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CAN/CGSB-43.147-2023

Supersedes CAN/CGSB-43.147-2005

Containers for transport of dangerous goods by rail

Canadian General Standards Board CGSB

Canada

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NATIONAL STANDARD OF CANADA **CAN/CGSB-43.147-2023**

Supersedes CAN/CGSB-43.147-2005

Containers for transport of dangerous goods by rail

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Preface

This National Standard of Canada CAN/CGSB-43.147-2023 supersedes the 2005 edition published in December 2005, Corrigendum 1 published in January 2007 and Amendment 1 published in July 2008.

Changes since the previous edition

- Transport Canada standard TP 14877 replaced CAN/CGSB-43.147 in 2013.
- This new edition of CAN/CGSB-43.147 now replaces TP 14877.
- All technical references to ton containers have been omitted from this new edition of CAN/CGSB-43.147.

The following definitions apply in understanding how to implement this National Standard of Canada:

- "shall" indicates a **requirement**;
- "should" indicates a **recommendation**;
- "may" is used to indicate that something is **permitted**;
- "can" is used to indicate that something is **possible**, for example, that an organization is able to do something.

Notes accompanying clauses do not include requirements or alternative requirements. The purpose of a note accompanying a clause is to separate explanatory or informative material from the text. Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

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Introduction

This edition of CAN/CGSB-43.147, *Containers for transport of dangerous goods by rail* supersedes the previous edition published in 2005.

The standard was updated in order to maintain consistency with and to incorporate language from other Canadian General Standards Board (CGSB) and Transport Canada (TC) publications that pertain to the *Transportation of Dangerous Goods Regulations* (TDG Regulations). This was done in order to facilitate compatibility with the other TDG standards referenced in the TDG Regulations.

This standard is intended for incorporation by reference into the TDG Regulations. Where there are differences between the requirements of the TDG Regulations and this standard, the TDG Regulations prevail, unless specified otherwise, to the extent of the difference. Until the Regulations are amended to adopt this edition of the standard, an earlier edition may be the one legally in effect in Canada.

The standard sets out requirements for:

- the design, manufacture, maintenance, qualification, inspection and marking of tank cars;
- the selection and use of tank cars and other large means of containment or transport units used in the handling, offering for transport or transporting of dangerous goods by rail of classes 2, 3, 4, 5, 8, 9 and division 6.1;
- the quality management system and its applicability; and
- the registration applicable to facilities performing manufacture, inspection, maintenance or qualification of tank cars.

The CGSB Committee on Containers for Transport of Dangerous Goods by Rail is comprised of members having responsibility and expertise in the design, manufacture, maintenance, qualification and inspection of tank cars and the selection and use of large means of containment or transport units used in the handling, offering for transport or transporting of dangerous goods by rail of classes 2, 3, 4, 5, 8, 9 and division 6.1. The Committee considers this standard, developed by consensus, to be practical, current with respect to technology and industry practices, useful and acceptable to all interested parties.

It is the intent of the CGSB Committee to maintain this standard in a manner that meets the needs of Canada.

This standard was prepared by the CGSB Committee on Containers for Transport of Dangerous Goods by Rail and has been formally approved by the Committee.

Containers for transport of dangerous goods by rail

1 Scope

1.1 Organization and content

This standard applies to the design, manufacture, maintenance, qualification, inspection and marking of tank cars and the selection and use of large means of containment or transport units used in the handling, offering for transport or transporting of dangerous goods by rail of classes 2, 3, 4, 5, 8, 9 and division 6.1. This standard does not apply to large means of containment that are used exclusively for non-dangerous goods.

This standard consists of eight main sets of requirements and five annexes.

Sections 1 through 3 specify the general scope, normative references and terms and definitions.

Section 4 sets out general requirements and defines the applicability of the standard and the precedence of each section.

Section 5 sets out the quality management system requirements and its applicability.

Section 6 outlines the registration requirements applicable to facilities performing manufacture, inspection, maintenance or qualification of tank cars.

Sections 7 and 8 set out tank car marking requirements and tank car manufacturer and modification requirements.

Section 9 sets out the requirements for the periodic qualification and maintenance of tank cars.

Section 10 covers the selection and use requirements for containers.

Section 11 provides some allowances for one time low risk movement of non-conforming containers.

Annexes A and B (normative) specify procedures and set out acceptance criteria for the side and head impact test for TC 117P tank cars.

Annex C (normative) specifies a procedure to test tank car head puncture resistance systems.

Annex D (normative) specifies test procedures and sets out acceptance criteria for simulated pool-fire and torch-fire.

Annex E (normative) sets out, in schedule 1, the requirements applicable to special provisions 1 to 81, and in schedule 2, lists dangerous goods and specifies the special provisions that are applicable to each of the listed dangerous goods.

1.2 Minimum requirements

This standard sets out certain minimum requirements regarding the design, manufacture, qualification, selection and use, or testing of containers. It is essential to exercise competent technical, engineering and safety judgment in conjunction with this standard.

1.3 Additional requirements

1.3.1 Conflict

The *Transportation of Dangerous Goods Act, 1992* (TDG Act) and the *Transportation of Dangerous Goods Regulations* (TDG Regulations) may set out additional requirements regarding the design, construction, qualification, selection, and use, or testing of containers. Where there is an inconsistency between the requirements of this standard and those of the TDG Act or TDG Regulations, the TDG Act or TDG Regulations prevail to the extent of the inconsistency. It is recommended to read the standard in conjunction with the TDG Regulations.

1.3.2 Safety

The testing and evaluation of a product against this standard may require the use of materials and/or equipment that could be hazardous. This standard does not purport to address all the safety aspects associated with its use. Anyone using this standard has the responsibility to consult the appropriate authorities and to establish appropriate health and safety practices in conjunction with any applicable regulatory requirements prior to its use.

1.3.3 Units of measurement

Quantities and dimensions used in this standard are provided in units from the International System of Units (SI units). Imperial equivalents may be shown in brackets, as applicable.

2 Normative references

The following documents contain provisions that, through reference in this text, constitute provisions of this National Standard of Canada. The referenced documents may be obtained from the sources noted below.

Note: The contact information provided below was valid at the date of publication of this standard.

An undated reference is to the latest edition or revision of the reference or document in question, unless otherwise specified by the authority applying this standard. A dated reference is to the specified revision or edition of the reference or document in question.

Where there is an inconsistency between the requirements of this standard and those of the referenced documents, the requirements of the standard prevail to the extent of the inconsistency.

