.11.2.2(e)(2).
7.4.13.2.2(d) See Diagram 2.11.2.2(f).

7.4.13.2.4 Type A material lifts cannot be operated from within the car, and passengers are not permitted.

7.4.13.2.5 Since there is no means to operate Type A material lift from the car, a risk of locking someone in the car that is in the process of loading and unloading should not be allowed.

It was intended that certain devices be activated by means other than automatic operation for the purpose of testing and, conversely, be reset by means requiring intervention by a person rather than by automatic means. The use of the phrase "by hand" in ASME A17.1-2007/CSA B44-07 and earlier codes was not intended to be taken literally as meaning that only a human hand may be used to "manually trip" or "manually reset" a device or component. The changing of the wording in ASME A17.1a-2008/CSA B44a-08 in the requirements allows for the use of devices other than the human hand to activate or reset a device safely.

While the generalized term "tripped by hand" was intended to convey a performance requirement that the governor be designed to allow for manual activation, it was also intended that the method of hand tripping the numerous designs of governors in the marketplace be done safely and without causing equipment damage. It was intended that hand tripping be applied to a stationary or relatively slow moving means and not to any components rotating at the same speed as the governor sheave.

Manual tripping or manual resetting may also be done from a location remote from the device by authorized persons or elevator personnel in areas and by means not readily accessible to the public.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to reference 2.12.1 so users can locate the required unlocking zone dimensions, which were previously specified in the definition of "unlocking zone" in Section 1.3.

7.4.13.2.6 Hoistway door vision panels serve no safety purpose.

7.4.13.2.7 The inclusion of glass on a device designated to carry materials adds an unnecessary risk that the materials may shift and cause breakage of the glass.

7.4.13.2.8 Landing-sill guards are not required on material lifts that do not transport passengers.

7.4.13.2.9 Bridging devices may be desirable to help with the transfer of carts from the landing to the car.

7.4.13.2.10 Pull straps inside the car are not necessary since the doors should not be closed from inside the car.

7.4.13.2.11 Combination horizontally sliding and swinging panels are not allowed.

7.4.14 Hoistway Door Locking Devices and Electric Contacts, and Hoistway Access Switches

ASME A17.1b-2009/CSA B44b-09 was revised to allow a Type B material lift to leave the floor while the doors or gates are closed but not locked. Motion with doors not locked is permitted only in a small zone. The inherent safety features of an interlock are maintained outside of this zone. Once out of the zone, the interlock circuit will be checked. This is a similar operation to private residence interlocks. This operation will permit fixed cams to be used on the car rather than a retiring cam.

In developing the revisions, the ASME A17 Committee considered the following:

(a) The anticreep requirements and truck leveling zone requirements for a Type B material lift should not be the same as for a hydraulic elevator, as the Type B material lift has special conditions that require specific rules for consistency.

(b) Next, there are few modes of automatic operation that seem to conflict with the safety principle of maintaining operator control through the use of continuous pressure. The operation modes giving concern were automatic leveling and anticreep operation with a 450-mm or 18-in. zone and low oil protection that automatically lowers a car.

(c) Finally, the changes ease up on a requirement that is probably not necessary on a lift with limitations in speed, control, and travel. Instead of requiring the door or gate to be closed and locked before leaving a landing, the requirement permits the car to leave the landing with the door or gate only closed. Once out of a small zone, interlocks must be used to lock the doors or gates in the closed position.

In implementing the previous requirement, it was discovered conflicts in the intended requirements are present as a result of Section 7.6, referencing both Sections 7.5 and 3.26, which in turn both modify Section 2.26 in their own way. The referencing was updated to eliminate potential conflicts.

7.4.14.1 The requirements for passenger elevators are not applicable to material lifts that do not transport passengers.

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7.4.14.2 The requirements for passenger elevators are not applicable to material lifts that do not transport passengers.

7.4.14.3 Unlocking devices are only needed for access to the overhead and pit for maintenance and inspection purposes.

7.4.14.6 and 7.4.14.7 Requirement 7.4.14.6 was revised and 7.4.14.7 was added in ASME A17.1-2016/CSA B44-16 to limit the Type B material lifts to full interlocks only. Lock and contacts are permitted only for Type A material lifts. This revision enhances the safety of Type B material lifts by ensuring that hoistway doors are locked before the car leaves the landing. Persons are permitted to ride Type B material lifts; disallowing the use of a mechanical lock and contact eliminates the risk of a lock failing and a person accidentally entering a hoistway when no car is present.

SECTION 7.5
ELECTRIC MATERIAL LIFTS WITHOUT AUTOMATIC TRANSFER DEVICES

NOTE: Throughout Section 7.5, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

In addition to the requirements in Section 7.5, the requirements in Section 7.4 apply to electric material lifts without automatic transfer devices.

7.5.1 Car Enclosures, Car Doors and Gates, and Car Illumination

7.5.1.1 Car Enclosure

7.5.1.1.1 This requirement prohibits the use of a forklift truck when placing a load on a Type A material lift car. It was revised in ASME A17.1-2016/CSA B44-16 to remove the width restriction for Type A material lifts with a restricted height. This revision continues to prevent forklifts from being driven onto Type A material lifts while expanding the range of lift sizes available.

7.5.1.1.2 This requirement contains the essence of the requirements in 2.14.1.2 except those requirements in 2.14.1.2 related to passenger-type elevators.

7.5.1.1.4 The criteria for design of the enclosure walls is more closely related to the actual load being carried than to a generalized design criterion suitable for a passenger-type application. Type A material lifts may have multiple compartments, and fixed and/or removable shelves.

7.5.1.1.5 Emergency exits are not required in non-passenger-carrying Type A material lifts.

7.5.1.1.7 This requirement was revised in ASME A17.1-2019/CSA B44:19 to require a car-top railing on Type B lifts that have a cartop.

7.5.1.1.8 The inclusion of glass on a device designed to carry materials adds an unnecessary risk.

7.5.1.1.9 This requirement contains the essence of the requirements in 2.14.1.9 except those requirements in 2.14.1.9 related to passenger-type elevators.

7.5.1.1.10 Emergency exits are not required in non-passenger-carrying Type A material lifts.

7.5.1.1.11 Specific requirements for passenger elevators, not applicable to Type A material lifts.

7.5.1.1.12 Grille or perforated construction may be used for the full height and car top, if provided. Type A material lift enclosures may be less than 1 828 mm or 72 in.

7.5.1.1.13 If ventilation grilles are provided, their location is irrelevant in a non-passenger-carrying Type A material lift.

7.5.1.2 Car Doors and Gates

7.5.1.2.2 This requirement ensures that the material lift will not run unless the car door or gate is in the closed position.

7.5.1.2.3 As there are no passengers, there is no safety hazard if a car door or gate is not provided. The only purpose of a car door or gate on this equipment is to assist in retaining materials carried within a Type A material lift car. This requirement provides minimum design criteria for a car door or gate, where provided.

7.5.1.2.4 As there are no passengers, there is no safety hazard to personnel if a Type A material lift car door or gate is not provided. The only purpose of a car door or gate on this equipment is to assist in retaining materials carried within the car. This requirement provides minimum design criteria for a car door or gate, where provided.

7.5.1.2.6 As there are no occupants on a Type A material lift, there is no hazard if the door or gate weight is located within the car enclosure. Guides or counterweight boxes prevent the weights from swinging freely and causing incidental damage, plus provisions for suitable restraint in the event of suspension member failure are required.

7.5.1.3 Car Illumination and Lighting Fixtures. Provides for a minimum level of illumination within Type A material lift car for loading and unloading, plus minimum design criteria for the light.

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7.5.2 Car Frames and Platforms

7.5.2.1 It is not the intent to dictate the design of the equipment, only to ensure that is designed to meet its intended purpose.

7.5.2.2 Exceptions to specific platform design parameters and specific loading classifications.

7.5.2.3 Type A material lifts do not carry passengers. Protection of the platform against fire is irrelevant.

7.5.2.4 When Type B material lifts can operate in a leveling or trucking zone above a landing with doors or gate open, etc., then the shear hazard between the platform and the landing sill needs to be eliminated. If it cannot operate in the leveling zone with the doors or gates open, then a platform apron is not required. Also see Handbook commentary on 7.4.14.

7.5.2.5 As an overlap of 75 mm or 3 in. is required, the need for the bevel is eliminated.

7.5.2.6 Requirement 7.5.2.6 was revised in ASME A17.1-2022/CSA B44:22 to require that both Type A and Type B material lifts comply with the deflection requirements. Previously, there was not a requirement for deflection for Type A material lifts.

7.5.3 Capacity and Loading

7.5.3.1 The requirements of a passenger elevator are not applicable to material lifts that do not transport passengers.

7.5.3.2 Similar to rated load requirements for freight elevators, provisions are included for the weight of a hand truck. Type A material lifts are designed for hand truck use but not intended for forklift use.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to restrict the use of Type A safeties to lifts traveling at 1 m/s or 200 ft/min or less where the space below the lift is not accessible. These safeties are permitted to be similar to that of freight elevators except a faster speed is allowed because Type A lifts carry no passengers. Limiting the use of slack-rope safeties when space below the material lift is accessible reduces the possibility of personal injury.

7.5.3.3 Riders are not permitted on Type A material lifts.

7.5.4 Car and Counterweight Safeties

7.5.4.1 The objective is to stop the car should a failure occur. Since there are no passengers on a Type A material lift car, the retardation force is of little importance. Type B safeties are permitted.

