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PRESS Construction & Structural Working Group

Fuel Tank Integrity on Non–Passenger Carrying Locomotives

Abstract: This standard establishes requirements, and provides guidance, for establishing a minimum level of integrity for all diesel fuel containment systems designed to accept, store and feed fuel to primary diesel engines installed on passenger rail equipment. This includes diesel electric and diesel electric dual mode locomotives (i.e., electrical and diesel electric compatible equipment) used in passenger revenue service. Minimum structural integrity, vehicle integration and construction requirements applied to the fuel containment systems are covered. Specific exceptions are stated. This standard does not apply to fuel transfer, feed, DMUs or fuel tender systems.

Keywords: containment, design, diesel, electric, fuel, integrity, locomotive, spills, tanks

Summary: This standard applies to the structural design of new passenger motive power fuel containment systems. The requirements laid down herein are not intended to be retroactive in their application to equipment now in service. New manufacture of a tank designed prior to this standard may be used in new passenger equipment as agreed between the builder and the operator. Design attributes or considerations given as examples of recommendation are presented merely to provide the designer with conventional options and are not prescriptive in nature.

Applicability: Applies only to new [applicable objects or system] ordered after [at least six months after publication, preferably on Jan. 1; no more than 18 months after publication], or placed into service for the first time after [on the 4th January 1st after publication].

Foreword

The American Public Transportation Association is a standards development organization in North America. The process of developing standards is managed by the APTA Standards Program's Standards Development Oversight Council (SDOC). These activities are carried out through several standards policy and planning committees that have been established to address specific transportation modes, safety and security requirements, interoperability, and other topics.

APTA used a consensus-based process to develop this document and its continued maintenance, which is detailed in the manual for the APTA Standards Program. This document was drafted in accordance with the approval criteria and editorial policy as described. Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

This document was prepared by the Construction & Structural Working Group, as directed by the Passenger Rail Equipment Safety Standards Planning Committee.

This document represents a common viewpoint of those parties concerned with its provisions, namely transit operating/planning agencies, manufacturers, consultants, engineers and general interest groups. APTA standards are mandatory to the extent incorporated by an applicable statute or regulation. In some cases, federal and/or state regulations govern portions of a transit system's operations. In cases where there is a conflict or contradiction between an applicable law or regulation and this document, consult with a legal adviser to determine which document takes precedence.

This document supersedes APTA PR-CS-S-007-98, Rev. 2, which has been revised. Below is a summary of changes from the previous document version:

- Section 1: Creates a standard format for description of each load case in Section 1.
  - Adds current applicable language from 49 CFR Part 238, Appendix D.
  - Scenario description:
    - Provides overview of the crash event.
    - Adds assumptions about state of equipment, conditions under which there is an impact to the tank, and what loading is applied to the tank.
    - Documents key discussion points of the committee for future revisions.
  - Load case definition:
    - Provides specific description of how to perform an analysis and/or test.
    - Describes how to apply load, including new figures.
    - Adds boundary conditions.
  - Performance requirements:
    - Adds specific guidance on how to interpret finite element analysis results.
    - Adds specific guidance on test results.
- Provides specific geometry of the impactors for load cases.
- Sections 2 through 7:
  - Makes various clarifications to previous text.
- Makes updates to references, definitions and abbreviations.

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Introduction

This introduction is not part of APTA PR-CS-S-007-98, Rev. 3, "Fuel Tank Integrity on Non–Passenger Carrying Locomotives."

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.

Scope and purpose

This standard applies to diesel fuel containment systems designed to accept, store, and feed fuel to prime movers installed on passenger rail equipment. This includes diesel electric dual mode locomotives (i.e., electrical and diesel fuel compatible equipment) used in revenue service. Minimum structural integrity, vehicle integration, and construction requirements applied to the fuel containment systems are described. Specific exceptions are stated. This standard does not apply to internal tanks, DMUs, the fuel transfer, feed, or fuel tender systems. The purpose of this standard is to provide minimum performance requirements and guidance to ensure the structural integrity of the tank, its attachment to the car body, and that no fuel is released when subjected to the load cases defined in this standard.

This standard applies to the structural design of new passenger motive power fuel containment systems. The requirements laid down herein are not intended to be retroactive in their application to equipment now in service. New manufacture of a tank designed prior to this standard may be used in new passenger equipment as agreed between the builder and the operator.

Fuel Tank Integrity on Non–Passenger Carrying Locomotives

1. Performance requirements

The following sections describe four loading scenarios to be used for evaluating the fuel tank. In the first three, the language from 49 CFR Part 238, Appendix D relevant to that scenario is provided for cross-reference. Then a description of the scenario and a definition of how to conduct an analysis and/or test is provided. In all cases, performance may be met by either FEA simulation or full-scale test as described by the requirements in Table 1.

TABLE 1. Performance Requirements

FEA simulation	The material ultimate strength of the tank's fuel containment skin shall not be exceeded at any integration point in the computational mesh over the range of temperatures defined in Section 6. This shall be assessed by determining the true effective plastic strain in the material at the ultimate strength appropriate for the mesh size used in the analysis.
Full-scale test	No leakage of the tank.
Both FEA simulation and full-scale test	The mounting elements for the tank shall not fail.

If FEA simulation is used, severe deformation load cases shall be carried out using nonlinear, large-deformation stress analysis. Either explicit or implicit FEA is acceptable. The analysis shall account for nonlinear material behavior above the material's elastic limit. The FEA simulation shall use a recognized software that is readily available and widely used in North America for rail car structural analysis.