2.1 American Petroleum Institute (API)

MPMS 9.1 — *Manual of Petroleum Measurement Standards Chapter 9.1 Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method (ASTM D1298)*

MPMS 9.3 — *Manual of Petroleum Measurement Standards Chapter 9.3 Standard Test Method for Density, Relative Density, and API Gravity of Crude Petroleum and Liquid Petroleum Products by Thermohydrometer Method (ASTM D6822)*

2.1.1 Contact information

The above may be obtained from the API. Telephone: 202-682-8000. Web site: https://www.api.org/products-and-services/standards.

2.2 American Welding Society (AWS)

AWS D15.1:2019 — *Railroad Welding Specification for Cars and Locomotives*

2.2.1 Contact information

The above may be obtained from the AWS Bookstore, Customer Service. Telephone: 305-443-9353 ext. 280 or 1-888-WELDING. Fax: 305-443-1552. E-mail: customerservice@aws.org. Web site: www.pubs.aws.org/t/Publications.

2.3 Association of American Railroads (AAR)

AAR Open Top Loading Rules Manual of Standards, August 26, 2020

Field Manual of the AAR Interchange Rules, July 1, 2020

Manual of Standards and Recommended Practices

Section C, Car Construction — Fundamentals and Details
Issue of 2020
Standard S-286 — *Free/Unrestricted Interchange for 286,000 lb Gross Rail Load Cars*

Section C, Part II
Issue of 2015
M-1001 — *Design, Fabrication, and Construction of Freight Cars*

Section C, Part III
Issue of November 2014, as amended from time to time by applicable Causality Prevention Circulars
M-1002 — *Specifications for Tank Cars*

2.3.1 Contact information

The above may be obtained from MxV Rail (formerly the Transportation Technology Centre Inc. (TTCI)), Publications Department. Telephone: 1-877-999-8824. Web site: www.aar.org.

2.4 American Society of Mechanical Engineers (ASME)

Boiler and Pressure Vessel Code (2019), Section VIII, Division 1 – *Rules for Construction of Pressure Vessels*

ASME B1.20.1 - 2013(R2018) — *Pipe Threads, General Purpose, Inch*

2.4.1 Contact information

The above may be obtained from the American Society of Mechanical Engineers, Information Central, Orders/Inquiries. Telephone: 1-800-843-2763. Fax: 973-882-1717. Web site: www.asme.org.

2.5 ASTM International

ASTM A20/A20M-15 — *Standard Specification for General Requirements for Steel Plates for Pressure Vessels*

ASTM A240/A240M-15b — *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications*

ASTM A262-15 — *Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels*

ASTM A302/A302M-12 — *Standard Specifications for Pressure Vessel Plates, Alloy Steel, Manganese-Molybdenum and Manganese-Molybdenum-Nickel*

ASTM A370-15 — *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A515/A515M-10(2015) — *Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service*

ASTM A516/A516M-10(2015) — *Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service*

ASTM A537/A537M-13 — *Standard Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel*

ASTM A1011/A1011M-13 — *Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength*

ASTM B162-99(2014) — *Standard Specification for Nickel Plate, Sheet, and Strip*

ASTM B209-14 — *Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate*

ASTM B209M-14 — *Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)* (Withdrawn 2021)

ASTM D287-12b(2019) — *Standard Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method)*

ASTM D4052-18 — *Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter*

ASTM D5002-19 — *Standard Test Method for Density, Relative Density, and API Gravity of Crude Oils by Digital Density Analyzer*

ASTM D7042-21A — *Standard Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)*

ASTM D7777-13(2018)e1 — *Standard Test Method for Density, Relative Density, or API Gravity of Liquid Petroleum by Portable Digital Density Meter*

2.5.1 Contact information

The above may be obtained from the ASTM International. Telephone: 610-832-9585. Fax: 610-832-9555. Web site: www.astm.org. They can also be obtained from IHS Global Canada Ltd. Telephone: 613-237-4250 or 1-800-854-8220. Fax: 613-237-4251. Web site: www.global.ihs.org.

2.6 Canadian Standards Association (CSA)

CSA B621:20 — *Selection and use of highway tanks, TC portable tanks, and other large containers for the transportation of dangerous goods, Classes 3, 4, 5, 6.1, 8, and 9*

CSA B622:20 — *Selection and use of highway tanks and TC portable tanks for the transportation of dangerous goods, Class 2*

2.6.1 Contact information

The above may be obtained from CSA Group, Standards Sales. Telephone: 416-747-4000 or 1-800-463-6727. Fax: 416-747-2473. E-mail: sales@csagroup.org. Web site: https://www.csagroup.org/store/.

2.7 The Sulphur Institute (TSI)

Issue of November 18, 2010 — *Molten Sulphur Rail Tank Car Guidance*

2.7.1 Contact information

The above may be obtained from The Sulphur Institute. Telephone: 202-331-9660. Fax: 202-293-2940. E-mail: sulphur@sulphurinstitute.org. Web site: www.sulphurinstitute.org.

2.8 Transport Canada (TC)

Canadian Rail Operating Rules, issue of April 24, 2020

Transportation of Dangerous Goods Act, 1992 (S.C. 1992, c. 34), including amendments

Transportation of Dangerous Goods Regulations (SOR/2001-286), including amendments

2.8.1 Contact information

The *Canadian Rail Operating Rules* may be obtained from Transport Canada Web site: https://tc.canada.ca/. The *Transportation of Dangerous Goods Act* and the *Transportation of Dangerous Goods Regulations* may be obtained from Justice Canada Web site: https://laws.justice.gc.ca/eng/. The above may also be obtained from the Publishing and Depository Services, Public Services and Procurement Canada. Telephone: 613-941-5995 or 1-800-635-7943. Fax: 613-954-5779 or 1-800-565-7757. E-mail: publications@tpsgc-pwgsc.gc.ca. Web site: https://publications.gc.ca/.

2.9 U.S. Department of Transportation (DOT)

49 CFR - Parts 171 to 180 of Title 49 of the *Code of Federal Regulations of the United States*

2.9.1 Contact information

The above may be obtained from U.S. Department of Transportation. Telephone: 202-366-4000. Web site: www.phmsa.dot.gov/hazmat.

3 Terms and definitions

In addition to the definitions, terms and abbreviations given in the *Transportation of Dangerous Goods Act* and *Regulations*, the following definitions and abbreviations apply in this standard.

