

ASME RT-2–2021
(Revision of ASME RT-2–2014)

Safety Standard for Structural Requirements for Heavy Rail Transit Vehicles

AN AMERICAN NATIONAL STANDARD



**The American Society of
Mechanical Engineers**

ASME RT-2-2021
(Revision of ASME RT-2-2014)

Safety Standard for Structural Requirements for Heavy Rail Transit Vehicles

AN AMERICAN NATIONAL STANDARD



**The American Society of
Mechanical Engineers**

Two Park Avenue • New York, NY • 10016 USA

Date of Issuance: December 14, 2021

This Standard will be revised when the Committee approves the issuance of a new edition. This Standard will become effective 6 months after the Date of Issuance.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. Interpretations are published on the ASME website under the Committee Pages at <http://cstools.asme.org/> as they are issued.

Errata to codes and standards may be posted on the ASME website under the Committee Pages to provide corrections to incorrectly published items, or to correct typographical or grammatical errors in codes and standards. Such errata shall be based on the date posted.

The Committee Pages can be found at <http://cstools.asme.org/>. There is an option available to automatically receive an e-mail notification when errata are posted to a particular code or standard. This option can be found on the appropriate Committee Page after selecting "Errata" in the "Publication Information" section.

ASME is the registered trademark of The American Society of Mechanical Engineers.

This code or standard was developed under procedures accredited as meeting the criteria for American National Standards. The Standards Committee that approved the code or standard was balanced to assure that individuals from competent and concerned interests have had an opportunity to participate. The proposed code or standard was made available for public review and comment that provides an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

ASME does not "approve," "rate," or "endorse" any item, construction, proprietary device, or activity.

ASME does not take any position with respect to the validity of any patent rights asserted in connection with any items mentioned in this document, and does not undertake to insure anyone utilizing a standard against liability for infringement of any applicable letters patent, nor assume any such liability. Users of a code or standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this code or standard.

ASME accepts responsibility only for those interpretations of this document issued in accordance with the established ASME procedures and policies, which preclude the issuance of interpretations by individuals.

No part of this document may be reproduced in any form,
in an electronic retrieval system or otherwise,
without the prior written permission of the publisher.

The American Society of Mechanical Engineers
Two Park Avenue, New York, NY 10016-5990

Copyright © 2021 by
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
All rights reserved

CONTENTS

Foreword		i
Committee Roster		v
Correspondence With the RTV Committee		vi
Introduction		viii
Summary of Changes		ix
1	Scope	1
2	Definitions	1
3	Interoperability	3
4	Structural Requirements	3
5	Design Loads and Assessment Criteria	8
6	Coupler System	9
7	Structural Materials	9
8	Crash Energy Management (CEM)	9
9	Analysis	9
10	Tests	11
11	References	14
Figure		
4.8-1	Gangway Configuration	8
Tables		
4-1	Structural Load Requirements for Heavy Rail Transit Vehicles	4
4.9-1	Crashworthiness for Heavy Rail Transit Vehicles	8

FOREWORD

On March 18, 1998, The American Society of Mechanical Engineers (ASME) formed the Rail Transit Vehicle (RTV) Standards Committee.

The RTV Standards Committee develops and maintains standards that cover safety, functional, performance, and operability requirements, as well as mechanical systems, components, and structural requirements for RTVs. RTVs include streetcars, conventional subway (rapid) transit rail vehicles, and light rail vehicles and excludes freight, commuter, high-speed, or any other rail vehicles under the jurisdiction of the Federal Railroad Administration.

The RTV Standards Committee is responsible for developing a series of safety standards within its Charter under the designation of RT. The purpose of the RT standards is to provide the rail transit industry with safety standards that address vehicle mechanical systems, components, and structural requirements, so as to enhance public safety. Principles, recommendations, and requirements included in these standards promote good engineering judgment as applied in designing rail transit vehicles for safety. The standards are subject to revisions that are the result of the Committee's consideration of factors such as technological advances, new data, and changing environmental and industry needs.

Both SI and U.S. Customary units are used in this Standard, with the latter placed in parentheses. These units are noninterchangeable, and, depending on the country as well as industry preferences, the user of this Standard shall determine which units are to be applied. Parameters are derived from the "Standard for Use of the International System of Units (SI): The Modern Metric System," IEEE/ASTM SI 10-1997, or the latest revision.

The first edition of ASME RT-2 was approved by the American National Standards Institute (ANSI) in 2008. A revised edition was approved by ANSI in 2014.