1.1 Bottom loading

In the following three load case scenarios, a description of the load case scenario is first provided for reference. Next, a specific method for analysis and/or testing is provided as a load case definition. Finally, the guiding language from 49 CFR Part 238, Appendix D is also provided for comparison.

1.1.1 Load Case 1: Minor derailment

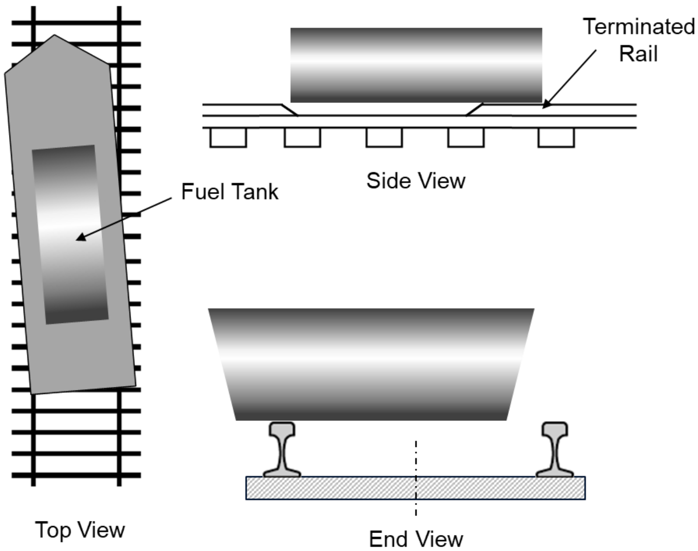
1.1.1.1 Scenario description

In a minor derailment, a single truck's wheels fall to the side of the rails after "climbing" over the top of the rails, as shown in **Figure 1**. The impact between the tank bottom end plate and track occurs only on the tank end adjacent to the derailed truck.

Scenario key points for requirements:

- The falling of the wheels to the track bed may cause an impact (dynamic loading) of the adjacent end plate of the fuel tank with the track. The other end of the fuel tank that is adjacent to the truck that remains on the track does not impact track.
- It is assumed that both trucks remain fully supported by the rails and/or ground and are not hanging from the car body. The locomotive car body is supported through contact with the rails. Therefore, the weight of the trucks is not considered in this scenario.
- The impact may initially occur on the fuel tank by a single rail.
- It is assumed that the locomotive is derailed off center such that only half of the car body weight is supported by the single rail.
- For this condition, the dynamic loading is approximated to be equivalent to a static load with a dynamic factor of 2.
- The total equivalent static load is therefore the weight of the car body.
- The supporting single rail is assumed to terminate with an open end.
- The range of the impact location is approximately equivalent to the wheel width on each side of the track gauge-line (assumed to be +/- 8 in from the rail center). Therefore, the most vulnerable position within a 16-in. band is to be considered for analysis.

FIGURE 1
Minor Derailment



1.1.1.2 Load case definition

A rigid rail shall be oriented horizontally and positioned below the tank as shown in Error! Reference source not found.. The terminated end of the rail shall be aligned at the start of radius R at length X = 10 in. from the end of the tank. The fuel tank shall be supported by its mounting elements. The locomotive structure holding the mounting elements shall be considered as rigid unless the locomotive structure influences the reaction of the mounting elements and/or tank under loading. The rail shall be constrained to move only vertically and stroked into the bottom of the fuel tank at a quasistatic rate until a load equal to W_{cb} is reached. The rail shall then be stroked in the opposite direction until there is no load.