AAR
Association of American Railroads. *(AAR)*

AAR Executive Director
Executive Director, Tank Car Safety, Association of American Railroads. *(directeur général de l'AAR)*

AAR Tank Car Committee
standing committee within the AAR Safety and Operations Department that is responsible for development and publication of interchange standards for the design, construction, maintenance, and safe operation of all tank cars used in interchange for rail transport of commodities in North America. *(comité des wagons-citernes de l'AAR)*

AFFTAC
Analysis of Fire Effects on Tank Cars computer program that is proprietary to the RSI-AAR Tank Car Safety Research & Test Project. *(AFFTAC)*

alteration
change in a tank car or service equipment that does not change the specification but that changes the certificate of construction. *(transformation)*

assembler
an entity that constructs a tank car without welding on the tank car tank. *(assembleur)*

bottom shell
portion of a tank car tank surface, excluding the heads, which lies within 610 mm (24 in.) of the bottom longitudinal centreline of the tank car tank when measured circumferentially. *(coque inférieure)*

certificate of construction
a document certifying that the tank car and/or service equipment conform to the requirements of 4.1. *(certificat de construction)*

check valve
valve that automatically closes to stop the flow of liquid or vapor in one direction. *(soupape antiretour)*

class
general designation usually including several tank car specifications. The word class is used when the designation embraces several specifications. For example the numerals 111 and 112 are classes. *(classe)*

closure
device that closes an opening into a container, or an auxiliary device that closes an outlet or inlet connection on a valve or fitting, including pipe plugs, quick disconnect caps, blind flanges, manway covers, outlet caps, eduction pipe caps, and fill hole covers. *(fermeture)*

compliance mark
compliance mark as defined in the TDG Act. *(indication de conformité)*

condensate
a dangerous good that is a hydrocarbon mixture, sourced from liquid recovery units of natural gas production, gas plant, crude oil vapour treatment units and other plant and refinery operations and that is commonly blended with bitumen or heavy crude oil for use as a diluent to control viscosity and density for the purpose of transport. *(condensat)*

container
large means of containment as defined in the TDG Regulations. *(contenant)*

conversion
change in a tank car that changes its specification. *(conversion)*

crude oil
dangerous goods products or substances, or a blend of products or substances, that are produced at a well-head in liquid form or any other hydrocarbons, except coal and natural gas, including hydrocarbons that may be extracted or recovered from surface or subsurface deposits, including deposits of oil sand, bitumen, bituminous sand, oil shale and other types of deposits on the surface or subsurface of the seabed or its subsoil, but does not include a product or a blend of products that are exclusively refined petroleum products. *(pétrole brut)*

cryogenic liquid
refrigerated liquefied gas that is handled or transported at a temperature equal to or less than -100 °C (-148 °F). *(liquide cryogène)*

CTC
Canadian Transport Commission, the predecessor of TC. *(CCT)*

dangerous goods
dangerous goods as defined in the TDG Act, and includes dangerous goods listed in schedule 2 of Annex E. *(marchandises dangereuses)*

dangerous goods toxic by inhalation
for the purpose of tank car selection, any one of the following:

a) a liquid, other than a mist, meeting the criteria in the TDG Regulations for division 6.1, packing group I, because of its inhalation toxicity, whether having the classification of division 6.1 or not, and assigned to hazard zone A or B in accordance with 10.5.2;

b) a division 2.3 gas assigned to hazard zone A, B, C, or D in accordance with 10.5.2; or

c) any dangerous goods identified as an inhalation hazard by a special provision of schedule 1 in Annex E.

Note: Toxic by inhalation (TIH) is synonymous with poisonous by inhalation (PIH). *(marchandises dangereuses toxiques à l'inhalation*)

DOT
United States Department of Transportation. *(DOT)*

elevated temperature dangerous goods
dangerous goods that, when offered for transport or transported:

a) are in a liquid phase and at a temperature equal to or greater than 100 °C (212 °F);

b) are in a liquid phase with a flash point equal to or greater than 37.8 °C (100 °F) and that are intentionally heated to a temperature equal to or greater than its flash point; or

c) are in a solid phase and at a temperature equal to or greater than 240 °C (464 °F). *(marchandises dangereuses à température élevée)*

enhanced class 111 tank car
a tank car that complies with the requirements of 8.3.24.1 or 8.3.24.2.

Note: An enhanced class 111 tank car is also known as a CPC 1232 tank car. *(wagon-citerne renforcé de classe 111)*

excess-flow valve
device that closes automatically against the outward flow of fluid in the event that the flow rate through the device reaches a set value. *(limiteur de débit)*

fatigue life
the period in which a number of applications of a given stress can be subjected to a component before a crack is detected by the unaided eye with or without an eyeglass or contact lens. *(durée de vie en fatigue)*

filling density
percent ratio of the mass of the dangerous goods in a tank to the mass of water that the tank will hold at 15.6 °C (60 °F).

For cryogenic liquids, the percent ratio of the mass of the dangerous goods in the tank to the mass of water that the tank will hold at the design service temperature.

For the purpose of determining the water capacity of the tank, the mass of 1 L of water at 15.6 °C (60 °F) is 0.999007 kg (the mass of 1 US gallon of water is 8.33712 lb). *(densité de remplissage)*

grounding
process of connecting one or more objects to earth in order to minimize differences of electrical potential between objects and the ground. *(mise à la terre)*

hazard zone
one of four levels of hazard, hazard zones A through D, assigned to gases that are toxic by inhalation, as specified in 10.5.2. A hazard zone is based on the LC_{50} value for acute inhalation toxicity of gases and vapours.

Note: Refer to the TDG Regulations for the definition of LC_{50}. *(zone de risque)*

insulation
material surrounding the tank, other than a jacket, that forms part of an insulation system. *(calorifugeage)*

insulation system
a safety system that reduces the overall thermal conductance of the tank under normal conditions of transport. *(système de calorifugeage)*

interior heater system
piping system within a tank that uses a fluid medium to heat the dangerous goods. *(système de chauffage intérieur)*

lining or coating owner
party financially responsible for the maintenance of the lining or coating. *(propriétaire du revêtement ou de la doublure)*

liquid dangerous goods
dangerous goods that are in liquid or slurry form, including dangerous goods that are under a liquid blanket, at any time during their handling, offering for transport, or transport. *(marchandises dangereuses liquides)*

maintenance
upkeep or preservation of a container or any of its components, including repairs. *(entretien)*

manufacture
to produce a tank car capable of rolling on its own wheels, operational service equipment, or other containers. *(fabrication)*

marking
application by stenciling or stamping of symbols or words required by this standard. *(marquage)*

material compatible with the dangerous goods
material that does not react physically or chemically with the dangerous goods in a way that under normal conditions of handling or transportation would cause a condition or release of dangerous goods that could endanger public safety, including corrosion, environmental stress cracking, solvation, fusion or chemical or physical reaction with the dangerous goods. *(matériau compatible avec les marchandises dangereuses)*

modification
any deviation in the currently allowed configuration of a tank car from that described in the certificate of construction. *(modification)*

national pipe taper (NPT)
tapered pipe thread that conforms to ASME B1.20.1. *(filetage conique américain (NPT))*

non-destructive examination (NDE)
see definition for “non-destructive inspection and testing”. *(examen non destructif (END))*

