APTA STANDARDS DEVELOPMENT PROGRAM

STANDARD

American Public Transportation Association
1300 I Street, NW, Suite 1200 East, Washington, DC 20006

APTA PR-CS-S-012-02, Rev. 2

First Published: March 4, 1999
First Revision: March 22, 2004
Second Revision: February 4, 2022

PRESS Construction & Structural Working Group

Door Systems for New and Rebuilt Passenger Cars

Abstract: This standard contains the minimum requirements for door systems and door system operation on new and rebuilt rail passenger cars.

Keywords: doors, door systems, emergency evacuation

Summary: This standard provides uniformity regarding doors, doorways and door systems for new and rebuilt rail passenger cars. Doors provide the primary emergency egress/access path, as well as the convenient, safe entrance and exit for normal boarding, detraining and passing between connected cars.

Scope and purpose: This standard sets out requirements and references regarding the size and strength requirements of exterior passenger car door systems and vestibule doors. It also provides guidance on how to apply removable panels. This information provides a standardized basis to describe and specify exterior passenger car door systems. Electric locker doors, trap doors, equipment access doors, toilet doors, cab partition doors, luggage compartment doors and equipment hatches are not covered by this standard. This standard should be reviewed in conjunction with APTA PR-M-S-018-10, "Powered Exterior Side Door System Design for New Passenger Cars," and APTA PR-PS-S-002-98, "Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment," This standard shall be used in specifications for the procurement of new passenger cars. It shall also apply for door systems for rebuilt passenger cars if the rebuild specification includes complete replacement of the door system with a new door system. If the rebuild specification includes overhauling the previous door system, the requirements to validate the overhauled door system shall be agreed between the purchaser and the carbuilder.

Note: It is anticipated that APTA PR-PS-S-002-98, "Emergency Signage for Egress/Access of Passenger Railroad Equipment" will be superseded by APTA PR-PS-S-006-2X, "Emergency Egress/Access Signage

and Low-Location Exit Path Markings for Passenger Rail Equipment." Once APTA PR-PS-S-006-2X has been approved, all references to APTA PR-PS-S-002-98 shall be replaced with APTA PR-PS-S-006-2X.

Table of Contents

List of Figures and Tables

Participants

The American Public Transportation Association greatly appreciates the contributions of the **Passenger Rail Equipment Safety Standards (PRESS) Construction & Structural Working Group**, which provided the primary effort in the drafting of this document.

At the time this standard was completed, the working group included the following members:

Francesco Maldari, MTA Long Island Railroad, *Chair*
Martin Young, Sound Transit, *Vice Chair*
Mehrdad Samani, Hatch LTK, *Secretary*

Gabriel Amar, *Systra*
Enrique Arroyo-Rico, *Alstom*
Danny Bailey, *DCTA*
Jeffrey Bennett, *DDOT*
Evelyne Berthomme, *Alstom*
Allen Bieber, *STV*
Martin Bigras, *Bombardier*
Robert Bocchieri, *ARA*
Michael Burshtin, *Amtrak*
Paul Callaghan, *Transport Canada*
Gordon Campbell, *Crosslinx*
Luiz Cano Fernandez, *Alstom*
Bruce Cardon, *UTA*
Michael Carolan, *Volpe Center*
Mike Cook, *Hatch LTK*
Robert Cook, *SCRRA*
Joshua Coran, *Talgo*
Sean Cronin, *Metra*
Richard Curtis, *Curtis Engineering*
Felipe Czank, *Alstom*
Nathaniel Eckman, *Hatch LTK*
Shaun Eshraghi, *Volpe Center*
Steve Finegan, *SNC Lavalin*
Christian Forstner, Seisenbacher
Tom Freeman, *Intl. Name Plate*
Andre Gagne, *Bombardier*
Gene Germaine, *Kustom Seating*
Michael Gill, *SNC Lavalin*
Garrett Goll, *Voith*
Robert Gonzales, *Mid Region Council of Govts*
Jeffrey Gordon, *Volpe Center*
Glenn Gough, *Siemens*
Hugues Gregoire, *Bombardier*
Yosi Grunberg, *SNC Lavalin*
Tony Gutierrez, *Siemens*
Dong Keun Ha, *SCRRA*
Dongni Han, CRRC
Nicholas Harris, *Hatch LTK*
Jason Hesse, *STV*
Ritch Hollingsworth, *Hatch LTK*
Karina Jacobson, *Volpe Center*
Paul Jamieson, *Atkins*
Robert Jones, *Stadler*
Larry Kelterborn, *LDK Advisory*
Joseph Kenas, *Bombardier*
Steven Kirkpatrick, *ARA*
Peter Lapre, *FRA*
Paul Larouche, *Bombardier*
Dominique Le Corre, *Alstom*
Ana Maria Leyton, *Transport Canada*
Patricia Llana, *Volpe Center*
William Luebke, *Kustom Seating*
Francesco Maldari, *LIRR*
Amy Mayes, *Knorr*
Ronald Mayville, *Independent Consultant*
James Michel, *retired Amtrak*
Dimitar Mihaylov, *NCTD*
Tomoyuki Minami, *JRC*
Travis Nelson, *Hatch LTK*
Juergen Neudorfsky, *Seisenbacher*
Steve Orzech Jr., *Freedman Seating*
Chase Patterson, *Voith*
Thomas Peacock, *Atkins*
Gary Petersen, *TransLink*
Anand Prabhakaran, *Sharma & Assoc.*
Denis Robillard, *Baultar*
Steven Roman, *Hatch LTK*
Mehrdad Samani, *Hatch LTK*