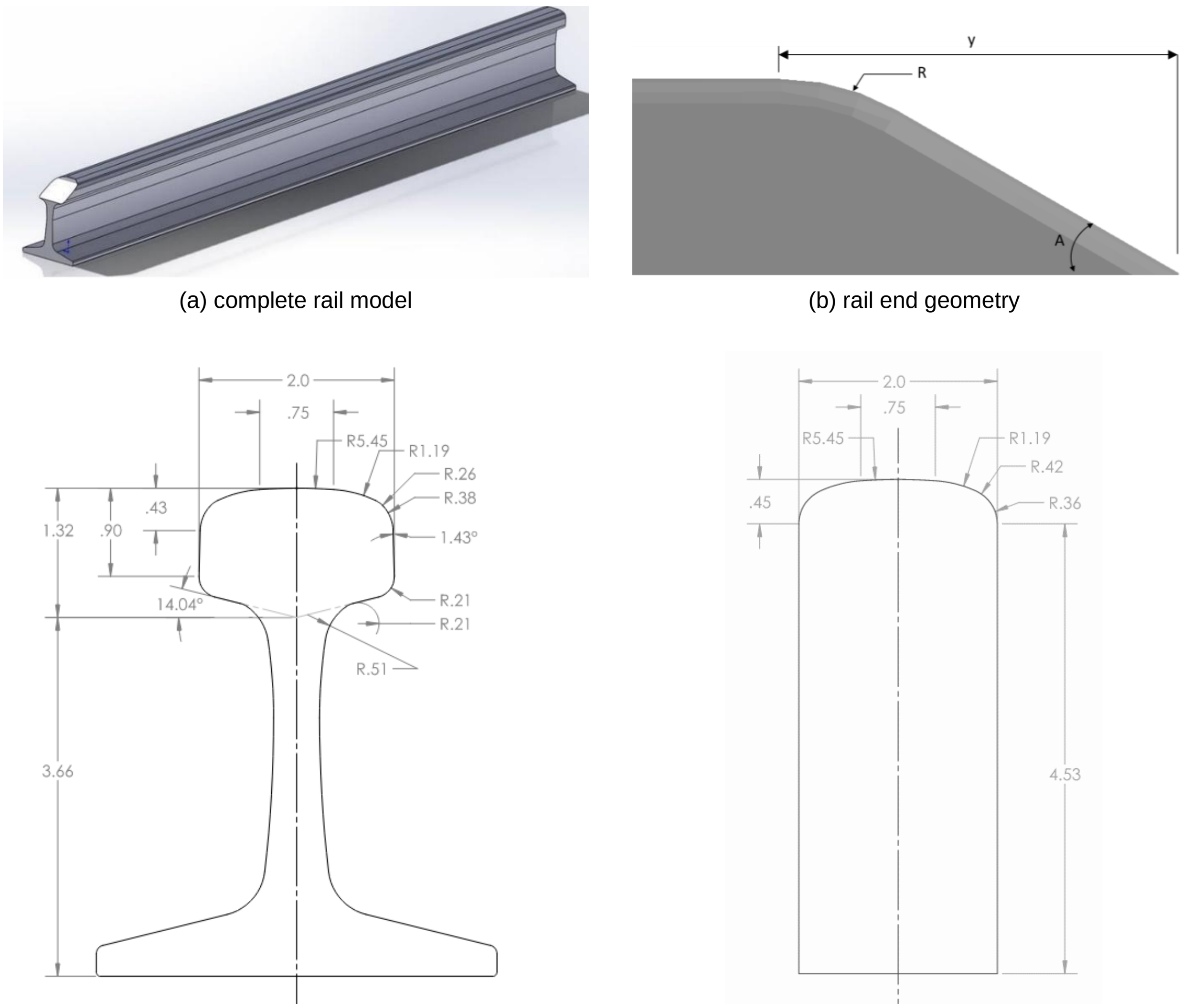
The complete rail geometry used for analysis is shown in Error! Reference source not found.**(a)**. Geometry of the terminated end of the rail is shown in Error! Reference source not found.**(b)** with the slope with angle A = 30 deg. to a maximum length Y = 3 in. and a starting radius R = 1 in. Two options for the rail cross section can be used, as shown in Error! Reference source not found.**(c)** and **Figure 3 (d)**. Note that this is the railhead g eometry identified by the AREMA 136RE rail profile, as shown in Error! Reference source not found., scaled to 2 in. wide. This geometry is provided in Appendix A. Loading shall be performed with the rail positioned at the most vulnerable location along the fuel tank width within ± 8 in. of one half of the track gauge.

The performance of the tank shall be in accordance with **Table 1**.

FIGURE 2
Rail Position for Load Case 1

FIGURE 3

Rail Geometry for Load Case 1 Analysis



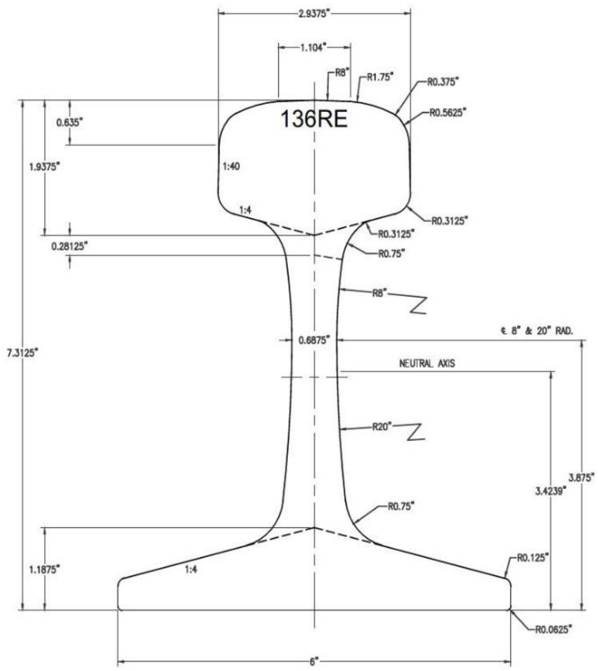
(a) complete rail model

(b) rail end geometry

(c) full rail profile

(d) extended head profile

FIGURE 4
AREMA 136RE Rail Geometry



The text from 49 CFR Part 238, Appendix D(a)(1) for this load case is provided for reference.

The end plate of the fuel tank shall support a sudden loading of one-half the weight of the car body at a vertical acceleration of 2g, without exceeding the ultimate strength of the material. The load is assumed to be supported on one rail, within an eight-inch band (plus or minus) at a point nominally above the head of the rail, on tangent track. Consideration should be given in the design of the fuel tank to maximize the vertical clearance between the top of the rail and the bottom of the fuel tank.