non-destructive inspection and testing (NDT)
process that involves the inspection, testing, or evaluation of materials, components, or assemblies for discontinuities, properties, and/or other flaws without impairing or destroying the parts' serviceability. *(inspection et essai non destructifs)*

nozzle
sub-assembly of a tank consisting of a pipe or tubular section with or without a flange on one end. *(manchon)*

one million mile fatigue life
components of a tank car that are designed and built to reach one million miles of service before reaching their fatigue life. *(durée de vie en fatigue d'un million de milles)*

outage
for a tank containing a liquid, the volumetric fraction of the tank in the vapour space, expressed as a percentage. *(creux)*

padding
inert gas deliberately introduced into the vapour space of a tank in order to make the vapour space gas mixture non-flammable or moisture-free. *(gaz de remplissage)*

ppm
parts per million. *(ppm)*

pressure-relief device
device that is designed to prevent the rise of internal pressure in excess of a specified value, including a reclosing pressure-relief device, a non-reclosing pressure-relief device, or reclosing and non-reclosing pressure-relief devices in combination. *(dispositif de décharge de pression)*

pressure tank car tank
tank car tank conforming to any specification within classes 105, 112, 114 or 120. *(citerne de wagon-citerne sous pression)*

primary closure
first closure after the tank that closes the flow of liquid or vapor. *(fermeture primaire)*

psi
pound-force per square inch. *(lb/po^2)*

qualification
careful and critical examination of an item, including a container, based on a written program, to verify that the item conforms to a standard, followed by a representation that the item conforms to that standard. *(qualification)*

refined petroleum products
dangerous goods that are:

a) gasoline-type fuels for use in internal combustion engines;

b) refined product for use as a component in the blending of gasoline-type fuels referred to in paragraph a);

c) middle distillates, including the products commercially known as kerosene, solvents, stove oil, diesel fuel, furnace oil, diesel oil, gas oil, distillate heating oil, engine distillates and nos. 1, 2, and 3 fuel oils; or

d) heavy fuel oils, including nos. 4, 5 and 6 fuel oils, bunker "C" oil, "C" grade oil, residual fuel oil, heavy bunker oil, intermediate and thin bunker fuels and any blend of heavy fuel oils. *(produits pétroliers raffinés)*

reinforcing plate
metal plate attached directly to a tank by welding, supporting structural components for the purpose of preventing damage to the tank through fatigue, overstressing, denting, puncturing, or tearing. *(plaque de renfort)*

release
includes discharge, emission, explosion, or other escape of dangerous goods, or any component or compound evolving from dangerous goods. *(rejet)*

reliability
quantified ability of a device or structure to be used in a known environment without failure for a specified period. *(fiabilité)*

repair
remanufacture or restoration of a container or any of its components to its original function. *(réparation)*

replace in-kind
replacement with the same manufacturer, model, size and capacity. *(remplacement en nature)*

representation
certification, in writing or in electronic format on a document or by marking the container, that the container conforms to the requirements set out in this standard. *(attestation)*

RSI
Railway Supply Institute. *(RSI)*

safety system
devices that equip some tank cars, including a tank-head puncture-resistance system, a coupler vertical restraint system, a system used to protect discontinuities including skid protection and protective housings, a thermal protection system, and an insulation system conforming to 8.3.19 or to a special provision of schedule 1, that is used to control pressure or outage. *(système de sécurité)*

SCFM
volumetric flow rate of a gas expressed in standard cubic feet per minute, where the standard temperature is 15.6 °C (60 °F) and the standard pressure is 101.3 kPa (14.7 psia). *(pi^3/min standard)*

secondary closure
first closure downstream from the primary closure that closes the flow of liquid or vapor if the primary closure would be normally operated. *(fermeture secondaire)*

service equipment
devices attached to and forming part of a container and that are necessary for the purpose of filling, loading, unloading, venting, pressure relief, vacuum relief, heating from within the tank, sampling, and measuring. Such devices include fittings, vacuum and pressure-relief devices, valves, pressure-relief valves, excess-flow valves, and closures. *(matériel de service)*

service equipment owner
party financially responsible for the maintenance of the service equipment. *(propriétaire du matériel de service)*

solid dangerous goods
dangerous goods which are in solid, granular, crystalline, or powder form during handling, offering for transport, or transport. *(marchandises dangereuses solides)*

specification
specific designation within a class. For example the designation 111A100W2 is a specification. *(spécification)*

spring-loaded check valve (mechanically operated)
spring loaded check valve located below the pressure plate that can be manually disengaged. *(soupape antiretour à ressort (à manœuvre mécanique))*

stamping
marking method that removes or displaces material leaving a permanent imprint on the surface to be marked. *(estampage)*

stencilling
marking method using paint or decal. *(marquage au pochoir)*

stub sill
longitudinal structural member at the ends of a tank car designed to accommodate the coupler and draft gear, and to transmit coupler forces to the tank car tank or outer shell on tank cars without continuous centre sills. *(longrine centrale courte)*

tank
closed container consisting of a shell, heads, reinforcing plates, nozzles, reinforcements, or other components welded directly to the shell, excluding external reinforcing pads and internal attachment pads. *(citerne)*

tank car
railway vehicle, other than a hopper car, to which a tank, other than a fuel tank that is required for the purpose of supplying fuel for propulsion of the railway vehicle, is permanently attached. *(wagon-citerne)*

tank car facility
a) Subject to b), an entity that is engaged in manufacturing, repairing, inspecting, testing, qualifying, maintaining, marking, or modifying a tank car or service equipment including entities that:

    1) install, qualify, or repair interior linings and coatings in tank cars when such linings and coatings are intended to protect the tank car tank against the corrosive action of the dangerous goods; or

    2) remove and replace tank car service equipment or change gaskets, including replacing pressure seals/O-rings on vacuum or pressure-relief devices, eduction pipe removal and replacement or eduction pipe gasket removal and replacement.

b) An entity that only performs one or more of the following operations is not a tank car facility:

    1) replace in-kind:

        i) rupture disks and/or rupture disk gaskets in safety vents;

        ii) bottom outlet valve caps;

        iii) hinged manway cover gaskets and/or fill-hole cover gaskets;

        iv) bottom outlet cap gaskets or quick disconnect dust cap gaskets;

        v) magnetic gauging device rods;

        vi) O-rings in gauging device caps;

        vii) O-rings in thermometer well housing tubes;

        viii) secondary plugs, chains and flanges external to valves;

ix) defective eyebolts on tank cars with hinged manway covers;

x) surge protectors and/or surge protector gaskets on tanks where the surge protector is located outside the tank; or

xi) any closures, fittings, and valves that are not primary;

2) remove and replace eduction pipe caps or eduction pipe blind flange gasket as part of loading/unloading operations or limited maintenance;

3) replace breather vent filters on tank cars used in the handling, offering for transport or transporting of hydrogen peroxide or sodium chlorite solution;

4) examinations prior to shipping pursuant to 10.7, 10.8 and 10.9;

5) conductivity or resistivity examinations of tank car interior linings and interior coatings prior to shipping;

6) replacement or repair of any markings or stencils;

7) double shelf coupler replacement (i.e., coupler vertical restraint system) in accordance with the Field Manual of the AAR Interchange Rules;

8) manufacture of O-rings, gaskets, eye-bolts, washers, and threaded fasteners;

9) repair of attachments to jacket pads;

Note: See Field Manual of the AAR Interchange Rules, Rule 81.