7.5.4.2 Passengers are not carried.

7.5.4.3 The objective is to stop the car should a failure occur. Since there are no passengers on a Type A material lift, the retardation force is of little importance. Type B safeties are permitted. When the speed is slow, broken rope safeties are considered sufficient.

This requirement was revised in ASME A17.1-2016/CSA B44-16 to restrict the use of Type A safeties to lifts traveling at 1 m/s or 200 ft/min or less where the space below the lift is not accessible. These safeties are permitted to be similar to those of freight elevators except a faster rated speed is allowed because Type A material lifts carry no passengers. Limiting the use of slack-rope safeties when space below the material lift is accessible reduces the possibility of personal injury.

7.5.4.4

7.5.4.4.1 Requirement allows for different rail design other than "T" rails.

7.5.5 Speed Governors

7.5.5.1 Passengers are not carried.

7.5.5.3

7.5.5.3.1 Incorporates provisions for governor ropes smaller than 9.5 mm or $^{3}/_{8}$ in. when the suspension means is less than 9.5 mm or $^{3}/_{8}$ in.

7.5.6 Suspension Ropes and Their Connections

Requirement 7.5.6, specifically 7.5.6.2 and 7.5.6.6, was revised in ASME A17.1-2022/CSA B44:22 to change "manufacturer's rated breaking strength" to "minimum ultimate tensile strength (MUTS)" to align with the requirements in ASME B29.1.

7.5.6.1 Permits the use of chains and wire ropes other than elevator wire rope.

7.5.6.2 Chain Data. Includes requirements for chain data similar to that required for wire ropes.

7.5.6.3 To include an appropriate safety factor for chains.

7.5.6.5 Two ropes provide sufficient redundancy on a non-passenger-carrying Type A material lift. Allows single-bar-type equalizers on all drives when only two ropes are provided.

7.5.6.6 Adds suspension fastening requirements for chains.

7.5.8 Buffers and Bumpers

Retardation force on a non-passenger-carrying Type A material lift can be less stringent than that required for passenger-carrying elevators.

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Requirements 7.5.8 and 7.5.8.1 were revised in ASME A17.1-2022/CSA B44:22 to be consistent with the language used in Section 2.22. A new requirement 7.5.8.3 was added to permit elastomeric buffers.

7.5.9 Car and Counterweight Guide Rails, Guide-Rail Supports, and Fastenings

7.5.9.1 Use of Common Guide Rails. It is common practice for small elevators such as residence elevators, personnel elevators, and dumbwaiters to have the car and counterweight run in a common rail.

7.5.9.2 Guide-Rail Sections. Allows for rails with smaller section modulus and moment of inertia consistent with cars and counterweights of smaller size, weight, and rated capacity. Does not dictate the size of bolts required for fastening the guide rail to the rail brackets; however, strength requirements remain applicable. Adds the requirement that the allowable deflection, in addition to compliance with that specified in Section 2.23, cannot allow the safety to disengage from the rail.

7.5.10 Driving Machine and Sheaves

7.5.10(a)(1) A material-only handling device can meet a lower standard for pitch diameter.

7.5.10(b) Permits the use of chain drives and provides for general design criteria.

7.5.10(f)(1) This requirement was revised in ASME A17.1-2019/CSA B44:19 to allow the driving machine to be located above the platform when a car top is provided. This allows alternative material lift designs with the machine above the car in the hoistway while also enhancing the safety of the operator and material handler by providing a car top in these situations.

7.5.11 Terminal Stopping Devices

A final terminal stopping device within the confines of the hoistway, in addition to the normal stopping means, provides an adequate level of redundancy and sufficient overtravel protection on a device designed solely to carry materials.

7.5.12 Operating Devices and Control Equipment

7.5.12.1

7.5.12.1.1 Passengers are not permitted on Type A material lift car.

7.5.12.1.2 One-piece loads greater than the rated load are not permitted.

7.5.12.1.3 This requirement was added in ASME A17.1-2016/CSA B44-16 to specify that 2.26.1.4.1(a)(1)(-a) does not apply for car sizes where the platform is less than 1.4 m^2 or 15 ft^2. People should not be on the car top if there is not adequate refuge space. The area was chosen based on the space needed to accommodate the equipment typically provided on the top of the material lift, including door operator(s), crosshead, etc., and possible refuge space. The remaining requirements in 7.5.12.1 were editorially redesignated.

7.5.12.1.6 Passengers are not permitted on Type A material lift cars.

7.5.12.1.25 This requirement was added in ASME A17.1-2016/CSA B44-16 to clarify that fire service is not applicable to dumbwaiters and material lifts.

7.5.12.1.26 Requirement 7.5.12.1.26 was added in ASME A17.1-2022/CSA B44:22 to exclude remote interaction operation (RIO) on Type A electric material lifts without automatic transfer devices until such time that appropriate requirements are developed by the responsible ASME working group.

7.5.12.2

7.5.12.2.5 Operation in Leveling or Truck Zone. The speed limitation was removed in ASME A17.1b-2009/CSA B44b-09 to allow for the maximum Type B material lift rated speed. It is only 0.025 m/s or 5 ft/min faster than elevator leveling speed.

7.5.12.2.5.1 See Handbook commentary on 7.4.14.

7.5.12.2.5.2 Provides a Type B material lift leveling zone specific to the characteristics of a device with no car doors, little or no car platform guard, and continuous pressure operation. The same small zone will be used for anticreep operation. Also see Handbook commentary on 7.4.14.

7.5.12.2.5.3 Requirements were added in ASME A17.1b-2009/CSA B44b-09 to create conditions that will permit a truck zone. Prior requirements did not restrict truck zones even though platform guards are not required. Also see Handbook commentary on 7.4.14.

7.5.12.2.5.4 See Handbook commentary on 7.4.14.

7.5.12.2.6 This requirement was revised in ASME A17.1-2016/CSA B44-16 to permit use of a nonlatching emergency stop switch at the landings for Type B material lifts. This revision is intended to prevent operator entrapment, which can occur if someone activates a latching emergency stop switch at the landing while an operator is in the car. Requiring that all operating devices at the landing and in the car be released before the car is allowed to operate ensures that an operator in the car can regain control of the car by releasing and actuating an operating device. The labeling requirements in 2.26.2.5(c) still apply to the continuous-pressure emergency stop switch. The operation of the continuous-pressure emergency stop switch is still required to cause the power to be removed from the driving machine.

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7.5.12.2.18 Hoistway Door Close Contacts. Requirements were added in ASME A17.1b-2009/CSA B44b-09 to define hoistway door contacts as Type B material lift electrical protective devices. See also Handbook commentary on 7.4.14.

7.5.12.2.34 This requirement was added in ASME A17.1-2016/CSA B44-16 to clarify that fire service is not applicable to dumbwaiters and material lifts.

SECTION 7.6
HYDRAULIC MATERIAL LIFTS WITHOUT AUTOMATIC TRANSFER DEVICES

NOTE: Throughout Section 7.6, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

In addition to the requirements in Section 7.6, the requirements in Section 7.4 apply to hydraulic material lifts without automatic transfer devices.

7.6.7 Terminal Stopping Devices

This requirement was revised in ASME A17.1-2019/CSA B44:19 to require Type A hydraulic material lifts to have identical terminal stopping devices as hydraulic passenger and freight elevators.

7.6.8 Operating Devices and Control Equipment

Requirements 7.6.8.1 and 7.6.8.2 were revised in ASME A17.1b-2009/CSA B44b-09. As high speed is possible on Type A material lifts, car doors and car aprons are required, along with compliance with anticreep requirements, on hydraulic material lifts. Special conditions for Type B material lifts require specific requirements. Also see Handbook commentary on 7.4.14.

7.6.8.1 Operating Devices and Control Equipment. This requirement was revised in ASME A17.1-2019/CSA B44:19 to clarify that terminal stopping devices are not required on material lifts.

Requirement 7.6.8.1(g) was added in ASME A17.1-2022/CSA B44:22 to exclude remote interaction operation (RIO) on hydraulic material lifts without automatic transfer devices until such time that appropriate requirements are developed by the responsible ASME working group.

7.6.8.2 Anticreep Operation

7.6.8.2.1 Requirements were added in ASME A17.1b-2009/CSA B44b-09 to specify the anticreep zone to be the same as the leveling zone. See Handbook commentary on 7.4.14.

7.6.8.2.2 Requirements were added in ASME A17.1b-2009/CSA B44b-09 to specify the floor level tolerance for the anticreep feature. The tolerance is the same as required for a hydraulic elevator (3.26.3.1.2). See also Handbook commentary on 7.4.14.

7.6.8.2.3 Through 7.6.8.2.5 See Handbook commentary on 7.4.14.

7.6.8.5 Low Oil Protection. Requirements were added in ASME A17.1b-2009/CSA B44b-09 to limit the amount of automatic operation on Type B material lifts. Having a Type B material lift go automatically down while the operator is pressing the continuous pressure button to go up removes the operator's control of the device. Only leveling, including anticreep, in a very small zone will be operated automatically. All other operation should be continuous pressure to allow the operator to maintain control at all times. This special low oil feature will not allow the car to go up or the pump to run, but will allow the car to descend under control of the operator. Also see Handbook commentary on 7.4.14.