Brian Schmidt, *Altamont Corridor Express*
Gerhard Schmidt, *Siemens*
Martin Schroeder, *Jacobs*
Frederic Setan, *Alstom*
Kristine Severson, *Volpe Center*
Melissa Shurland, *FRA*
Nick Sorensen, *UTA*
Benjamin Spears, *Hatch LTK*
Jeremy Spilde, *Metro Transit*
Laura Sullivan, *VOLPE*
Lukasz Szymsiak, *VIA Rail Canada*
Michael Trosino, *Amtrak*
Rudy Vazquez, *Amtrak*
Doug Warner, *Herzog*
Cliff Woodbury, *Hatch LTK*
Leonard Woolgar, *Baultar*
Galiane Yergeau, *VIA Rail Canada*
Theresa Zemelman, *RVBA*
Steven Zuiderveen, *FRA*

Project team

Narayana Sundaram, *American Public Transportation Association*
Nathan Leventon, *American Public Transportation Association*

Revision 3 team

The following from Subject Matter Expert group #2 members of the PRESS Construction & Structural Committee contributed to Revision 3 of this standard:

Beaudoin David, *Vapor (Wabtec)*
Benjamin Spears, *Hatch LTK*
Eloy Martinez, *Hatch LTK*
Francesco Maldari, *MTA LIRR*
Gunneet Singh, *Hatch LTK*
Joseph Kenas, *Alstom*
Marc Lessard, *Vapor (Wabtec)*
Narayana Sundaram, *APTA*
Rich Bowie, *Knorr*
Rick Spencer, *Knorr*
Martin Young, *Sound Transit*
Andrew Stojc, *Vapor (Wabtec)*
Weylin Doyle, *Sound Transit*
Pascal Parent, *Alstom*
Ethan Loper, *UTA*

Introduction

This introduction is not part of APTA PR-CS-S-012-02, Rev. 2, "Door Systems for New and Rebuilt Passenger Cars".

This standard applies to all:

1. Railroads that operate intercity or commuter passenger train service on the general railroad system of transportation; and
2. Railroads that provide commuter or other short-haul rail passenger train service in a metropolitan or suburban area, including public authorities operating passenger train service.

This standard does not apply to:

1. Rapid transit operations in an urban area that are not connected to the general railroad system of transportation;
2. Tourist, scenic, historic, or excursion operations, whether on or off the general railroad system of transportation;
3. Operation of private cars, including business/office cars and circus trains; or
4. Railroads that operate only on track inside an installation that is not part of the general railroad system of transportation.

Door Systems for New and Rebuilt Passenger Cars

1. Overview

1.1 General

The following requirements define the required strength for exterior side doors and vestibule doors. Guidance on how to apply removable panels is also provided.

1.2 Compliance

Testing or analysis as outlined below for each requirement shall be performed to demonstrate compliance with all strength requirements contained in this standard. The carbuilder is responsible for demonstrating compliance with the requirements of this standard.

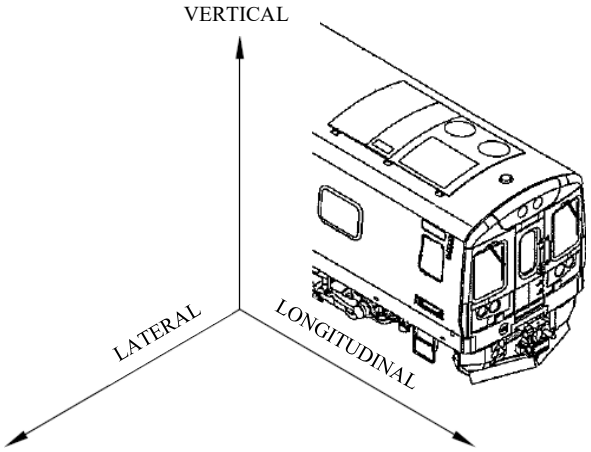
Analysis requirements are included in Section 9, and testing requirements are included in Section 10. Analysis may only be used in lieu of testing if the model has been previously validated in accordance with Section 9.

These requirements apply to all new equipment ordered after XXX (publication date plus six months).

1.3 Coordinate system and units of measurement

Figure 1 shows the coordinate system used in this standard. This coordinate system is used to be consistent with Federal Railroad Administration terminology. **Figure 1** shows coordinates in relation to the passenger car. Longitudinal also refers to the "x" direction, lateral to the "y" direction and vertical to the "z" direction.

FIGURE 1
Passenger Car Coordinate System



Units of measurement used in this standard are U.S. customary units. These are followed by their equivalents in SI units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate.

2. Types of doors

See Appendix A for photos of these door types.

2.1 Sliding

Sliding doors are those in which the panel or panels slide open and closed on a hanger mechanism that is usually mounted above the doorway opening. A sliding door system can have either a single or double (biparting) panel configuration. A sliding door system can either be a door pocket sliding or external sliding.

2.2 Plug

Plug doors are those in which the panel or panels, in the open position, are positioned parallel to and outside of the carbody. Plug doors can be of the sliding plug type, whereby to open the door panel(s) first unplug by moving perpendicular to the carbody and then open by moving parallel to the carbody. Plug doors can also rotate open and closed in a parallelogram motion. Plug door systems can have either a single or double panel configuration.

2.3 Biparting

Biparting doors are those with two panels that open by moving in opposite directions.

2.4 Bifolding

Bifolding doors have one or two hinged panel assemblies that fold inward or outward against themselves. In the open position, the folded, hinged panels rest against the door post or bulkhead.

2.5 Hinged

Hinged doors are those with a panel hinged on one side that opens and closes by rotating about the hinge.

3. Strength requirements

3.1 General

The strength of door frames, door locks and associated equipment shall be commensurate with the strength of the doors specified throughout this section. See **Table 1** for a summary of these requirements.

TABLE 1
Summary of Door Load Test Requirements

Load Case	End Frame Door	Exterior Side Door	Vestibule Door	Other Interior Doors
Section 3.2	X**	X	N/A	N/A
Section 3.3	X	X	X	N/A
Section 3.4.1	X	X	N/A	N/A
Section 3.4.2	N/A	N/A	X	X
Section 3.5	X*	X	N/A	N/A
Section 3.6	N/A	X	N/A	N/A
Section 3.7	X**	X	N/A	N/A
Section 3.8	N/A	X	N/A	N/A
Section 3.9	X**	X	N/A	N/A

*Only if the end frame door is powered and exposed to the exterior.
**Only if the end frame door is exposed to the exterior. An unexposed end frame door is an end frame door that can never physically be located at the leading or trailing end of a passenger train.