10) repair of draft lugs, striker, draft key slot, and coupler carrier;

Note: See Field Manual of the AAR Interchange Rules, Rule 81.

11) assembly or manufacture of closures or fittings. *(installation pour wagons-citernes)*

tank car owner
person identified in the Umler® Equipment Management Information System of the AAR as the owner of the tank car. *(propriétaire de wagon-citerne)*

tank car tank
tank that is intended for attachment to a railway vehicle to form a tank car, but does not include

a) a device that is service equipment; or

b) any other equipped device, for example jacket, unless the specification requires that it forms part of the tank car tank. *(citerne de wagon-citerne)*

TC
Transport Canada. *(TC)*

TC Director
Executive Director, Regulatory Frameworks and International Engagement, Regulatory Affairs Branch, Transportation of Dangerous Goods Directorate, Transport Canada. *(directeur de TC)*

TDG Act
Transportation of Dangerous Goods Act, 1992, as amended from time to time. *(LTMD)*

TDG Regulations
Transportation of Dangerous Goods Regulations, as amended from time to time. *(RTDG)*

thermal protection system (TPS)
a safety system that complies with the requirements of 8.2.7. *(système de protection thermique (SPT))*

top shell
surface of a tank car tank, excluding the heads and bottom shell. *(coque supérieure)*

working pressure
the working pressure of a tank is the sum of the static head, padding pressure, and the dangerous goods vapour pressure at the following reference temperatures:

a) 46.1 °C (115 °F) for a non-insulated tank;

b) 43.3 °C (110 °F) for an insulated tank or tank having a thermal protection system incorporating a metal jacket that provides at 15.6 °C (60 °F) an overall thermal conductance of less than or equal to 10.22 kJ/h·m^{2}·°C (0.5 Btu/h·ft.^{2}·°F); or

c) 40.6 °C (105 °F) for an insulated tank when the overall thermal conductance is equal to or less than 1.533 kJ/h·m^{2}·°C (0.075 Btu/h·ft.^{2}·°F). *(pression de service)*

4 General requirements

4.1 Application

The requirements set out in this standard apply to containers that are used or may be used in the handling, offering for transport, or transporting of dangerous goods by rail in Canada. These requirements do not apply to containers that are used exclusively for commodities that are not dangerous goods. The containers shall conform to:

a) requirements of the TDG Act, the TDG Regulations, the requirements of this standard, and the requirements of the DOT and the AAR that are specified in this standard, including manufacture, qualification, maintenance, and selection and use; and

b) unless otherwise specified in this standard, the requirements for manufacture set out in the specifications of the containers that were in effect at the time of manufacture and the requirements for maintenance that were in effect during and after manufacture of the containers.

Note: Refer to the *Transportation of Dangerous Goods by Rail Security Regulations* for security requirements that apply to the handling and transporting of dangerous goods by rail in Canada.

4.2 Continued use

4.2.1 Qualification and maintenance of tank cars

Subject to 4.1, a tank car that is or may be used in the handling, offering for transport, or transporting of dangerous goods shall conform to the requirements for qualification and maintenance set out in section 9 of this standard.

4.3 Equivalency

If the requirements for selection and use set out in this standard permit a tank car with a given class or specification to contain dangerous goods, a TC, a CTC, or a DOT tank car equivalent to the given class or specification may be used.

4.4 Other containers

Unless otherwise specified in this standard, TC portable tanks of specifications 11, 44, 51 or 60 conforming to the requirements of CSA B621 or B622 may be used in the handling, offering for transport, or transporting of dangerous goods by rail.

4.5 Classification

Dangerous goods shall be classified in accordance with Part 2 of the TDG Regulations and the appropriate shipping name, UN number, classification, division, and packing group, as applicable, shall be assigned.

4.6 Schedule 1 and special provisions

In addition to the other requirements of this standard, when there is a special provision of schedule 1 in Annex E for dangerous goods, that special provision applies to the container and the handling, offering for transport, and transporting of the dangerous goods.

4.7 Schedule 2 and list of dangerous goods

In addition to the other requirements of this standard, schedule 2 in Annex E shall be used when determining the authorized containers and specific conditions applicable to the handling, offering for transport, or transporting of dangerous goods.

4.8 Conflict

If there is a conflict between a special provision of schedule 1 in Annex E and other provisions of this standard, the special provision applies. If there is a conflict between any requirement of this standard and a requirement in any of the referenced publications listed in section 2, the requirement of this standard applies.

4.9 Danger to public safety

4.9.1 Condition or release from a container that could endanger public safety

A container shall be designed, manufactured, qualified, loaded, unloaded, filled, secured, closed, and maintained so that, under normal conditions of transport, including handling and under all conditions of temperature, pressure and vibration that may be expected to occur, no condition or release of dangerous goods that could endanger public safety occurs or may reasonably be expected to occur.

4.9.2 Venting of containers

Subject to 4.9.1, venting of a container, in order to reduce internal pressure that may develop by the evolution of gas or vapour from the dangerous goods contained within the container, is permitted only when authorized for the specific dangerous goods by a special provision in Annex E or when authorized pressure-relief or pressure-regulating devices are operating as intended.

4.10 Closures

4.10.1 Compliance with specification

Unless otherwise specified in this standard, a closure on a container shall be designed, manufactured, qualified, maintained, secured, and closed so that the closure conforms to the requirements of the specification for the container.

4.10.2 Securing of closure

Subject to 4.9.2, a closure on a container shall be designed, manufactured, qualified, maintained, secured, and closed so that, under normal conditions of transport, including handling and all conditions of temperature, pressure and vibration that may be expected to occur, the closure remains secured and closed.

4.10.3 Closures for manways

4.10.3.1 Automatic pressure release

A hinged and bolted manway cover on a tank car shall be designed, manufactured, qualified, and maintained in a way that, in the process of opening the manway cover, pressure will be released automatically and no condition or release of dangerous goods that could endanger public safety occurs or may reasonably be expected to occur.