1.1.2 Load Case 2: Jackknifed locomotive

1.1.2.1 Scenario description

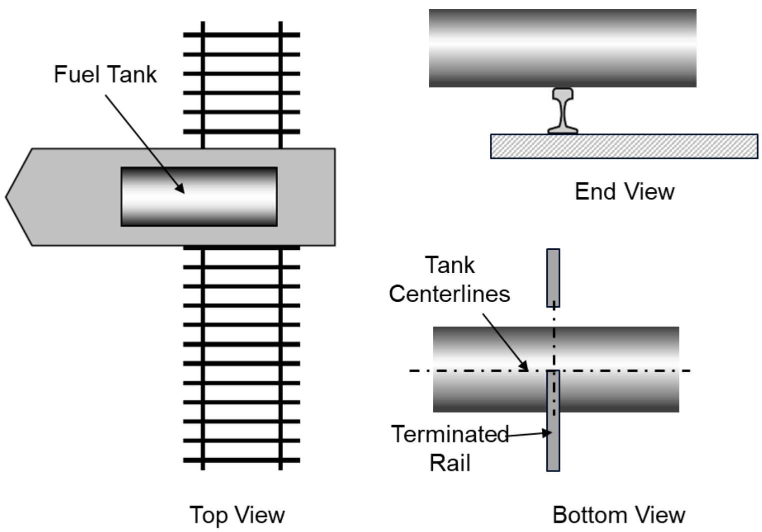
Extreme longitudinal forces in a collision can throw a locomotive to a perpendicular position across the track, as shown in Error! Reference source not found.. This occurs when longitudinal forces in the linking couplers i mpart proportionally large lateral/vertical forces over any perturbation in the couplers. This causes additional perturbation and an increase of the lateral and vertical forces, lifting the locomotive out of its parallel orientation until it is perpendicular with the track (jackknifed).

Scenario key points for requirements:

- The lifting and subsequent falling of a jackknifed locomotive may cause a dynamic load to the locomotive fuel tank.
- The critical jackknifing angle is considered to be 90 deg. (perpendicular) to the track, as this imparts the greatest concentration of load on a tank.
- The dynamic loading to a jackknifed locomotive may initially occur on a fuel tank by a single rail.

- For this dynamic event, it is assumed that half the locomotive's total weight with trucks is supported through contact with this single rail (a jackknifed locomotive may be supported solely by a single track with its trucks elevated above the ballast) and the other half is supported elsewhere. For this condition, the dynamic loading is approximated to be equivalent to a static load equal to half the weight of the ready-to-run locomotive with a dynamic factor of 2. The total equivalent static load is therefore the locomotive weight with trucks.
- The supporting single rail is assumed to terminate with its open end aligned with the longitudinal centerline of the tank.
- The worst-case load to a fuel tank for this condition is typically considered to be at the center of the fuel tank length. However, due to varied construction of tanks, this location may also be at a the most vulnerable location along the fuel tank's length that is susceptible to leakage in the tank shell (areas containing fuel resulting in the highest stresses in the tank shell).

FIGURE 5
Jackknifed Locomotive



1.1.2.2 Load case definition

A rigid rail shall be oriented horizontally and positioned below the tank, as shown in Error! Reference source not found.. The terminated end of the rail shall be aligned with the start of radius R at the centerline of the tank. Loading shall be performed with the rail positioned at the center of the tank and the most vulnerable location along the fuel tank's length. The fuel tank shall be supported by its mounting elements. The locomotive structure holding the mounting elements shall be considered as rigid unless the locomotive structure influences the reaction of the mounting elements and/or tank under loading. The rail shall be constrained to move only vertically and shall be stroked vertically into the bottom of the fuel tank at a quasistatic rate until a load of W_l is reached. The rail shall then be stroked in the opposite direction until there is no load.

The complete rail geometry used for analysis is shown in Error! Reference source not found.**(a)**. Geometry of the terminated end of the rail is shown in Error! Reference source not found.**(b)** with the slope with angle A ≥ 30 deg. to a maximum length Y = 3 in. and a starting radius R ≤ 1 in. Two options for the rail cross-section can be used, as shown in Error! Reference source not found.**(c)** and **Figure 7 (d)**. Note that this is the railhead geometry identified by the AREMA 136RE rail profile, as shown in Error! Reference source not found., scaled to 2 in. wide. This geometry is provided in Appendix A.

The performance of the tank shall be in accordance with **Table 1**.

FIGURE 6
Rail Position for Load Case 2

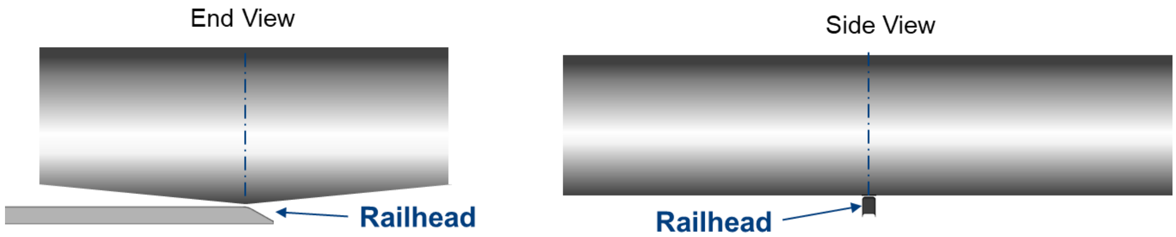
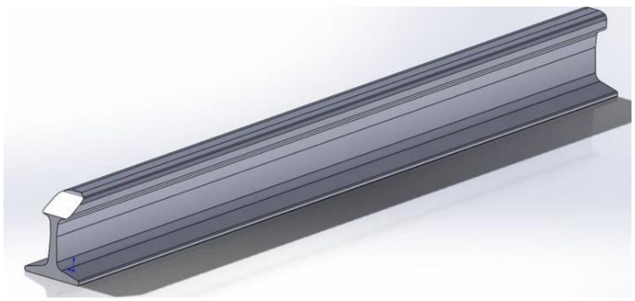
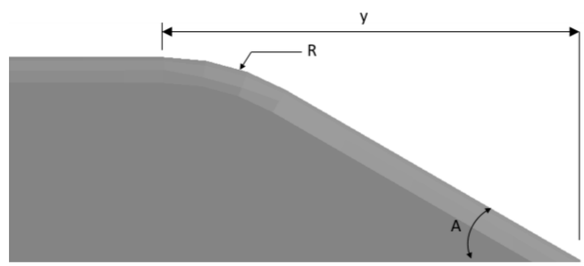