3.2 Exterior door panel (exterior side and end-frame doors only)

A concentrated load of 562 lbf (2.5 kN) shall be applied over an area of 4 by 4 in. (0.1 by 0.1 m), acting on the door system and its mounting as it is installed on the car. The door systems and its mounting shall be capable of withstanding this load at the weakest location on the internal surface of the door. Door glazing and glazing attachment do not need to meet this load case.

There shall be no permanent deformation once the load is removed. If agreed between the purchaser and the supplier, localized deformation is allowed as long as the operational functionality, safety and sealing of the door system is not compromised.

This load case shall be validated by test on a complete door system as installed on the car. All variations of door systems shall be tested. A test jig simulating the carbody structure may be used in lieu of testing on an actual car. The load application point shall be agreed between the purchaser and the supplier prior to the test and shall represent the worst-case loading location for the door system.

3.3 Door panel (all exterior side doors, end frame doors and vestibule doors)

A concentrated load of 200 lbf (890 N) shall be applied over an area of 4 by 4 in. (0.1 by 0.1 m), acting on the door panel. The load shall be applied perpendicularly to the plane of the door surface, at the center of the leading edge of the panel. If the center of the leading edge is not the weakest area of the panel, then the load shall be applied to the weakest section.

The maximum deflection of the panel at the applied load shall be no more than 0.375 in. (9.5 mm), without permanent deformation. For side doors that are full length for both low- and high-level boarding or for vestibule doors with removable panels or windows, the maximum deflection at the applied load shall be no more than 0.5 in. (12.7 mm) without permanent deformation

This load case shall be validated by test on each type of door panel on the car. The supplier may utilize a simply supported jig with the panel in either a vertical or horizontal position. The load application point shall be agreed between the purchaser and the supplier prior to the test and shall represent the worst-case loading location for the door system.

3.4 Door lock, door isolation lock and mechanical interfaces

3.4.1 Exterior side doors and end frame doors

The door lock and the door panel mechanical interfaces (e.g., door hangers and mounting brackets) shall have an ultimate strength to be able to withstand the following individually applied accelerations acting on the weight (C.G.) of the complete door panel assembly with door hanger and door guide. The door lock shall keep the door in its closed position.

1. ±8g in the longitudinal direction
2. ±4g in the lateral direction
3. ±4g in the vertical direction

The door isolation lock shall have an ultimate strength to be able to withstand an individually applied acceleration acting on the weight (C.G.) of the door panel of 8g or 4g (as applicable to the mounting orientation of the door) in the direction in which the door panel movement is constrained by door isolation lock.

The door lock and the door panel mechanical interfaces (e.g., door hangers and mounting brackets) for Tier III trainsets that comply with 49 CFR Part 238.705(b)(2) shall have an ultimate strength to be able to withstand the following individually applied accelerations acting on the weight (C.G.) of the complete door panel assembly with door hanger and door guide. The door lock shall keep the door in its closed position.

1. ±5g in the longitudinal direction
2. ±3g in the lateral direction
3. ±3g in the vertical direction

The door isolation lock for Tier III trainsets that comply with 49 CFR Part 238.705(b)(2) shall have an ultimate strength to be able to withstand an individually applied acceleration acting on the weight (C.G.) of the door panel of 5g or 3g (as applicable to the mounting orientation of the door) in the direction in which the door panel movement is constrained to keep it in the closed position.

This load case shall be demonstrated by test. However, proof of compliance can be conducted by analysis in lieu of testing upon agreement between the purchaser and supplier.

3.4.2 Vestibule doors and other interior doors intended for passage through a passenger car

The door panel mechanical interfaces (e.g., door hangers and mounting brackets) shall have an ultimate strength to be able to withstand the following individually applied accelerations acting on the weight (C.G.) of the complete door panel assembly with door hanger and door guide:

1. ±8g in the longitudinal direction
2. ±4g in the lateral direction
3. ±4g in the vertical direction

The door panel mechanical interfaces (e.g. door hangers and mounting brackets) for Tier III trainsets that comply with 49 CFR Part 238.705(b)(2) shall have an ultimate strength to be able to withstand the following

individually applied accelerations acting on the weight (C.G.) of the complete door panel assembly with door hanger and door guide.

1. ±5g in the longitudinal direction
2. ±3g in the lateral direction
3. ±3g in the vertical direction.

This load case shall be demonstrated by test. However, proof of compliance can be conducted by analysis in lieu of testing upon agreement between the purchaser and supplier.

3.5 Shock and vibration (all exterior doors with operators only)

The complete door system shall be tested to demonstrate compliance with IEC 61373, latest revision. To minimize the size of the test sample, the door panel weight may be simulated by a smaller panel with the same mass, as long as the supplier can prove it to be equivalent or worse than the full-scale system, as agreed between the purchaser and the supplier.

After completion of the shock and vibration testing with the main door lock engaged, the main door lock shall be disengaged, and the door system shall be shocked in the longitudinal or lateral direction (as applicable to the mounted orientation of the door) in the direction in which the door panel movement is constrained by door isolation lock. The door isolation lock shall resist this applied load with the following criteria.

Deformation of the door isolation lock is allowed as long as the following conditions are true:

1. The door does not open beyond 1 in. (25.4 mm) clear opening. The overlap of the leading-edge seal does not count in the clear opening measurement.
2. The emergency handle shall still disengage the door isolation lock to allow the door to be opened in case of emergency.

During the door isolation lock test, only the door isolation lock shall be evaluated.

The load case must be validated by test.