4.10.3.2 Manway below liquid level

A tank car used in the handling, offering for transport, or transporting of dangerous goods shall not be equipped with a manway located below the liquid level.

4.10.4 Gaskets

Gaskets shall be compatible with the tank car commodity service and service temperature and shall be suitable/durable for the location they are used on the tank car in an effort to minimize the risk of spillage due to a failed gasket. Except for temporary repairs of non-conforming containers, substances shall not be used in place of or in addition to the owner-specified gaskets to block the passage of fluids through the surface or joints or openings in materials.

4.11 Tank car integrity and continued use

4.11.1 Tank car

Subject to 4.11.2, a tank car shall conform to its original certificate of construction or subsequent approvals by the AAR Executive Director. A tank car is not in conformance if it has defects such as cracks or fractures in the tank car tank, external shell, continuous center sill or draft sill such that the tank car is no longer capable of withstanding the minimum loads, stresses and fatigue requirements specified by the AAR *Specifications for Tank Cars* and *Design, Fabrication, and Construction of Freight Cars* publications.

4.11.2 Excepted insulation

A tank car that has deteriorated insulation or jackets is not considered in non-conformance when an insulation system is not mandatory by the tank car specification and the tank car is equipped with safety relief devices, as required, for non-insulated tank cars.

5 Quality management system

5.1 Scope

For the purpose of this section, a quality management system means all of the planned and systematic actions taken by a tank car facility to provide adequate confidence that a tank car, service equipment, lining or coating conforms to the requirements set out in this standard and the TDG Regulations, including the requirements for design, manufacture, qualification, maintenance of tank cars and handling of dangerous goods.

5.2 Application

Each tank car facility shall have a quality management system that includes all of the elements and processes specified in 5.4.

5.3 General requirements

The quality management system shall be developed and established in accordance with the requirements of a standard or series of standards and shall be registered, approved, or certified by an organization independent of both Transport Canada and the tank car facility. The standard or series of standards shall be internationally recognized as being capable of meeting or exceeding the requirements of this section.

5.4 Specific elements and processes of the quality management system

5.4.1 Management commitment

The management of the tank car facility shall appoint a member of management who, irrespective of other responsibilities, shall have the authority and responsibility for overseeing the quality management system of the tank car facility, including:

a) ensuring the quality management system is established and maintained;

b) reporting to management on the performance of the quality management system; and

c) promoting awareness of the importance of the requirements of this standard and the TDG Regulations throughout the tank car facility.

5.4.2 Planning

A planning process for the products and services provided by the tank car facility for transforming the requirements of this standard and the TDG Regulations into quality objectives for each product or service shall be established and documented. The planning process shall include a means for determining:

a) processes and documentation and the level of detail required;

b) verification and validation activities;

c) records that are necessary to ensure compliance to the requirements of this standard and the Regulations; and

d) if the tank car facility has the ability to meet the determined requirements.

5.4.3 Human resources

A human resources management process shall be established and documented. This process shall:

a) determine competency needs for personnel affecting quality;

b) provide effective training to ensure competency of personnel;

c) create and maintain records of education, training, qualification, and certification, as required;

d) create and maintain awareness and importance of the quality management system to all employees; and

e) assign quality responsibilities to personnel on the basis of them meeting the respective competency needs.

5.4.4 Purchasing

A purchasing control process shall be set out to ensure purchased products and services conform to the requirements of this standard and the TDG Regulations. The purchasing control process shall include procedures for the evaluation and selection of suppliers.

5.4.5 Product realization

An operations control process for the products and services provided by the tank car facility shall be established and documented. The operation control process shall require:

a) provision of information to personnel that specifies the quality of the product or service;

b) provision of written procedures as determined by the quality planning process;

c) availability and good order of equipment used for the realization of products and services;

d) availability and accuracy of monitoring and measuring devices;

e) provision of written instructions to employees;

f) provision of a description of the manufacturing, repair, inspection, testing, and qualification or maintenance program including the acceptance criteria, so that the characteristics of the tank car, service equipment, lining or coating and the elements to inspect, examine, and test can be identified;

g) provision of procedures for non-destructive examinations for qualification authorized and evaluated by the owner to ensure the inspection and test technique employed, taking into account the accessibility of the area, has the capability of detecting a defect of the minimum rejectable size;

h) system for the maintenance of records, inspections, tests, and the interpretation of inspection and test results; and

i) qualification of personnel involved in performing any non-destructive inspections and tests in accordance with Appendix T of the AAR *Specifications for Tank Cars* publication.

5.4.6 Measurement, analysis and improvement

A measurement, analysis, and improvement process shall be established that allows a tank car facility to verify the compliance of the products and services provided to the requirements of this standard and the TDG Regulations, to determine and address the cause of any non-compliance, and if necessary to improve the quality management system. The measurement, analysis, and improvement processes shall address:

a) measurement and monitoring of processes;

b) evaluation and monitoring of products and services;

c) release and delivery of products and services, including post-delivery activities and maintenance of records;

d) control of non-compliant products and services;

e) determination and elimination of the causes of any non-compliance;

f) periodic internal audits to determine if the quality management system complies with the requirements of this standard and the TDG Regulations and has been effectively implemented and maintained; and

g) calibration of inspection and test equipment.

5.4.7 Other elements

Procedures shall be established to ensure:

a) that the applicable drawings, design calculations, specifications, and instructions are used in the manufacturing, repair, inspection, testing, and qualification or maintenance;

b) that incoming parts and materials are properly identified and segregated when received and in storage; and

c) that any maintenance or modification of a tank car involving welding is documented in the form of a detailed procedure.

6 Registration, approvals and certification

6.1 Registration of tank car facilities

6.1.1 Registration

A tank car facility shall register with the TC Director if

a) the tank car facility is located in Canada; or

b) the tank car facility is located outside Canada, is not already subject to the regulatory authority of the DOT, and conducts operations on tank cars that may be used in Canada.

A registered tank car facility shall only perform the tank car, service equipment and lining and coating functions authorized by the TC Director.

Tank car facilities located outside of Canada not already subject to the regulatory authority of the DOT, shall register with the TC Director within one year after the coming into force of this standard in the TDG Regulations. Tank cars, service equipment, and linings and coatings having functions performed by these facilities prior to coming into force of this standard in the TDG Regulations may continue to be offered for transport, imported, handled and transported in Canada.

6.1.2 Certificate of registration

A facility is registered upon the issuance, by the TC Director, of a certificate of registration, which will be valid until the expiration date indicated on the certificate or its revocation for cause. The registered facility shall perform the functions authorized by the certificate of registration at the location stipulated on the certificate of registration unless the certificate authorizes the facility to conduct these activities elsewhere.

A copy of the facility's current certificate of registration shall be available for review upon request by a Transport Canada inspector.