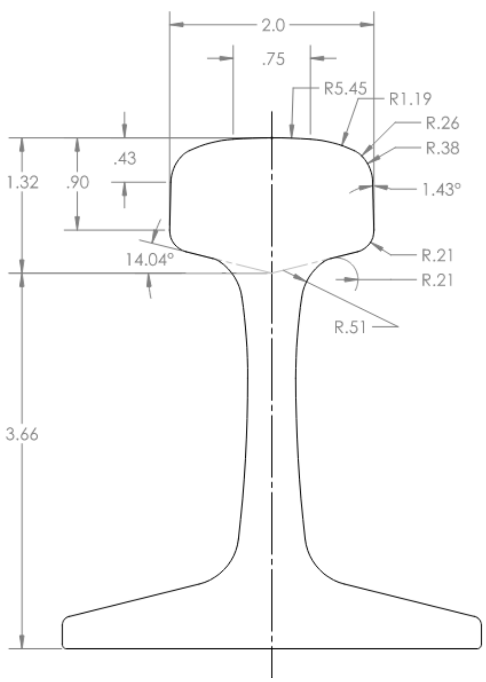
FIGURE 7
Rail Geometry for Load Case 2 Analysis



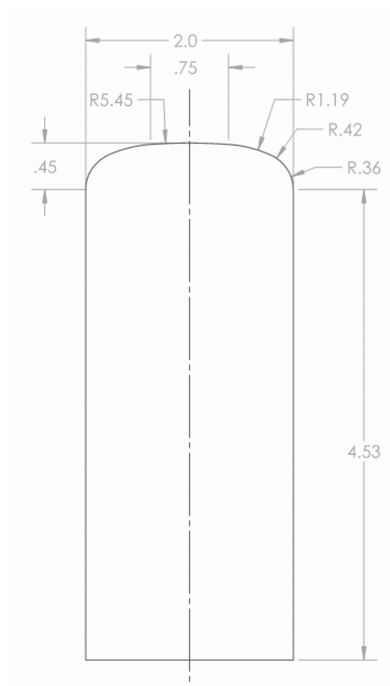
(a) complete rail model



(b) rail end geometry



(c) full rail profile



(d) extended head profile

The text from 49 CFR Part 238, Appendix D(a)(1) for this load case is provided for reference.

The fuel tank shall support transversely at the center a sudden loading equivalent to one half the weight of the locomotive at a vertical acceleration of 2g, without exceeding the ultimate strength of the material. The load is assumed to be supported on one rail, distributed between the longitudinal center line and the edge of the tank bottom, with a rail head surface of two inches.

Load Case 3: Side loading

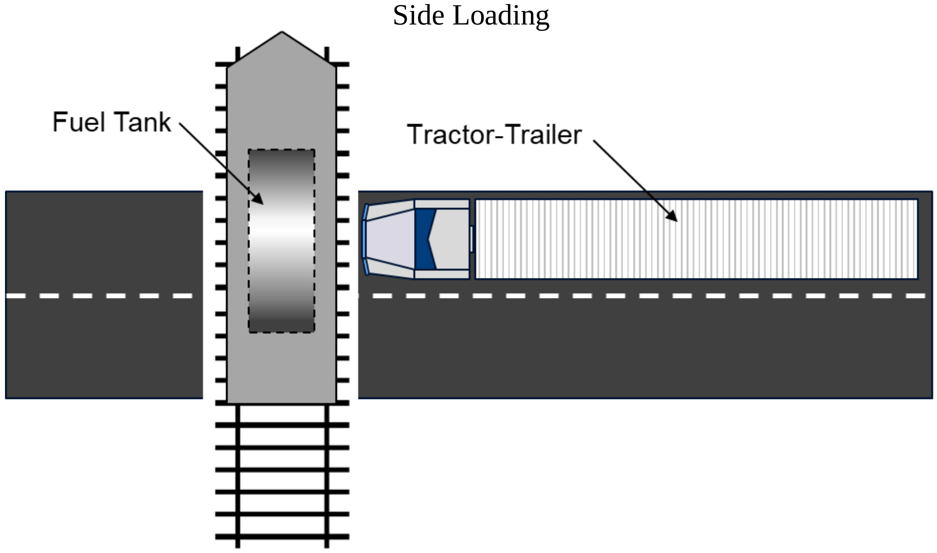
1.1.2.3 Scenario description

The bumper from a colliding truck at a grade crossing, as shown in **Figure 8**, applies a concentrated dynamic load on the side of a fuel tank.

Scenario key points for requirements:

- Critical impact angle is 90 deg. (perpendicular) to the track because this applies the greatest load on a tank.
- The dynamic loading from an impacting truck is approximated to be equivalent to a static load of 200,000 lbs.
- Locomotive components other than the fuel tank assembly that may provide protection are neglected.[1]
- Only the geometry of the bumper is considered to transfer the entire load from the side impact.
- The most vulnerable position along the fuel tank's length is to be considered in all cases, including when the tank is positioned above the side impact envelope.