3.6 Exterior side door interior crush load

The door strength shall withstand the following load cases based on vehicle overturning situation, if such load case is required in the technical specification.

The door system shall withstand as an ultimate load case a sustained pressure of 0.87 psi (6 kPa) over its internal exposed surface. It shall not be necessary for the door and associated components to remain operational after the application of this load. The load application methodology shall be agreed between the purchaser and the supplier prior to the test.

For doors exclusively for the use by train crew or personnel, the door system shall withstand a 0.44 psi (3 kPa) internal surface pressure load.

This load case shall be demonstrated by test. The test shall be conducted on a complete door system as installed on the car. Each type of side door system shall be tested. A test jig simulating the carbody structure may be used in lieu of testing on an actual car. The door system may be oriented in either a vertical or horizontal orientation. However, proof of compliance can be conducted by analysis in lieu of testing upon agreement between the purchaser and supplier.

3.7 Exterior pressure load on all exterior doors

The door system shall withstand a pressure load of 0.36 psi (2.5 kPa) on the external surface of the door system and its mounting as it is installed on the car. There shall be no permanent deformation. If agreed between the purchaser and the supplier, localized deformation is allowed as long as the operational functionality, safety and sealing of the door system is not compromised. The load application methodology shall be agreed between the purchaser and the supplier prior to the test.

This load case shall be demonstrated by test. The test shall be conducted on a complete door system as installed on the car. Each type of side door system shall be tested. A test jig simulating the carbody structure may be used in lieu of testing on an actual car. The door system may be oriented in either a vertical or horizontal orientation. However, proof of compliance can be conducted by analysis in lieu of testing upon agreement between the purchaser and supplier.

Note: the pressure load must be applied to the entire surface of the door panel, both the exposed and unexposed surfaces.

3.8 Exterior side door interior pressure load with passenger impact

The door system shall withstand a pressure load of 0.36 psi (2.5 kPa), applied over the internal surface of the door, plus a concentrated perpendicular load, acting from within the vehicle, of 180 lbf (0.8 kN) applied over an area of 4 by 4 in. (0.1 by 0.1 m). The structure shall be capable of withstanding the concentrated load at any position on the surface of the door. The load application methodology including worst-case loading position for the concentrated load shall be agreed between the purchaser and the supplier prior to the test.

There shall be no permanent deformation that would impair the normal operation, safety and sealing of the closed door.

This load case shall be demonstrated by test. The test shall be conducted on a complete door system as installed on the car. All variations of door systems shall be tested. A test jig simulating the carbody structure may be used in lieu of testing on an actual car. The door system may be oriented in either a vertical or horizontal orientation. However, proof of compliance can be conducted by analysis in lieu of testing upon agreement between the purchaser and supplier.

Note: the pressure load must be applied to the entire surface of the door panel, both the exposed and unexposed surfaces.

3.9 Aerodynamic loads

Vehicles with pressure-sealing and/or a maximum speed above 125 mph (200 kph) shall be designed to withstand maximum transient pressure loads caused by passing trains and by entering, passing through and exiting tunnels if the load case is required in the technical specification. There shall be no permanent deformation.

This load case may be demonstrated by analysis.

3.10 Door handle vertical load

External handles on external doors shall withstand a downward vertical proof load of 382 lbf (1.7 kN) without significant permanent deformation, if the handle is used to climb up into the car. If the handle is not used to climb up, as agreed between the purchaser and supplier, localized deformation is allowed as long as the operational functionality of the external handle and door function are not compromised. For external handles which rotate, the proof load shall be applied with the handle in the worst-case position(s).

This load case shall be validated by test. However, proof of compliance can be conducted by analysis in lieu of testing upon agreement between the purchaser and supplier.

3.11 Emergency handles

Interior and exterior emergency release actuation devices shall be designed to withstand a minimum of 125-pound pull force (556 N) without permanent deformation of any component of the system, including but not limited to handle assembly, cable and operating mechanism for the complete stroke of the handle.

This load case shall be validated by test. However, proof of compliance can be conducted by analysis in lieu of testing upon agreement between the purchaser and supplier.

4. Door operation

4.1 General

All emergency exit doors shall be capable of manual operation without keys or tools in accordance with 49 CFR, Part 238.112, “Door emergency egress and rescue access systems.”

All doors must be capable of being functionally tested in accordance with the manufacturer’s recommendations.

All emergency exit doors shall be marked in accordance with APTA PR-PS-S-002-98, “Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment,” and 49 CFR, Part 239, “Passenger Train Emergency Preparedness.”

Note: It is anticipated that APTA PR-PS-S-002-98, “Emergency Signage for Egress/Access of Passenger Railroad Equipment” will be superseded by APTA PR-PS-S-006-2X, “Emergency Egress/Access Signage and Low-Location Exit Path Markings for Passenger Rail Equipment.” Once APTA PR-PS-S-006-2X has been approved, all references to APTA PR-PS-S-002-98 shall be replaced with APTA PR-PS-S-006-2X.

4.2 Manual doors

4.2.1 Handles

All manually operated doors shall include readily accessible handles, (including handles that are part of a lock set), or recessed handles.

4.2.2 Opening and closing devices

Manually operated doors may include door closing or cushioning devices, hold-open devices and other mechanical assist devices.

4.3 Powered

4.3.1 Operator type

Doors may be powered by either electric or pneumatic devices that can be mounted either on the floor, in the wall or overhead. Motion can be imparted to the door panels through linkages and arms, or by a direct connection to the panel.

4.3.2 Locks

Locks shall be included as required in APTA PR-M-S-018-10.

4.3.3 Door stops

If door travel is not limited by door operators, then door open and door closed stops shall be incorporated to facilitate adjustments and to keep doors from overtravel. Door stops shall be adjustable with respect to the door panel movement. Door stops shall be of a robust design and manufactured to prevent their binding and/or distortion. Access to the door stops and operator travel adjustments shall be provided for adjustment purposes during their service life.