6.1.3 Application for registration

Application for registration shall be submitted to the TC Director and, at a minimum, shall include the following information:

a) name, street address, mailing address of the facility applying for registration, and proof of business registration (e.g., certificate of incorporation, letters patent);

b) detailed description of the facility, equipment, personnel (including the certificate(s) of the NDT level III individuals), quality management system and of the functions that will be performed; and

c) evidence that the facility meets the certification requirements in 5.3, for the functions for which registration is requested.

6.1.4 Registration and compliance

The TC Director shall register the facility if the TC Director is satisfied that the facility is capable of consistently complying with the applicable requirements of this standard.

6.1.5 Revocation for cause

The TC Director may revoke the certificate of registration of the facility if he/she is satisfied that the facility is not capable of or is not complying with the applicable requirements of this standard.

6.2 Procedure for securing approval of tank cars

6.2.1 Application

Before a tank car enters service after manufacture or re-enters service after modification, approval shall be obtained from the AAR Tank Car Committee or the AAR Executive Director, if granted the approval authority by the AAR Tank Car Committee. To obtain approval for the design, manufacture, modification, or weld repair of a specification tank car, an application together with detailed drawings shall be submitted in accordance with the requirements set out in 1.4 of the AAR *Specifications for Tank Cars* publication. The AAR Tank Car Committee shall issue approvals or rejections of applications.

6.2.2 Compliance

If the tank car is not in compliance with the requirements of this standard, the application shall not be approved by the AAR Tank Car Committee.

6.3 Certificate of construction

6.3.1 Manufacturer responsible for certificate of construction

Before a tank car is used for the handling, offering for transport, or transporting of dangerous goods, the manufacturer of the tank car shall provide the owner and the AAR Tank Car Committee each with a copy of the certificate of construction in the form specified in 1.4 of the AAR *Specifications for Tank Cars* publication.

6.3.2 Manufacture of tank cars in series

If more than one tank car or tank car tank are manufactured successively, are identical in all details of design, manufacture, and materials to one another, and are submitted as one application in accordance with the procedure for approval under 6.2, only one certificate of construction covering each series or subset of a series of such tank cars or tank car tanks is required.

6.4 Service equipment approval

If the AAR *Specifications for Tank Cars* publication specifies that approval is required for service equipment of a tank car, the tank car shall not be used for the handling, offering for transport, or transporting of dangerous goods by rail unless the service equipment has been approved by the AAR Tank Car Committee.

7 Markings

7.1 Scope

In addition to any other marking requirements set out in this standard, the marking requirements of this section apply.

7.2 Tank car stencilled markings

7.2.1 AAR requirements

A tank car shall be marked in accordance with the requirements set out in Appendix C of the AAR *Specifications for Tank Cars* publication with the exception, subject to 8.5.22, that the requirements of C.2.3.1.3 and C.5.0 relative to commodity markings do not apply.

7.2.2 Tank car specification delimiter

A tank car, other than class 113, may have a delimiter letter from column 1 of Table 1 substituted for the letter “A” in the specification marking if the tank car is equipped with each of the safety systems that has an X in the row for the delimiter in Table 1.

Table 1 – Tank car specification delimiter

Delimiter	Tank-head puncture resistant system (8.2.7)	Jacket thermal protection system (8.2.6)	117 Performance standard [8.3.25.2 f)]	117 Retrofit [8.3.25.2 e)]	Top-fitting protection system (8.2.2.5)
S	X	—	—	—	—
J	X	X	—	—	—
P[1]	X	X	X	—	—
R[1]	X	X	—	X	—
H	X	X	—	—	X

Note: Delimeters P and R apply to class 117 only.

7.3 Identification plates

7.3.1 Alternative to permanent markings

As an alternative to the permanent markings required by a tank car specification, including 8.3.20, 8.4.21, and 8.5.21, a tank car may be equipped with tank identification plates conforming to 7.3.1.1 to 7.3.1.3. Tank cars manufactured after January 15, 2015 shall conform to 7.3.1.1 to 7.3.1.3.

7.3.1.1 The tank manufacturer shall install two identical permanent identification plates, one located on both inboard surfaces of the body bolsters of the tank car. One identification plate shall be installed on the brake-end left side (BL) body bolster web and the other shall be installed on the opposite-end right side (AR) body bolster web so that each plate is readily accessible for inspection. The plates shall be at least 2.38 mm (3/32 in.) thick and manufactured from corrosion resistant metal. When the tank jacket (flashing) covers the body bolster web and identification plates, additional identical plates shall be installed on the AR and BL corners of the tank in a visible location.

7.3.1.2 Each plate shall be stamped, embossed, or otherwise marked by an equally durable method in letters 4.76 mm (3/16 in.) high with the following information (parenthetical abbreviations may be used), and the AAR form reference is to the applicable provisions of the AAR *Specifications for Tank Cars* publication:

a) Tank Manufacturer (TANK MFG and/or FAB. CIT.): Full name of the car builder as shown on the certificate of construction (AAR form 4-2).

b) Tank manufacturer's serial number (SERIAL NO. and/or N^{o} SÉRIE): For the specific car.

c) AAR number (AAR NO. and/or N^{o} AAR): The AAR number from line 3 of AAR form 4-2.

d) Tank design specification (SPECIFICATION adn/or SPÉCIFICATION): The specification to which the tank was built from line 7 of AAR form 4-2.

e) Tank shell material/head material (SHELL MATL./HEAD MATL. and/or MAT. COQUE/MAT. TÊTE): ASTM or AAR specification of the material used in the construction of the tank shell and heads from lines 15 and 16 of AAR form 4-2. For class 113, 115, AAR-204W, and AAR-206W, the materials used in the construction of the outer tank shell and heads shall be listed. Only list the alloy (for example 5154) for aluminum tanks and the type (for example 304L or 316L) for stainless steel tanks.

f) Insulation material (INSULATION MATL. and/or MAT. CALORIFUGEAGE): Generic names of the first and second layer of any thermal protection/insulation material applied.

g) Insulation thickness (INSULATION THICKNESS and/or ÉPAISSEUR CALORIFUGEAGE): In millimetres but may include inches (for example: 00 mm [00 in.]).

h) Underframe/Stub sill type (UF/SS DESIGN and/or CONCEPTION DE CI/LCC): The design from line 32 of AAR form 4-2.

i) Date of manufacture (DATE OF MFR. and/or DATE DE FAB.): The month and year of tank manufacture. If the underframe has a different built date than the tank, show both dates.

7.3.1.3 When a modification to the tank changes any of the information shown in 7.3.1.2, the car owner or the tank car facility making the modification shall install an additional variable identification plate on the tank in accordance with 7.3.1.1 showing the following information:

a) AAR number (AAR NO. and/or N^{o} AAR): The AAR number from line 3 of AAR form 4-2 for the alteration or conversion.

b) All items of 7.3.1.2 that were modified, followed by the month and year of modification.