SECTION 7.7
AUTOMATIC TRANSFER DEVICES

There are many varieties of lifts with automatic transfer devices and the following are descriptions of the commonly used types. These descriptions are generalized and are not intended to describe any particular manufacturer's approach.

(a) Cart Lift [See Diagram 7.7(a)]. This type is mounted on a small floor-stopping elevator or dumbwaiter and acts to pull the cart from the floor landing onto the lift or to push the cart from the lift onto the floor landing. The sequence is automatic in that the cart is placed in a position in front of the lift and a call or send signal is registered. Lift operation consists of automatic opening of doors, extension of the transfer device, and engaging of the coupler on the underside of the cart with the mating coupler of the transfer device. The transfer device retracts, pulling the cart into the lift, the doors automatically close, and the lift travels to the destination. When the reverse cycle takes place, the doors open; the transfer device pushes the cart out, disengages the coupler, and retracts; the doors close; and the lift is free to move to service the next demand. Lifts have capacities of 113.4 kg or 250 lb to 453.6 kg or 1,000 lb at speeds from 0.25 m/s or 50 ft/min to 2.54 m/s or 500 ft/min or more. Dumbwaiter types have a capacity up to 227 kg or 500 lb with a platform area not exceeding 0.84 m^2 or 9 ft^2 with speeds up to 2.54 m/s or 500 ft/min. They are generally used in hospitals for transporting supplies and meals and in office buildings for mail distribution.

For the cart-lift system, an indexing-type floor conveyor may also be installed to allow the queueing of carts at a main dispatch landing. The carts are then automatically

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moved into position to be loaded, each cart having an encoded address to indicate the destination.

(b) Tote Box Lift [See Diagram 7.7(b)]. This type is a small version of the cart lift, utilizing a counter-stopping dumbwaiter, which provides for the handling of tote boxes. Boxes are placed on a table in front of the lift and the call button is operated. The lift arrives and opens its doors, the transfer mechanism operates to pull a box into the lift, the doors close, and the lift travels to another landing. Ejection is the reverse process. Usually, the tote box lift is used in hospitals for transporting records and small supplies. It is also used in banks for security transfers and in office buildings for mail handling. The capacity ranges from 22.7 kg or 50 lb to 227 kg or 500 lb and speeds vary from 0.25 m/s or 50 ft/min to 2.54 m/s or 500 ft/min, with 0.51 m/s or 100 ft/min being the most common speed.

(c) Overhead Chain Conveyor Lift [See Diagram 7.7(c)]. Carriers on a power and free chain conveyor system are driven by the power chain to a position in front of the lift where a destination signal calls the lift. The door opens and a transfer device, either on the lift or at the landing, operates to transfer the carrier onto the lift, which has a mating power conveyor in the overhead. The door closes and the lift travels. Ejection is in a similar manner. The carrier is equipped with a fastening device that engages a cart and, generally, by means of an inclined power chain, lifts the cart off the floor. This chain conveyor lift is commonly used in hospitals for transporting food and for supply distribution, in stores for stock distribution, and for industrial use. The capacity in hospitals is usually 272.2 kg or 600 lb and speeds range from 0.25 m/s or 50 ft/min to 2.54 m/s or 500 ft/min, with 1.27 m/s or 250 ft/min to 1.52 m/s or 300 ft/min being the most common speeds.

(d) In-Floor Tow Chain Conveyor Lift [See Diagram 7.7(d)]. Carts are propelled along the floor by a powered tow chain engaged by a pin on the cart through a continuous slot in the floor. At the entrance to the lift, the cart is released from the floor tow chain and a signaling device calls the lift. The lift doors open and a transfer mechanism in the floor of the lift extends to engage the pin on the cart and pulls the cart into the lift where it is engaged with a lift tow chain. Ejection is in the reverse order through a rear lift entrance. The cart is then picked up by the floor tow chain and moved to its destination. This lift design is used in warehouses for loads from 1 360.8 kg or 3,000 lb to 2 721.6 kg or 6,000 lb and at speeds from 0.51 m/s or 100 ft/min to 3.05 m/s or 600 ft/min.

(e) Pallet Lift [See Diagram 7.7(e)]. Loaded or empty pallets are automatically loaded onto the lift by the use of a powered roller conveyor or conveyors at the landing and powered roller conveyor on the lift. The landing conveyor may be an indexing type where a number of pallets are rolled one at a time into position in front of the lift; the lift automatically opens its doors, and both the last section of the floor conveyor and the first section of the lift conveyor are actuated. When the pallet reaches a fixed position on the lift, the doors close, the lift travels, and the conveyor operates at the destination to transfer the pallets onto a receiving floor conveyor or conveyors, which may be powered or nonpowered. Pallet lifts are used in warehouses and industrial plants for loads from 1 814.4 kg or 4,000 lb to over 5 443.2 kg or 12,000 lb with speeds from 0.25 m/s or 50 ft/min to 3.05 m/s or 600 ft/min. They may be arranged to carry more than one pallet at a time.

(f) Robot Vehicle Lift [See Diagram 7.7(f)]. A self-propelled cart is used to carry a load and/or pull a trailer carrying a load. The cart moves at about 1.61 k/h or 1 mph following a guide path on or in the floor. The cart is equipped with a designation-coding device, which will signal an elevator or lift. When the elevator or lift arrives, the car will move onto the elevator or lift. Further signals will indicate the destination and initiate door closing. Variations have included a single cart operating onto a passenger-type elevator shared with pedestrians and equipped for self-propelled cart operation and freight-type elevators accommodating a self-propelled tractor pulling a number of loaded trailers. This system must comply with the requirements of Part 2, Part 3, or Section 4.2 of this Code when operated as an elevator and Part 7 when operated as a material lift. Robot vehicle lifts are used in hospitals for loads of 907.2 kg or 2,000 lb to 1 587.6 kg or 3,500 lb at speeds from 0.51 m/s or 100 ft/min to 2.54 m/s or 500 ft/min. They are used in industrial plants for loads up to 13 608 kg or 30,000 lb and speeds up to 3.05 m/s or 600 ft/min.

7.7.1 General

See Diagram 7.7.1, which shows an automatic load and unload unit (automatic transfer device) projected from the lift preparing to couple with a cart located in front of the lift door. The underside of the cart is equipped with a coupling bar.

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Diagram 7.7(a)
Cart Lift

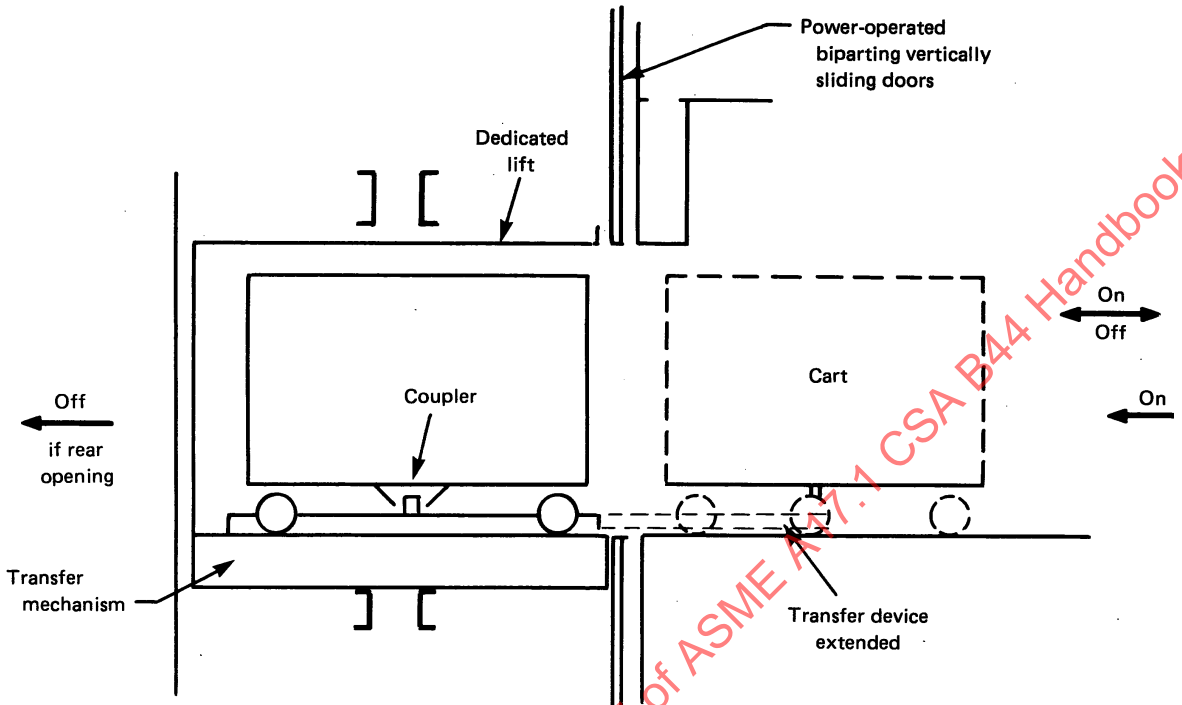
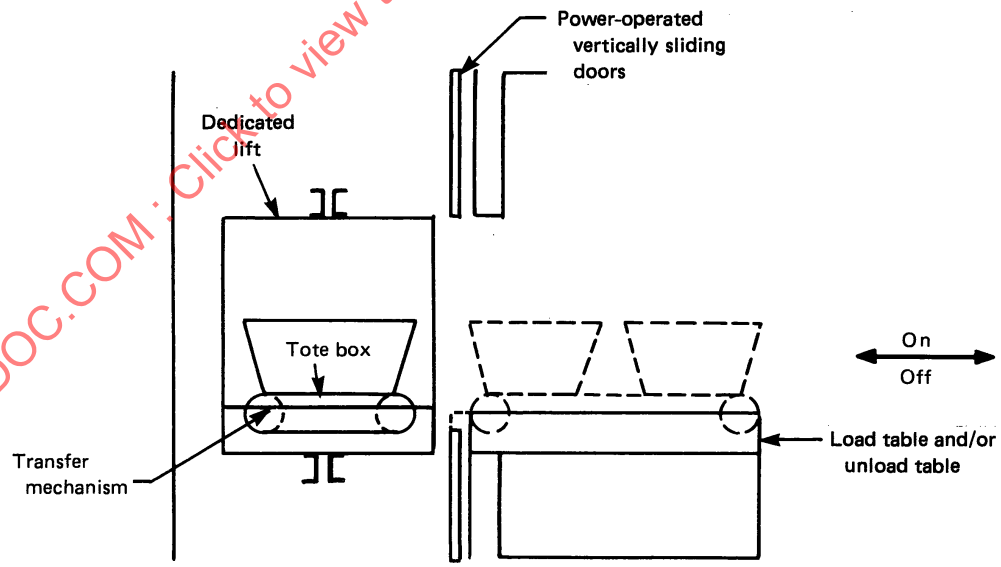