5. Emergency operation

5.1 Manual doors

All latches and/or handles shall be readily accessible to a person inside or outside the door opening and shall not require the use of tools to access or operate. All latches and handles shall be clearly marked in compliance with the requirements of APTA PR-PS-S-002-98, "Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment," 49 CFR 238.112, "Door Emergency Egress and Rescue Access Systems," and 49 CFR Part 239, "Passenger Train Emergency Preparedness." Consideration of the Americans with Disabilities Act, 49 CFR Part 38, shall be given when designing and locating latches and handles.

Note: It is anticipated that APTA PR-PS-S-002-98, "Emergency Signage for Egress/Access of Passenger Railroad Equipment" will be superseded by APTA PR-PS-S-006-2X, "Emergency Egress/Access Signage and Low-Location Exit Path Markings for Passenger Rail Equipment." Once APTA PR-PS-S-006-2X has been approved, all references to APTA PR-PS-S-002-98 shall be replaced with APTA PR-PS-S-006-2X.

5.2 Emergency release actuation device, powered doors

Requirements for emergency release actuation devices for exterior powered side doors are included in APTA PR-M-S-018-10.

The following shall be taken into account for the installation of emergency release actuation devices:

1. Conduit shall be provided for the exterior emergency release actuation device cable to facilitate cable replacement.
2. Design of the interior emergency release cable and its interface with the car structure shall reduce the possibility of cable kinks or chafing.
3. Bend radius of the cable shall be based on the requirements of the cable manufacturer.
4. The number of bends shall be kept to a minimum.

5.3 Interior emergency device signage

Signage for the interior emergency release actuation device shall comply with the requirements of APTA PR-PS-S-002-98, "Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment," 49 CFR 238.112, "Door Emergency Egress and Rescue Access Systems," and 49 CFR Part 239.

Note: It is anticipated that APTA PR-PS-S-002-98, "Emergency Signage for Egress/Access of Passenger Railroad Equipment" will be superseded by APTA PR-PS-S-006-2X, "Emergency Egress/Access Signage and Low-Location Exit Path Markings for Passenger Rail Equipment." Once APTA PR-PS-S-006-2X has been approved, all references to APTA PR-PS-S-002-98 shall be replaced with APTA PR-PS-S-006-2X.

5.4 Exterior emergency device signage

5.4.1 Side door

Signage for the exterior side door emergency release actuation device shall comply with the requirements of APTA PR-PS-S-002-98, "Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment,"

49 CFR 238.112, “Door Emergency Egress and Rescue Access Systems,” and 49 CFR Part 239, “Passenger Train Emergency Preparedness.”

Note: It is anticipated that APTA PR-PS-S-002-98, “Emergency Signage for Egress/Access of Passenger Railroad Equipment” will be superseded by APTA PR-PS-S-006-2X, “Emergency Egress/Access Signage and Low-Location Exit Path Markings for Passenger Rail Equipment.” Once APTA PR-PS-S-006-2X has been approved, all references to APTA PR-PS-S-002-98 shall be replaced with APTA PR-PS-S-006-2X.

5.4.2 Collision post doors and passenger compartment doors

Signage for the collision post door emergency release device shall comply with the requirements of APTA PR-PS-S-002-98, “Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment,” 49 CFR 238.112, “Door Emergency Egress and Rescue Access Systems,” and 49 CFR Part 239, “Passenger Train Emergency Preparedness.”

Note: It is anticipated that APTA PR-PS-S-002-98, “Emergency Signage for Egress/Access of Passenger Railroad Equipment” will be superseded by APTA PR-PS-S-006-2X, “Emergency Egress/Access Signage and Low-Location Exit Path Markings for Passenger Rail Equipment.” Once APTA PR-PS-S-006-2X has been approved, all references to APTA PR-PS-S-002-98 shall be replaced with APTA PR-PS-S-006-2X.

6. Door sizes

6.1 General

Doorways designated for access to accessible areas of the cars shall comply with 49 CFR, Parts 37 and 38, “Americans with Disabilities Act.”

6.2 Side doors

Side doors shall comply with the provisions of 49 CFR Part 238, “Rail Passenger Equipment Safety Standards.”

7. Door glazing

All exterior door glazing shall comply with the provisions of 49 CFR, Part 223, “Safety Glazing Standards, Locomotive, Passenger Cars, and Cabooses,” and 49 CFR 238.221, “Glazing.”

8. Removable panels and windows

In accordance with 49 CFR 238.112, “Door emergency egress and rescue access systems,” vestibule doors and other interior doors intended for passage through a passenger car shall be equipped with a compliant removable panel or window to permit passenger emergency escape or rescue access for when the door is difficult to open or when the vehicle is on its side. The panel and window pass-through dimensions and height above the floor are defined in 49 CFR 238.112.

Each removable panel or removable window shall be designed to permit rapid and easy removal from each side of the door during an emergency situation without requiring the use of a tool or other implement.

Removal of the panel or window from either side of the door shall require manual pull handles similar in concept to emergency side window pull handles to remove the retaining seal. If necessary, an additional pull attachment can be used to extract the panel or window if not easily accomplished by hand. Other types of retention methods are acceptable as long as the clear opening requirements are met and the panel can be removed from both sides of the door.

The maximum removal force to extract the panel or window shall not exceed 60 lbf (267 N). Care shall be taken when selecting the seal materials to prevent age hardening and resulting increase of removal force above 60 lbf (267 N).

The pull handle shall be sized to allow a minimum 1.25 in. (32 mm) knuckle clearance when the handle is in the pull/release position.

All sharp edges around the opening shall be protected or removed to facilitate passage through the escape opening without injury.

The maximum deflection of a door with a removable panel or window under load shall be compliant with Section 3.3 of this standard. This deflection shall be respected only with the removable panel or window in place.