FIGURE 8
Side Loading



1.1.2.4 Load case definition

A rigid 6 in. by 48 in. ram shall be centered 30 in. above the rail, as shown in Error! Reference source not found.**(a)**. For fuel tanks where the bottom of the tank is 27 in. or greater from the top of the rail, the ram shall be positioned 1 in. above the bottom outside edge of the tank, as shown in Error! Reference source not found.**(b)**. Loading shall be performed with the ram positioned at the most vulnerable locations along the fuel

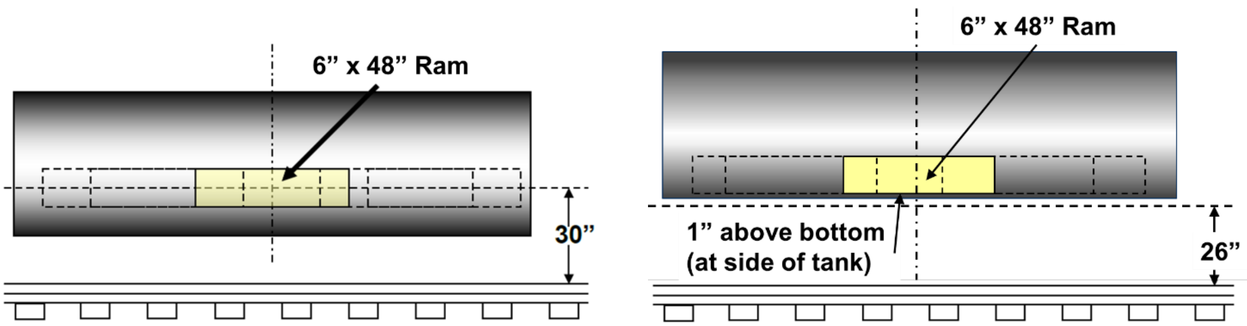
1. Actual crash loads are often subject to details unique to the equipment arrangement. For instance, it is common that air reservoirs or battery boxes might shield one side of the tank, serving to distribute the load of the truck bumper. However, tank shields specifically designed to protect the tank may be considered as part of the tank as long as the tank cannot be mounted without the protective tank shield.

tank's length (e.g., center of the tank). The fuel tank shall be supported by its mounting elements. The locomotive structure holding the mounting elements shall be considered as rigid unless the locomotive structure influences the reaction of the mounting elements and/or tank under loading. The ram shall be constrained to move only horizontally and stroked into the side of the fuel tank at a quasistatic rate until a load of 200,000 pounds is reached. The ram shall then be stroked in the opposite direction until there is no load.

Geometry for the rigid 6 by 48 in. impactor is shown in Error! Reference source not found.. The ram has a 1 i n. radius around the perimeter.

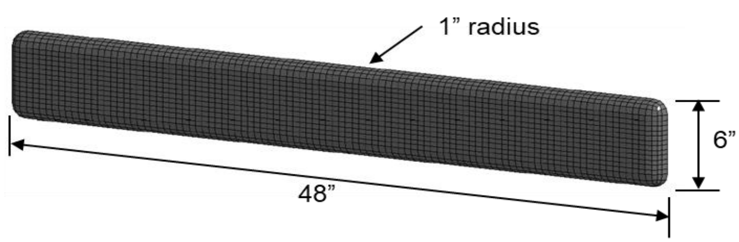
The performance of the tank shall be in accordance with **Table 1**.

FIGURE 9
Impact Position, Orientation and Dimensions on a Fuel Tank for Load Case 3



(a) Bottom of tank below 26 in. (side view)   (b) Bottom of tank above 26 in. (side view)

FIGURE 10
Ram Geometry



The text from 49 CFR Part 238, Appendix D(a)(1) for this load case is provided for reference.

In a side impact collision by an 80,000 pound Gross Vehicle Weight tractor/trailer at the longitudinal center of the fuel tank, the fuel tank shall withstand, without exceeding the ultimate strength, a 200,000 pound load (2.5g) distributed over an area of six inches by forty-eight inches (half the bumper area) at a height of thirty inches above the rail (standard DOT bumper height).

1.2 Load Case 4: Penetration resistance

The minimum thickness of the sides, bottom sheet and end plates of the fuel tank shall be equivalent to ⁵⁄₁₆ in. steel plate at 25,000 psi yield strength (where the thickness varies inversely with the square root of the yield strength)., The lower one-third of the end plates shall have the equivalent penetration resistance of ¾ in. steel plate at 25,000 psi yield strength. This may be accomplished by any combination of materials or other mechanical protection.

The text from 49 CFR Part 238, Appendix D(a)(1) for this load case is provided for reference.

The minimum thickness of the sides, bottom sheet and end plates of the fuel tank shall be equivalent to a 5⁄16-inch steel plate with a 25,000 pounds-per-square-inch yield strength (where the thickness varies inversely with the square root of yield strength). The lower one third of the end plates shall have the equivalent penetration resistance by the above method of a 3⁄4-inch steel plate with a 25,000 pounds-per-square-inch yield strength. This may be accomplished by any combination of materials or other mechanical protection.

2. Design requirements

2.1 Tank to rail clearance

Fuel tank to rail static clearance shall not be less than 6.0 in., when the equipment is in a fully serviced condition, with fully worn wheels.