Diagram 7.7(b)
Tote Box Lift



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Diagram 7.7(c)
Overhead Chain Conveyor Lift

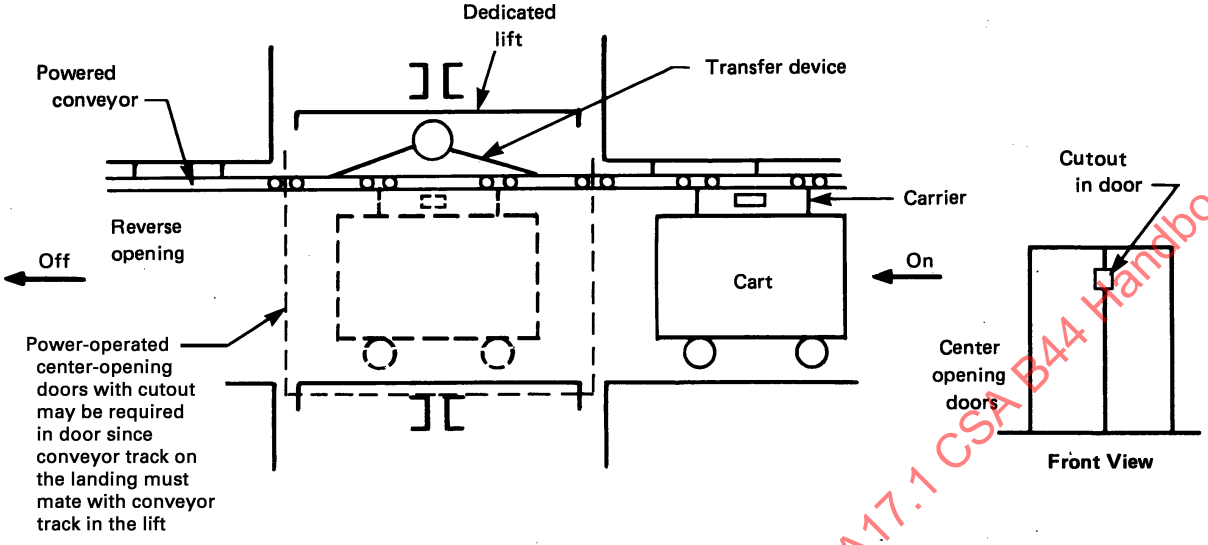
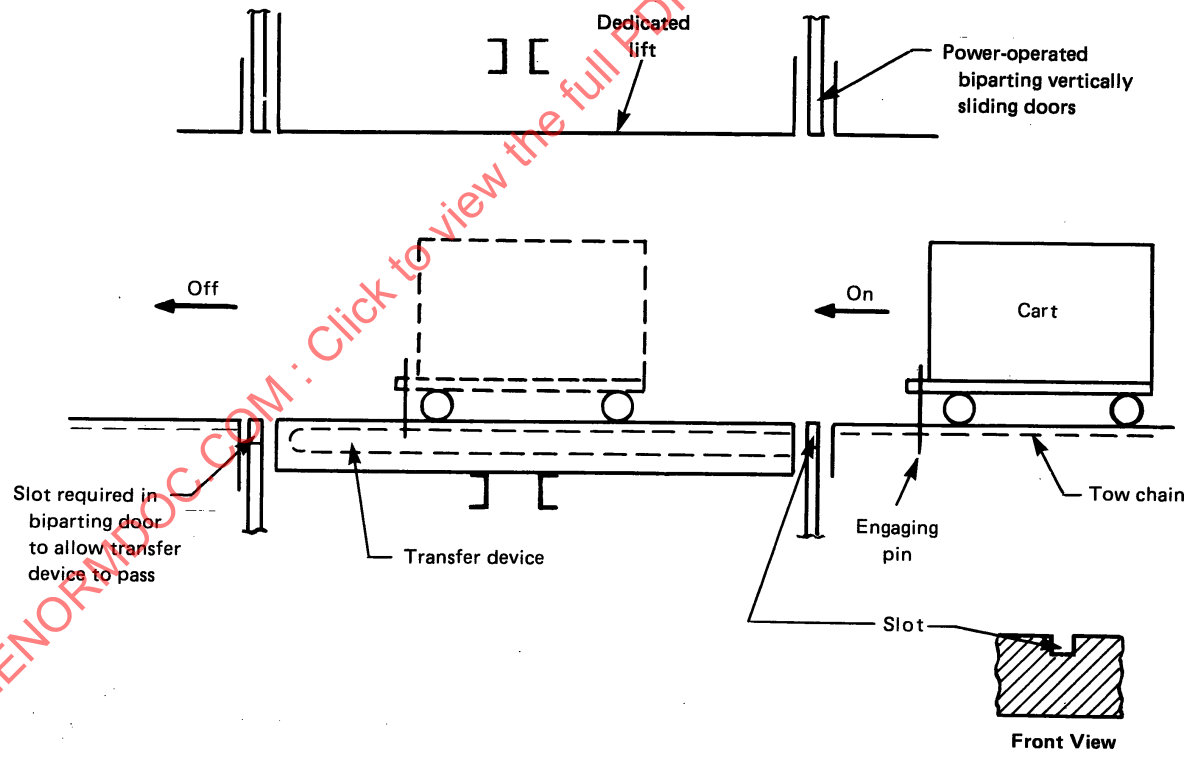


Diagram 7.7(d)
In-Floor Tow Chain Conveyor Lift



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Diagram 7.7(e)
Pallet Lift

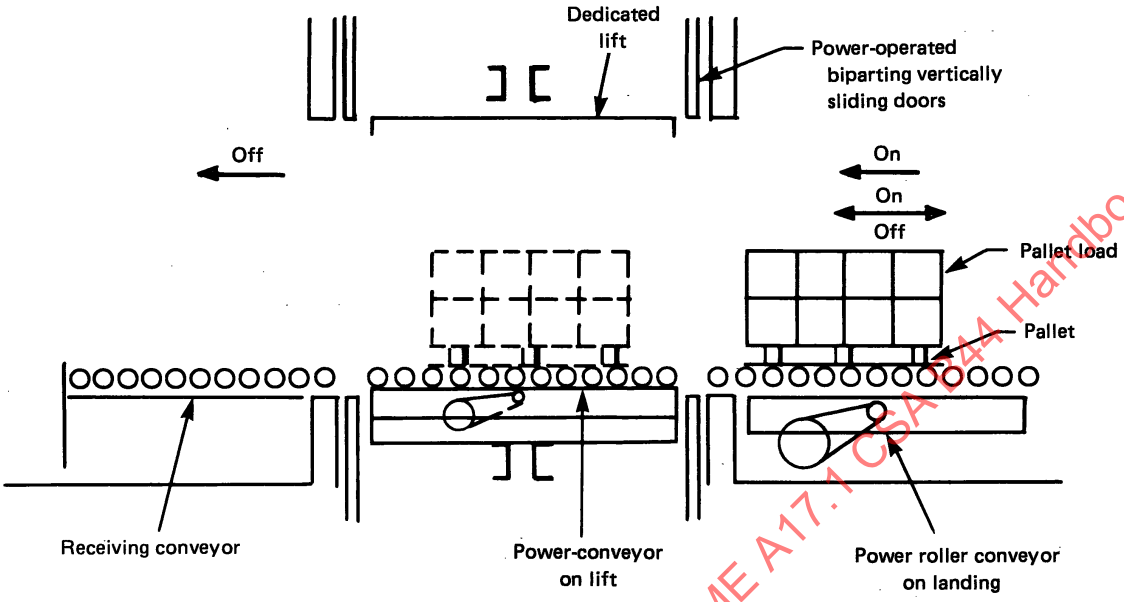
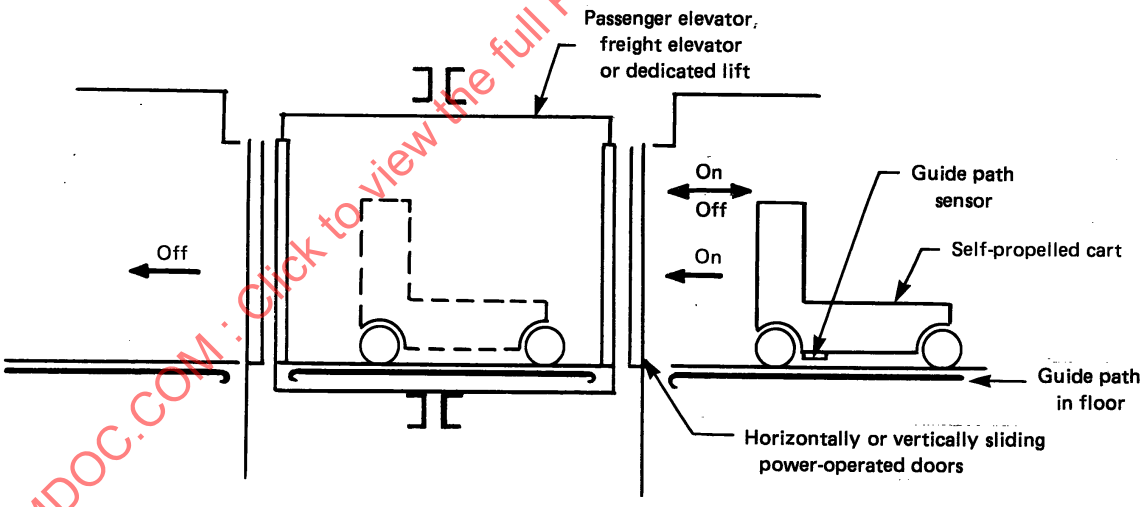