All escape removable panels and windows shall be appropriately marked with luminescent material on each side of the door as specified in Section 5.4.2 of APTA PR-PS-S-002-98, "Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment." Legible and understandable operating instructions, compliant with the HPPL requirements of APTA PR-PS-S-002-98, "Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment," shall be posted on each side of the door at each such panel or window.

Note: It is anticipated that APTA PR-PS-S-002-98, "Emergency Signage for Egress/Access of Passenger Railroad Equipment" will be superseded by APTA PR-PS-S-006-2X, "Emergency Egress/Access Signage and Low-Location Exit Path Markings for Passenger Rail Equipment." Once APTA PR-PS-S-006-2X has been approved, all references to APTA PR-PS-S-002-98 shall be replaced with APTA PR-PS-S-006-2X.

9. Analysis

9.1 General

If testing is performed, there is no requirement to perform additional analysis, unless specified.

The manufacturer shall perform structural analysis of the door system as defined in this standard. By agreement, the equipment purchaser may review and approve reports of the structural analysis as a condition for acceptance of the door system. Format and content of the structural analysis reports should be as agreed to by the purchaser and manufacturer. The manufacturer and purchaser shall agree on an analysis plan prior to performing the analysis.

9.2 Structural representation

In order to define the door system, a structural representation is required. The purpose of the structural representation is to define the primary door system in advance of formal stress analysis and structural drawings.

A 3D representation shall be issued in a format that will allow review and dimensional extraction with the use of commonly available 3D viewers. Whether presented in 2D or 3D, material identification shall be provided, along with a preliminary description of anticipated connections.

The members shown shall include, to the extent used in the particular design, typical door mounting and locking/latching points.

9.3 Elastic and elastic-plastic stress analysis

Linear elastic load cases shall be subject to stress analysis consisting of a linear-elastic finite element analysis supplemented as necessary by manual analyses. The FEA shall use a recognized code that is readily available and widely used in North America for railcar structural analysis.

For all linear-elastic load cases, the elastic stability of plates, webs and flanges shall be calculated for members subject to compression and/or shear as agreed upon by the purchaser and manufacturer.

Elastic-plastic load cases shall be carried out using nonlinear stress analysis consisting of an FEA. The analysis shall account for nonlinear material behavior above the material's elastic limit. The FEA shall use a recognized code that is readily available and widely used in North America for railcar structural analysis.

Manual analysis shall be performed to examine details of the door system installation (e.g., weld connections, welded and/or bolted joints, buckling and fatigue conditions) that are not readily handled in the FEA.

9.4 Stress analysis report

Analysis report(s) shall be created to demonstrate compliance with the analysis requirements of this standard. The format and content of the report(s) shall be as agreed to by the purchaser and manufacturer, but shall contain the following at a minimum:

1. General information about the analyzed item(s), including:
    a. description of each item and the item's intended function;
    b. load case(s) documented in the report;
    c. diagram showing key dimensions, identifying relevant structural member(s), and showing the load application and reaction location(s); and
    d. drawing references.
2. Details about the materials used in the analyzed item(s), including:
    a. diagram showing the locations of each material used; and
    b. mechanical properties and their sources for all materials used, including, at a minimum, tensile modulus, Poisson's ratio or shear modulus, yield strength/proof strength and ultimate tensile strength.
3. Description of the acceptance criteria for each analysis performed, including:
    a. allowable stresses and/or strains and the means for deriving these values; and
    b. reference to the applicable requirements of this standard.
4. Description of finite element analyses performed, including:
    a. identification of the solver used and type of analysis performed;
    b. diagram showing the applied forces and other boundary conditions for each loading condition;
    c. modeling methods used for load application;
    d. assumptions of how joint behavior is represented (e.g., rivets, bolts, welds);
    e. description of the mesh, including element types, quantity of elements, characteristic element sizes, locations of mesh refinement, and meshing accuracy index; and
    f. important differences between the model and the actual structure.
5. Analysis results using appropriate views and scales, including:
    a. reaction forces and moments;
    b. deflection in three orthogonal axes;
    c. contour plots of von Mises or other approved combination stress;
    d. where agreed to by the purchaser and manufacturer, minimum and maximum principal stresses and their directions;

e. detailed results at locations of highest stress and other critical areas;
f. identification of structural components with margins of safety less than a threshold agreed to by the purchaser and manufacturer, at a minimum 0.2; and
g. identification of any locations at which allowable stresses are exceeded and an explanation of whether such exceedances are acceptable.

6. Supporting hand calculations or other supplemental analyses, such as buckling, joint strength or fatigue analysis, with sufficient detail to explain the methodology employed and complete results.
7. Conclusion presenting whether the identified acceptance criteria were met.
8. For large-deformation analyses, the report shall include the nonlinear stress/strain curve and other material properties, such as damping, used in the analysis. Allowable plastic equivalent strain values shall be identified for each material. In addition to identifying the solver and type of analysis, the time step used for the analysis shall be provided. Analysis results shall show, at a minimum, plots of reaction forces and moments over time, deflection in all three axes, energy parameters, and plastic equivalent strain values. The results shall demonstrate that the support structure of the plastically deforming components remains stable under the prescribed conditions.

9.5 Model validation

It is anticipated that compliance with load cases required to achieve compliance with industry standards and the technical specification will not all be demonstrated through physical testing and that modeling results alone will be used to satisfy some of these requirements.

Therefore, it is critical that adequate documentation be provided to establish credibility in the modeling methodology and the ability of the model to produce realistic results.