ASME RT-2-2021 is a complete revision of the 2014 edition. Following its approval by the RTV Standards Committee and ASME, ASME RT-2-2021 was approved by ANSI on November 30, 2021.

ASME RTV COMMITTEE

Rail Transit Vehicle

(The following is the roster of the Committee at the time of approval of this Standard.)

STANDARDS COMMITTEE OFFICERS

B. F. Holland, *Chair*
M. P. Schroeder, *Vice Chair*
R. Mohamed, *Secretary*

STANDARDS COMMITTEE PERSONNEL

M. L. Burshtin , Retired	R. MacNeill , Simpson, Gumpert and Berger
D. W. Casper , STV, Inc.	F. J. Major , Dellner, Inc.
R. Chuback , MTA	R. Mohamed , The American Society of Mechanical Engineers
T. F. Conry , University of Illinois	P. Rakoczy , RRI
R. D. Curtis , Curtis Engineering Consulting	M. P. Schroeder , Jacob
S. I. Eisl , SEPTA	A. Starlinger , Stadler Rail
I. Erostarbe , CAF USA	N. Sundarai , American Public Transportation Association
D. B. Ghim , WMATA	J. D. Swanson , C-Lavalin Rail and Transit, Inc.
G. Gough , Siemens Industry	J. H. Xue , WSP
R. E. Green , Lea and Elliott, Inc.	L. C. Conc , <i>Alternate</i> , Alstom Transporte
J. Hesse , STV, Inc.	A. Hubert , <i>Alternate</i> , Alstom Transport
B. F. Holland , Honolulu Rail Operations	P. E. Jamison , <i>Alternate</i> , Retired
G. Hud , LTK Engineering Services	R. Kiela , <i>Alternate</i> , Chicago Transit Authority
W. R. Keevil , Consultant	M. J. Zell , <i>Alternate</i> , Dellner Dampers
J. E. Kenas , Alstom Transport	V. Phan , <i>Alternate</i> , Applied Research Associates, Inc.
S. W. Kirkpatrick , Applied Research Associates, Inc.	N. M. Zeolla , <i>Alternate</i> , LTK Engineering Services of New York, LLP
D. LeCorre , Alstom Transport	M. B. Samani , <i>Contributing Member</i> , LTK Engineering Services
G. Macey , Chicago Transit Authority	

CORRESPONDENCE WITH THE RTV COMMITTEE

General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions or a case, and attending Committee meetings. Correspondence should be addressed to:

Secretary, RTV Standards Committee
The American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990
<http://go.asme.org/Inquiry>

Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Interpretations. Upon request, the RTV Standards Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the RTV Standards Committee.

Requests for interpretation should preferably be submitted through the online Interpretation Submittal Form. The form is accessible at <http://go.asme.org/InterpretationRequest>. Upon submittal of the form, the Inquirer will receive an automatic e-mail confirming receipt.

If the Inquirer is unable to use the online form, he/she may mail the request to the Secretary of the RTV Standards Committee at the above address. The request for an interpretation should be clear and unambiguous. It is further recommended that the Inquirer submit his/her request in the following format:

Subject: Cite the applicable paragraph number(s) and the topic of the inquiry in one or two words.
Edition: Cite the applicable edition of the Standard for which the interpretation is being requested.
Question: Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. Please provide a condensed and precise question, composed in such a way that a "yes" or "no" reply is acceptable.
Proposed Reply(ies): Provide a proposed reply(ies) in the form of "Yes" or "No," with explanation as needed. If submitting replies to more than one question, please number the questions and replies.
Background Information: Provide the Committee with any background information that will assist the Committee in understanding the inquiry. The Inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in the format described above may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

Moreover, ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Standard requirements. If, based on the inquiry information submitted, it is the opinion of the Committee that the Inquirer should seek assistance, the inquiry will be returned with the recommendation that such assistance be obtained.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not “approve,” “certify,” “rate,” or “endorse” any item, construction, proprietary device, or activity.

Attending Committee Meetings. The RTV Standards Committee regularly holds meetings and/or telephone conferences that are open to the public. Persons wishing to attend any meeting and/or telephone conference should contact the Secretary of the RTV Standards Committee.

Currently in preview, click buy full version

INTRODUCTION

Safety of heavy rail transit operations, like all rail vehicles, is a system characteristic. As do all transportation options in a given corridor, the operation of rail vehicles has certain risks, including derailment and collision with another vehicle. The risks are mitigated by the design of the signal system and other systems elements, by operating and maintenance procedures, and by the design of the vehicle. Risks are further mitigated by the elimination of grade crossings and the provision of safety barriers. Active safety systems on the vehicle include train control, communication, and propulsion and braking subsystems. The vehicle carbody, if properly designed, may be considered a passive safety device, and this Standard is intended to address the performance of the carbody in collisions.