Diagram 7.7(f)
Robot Vehicle Lift



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Diagram 7.7.1
Typical Automatic Transfer Device



GENERAL NOTE: Courtesy of Courion Industries, Inc.

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SECTION 7.8
POWER DUMBWAITERS WITH AUTOMATIC TRANSFER DEVICES

NOTE: Throughout Section 7.8, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

7.8.2 Safety Devices

Where the suspended or supported gross load exceeds 700 kg or 1,500 lb, the car is generally large enough for maintenance or inspection personnel to ride on top of the car. This requirement is designed to protect such persons. In addition, a load of this nature falling from any height can damage the enclosing structure and may injure persons in the vicinity of the lowest landing.

7.8.3 Emergency Stop Switch

The emergency stop switch should be so located that a person does not have to reach over a transfer device to operate the emergency stop switch while the material is being transferred to or from the car.

7.8.4 Structural Capacity Load

This area is large enough for a person to stand on top of the dumbwaiter. As such, it must be capable of holding a load of not less than 135 kg or 300 lb.

SECTION 7.9
ELECTRIC MATERIAL LIFTS WITH AUTOMATIC TRANSFER DEVICES

NOTE: Throughout Section 7.9, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

7.9.1 Hoistways, Hoistway Enclosures, and Related Construction

7.9.1.2 The maximum clearance has been increased from 32 mm or 1.5 in. to 125 mm or 5 in. in order to provide for the necessary clearances required by some of the transfer devices, especially those on overhead track conveyors.

7.9.1.5 Roller guides are not permitted since they allow a lateral movement of the car, which could allow the car to strike a protruding transfer device or track.

7.9.1.7 The intent of this requirement is to allow a car to start before its doors are fully closed. A restricted area is an area accessible only to authorized personnel who have been fully instructed in the use and operation of the automatic aspects of the transfer equipment.

7.9.2 Machinery and Equipment

7.9.2.2 Requirement 2.14.3.1 states that car enclosures must be at least 1 825 mm or 72 in. high. Material lift enclosures only need to be as high as required for the material or cart to be transferred plus the height of the transfer device and necessary clearances.

7.9.2.4 This requirement was added in ASME A17.1-2016/CSA B44-16 to require that transfer devices in the car be visible or, if obscured, clearly marked so that people will not mistake a material lift with automatic transfer devices for a passenger elevator or freight elevator. The existing requirements of 7.9.2 were editorially redesignated.

7.9.2.5 The transfer device can form part of the car platform.

7.9.2.7 This requirement (formerly 7.9.2.6) was revised in ASME A17.1-2016/CSA B44-16 to prohibit persons from riding *any* material lift with an automatic transfer device, regardless of the lift's location. A passenger riding a material lift with an automatic transfer device could be injured should the automatic device actuate. The revision eliminates that risk.

7.9.2.13 Through 7.9.2.15 People are not permitted to ride material lifts; therefore, the additional impact forces when striking spring buffers at higher speeds than allowed by Section 2.22 are acceptable and can be tolerated by the equipment.

7.9.2.16 When provided, the car operating device must be in a locked cabinet or consist of key-operated-type switches, ensuring that the material lift can be operated from inside the car only by authorized personnel.

7.9.2.19 The location of the emergency stop switch is to ensure that a person can operate the emergency stop switch while material is being transferred to or from the lift.

SECTION 7.10
HYDRAULIC MATERIAL LIFTS WITH AUTOMATIC TRANSFER DEVICES

NOTE: Throughout Section 7.10, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

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Part 8
General Requirements

SECTION 8.1
SECURITY

NOTE: Throughout Section 8.1, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

Prior to publication of ASME A17.1-2000 and CSA B44-00, security provisions were addressed throughout the Code. Some Code requirements restricted availability of keys. Other Code requirements were silent. The Committee was concerned that unqualified personnel were obtaining and using keys, placing themselves and the public in danger. An extensive study was undertaken and the Committee concluded that security levels needed to be established everywhere a lock is required by ASME A17.1/CSA B44. To assist the building owners/operators, Section 8.1 was developed in lieu of specifying details for each security level throughout ASME A17.1/CSA B44.

This Section requires a "key" for access to or operation of equipment. Combination locks do not comply. Combination locks do not provide equivalent security since the combination is easily disseminated.

There is no safety hazard if a key used for an elevator device can also open other locks in the building. In fact, multiple locks accessible by a single key could be helpful to maintenance or inspection personnel. Hazards occur when a key used for other locks in the building can access or operate elevator equipment.

Section 8.1 applies to both new and existing installations (see 1.1.3). Building owners/operators are required by 8.6.11.3 to control the access to keys as specified in this Section.

8.1.2 Group 1: Restricted

Elevator personnel (see Section 1.3) are persons who have been trained in the construction, maintenance, repair, inspection, or testing of equipment. This category includes elevator mechanics and inspectors. It does not include building engineers, building security personnel, electricians, janitors, etc. Group 1 keys can operate all Group 1 locks as well as locks in Groups 2, 3, and 4. The Note includes some but not necessarily all ASME A17.1/CSA B44 requirements that reference Group 1 Security. The Note was revised in ASME A17.1-2016/CSA B44-16 to include rack-and-pinion requirements.

8.1.2, Note (a) Since nonelevator personnel have access to machine rooms, etc., any access into the hoistway from such space must be additionally protected from access by nonelevator personnel. This requirement ensures that nonelevator personnel would have only supervised access to the elevator hoistway even from an elevator equipment area that they are permitted to enter.

The Note was revised in ASME A17.1-2019/CSA B44:19 to update the reference in (j) and add a new requirement (z) for the top emergency exit.

Requirement 8.1.2 was revised in ASME A17.1-2022/CSA B44:22 to correct a reference for pit access doors.

Requirement 8.1.2(aa) was added in ASME A17.1-2022/CSA B44:22 to add the Flood Detection Operation (see 2.27.13) reset means to the list of items that require Group 1 Security.

8.1.3 Group 2: Authorized Personnel

Authorized personnel (see Section 1.3) are persons who have been instructed in the operation of elevator and escalator equipment and designated by a building owner to use the equipment. This category includes building personnel who have been properly trained and elevator personnel (see Section 1.3). Group 2 keys can operate all Group 2 locks as well as locks in Group 3 and 4. A Group 2 key is not allowed to operate a Group 1 lock.

The Note includes some but not necessarily all ASME A17.1/CSA B44 requirements that reference Group 2 Security. The Note was revised in ASME A17.1-2016/CSA B44-16 to include rack-and-pinion requirements. The Note was revised again in ASME A17.1-2019/CSA B44:19 to add requirements for control panel and access doors.

8.1.4 Group 3: Emergency Operation

Group 3 includes emergency personnel, elevator personnel, and authorized personnel. Emergency personnel (see Section 1.3) are persons who have been trained in the operation of emergency or standby power and Firefighters' Emergency Operation or emergency evacuation. Authorized personnel (see Section 1.3) are persons who have been instructed in the operation of the equipment and designated by the owner to use the equipment. This category typically includes building engineers, fire wardens, etc., who have been properly trained; firefighters; and elevator personnel (see Section 1.3). Group 3 keys

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can operate all Group 3 locks. Group 3 keys are not allowed to operate Group 1 or Group 2 locks. See Handbook commentary on 2.27.8.

The Note includes some but not necessarily all ASME A17.1/CSA B44 requirements that reference Group 3 Security.

Requirement 8.1.4 was revised in ASME A17.1-2022/CSA B44:22 to align with the new definition for "emergency or standby power" and to remove the word "access" from the Note.