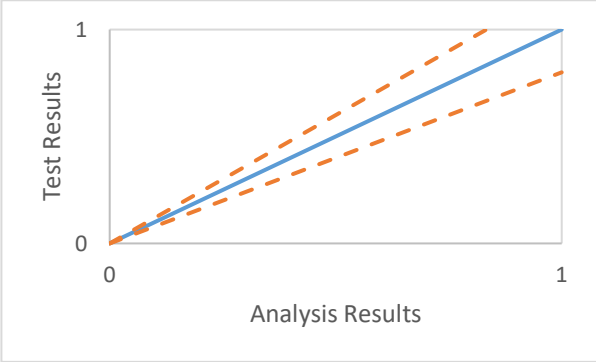
A model validation report that fulfills this purpose is to be provided. The format and content of the report shall be as agreed to by the purchaser and manufacturer, but shall contain the following at a minimum:

- Identification of which tests will be used for model validation.
- Identification of which measurement device (strain gauges, displacement sensors, load cells, etc.) output will be used for model validation (if not all). It is recommended that strain gauge measurements that indicate stresses greater than or equal to 25% of the allowable be considered in the validation activity. The manufacturer shall provide an explanation of the rationale for excluding any measurements from the validation activity.
- Identification of the version of the model used to perform the validation activities.
- Appropriate tabulations or other graphical depictions of the comparisons of the model and test results for each of the relevant load cases and for each of the relevant measurement devices, and documentation of the relative differences between the two results.
- Explanation of reason(s) for instances in which model results do not correlate with the measured value using the prescribed criteria.
- For the purposes of the validation report, the following maximum correlation criteria shall be applied. More restrictive values can be used if agreed to by the purchaser and manufacturer:
    - Model-predicted values of strains/stresses shall be within ±20% of the measured values at the relevant locations.
    - Model-predicted values of deflections/displacements shall be within ±10% of the measured values at the relevant locations.
    - Model-predicted load reactions shall be within 5% of the measured values at the relevant locations.

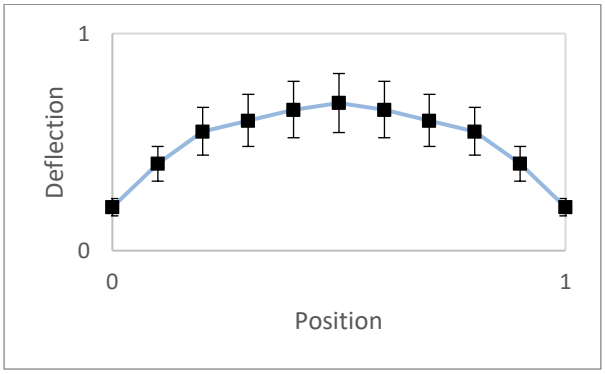
Correlation between measured and predicted values shall be presented in a form similar to that shown in **Figure 2**, in which the dashed curves or the error bars represent the correlation tolerance and the solid curves

represent the test result. Data for the model-predicted values are added to these plots. Quantities represented by the horizontal and vertical axes are selected based on the relevant load case. Depending on the quantities compared, alternate representations are allowed based on agreement between the purchaser and the manufacturer.

FIGURE 2
Format for Correlations Between Measured and Predicted Values



Typical depiction of comparison between test and analysis results for stresses or strains.



Typical depiction of comparison between test and analysis results for deflections/displacements.

In the event that validation cannot be achieved within the correlation tolerances, and model refinement or revision is required for any reason to improve correlation, results for all load cases must be reproduced using the revised model unless the manufacturer can provide a documented, compelling case describing why this is not necessary.

If the same door system FEA analysis has been previously validated on other projects, this information can be used to fulfill the requirements of this section as agreed to between the purchaser and manufacturer.

10. Testing

10.1 General

Testing door system, as required by this standard, shall be performed in accordance with the requirements of this section. The test articles shall be completely inspected and any nonconformances corrected and documented prior to testing and are subject to approval by the purchaser. The manufacturer and purchaser shall agree on a test plan prior to performing the testing.

All gauges and instruments used as part of the test shall be in current calibration and remain so for the duration of the test. The methods of calibration and time periods for recalibration shall be in accordance with a certified standard.

For any design for a door system that is based on a qualified design, the manufacturer may provide data from previous tests to satisfy the corresponding portion of these requirements, as approved by the purchaser. The differences between the qualified door system and the new design and the effect of those changes on the door structure shall be defined by the manufacturer.

Prior to static testing, it is permissible to apply and remove a 100% preload to relieve any manufacturing prestresses that may be present.

Testing should be conducted in the following conditions, as applicable:

1. All tests are to be done at a temperature range of 50 to 86 °F (10 to 30 °C).
2. All tests are to be done on level track (i.e., no vertical grade, no superelevation).
3. All tests are to be done at nominal voltage.

10.1.1 Test procedure

A test procedure shall be developed prior to conducting any test. The test procedure shall include, but shall not necessarily be limited to, drawings, sketches, tables and other descriptions that provide the following:

1. The purpose of the test.
2. A description of the load application equipment and test fixture.
3. The location and type of each load applicator and point of fixation (boundary conditions).
4. A table showing the load applied at each load applicator for each test increment.
5. A table showing the parameters that should be recorded for each test increment.
6. A table showing the pass/fail criteria for each test.
7. The location of each load, strain and deflection-measuring device.
8. Requirements for monitoring deflection, stress (or strain) output during the test.
9. A list of conditions under which the test will be terminated, including maximum allowable strains or displacements.

The following item shall be agreed upon by the purchaser and manufacturer and listed in the test procedure:

1. Loading prior to the witness test.

10.1.2 Test report

The manufacturer shall develop a test report that describes test results and presents supporting data as agreed to by the purchaser and manufacturer. Test report shall contain the following, as a minimum:

1. Tables showing stresses and deflections.
2. Description and explanation of any value that exceeded the test criteria.
3. Appendixes containing all data, i.e., output from each strain gauges, displacement transducers. These data shall be clearly identified and include the date that they were recorded.
4. Stress (or strain) versus load curves for any gauges.
5. A table showing each applied load and reaction load.
6. The temperature at the time of testing.