This Standard draws from existing requirements for the design of the carbody of heavy rail transit vehicles. It also considers recent developments in the design of rail carbody structures intended to optimize the structural performance under the conditions of an overload, such as might occur during a collision. This topic is commonly identified as crash energy management (CEM). The intent of CEM is to better manage the dissipation of the portion of the energy of a collision that can reasonably be expected to be absorbed by the deformation of the carbody. CEM design, when appropriately applied, may reduce risk of injuries to occupants of the rail vehicle due to loss of survivable volume and due to secondary collisions of occupants with the car interior. Specific portions of the carbody are designed for controlled deformation and energy absorption and are located in the structure so as to limit the damage to, and acceleration of, occupied volumes. This Standard requires the incorporation of CEM principles in the design of heavy rail transit vehicles. For multiple unit operation, distributing structural energy absorption through the train has been shown to be beneficial.

ASME RT-2-2021 SUMMARY OF CHANGES

Following approval by the ASME RTV Committee and ASME, and after public review, ASME RT-2-2021 was approved by the American National Standards Institute on November 30, 2021.

This Standard has been revised in its entirety.

Currently in preview, click buy full version

INTENTIONALLY LEFT BLANK

SAFETY STANDARD FOR STRUCTURAL REQUIREMENTS FOR HEAVY RAIL TRANSIT VEHICLES

1 SCOPE

The objectives of the passive safety requirements described in this Standard are to reduce the risk to passenger injury and damage to equipment resulting from collision accidents by providing a means of protection when all possibilities of preventing an accident have failed. In the event of a collision, application of this Standard provides protection for the occupants of new designs of crashworthy vehicles through the preservation of structural integrity, reducing the risk of overriding and limiting decelerations. This Standard does not extend to the design of the vehicle interior structures that may help reduce injury risk caused by impacts between the occupants and vehicle interior, beyond limiting vehicle acceleration and consequential secondary impact velocity of passengers colliding with interior surfaces.

1.1 Subjects Not Addressed by This Standard

There are several design considerations related to safety that are not addressed, such as, but not limited to

- (a) structural repairs
- (b) fatigue
- (c) corrosion
- (d) fire protection
- (e) interior vehicle design
- (f) emergency egress from vehicle
- (g) inspection and maintenance

1.2 Effective Date

This Standard applies to newly constructed heavy rail transit vehicles for transit passenger service ordered 6 months following the date of issuance of this Standard by the Rail Transit Vehicle (RTV) Standards Committee and ASME.

2 DEFINITIONS

This Standard relies, where practical, on terms already in use by ASME, the American Public Transportation Association (APTA), and the Institute of Electrical and Electronics Engineers (IEEE). For the purposes of this Standard, the following definitions apply:

anticlimber: a structural member or mechanism located at each end of the vehicle, used to engage an opposing vehicle, coupled or not, to resist relative vertical travel between the two carbodies during a collision.

antitelescoping plate: a single structural member that spans the full width of the carbody at the top of the end frame, that is attached to the tops of the collision and corner posts, and is designed to transmit the collision and corner post top reaction loads to the carbody sides.

articulation: a rotating connection at the intermediate ends of carbody sections to allow negotiation of tracks with various vertical and horizontal profiles.

average collision acceleration: the longitudinal acceleration of each car computed using a 100-ms simple moving average over the duration of the collision event and averaged over each car.

belt rail: a longitudinal structural member of the carbody located on each side of the carbody below the passenger side windows. The distance between opposite belt rails often establishes the overall width of the carbody, exclusive of the side door thresholds, side cameras, and mirrors.

car: see *heavy rail transit vehicle*.

carbody: the main load-carrying structure above all truck suspension units. It includes all components that are connected to this structure and contribute directly to its strength, stiffness, and stability.

collision posts: a set of two full-height structural posts located at each end of the carbody, extending from the bottom of the underframe structure up to a structural shelf or an antitelescoping plate. Collision posts may be made of several structural members assembled to each other, provided that the required performance is met. They are located at the approximate one-third points across the width of the vehicle, and are forward of the seating position of any passenger or crew person. An alternative to collision posts is a collision wall.

collision wall: a structure at the leading end of the vehicle spanning the area between the structural shelf, corner posts, and top of the underframe. The use of a collision wall is intended to provide a collision performance equivalent to a collision post design.

consist: a set of vehicles forming a complete train.