8.1.5 Group 4: Other

This is the lowest security requirement and typically is applicable where there are no training requirements for personnel who have access to and/or use keys assigned to this security group. Group 4 keys are not allowed to operate Group 1, Group 2, or Group 3 locks.

SECTION 8.2
DESIGN DATA AND FORMULAS

NOTES:

(1) The author expresses his appreciation to George W. Gibson for his extensive contributions to Section 8.2.

(2) Throughout Section 8.2, references are made to other requirements in ASME A17.1/CSA B44. To gain a complete understanding of a requirement, the reader should review the Handbook commentary on all referenced requirements.

This Section of ASME A17.1/CSA B44 contains design data, formulas, and charts based on the requirements found in Parts 1, 2, and 7 and Section 5.1 of the ASME A17.1/CSA B44 Code. This information is useful to the designer of elevator equipment.

8.2.1 Minimum Rated Load for Passenger Elevators

8.2.1.1 These requirements and Section 2.16 establish a minimum rated load for the inside net platform area of various size passenger elevator cars. ASME A17.1/CSA B44 does not prohibit a rated load greater than the minimum rated load required for a given inside net platform area.

8.2.2 Electric Elevator Car Frame and Platform Stresses and Deflections

ASME A17.1/CSA B44, Section 1.3 defines the following:

car frame: the supporting frame to which the car platform, upper and lower sets of guide shoes, car safety, and the hoisting ropes or hoisting rope sheaves, or the hydraulic elevator plunger or cylinder are attached. The car frame is sometimes referred to as the car sling. Specific types include the following:

car frame, overslung: a car frame to which the hoisting rope fastenings or hoisting rope sheaves are attached to the crosshead or top member of the car frame.

car frame, subpost: a car frame all of whose members are located below the car platform.

car frame, underslung: a car frame to which the hoisting rope fastenings or hoisting rope sheaves are attached at or below the car platform.

The car frame is a rigid rectangular frame consisting of a crosshead, uprights, and plank, as shown in Diagrams 8.2.2(a) and 8.2.2.5.

The crosshead usually consists of a pair of structural members, generally channel-shaped, that form the top of the frame.

The uprights or stiles are the vertical structural members at the sides of the car.

The plank is the structural member (or pair of members), similar to the crosshead, forming the bottom of the car frame.

The guide shoes, which are mounted on the four corners of the car frame, serve as the point of riding contact between the car frame and guide rails.

The car safety is the device mounted beneath or within the planks, which retards and stops the car in case of an overspeed.

The car frame hitch is the pickup point on the crosshead where the suspension (hoisting) means are fastened.

Bracing members, although not part of the car frame proper, support the corners of the platform and are, in turn, fastened to the car frame.

Except for very large load capacities, the car frame members have historically been rolled structural steel channel sections as produced by the steel mills; however, in recent years, the elevator industry has seen the introduction of car frame members of formed or bent-up design. The primary advantage of this latter type of design is that the metal can be put where it does the most good. In this way, more efficient and lighter weight structures result.

The general design, necessarily modified to suit the variations in sizes, is substantially the same in all cases where the suspension (hoisting) means are attached to the crosshead; therefore, the following design considerations apply to all.

The forces acting on the car frame members are more complex than those acting on any other part of the elevator equipment due to the nature of its design and the fact that it must carry variable loads.

If the loading condition, that is, the manner in which the load enters or leaves the platform, as well as the position it takes while the elevator is running, is unknown, then the forces acting on the car frame cannot be determined.

If the center of gravity of the rated load and car coincided with the center of action of the suspension (hoisting) means, there would be mainly tension in the uprights and bending in the crosshead and plank, but this condition

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cannot exist with a moving load; therefore, the car frame must be able to resist turning moments that produce bending in the uprights and, at times, twisting of the crosshead and plank.

Since we are dealing with loads that move about while entering or leaving the platform, the exact position of the load at any given time is unknown, so we must make certain assumptions regarding the position of the load while the elevator is being loaded and while it is running. Consider the case of the side-post elevator, as shown in Diagrams 2.15.1(a) and 8.2.2(b). We do know, for instance, the clear opening at the entrance and that any load passing through this point cannot be more eccentric from the center of the car than the entrance width will permit. On the inside of the car, the load can be no more eccentric than will be permitted by its physical size next to the car enclosure wall. Therefore, we have a starting point for designing a car frame. Figure 8.2.2.5.1 of ASME A17.1/CSA B44 shows the specified loading eccentricities specified by 8.2.2.5 as a function of the Class of Loading.

The calculations are in most cases simple for determining the required sizes of the car frame crosshead and plank. With the uprights, however, the case is somewhat different. Here the sections are more or less limited since they must occupy a minimum amount of space between the guide rail and the side of the car so as not to encroach too much on the width of the car. The result is that the uprights become limited in strength for bending in the plane of the car frame, and a check is therefore necessary for special cases to make certain they are of sufficient strength and stiffness.

In both cases of loading shown in Diagram 8.2.2(b), the car frame is subjected to an overturning moment within its own plane, the magnitude of which is equal to the load times the eccentricity, i.e., to the center of the car frame. The guide shoes contacting the rails resist this overturning moment and in doing so, guide-shoe forces are impressed upon the shoes and rails. It is these guide-shoe forces that produce bending of the uprights. As a result, the uprights deflect and cause the platform to sag on one side. A typical example of this deflected car frame is shown in Diagram 8.2.2(a).

Although side braces and trusses are necessary adjuncts to the car frame, they are usually considered as separate parts of the equipment, since either type of platform supports may, under certain conditions, be used with the same type of car frame. When taken in connection with the forces acting on the car frame, a distinction must be made, as the stresses induced by the trusses are not the same as those caused by the side braces. Trusses, as a general rule, cause greater stresses than side braces and will be treated in a subsequent discussion.

The following is a brief outline of the points that must be considered to determine the required strength of uprights for the most common cases, during loading and running conditions.

It was noted previously that space beyond the car line is at a premium because it represents lost rentable floor space in the building per floor, and so for that reason, car frame uprights are set such that they occupy a minimum amount of space. However, in so doing, some of the inherent strength of the upright is sacrificed. In this position, the upright will bend about its weak axis. Occasionally, when the rated loads are high, causing large car frame bending moments, and the available hoistway space is small, alternate means of structural reinforcing for the upright must be used, such as adding reinforcing members. When the loads become too great for these types of construction, typically occurring on heavy-duty freight cars, double uprights are used and placed in such a manner that they will bend about their strong axis. Hoistway space is generally sufficient to do this.

A simple case of a side-post elevator subject to uniformly distributed loads and arranged with four side braces will be discussed. This loading is seen in Diagram 8.2.2(b) in elevation.

This is the simplest case and the only one where the loading condition is definitely known. The maximum bending moment in the upright occurs when one-half of the rated load is uniformly distributed over one-half of the platform area between the side of the cab and the centerline. The overturning moment is equal to the load times the eccentric distance from the center of the car, i.e., $P/2 \times E/4$, and is equal to $PE/8$. This bending moment causes reactions at the guide shoes, which, in turn, produce bending about the weak axis of the upright and bending of the guide rails. In addition, the uprights are also in tension due to the weight of the rated load, car, and compensation. The ends of the platform are supported by the side braces, which are in turn fastened to the upright. When short side braces are used, which is the most common arrangement for passenger elevators since the 1960s, an additional bending moment is produced in the upright due to the brace loads; however, these bending moments cause bending about the strong axis of the upright and produce bending stresses of very low magnitude. When long side braces are used, this additional bending does not occur, since the line of action of the side braces intersects the center of the guide shoe contact with the guide rails.

Corner-post cars are used where it is necessary to have adjacent openings. In this case, the car frame is located approximately on the diagonal of the platform. The loads imposed on a corner-post car frame are generally more severe than on a side-post car. See Diagrams 2.15.1(b) and 8.2.2(c).

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In this case, more than in any of the previous cases, the exact loading condition must be known if the car frame is to be of economical design. The points of application of the load with reference to the entrances both at loading or unloading, as well as its position with reference to the center of the car while the elevator is running, have such a great influence on the size of the required car frame members that, unless the loading is known, the extreme conditions must be assumed for all calculations, resulting in a much heavier construction than may actually be required.

If the platform has considerably more length than width, or vice versa, and if the load enters at the short side, then the turning moment, *PD*, which acts in the weak direction of the uprights, may become quite large, depending on how close to the uprights the center of gravity of the load will set.

The total sag of the corner of the platform is caused by the cumulative effects of

(a) vertical crosshead deflection due to the direct load on the truss

(b) crosshead twist, which carries the truss with it, and magnifies the deflection at the end of the rod

(c) truss deflection

(d) upright deflection due to the twist of the crosshead

(e) guide-rail deflection

In the load cases described above, it should be noted that stresses are induced not only because of the live load, but also due to the dead load of the car itself. The objectionable deflections of the platform are those due to the live load only. Deflections due to dead load, such as the weight of the platform, enclosure, truss, etc., can be taken up by adjustment of the truss rods, provided the allowable stresses in the members are not exceeded.

The few cases mentioned above are those most frequently encountered and constitute the greater part of the conditions that must be considered in designing car frame members insofar as the loading conditions are concerned. In addition to designing the car frame for normal running and loading conditions, we also must be concerned with emergency conditions such as those caused by safety application and buffer engagement.