Related APTA standards

APTA PR-IM-S-003-98, Latest revision, "Door System Periodic Inspection and Maintenance"
APTA PR-PS-S-002-98, Latest revision, "Emergency Signage for Egress/Access of Passenger Rail Equipment"
APTA PR-M-S-018-10, Latest revision, "Powered Exterior Side Door System Design for New Passenger Cars"

References

This standard is to be used in conjunction with the following publications. When the following references are superseded by an approved revision, the latest revision shall apply.

49 CFR, Parts 37 and 38, "Americans with Disabilities Act"

49 CFR, Part 238, "Rail Passenger Equipment Safety Standards"

49 CFR, Part 239, "Passenger Train Emergency Preparedness"

49 CFR Part 223, "Safety Glazing Standards, Locomotive, Passenger Cars, and Cabooses"

Definitions

bifolding door: A door with hinged panels that in the open position fold against the door bulkhead.

biparting door: A door, usually sliding, that has two panels that open from the center and are normally synchronized.

door isolation lock: A cutout/lockout mechanism installed at each exterior side door panel (leaf) used to secure a door in the closed and locked position, to provide a door-closed indication to the summary circuit, and to remove power from the door motor or door motor controls.

door pocket: A compartment into which a door panel is retracted when in the open position.

end frame door: an end-facing door normally located between, or adjacent to, the collision posts or similar end-frame structural elements. (49 CFR 238.5 definition)

exterior side door: The door on the side of the passenger car normally used for passenger access and egress.

interface: A point at which two or more systems, subsystems or structures meet to transfer energy and/or information.

interior door, other: A door that is not exposed to the exterior and is intended for passageway through the car.

lock: A device, usually key-operated, used in normal train operations to secure the ends of a train or portion of individual cars from unauthorized access or used to secure a door in the closed position when that door is taken out of service. Bars, latches, hasps and similar devices used to secure a cars for storage (overnight or long term) are not covered by this definition, nor are latches and similar devices on equipment access doors

manual operation: A door capability that permits operation by hand without tools or keys.

plug door: A door with a mechanism that, when opening, moves the door panel(s) out and parallel to the side of the car in the open position.

power operation: A door capability that results in the door opening or closing by means of an electric or pneumatic mechanism or a combination thereof controlled from one or more locations, and in an emergency shall be capable of manual operation with an override device in accordance with 49 CFR Part 238.

purchaser: Owner/operator purchasing the equipment.

side entrance door: The door opening(s) on the side of the car normally used for passenger access and egress.

trap door: A hinged panel that rotates upward to reveal a set of steps used for low-level access. In the down position, the panel becomes part of the floor used for high-level platform access. In both the up and down positions, the panel is retained by a latch, and the panel usually contains a handrail on the underside for use when in the up position.

vestibule: An area of a passenger car that normally does not contain seating, is located adjacent to a side exit door, and is used in passing from a seating area to a side exit door. (49 CFR 238.5 definition)

vestibule door: A door separating a seating area from a vestibule. End-frame doors and doors separating sleeping compartments or similar private compartments from a passageway are not vestibule doors. (49 CFR 238.5 definition)

Abbreviations and acronyms

AAR Association of American Railroads
CFR Code of Federal Regulations
FEA finite element analysis
FRA Federal Railroad Administration
MIL-STD Military Standard

Summary of document changes

- This document is a complete re-write of the version published in 2004. New sections were added to create strength requirements, removable panels, analysis and testing for door systems for passenger railcars. Additionally, an informative appendix was added with photos of door systems in operations.

Document history

Document Version	Working Group Vote	Public Comment/ Technical Oversight	Rail CEO Approval	Policy & Planning Approval	Publish Date
First published	—	—	—	Oct. 30, 2002	Jan. 13, 2003
First revision	—	—	—	—	March 22, 2004
Second revision	June 30, 2021	Oct. 1, 2021	Nov. 23, 2021	Jan. 28, 2022	Feb. 4, 2022
Third revision	—	—	—	—	—

Appendix A: Photos supporting door types in Section 2

FIGURE 3

Single Sliding Pocket Doors

Photo courtesy of Long Island Rail Road

Photo courtesy of Vapor Rail

FIGURE 5
Biparting Sliding Pocket Door

Photo courtesy of Vapor Rail

FIGURE 4
Single Sliding Full Height Pocket Doors

Photo courtesy of Vapor Rail

Photo courtesy of Vapor Rail

FIGURE 6
Single Sliding Pocket End Frame Door

Photo courtesy of Long Island Rail Road

FIGURE 7
Sliding Pocket Vestibule Door

Photo courtesy of Vapor Rail

FIGURE 8
Single Plug Door, Closed and Open

Photos courtesy of TTC

FIGURE 9
Biparting Plug Door, Closed and Open

Photos courtesy of Vapor Rail

FIGURE 9
Exterior Sliding Biparting Door, Closed and Open

Photos courtesy of Vapor Rail

FIGURE 10
Single Bifolding Door, and Double Bifolding Doors

Photos courtesy of St. Louis MetroLink

FIGURE 11
Manual Hinged End Frame Door

Photo courtesy of Long Island Rail Road

FIGURE 12
Other Interior Door

Photo courtesy of Siemens Mobility

FIGURE 13
Other Interior Door

Photo courtesy of Siemens Mobility

Appendix B: Design for ease of maintenance

Accessibility of door equipment for both operational access and maintainability shall be implicit in the design and integration of the door equipment. Subjects to be considered shall include equipment location, accessibility, modularity, ease of replacement, car systems interface requirements and proximity to other systems.

Door design shall allow periodic inspection and maintenance of doors in accordance with APTA PR-IM-S-003-98, Rev. 1, "Door System Periodic Inspection and Maintenance," and 49 CFR 238.307, "Periodic mechanical inspection of passenger cars and unpowered vehicles used in passenger trains."

Doors shall be designed for ease of access to sites where adjustments are required (such as door travel, etc.). However, the goal is to design doors that do not require frequent adjustment, so attention shall be paid to integration issues such as rigidity of car structure and brackets (so components do not bend or move).