2.2 Fuel tank sideswipes

Fuel tanks shall be protected against sideswipes. All gauges, fuel fills, vents, clean-out ports, fuel monitors and other fuel tank extensions shall be recessed, guarded, located or otherwise protected against catch and tear scenarios that could result in fuel release under normal revenue service conditions.

2.3 Emergency shutoffs

Fuel flow to the prime mover shall be capable of cut off from no less than the three locations required by 49 CFR 229.

2.4 Attachment

Attachment of fuel tanks to body shall be in accordance with APTA PR-CS-S-034-99, "Design and Construction of Passenger Railroad Rolling Stock."

3. Design guidelines

3.1 End plate penetration

Penetration resistance of the fuel tank end plate structures should be enhanced with forward (and aft, if a locomotive is operated in the long hood lead configuration) deflection, containment, capture, other design attributes, or a combination of such, capable of averting a puncture of the fuel tank by items passing below the pilot, snowplow or end plate.

Such designs might include angled reinforcements; downward angled fuel tank front plates; fuel tank guards, strategically located ancillary structures or other designs; or a combination of designs capable of adequate catch, break-away, deflection or otherwise puncture-averting characteristics. These structures should be either integral to the tank or immediately adjacent.

3.2 Skid plates

Use of above-rail skid plate fortification of critical tank bottom zones can be used in weight-critical and other unique applications. The plate(s) need not run the entire length of the tank. Critical zones typically include the fuel tank ends.

3.3 Ancillary structures

Ancillary structures affixed to the underbody of motive power equipment that pose a risk of puncture (structures stronger and stiffer than the tank design, such as the cast pneumatic crossing bell, which can act as a "knife" when forced back into the tank) should be avoided or they shall be located and attached to the motive power unit in such a manner that their presence does not increase the risk of puncturing the fuel tank. Fuel tank construction shall also minimize the attachment of ancillary structures to the fuel tanks.

4. Exposed fuel and transfer lines

Fuel tank piping or transfer systems supplying the prime mover with fuel shall incorporate the means to interrupt fuel loss upon damage. If this is not practical, then shields or some other means that satisfy this requirement shall be employed. To minimize fuel tank damage during sideswipes (railroad vehicles and grade crossings), all drain plugs, clean-out ports, inspection covers, sight glasses, gauge openings, etc., must be flush with the tank surface or adequately protected to avoid catching foreign objects or breakage. All seams must be protected to the extend practical or flush to avoid catching foreign objects.

5. Fuel spill minimization

In all passenger applications, fuel tank capacities shall be limited to volumes of no more than 1000 usable U.S. gallons unless additional measures are taken to minimize fuel spillage, such as compartmentalization, increased wall and end thickness, bladders, or other similar means.

6. Spill controls

Vents and fills shall be designed to avert fuel spill, even in the event of a rollover. Passenger locomotive vents shall perform their function at high acceleration/deceleration rates, as well as during all possible curve negotiation scenarios expected in service.

7. Materials

Fuel tanks shall be fabricated from steel or other structurally equivalent metallic material with sufficient strength and ductility to meet the performance requirements defined by this standard.

The material used for fuel tank exterior surface construction shall meet the performance requirements in this standard in the temperature range of −40 to 140 °F.

8. Workmanship

All workmanship affecting the tank shall conform to state-of-the-art quality techniques. Welds shall be in accordance with an applicable industrial standard for structural welding (e.g., AWS D1.1, AWS D15.1 or EN15085 for steel).

Related APTA standards

APTA PR-CS-RP-003-98, “Developing a Clearance Diagram for Passenger Equipment”
APTA PR-CS-S-034-99, “Design and Construction of Passenger Railroad Rolling Stock”

References

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

49 CFR Part 229, FRA rail clearance, venting and other requirements applied to “locomotives” AAR Report WP-161, Locomotive Fuel Tank Integrity Study, February 1994.

49 CFR Appendix D to Part 238, Requirements for External Fuel Tanks on Tier I Locomotives

AAR S-5506, Performance Requirements for Diesel Electric Locomotive Fuel Tanks, 2001.

AWS D1.1, Structural Welding Code – Steel, 2020/01/01.

AWS D15.1, Railroad Welding Specification - Car and Locomotives, 2021/01/01.

American Railway Engineering and Maintenance-of-Way Association (AREMA), Manual for Railway Engineering (MRE), Chapter 4: Rail, 2020.

ASTM Standard A370-24, “Standard Test Methods and Definitions for Mechanical Testing of Steel Products”, ASTM International, West Conshohocken, PA, 2024.

ASTM E8/E8M , “Standard Test Methods for Tension Testing of Metallic Materials”, ASTM International, West Conshohocken, PA, 2024.

EN15085, Welding of Railway Vehicles and Components.

Federal Register: Sept. 23, 1997 (Volume 62, Number 184), Passenger Equipment Safety Standards; Proposed Rule, pp. 49727-49824 NFPA 130, Fixed Guideway Transit Systems, 1997.

NTSB Report NTSB/SS-92-04, PB92-917009, Locomotive Fuel Tank Integrity - Safety Study, 1991.

NTSB/RAR-97/02), Collision and Derailment of Maryland Rail Commuter MARC Train 286 and National Railroad Passenger Corporation Amtrak Train 29, near Silver Spring, Maryland, on Feb. 16, 1996. Corresponding letter of recommendation to industry, dated Aug. 28, 1997.