During a safety application, the car frame must withstand the forces impressed upon it when the safeties grip the rails. Since the safeties and rails are manufactured items with manufacturing tolerances imposed on them, and also since no two guide rails will be lubricated the same, a difference in retarding force at the two sides of the car will exist. (See Diagram 2.23.5.) This difference in forces has the same effect as an eccentric load, and therefore an overturning moment will be introduced. As noted before, this overturning moment produces bending of the uprights. In addition to the bending, the uprights will also be subjected to compression due to that part of the force of retardation, which is transmitted through the side braces.

At buffer engagement, the plank channels are subjected to a severe bending load. The uprights will undergo compression and bending depending on the position of the load in the car.

Two bending moments are set up for corner-post cars, namely, *PC* and *PD*, each of which produces bending of the upright in two planes 90 deg apart as shown in Diagram 8.2.2(c). The bending moment *PC* acts through the truss rod, which transmits it to the truss. The truss then tends to twist the crosshead, which induces a moment at the upper end of the upright; this, in turn, produces a reaction in the guide shoes in contact with the rails. This twisting moment is divided between the two uprights in proportion to its distance from each, that is, equally divided between the uprights for a square car; and for a rectangular car, proportionally divided so that one of the uprights will take a greater part of the moment.

For these emergency conditions or for those times when tests must be conducted, a much higher allowable stress is used than is allowed by 2.15.10. This is justified since the time duration over which these high forces act is very small, and these emergency conditions are not encountered regularly.

In the cases previously discussed, it has been assumed that the car frames were supported by suspension means attached to the center of the crosshead, which is the case of 1:1 roping [Diagram 8.2.2(d)], 2:1 roping with one sheave [Diagram 8.2.2(e)], and 2:1 hitch when two sheaves are used, provided all of the ropes lead around the two sheaves [Diagram 8.2.2(f)].

8.2.2.4 Car Frame Plank (Buffer Engagement). This requirement was revised in ASME A17.1-2016/CSA B44-16 to add elastomeric buffers. The performance of these buffers is similar to that of oil buffers with regard to the stress resulting from buffer engagement.

8.2.2.5 Car Frame Uprights (Stiles). The evaluation of the stresses due to bending of the car frame uprights is based on the following load distribution and assumptions (see Diagram 8.2.2.5):

(a) Each corner of the frame carries one-fourth of the total overturning moment, *K*, taken at the intersection of the centroids of the car frame members.

(b) Free length bending of the upright occurs between the lowest fastening in the crosshead gusset-to-upright connection and the highest fastening in the plank-to-upright connection.

(c) Each upright carries equal shear loads since both uprights have equal stiffness.

Due to the car frame overturning moment, *K*, caused by an eccentric live load, equal guide-shoe forces are induced equal in magnitude and opposite in direction at the upper and lower set of guide shoes, as

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(Imperial Units)

$$R_1 = \frac{K}{H}(lbf)$$

The bending moment acting at each end of the upright is

(Imperial Units)

$$M = \frac{KL}{4H}(\text{in. -lbf})$$

For the upright member shown, the expression for the rotation of the tangent to the elastic curve at the ends of the upright is found from the standard beam formula

(Imperial Units)

$$\theta = \frac{ML}{6El}(\text{radians})$$

The deflection of one end of the upright relative to the other end is equal to the distance between the end tangents as

(Imperial Units)

$$\delta = L\theta(\text{in.})$$

Combining these equations and substituting $^3/_4$ in. for δ yields the equation in 8.2.2.5.3.

(Imperial Units)

$$l = \frac{KL^3}{18EH}(\text{in.}^4)$$

Substituting dimensional units yields

(Imperial Units)

$$l = \frac{(\text{in. -lbf}) \times (\text{in.}^2)}{\frac{\text{lbf}}{\text{in.}^2} \times (\text{in.})} = (\text{in.}^4)$$

8.2.2.6 Freight Elevator Platform. The construction of freight platforms typically consists of a welded channel frame with intermediate stringer channels welded to the outer frame. A steel floor plate is then welded to the stringers and frame. For purposes of design analysis, the stringers are supported by at least three points, namely, the front and rear end channels (members) and, at the center, the car frame plank. Depending upon the load ranges and the specific manufacturer, there may be additional intermediate supports. The platform end channels are supported by the side braces.

The load-carrying capacity of the floor plate between the stringers depends upon the plate thickness; the capacity of the stringers depends upon their strength in combination with an effective width of floor plate.

When hoistway conditions preclude the use of a one-piece platform, two-piece or multipiece sections, bolted together at erection, are commonly furnished.

As noted above, the stringers are supported at a minimum of three points (front, center, and rear). Therefore, they are designed as beams continuous over three supports, as shown in Diagram 8.2.2.6(a), and acted upon by a concentrated load at any one point. Since the stringers are spaced at certain intervals, depending upon the strength and rigidity of the floor plate, a certain amount of the rated load can be concentrated at one point. For general freight loading (Class A), we consider one-fourth of the rated load acting at one point. For truck loadings (Class C), an entire wheel load may occur directly over a stringer.

The end channels are treated as simple beams, supported at the ends by the side braces, under the action of a load or loads applied at any point in accordance with the provisions of 2.16.2.2 on classes of loading. For general freight service (Class A loading), as an example, one-fourth of the rated load would be considered as acting at the center of the end channel, as shown in Diagram 8.2.2.6(b).

For industrial truck loading (Class C), the beam would be acted upon by two wheel loads, placed in such a manner so as to produce maximum bending, as shown in Diagram 8.2.2.6(c).

Corner post freight platforms are used when openings occur on adjacent sides of the car. The method of construction is basically the same as for side post except that the frame channel usually borders the periphery of the platform. The design requirements are somewhat different, especially for truck loading elevators, since it is possible to have two wheel loads acting upon one stringer at the same time.

8.2.2.6(b) The 15 400 kg or 34,000 lb limit is based upon the maximum tandem axle load by the U.S. Department of Transportation "Bridge Gross Weight Formula."

8.2.3 Impact on Buffer Supports

8.2.3.1 Buffer Reaction and Impact for Oil Buffer and Elastomeric Buffer Supports. This requirement was revised in ASME A17.1-2016/CSA B44-16 to add the buffer reaction and impact to buffer supports for elastomeric buffers. The performance of these buffers is similar to that of oil buffers with regard to buffer reaction and impact loading into supports.

8.2.6 Stopping Distances for Car and Counterweight Safeties

The basis for the formula that establishes the minimum and maximum safety stopping distances for elevators comes from the fundamental equation of motion governing bodies moving under a constant retardation, i.e.,

$$s = \frac{v_g^2}{2a}$$

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The terms and general dimensional metric or Imperial units are

a = average safety stopping retardation of the elevator, m/s^2 or ft/sec^2
g = acceleration due to gravity, 9.81 m/s^2 or 32.2 ft/sec^2
s = safety stopping distance, mm or in.
v = rated speed of the car, m/s or ft/min
v_g = governor tripping speed, m/s or ft/min

The minimum retardation is based on a value, $a_{min} = 0.35g$.

The maximum retardation is based on a gravity stop, i.e., $a_{max} = 1.0g$.

The equation for the minimum stopping distance is given as

$$s_{min} = \frac{v_g^2}{2a_{max}}$$

Substituting the maximum value of the retardation and expressing the equation in dimensionally consistent imperial units yields

$$s_{min} = \frac{v_g^2(\text{ft})^2(\text{sec})^2(\text{min})^2(12\text{ in.})}{2(32.2)(\text{ft})^2(\text{min})^2(60\text{ sec})^2(\text{ft})}$$

from which the minimum safety stopping distance is given in imperial units as

$$s_{min} = \frac{v_g^2}{19,\ 320}(\text{in.})$$

This formula can be expressed in feet as

$$s_{min} = \frac{v_g^2}{231,\ 840}(\text{ft})$$

The maximum safety stopping distance is found from the general equation

$$s_{max} = \frac{v_g^2}{2a_{min}} + M$$

where M is a Type B safety deployment constant, taken as 10 in. or 0.84 ft to account for the height of the safety wedge plus the distance over which the safety retarding force builds up.

Substituting the minimum value of the retardation and expressing the equation in dimensionally consistent imperial units yields

$$s_{max} = \frac{v_g^2(\text{ft})^2(\text{sec})^2(\text{min})^2(12\text{ in.})}{2(0.35)(32.2)(\text{ft})(\text{min})^2(60\text{ sec})^2(\text{ft})} + 10\text{ in.}$$

from which the maximum safety stopping distance is given in imperial units as

$$s_{max} = \frac{v_g^2}{6,762} + 10\,(\text{in.})$$

This formula can be expressed in feet as

$$s_{max} = \frac{v_g^2}{81,144} + 0.84\,(\text{ft})$$

8.2.8 Hydraulic Jack and Piping

8.2.8.1 Plunger Design. The maximum free length of the plunger is determined by the unsupported length of the plunger when fully extended. This can be expressed as the distance between the top of the cylinder head and the top of the plunger with the stop ring engaging the stop collar. A plunger follower guide can be used to reduce the maximum free length.

The safety factors used on hydraulic elevators pertain to several different concerns such as bending, compression, tension, and pressure.

(a) Bending

(1) In 8.2.8.1.1(b), the factor of safety given by formula is approximately 3 times the limit of the value given by Euler's equation for various grades of steel. Requirement 8.2.8.1.1(d) merely restates that this value of 3 times be applied to plungers at varying cross sections. However, there is no formula given since how the plungers will vary on a special application is not known.

(2) In 3.18.2.3, it is required that the connection transmitting the eccentric bending moment into the plunger have a factor of safety of 4. This is slightly higher than the factor of safety of 3 used for elastic stability and is considered adequate.

(b) Car Hung in Hatch

(1) In 3.18.1.2, the situation of the car being hung in the hoistway intentionally or unintentionally is covered so that if this occurs, the plunger will not separate from the car. A factor of safety of 4 is considered adequate for this condition.

(2) Requirement 3.18.2.4(a) considers the same condition except covers plunger joints, if any. The same factor of safety of 4 is also used.

(c) Compressions. Requirements 3.18.2.1 and 3.18.2.4(b) are for the actual loading based on gross load. The gross load allowed, W, is defined in 8.2.8.1. Both requirements are consistent with a factor of safety of 5 being used. An appearance of redundancy of 3.18.2.1.1 is not a valid conclusion since as noted in 8.2.8.1 some plungers are also subjected to external pressure (factor of safety also 5), which needs to be considered.

(d) Pressures (Tensile Stress)

(1) Requirements 8.2.8.2, 8.2.8.3, and 8.2.8.4 all cover pressure and all state that one-fifth of the ultimate strength shall be used in the formula. In the case of mild steel, the ultimate strength at 414 MPa or 60,000 psi has already been divided by 5 to give a value of 83 MPa or

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12,000 psi to make it easier for the Code user since this is the material usually used. This division by 5 gives a factor of safety of 5 for items subject to pressure.

(2) Requirement 3.18.2.1 covering material is consistent with the safety factor of 5 and includes the cylinder connecting couplings.

(3) Requirement 3.19.1.1 also extends the safety factor of 5 to valves and fittings.

(4) For this special case of flexible hose and fitting assemblies, 3.19.3.3 specifies an even higher factor of safety of 10.

8.2.8.1.1 Plungers Not Subject to Eccentric Loading. This formula results from the application of the Euler equation for the allowable column load for a pin-ended column of constant cross section and a factor of safety on buckling equal to 3, as follows:

(Imperial Units)

$$W = \frac{\pi^2 E I}{F_s L^2}$$

where F_s = factor of safety.

Substituting $I = AR^2$ yields

(Imperial Units)

$$\frac{W}{A} = \frac{\pi^2 E}{F_s\left(\frac{L}{R}\right)^2}$$

Substituting $E = 29{,}000{,}000$ psi $(2.000 \times 10^6$ MPa) and $F_s = 3$ yields

(Imperial Units)

$$\frac{W}{A} = \frac{95{,}000{,}000}{\left(\frac{L}{R}\right)^2}$$

8.2.8.2 Cylinder Design. See Diagram 8.2.8.2.

8.2.8.3 Cylinder and Plunger Heads. See Diagram 8.2.8.3.

8.2.8.4 Wall Thickness of Pressure Piping. The allowable pressure for an oil line is limited by the lowest rated element in the line, which includes, but is not limited to, threads, grooves, fittings, valves, and connections.

8.2.10 Minimum Oil Buffer Strokes: Inclined Elevators

(a) The general discussion of accelerations and decelerations (retardations) is given in 8.2.11 and is applicable to all types of stops.

(b) The basis for the formula that establishes the minimum oil buffer stroke used with inclined elevators comes from the fundamental equation of motion governing bodies moving under a constant retardation, i.e.,

$$a = \frac{v_b^2}{2s}$$

The terms and general dimensional metric or Imperial units are

a = resultant retardation along the axis of the oil buffer, m/s^2 or ft/sec^2
g = acceleration due to gravity, 9.81 m/s^2 or 32.2 ft/sec^2
s = minimum oil buffer stroke, mm or in.
v = rated speed of the car measured along the incline, m/s or ft/min
v_b = buffer striking speed, m/s or ft/min, which is taken equal to 115% of the rated speed, i.e., $v_b = 1.15v$

The resultant retardation, a, can be expressed by its horizontal and vertical components, respectively, as seen in Diagram 8.2.11, as

$$a_h = \frac{v_b^2 \cos\theta}{2s} \text{ and } a_v = \frac{v_b^2 \sin\theta}{2s}$$

where

a_h = horizontal component of the buffer retardation, m/s^2 or ft/sec^2
a_v = vertical component of the buffer retardation, m/s^2 or ft/sec^2
α = angle of inclination of buffer with respect to the horizontal

The horizontal retardation is limited to the value, $a_h = 0.25g$.

The general equation for the minimum buffer stroke is found by solving the equation for the horizontal retardation as

$$s = \frac{v_b^2 \cos\theta}{2a_h}$$

Substituting the relationship for the rated speed and the limiting value of the horizontal retardation yields

$$s = \frac{2.645 v^2 \cos\theta}{g}$$

This equation is expressed in dimensionally consistent imperial unit terms as follows:

$$s_{\min} = \frac{2.645 v^2 (\text{ft})^2 \cos\theta (\text{sec})^2 (\text{min})^2 (12 \text{ in.})}{32.2 (\text{ft})^2 (\text{min})^2 (60 \text{ sec})^2 (\text{ft})}$$

from which the formula for the minimum oil buffer stroke is given as

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$$s_{\min} = \frac{v^2 \cos\theta}{3,\ 652}(\text{in.})$$

8.2.11 Stopping Distances for Car and Counterweight Safeties for Inclined Elevators

(a) All elevators are subject to accelerations and decelerations acting in the direction of motion. Under normal elevator operation, the car must be accelerated from its rest, or stopped, position to contract, or rated, speed, and decelerated (retarded) in going from rated speed to its stopped position.

(b) Unlike vertically moving elevators where the resultant acceleration/deceleration is directed vertically, inclined elevators are subject to a resultant acceleration/deceleration, a, acting in the direction of motion, which is resolved into two components, one acting vertically, a_v, the other acting horizontally, a_h, as shown in Diagram 8.2.11. While these normal acceleration/deceleration values in an inclined elevator system will be accompanied by a horizontal component, its magnitude will be of sufficiently small order so as to be a nonissue for ambulatory passengers.

(c) The vertical component of acceleration and deceleration for an inclined elevator system has the same effect on passengers as would occur on a vertically moving elevator. However, the horizontal component of acceleration and deceleration may destabilize the passenger(s) depending upon the rate of rise of the acceleration/deceleration, the magnitude of the acceleration/deceleration, and the time duration over which it acts.

(d) Concern for the destabilizing retardation, principally horizontal, but whose effects on passengers are amplified due to the simultaneous presence of vertical retardation, has to be viewed in the context of potential injury to passengers if the elevator was subjected to high retardations at an emergency electrical or mechanical stop and the resulting allegations of design defect.

(e) Whatever retardations are generated, the onus will be on the elevator designer, manufacturer, installer, and maintainer to show that a rational basis was used to quantify the magnitude of these retardations to which passengers would be subjected.

(f) The following types of stops can occur and produce horizontal retardations of varying magnitudes:

(1) normal elevator operation

(2) emergency electrical stop (electrical protective device tripped). Some examples include

(-a) power failure

(-b) open electrical protective device

(-c) weakened motor field

(-d) strengthened generator field

(-e) feedback failure

(3) emergency mechanical stop (safety application and buffer engagement)

(4) initialization stop

(g) Superior car-riding quality assurance is accomplished during normal elevator operation by the reduction of stimuli to a level below the threshold of passenger perception. However, if an inclined elevator is subject to an emergency electrical or mechanical stop, the goal will be to impress retardations upon the elevator to stop it quickly, but at a rate of change of speed and acceleration that can be withstood by passengers without destabilizing them.

(h) The riding public can be expected to behave passively during an elevator ride because of its perceived functionality rather than for its amusement value, and its acceptance as a routine event. Most passengers treat the elevator ride as a place of momentary respite, and while they tend not to communicate with each other during the ride, their posture is generally relaxed as opposed to being ready for a horizontal disturbance at the floor. Any attempt to counter an upsetting or destabilizing event will be largely intuitive.

(i) In the erect position, the human body is a multidegree of freedom system with a complex transfer function and nonconstant damping coefficient, i.e., a rather complex nonlinear transducer for acceleration/deceleration excitations. An extensive analysis is required to assess the effects of external retardations impressed upon such a body. Notwithstanding, the passenger response to these suddenly occurring motions is difficult at best to predict due to the variables involved at the onset of the horizontal retardation, which include the following:

(1) passenger posture/stance

(2) ability/mobility to make compensatory body adjustments

(-a) to shift the center of gravity of the body

(-b) to stabilize the body

(3) agility of the passenger

(4) alignment of the body axes with respect to the direction of motion

(5) strength and stability of the musculoskeletal structure

(6) passenger restraint

(j) Horizontal excitation to the elevator can cause any or many of the following effects on the passenger(s):

(1) feeling of discomfort

(2) difficulty in the maintenance of balance

(3) alarm/anxiety

(4) destabilization and loss of balance

(5) lateral impact with other passenger(s)

(6) lateral impact with elevator interior

(7) fall

(8) injury

(k) Body disturbances include

(1) minor, i.e., negligible horizontal effect

(2) moderate, i.e., staggering/stumbling potential

(3) major, i.e., destabilization resulting in falls and/or impact with elevator walls, handrails, and car operating panel

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