US DOT FRA, Locomotive Crashworthiness and Cab Working Conditions, Report to Congress, September 1996.

Definitions

internal tanks: Fuel tanks that are incorporated into the vehicle structure in such a way that the tank would not be directly impacted in the crash scenarios defined in this document without first impacting the vehicle structure.

ultimate material capacity: The maximum allowable stress or strain corresponding to ultimate tensile strength as determined using the standard ASTM E8/E8M, "Standard Test Methods for Tension Testing of Metallic Materials," and ASTM A370, "Standard Test Methods and Definitions for Mechanical Testing of Steel Products," for base material, and AWS D1.1 for weldment.

compartmentalization: use of multiple fuel storage compartments within a tank.

Abbreviations and acronyms

AREMA American Railway Engineering and Maintenance-of-Way Association
ASTM formerly the American Society for Testing and Materials
AW0 Empty car weight without any passenger loading
AWS American Welding Society
CFR Code of Federal Regulations
DMU Diesel multiple unit
DOT Department of Transportation
FEA finite element analysis
NTSB National Transportation Safety Board

Document history

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First published	—	—	—	—	Oct. 14, 1998
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Second revision	—	—	—	—	March 22, 2004
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Appendix A: Impactor geometry

AREMA136REscaled2inHead.zip

StraightSides2inHead.zip

Appendix B (informative): Background and historical information

Background

Fuel tanks on passenger motive power equipment can introduce a challenging fuel load in rail incidents where a compromise of the containment tank(s) is followed by fuel combustion. Passenger-related incidents involving fuel fires, while often at the focus of attention when they occur, are few. More common is the occurrence of adverse environmental impact associated with fuel spills or leaks. Adding to the risk of tank failure is the typical underframe location of fuel tanks, where they lie exposed to damage from side-on collision, roadbed debris and derailments.

Key to the development of a motive power fuel tank configuration is a thorough and validated risk assessment by the cognizant passenger rail authority. This is critical in deriving fact-based, value-added performance specifications, and ensuring prudent validation of applied designs.

The industry has continued to effect positive, productive design enhancements to tank structures, in light of residual fuel spill and fire risks. In conjunction with the Association of American Railroads, manufacturers collectively developed and adopted specifications for freight locomotive fuel tanks. The AAR specifications were generated to increase fuel tank integrity during those situations, identified by study, that contribute to the majority of incidents.

Differences in passenger motive power configurations often require selective application of these guidelines to achieve a safe practical design. In some cases, alternative designs and technologies may provide the better fuel containment solution, and must be given practical consideration.

Motive power, new or altered, requires that system clearance specifications (e.g., system profiles or plates) be systematically identified, and validated, before revenue service. This should occur in accordance with APTA PR-CS-RP-003-98, “Developing a Clearance Diagram for Passenger Equipment.”

Historical information

Flammable fossil fuels required for diesel-electric motive power operation instill risk. The National Transportation Safety Board identified and published some of these concerns after reviewing 29 predominately freight rail accidents investigated during 1991. Collectively, these incidents resulted in 83 locomotive derailments, 55 definitive fuel tank breaches, 43 fuel loss incidents and 25 associated fires. The NTSB, as a result of the study, recommended that industry research the integrity of fuel tanks, and apply standards accordingly.

The AAR responded with a study of its own.[2] This study spanned three years and involved 221 fuel spill incident reports to FRA from 1991 to 1993. The distribution of fuel tank spills showed that roughly 50% of the spills involved less than 1200 gallons of fuel. The conclusion was that fuel spills were not endemic, resultant fires were rare, and the need for additional research was questionable. The validity of the study was deemed indeterminate by the FRA due to the shortcomings of the existing accident reporting criteria.

In response, the rail industry “raised the bar” on fuel tank integrity, with the issuance of an AAR performance standard. The issue of new fuel tank integrity on freight locomotives stabilized when NTSB gave formal closure to open fuel tank integrity recommendations. This acknowledgment was appended with an NTSB

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letter to the rail industry, refreshing an appeal for crash or simulated testing and evaluation of recent incidents, as follows:

> Consideration should be given to crash or simulated testing and evaluation of recent and proposed design modifications to the locomotive fuel tank, including increasing the structural strength of end and side wall plates, raising the tank higher above the rail, and using internal tank bladders and foam inserts. (Class II, Priority Action) (R-92-10)

The recommendation came on the heels of NTSB findings associated with the collision and derailment of MARC Train 286, and AMTRAK Train 29, near Silver Spring, Maryland, on February 16, 1996. During the first quarter of 1996, an unanticipated rise in passenger rail incidents further sensitized the nation to the potential for collisions involving diesel electric freight trains, and passenger transportation sharing common infrastructure.

Fuel tank integrity during an accident often depends on complex, multivariant, unique, dynamic structural loading scenarios. Add to that the vast number of possible fuel tank collision permutations and combinations, and the cognizant authority ultimately faces a true challenge. In the final analysis, a prudent, fact-based level of residual risk must be determined. As such, it must recognize an unqualified range of incident velocities, resultant loads and other contributing factors. This is in keeping with the recently released proposed rule on Passenger Rail Equipment Safety Standards—specifically the systems safety and fire safety planning elements.

The task to develop fuel tank performance specification required a thorough degree of incident research and focused attention on practical improvement. Again, a fuel tank integrity standard for passenger rail equipment will not provide for all contingencies, being effectively value-added enhancement of current, recognized standards applied to other transportation systems.