7.3.1.4 The identification plates and their attachment to the tank car shall be capable of withstanding a fire at a temperature of 426.7 °C (800 °F).

7.4 Qualification and conversion markings

7.4.1 Qualification date and due date

When a tank car passes the required qualification for an item referred to in 9.3, the tank car facility shall mark on the tank car the date on which the tank car was qualified and the due date for the next qualification in conformance with the requirements set out in Appendix C of the AAR *Specifications for Tank Cars* publication.

7.5 Delayed installation

When a pressure-relief device is qualified within six months of installation on a tank car and is protected from deterioration during that period of time, the qualification date of the pressure-relief device marked on the tank car shall be either the installation date of the device on the tank car or the qualification date of the pressure-relief device. A pressure-relief device shall not be installed on a tank car after 6 months from the qualification date without first being qualified again.

8 Manufacture and modification of tank cars for transport of dangerous goods

8.1 General

8.1.1 Scope

The requirements set out in 8.1 and 8.2 are general and basically apply to all tank cars used in Canada for the handling, offering for transport, or transporting of dangerous goods. The requirements in 8.3 to 8.5 apply to the design and manufacture of TC specification tank cars. Specific requirements may have broader scope when referenced in other sections of this standard.

8.1.2 Responsibility of tank car manufacturers

Tank car manufacturers are responsible for obtaining approval in accordance with 6.2 for the design and manufacture of tank cars and for ensuring that the tank cars conform to all the applicable requirements of this standard.

8.1.3 Responsibility of tank car owner

Tank car owners are responsible for obtaining approval in accordance with 6.2 for the modification of tank cars and for ensuring that the tank cars conform to all the applicable requirements of this standard.

8.2 General technical and safety system requirements

8.2.1 Interior heater systems

8.2.1.1 Hydrostatic test

Interior heater systems are authorized on class 111, 115 and 117 tank car tanks. Each interior heater system shall be hydrostatically tested at the time of manufacture at not less than 1379 kPa (200 psi) and hold the pressure for 10 min without showing evidence of yielding or leakage.

8.2.2 Protection for service equipment

8.2.2.1 Bottom shell service equipment connections

Service equipment connections located in the bottom shell shall be designed, manufactured and protected in accordance with the applicable requirements in Appendix E of the AAR *Specifications for Tank Cars* publication.

8.2.2.2 Protective housing for pressure tank cars

A class 105, 112, or 120 tank car shall be equipped with a protective housing that conforms to the following requirements:

a) except as provided in 8.3.23, a protective housing of cast, forged or fabricated materials shall be fastened to the manway cover or joined to the nozzle or tank reinforcing pad with joint(s) strength not less than twenty 19.1 mm (3/4 in.) nominal diameter studs or bolts;

b) when the protective housing is fastened directly to the manway cover, the attachment strength shall be equal to or less than 70% of the total ultimate shear strength of the studs or bolts attaching the manway cover to the manway nozzle;

c) protective housing shall have steel sidewalls equal to or greater than 19.1 mm (3/4 in.) in thickness and shall be equipped with a metal cover equal to or greater than 6.35 mm (1/4 in.) in thickness that can be securely closed;

d) protective housing cover shall have a suitable stop to prevent the cover from striking the loading and unloading connections and shall be hinged; and

e) openings in the wall of the protective housing shall be equipped with screw plugs or other closures.

8.2.2.3 Protective housing for class 113 tank cars

8.2.2.3.1 Each valve, gauge, closure, and pressure-relief device, with the exception of secondary relief valves for the protection of isolated piping, shall be enclosed within a protective housing.

8.2.2.3.2 The protective housing shall be adequate to protect the enclosed service equipment from direct solar radiation, mud, sand, adverse environmental exposure, and mechanical damage encountered during the normal handling or transport of the tank car.

8.2.2.3.3 The protective housing shall be designed to:

a) provide reasonable access to the enclosed service equipment for operation, inspection, and maintenance; and

b) prevent vapour concentration build up to a dangerous level inside the housing in the event of valve leakage or pressure-relief device operation.

8.2.2.3.4 All equipment within the protective housing shall be operable by personnel wearing heavy gloves and shall incorporate provisions for locks or seals.

8.2.2.3.5 A protective housing and its cover shall be manufactured of metal equal to or greater than 3.02 mm (0.119 in.) in thickness.

8.2.2.3.6 The bottom plate of a side mounted protective housing shall be stainless steel and have a drain hole outboard of the rail flange.

8.2.2.3.7 Protective housing doors shall be single panel or bi-fold. Doors shall have hold-open features.

8.2.2.3.8 The protective housing for specifications with a “W9” delimiter shall additionally comply with the following requirements.

8.2.2.3.8.1 The ends of the protective housing shall have a longitudinal slope with a ratio less than or equal to 1:3.

8.2.2.3.8.2 The protective housing shall provide protection for the enclosed components when subjected to forces equal to the designated gross rail load of the car, less trucks, applied in the following manners:

a) The load distributed, in an orientation parallel to the longitudinal axis of the jacket, over a 76 mm (3 in.) wide area along the entire longitudinal length of the protective housing, centered approximately at the vertical midpoint of the protective housing;

b) The load distributed, in an orientation perpendicular to the longitudinal axis of the jacket, over a 76 mm (3 in.) wide area along the entire vertical height of the protective housing, centered approximately at the longitudinal midpoint of the protective housing; and

c) For analysis purposes, rotations can be resisted at the centerplates.

8.2.2.3.8.3 The resulting stresses in the outer shell and protective housing shall not exceed the ultimate strength of the material.

8.2.2.3.8.4 Any deformations of the structure shall not result in contact with the components enclosed within the protective housing.

8.2.2.4 Protective housing for class 111 and class 117 tank cars

A protective housing, if required, shall have a cover and sidewalls no less than 3.02 mm (0.119 in.) in thickness.

8.2.2.4.1 An enhanced class 111 tank car and, subject to 8.2.2.4.2 and 8.2.2.4.3, a class 117 tank car shall have a protective housing that conforms to the following.

The protective structure shall be as tall as the tallest fitting involved and shall provide protection for those fittings, without overstressing the tank shell and nozzles, when subjected to forces of 1/2W in the vertical downward direction, 1W horizontal in the longitudinal direction, and 1/2W horizontal in the lateral direction, where:

a) W is defined as the designed gross rail load of the tank car, less trucks;

b) forces are applied separately and uniformly over the projected plane of the protective structure perpendicular to the direction of the force;

c) for horizontal loads, the projected plane extends from the top of the tank to the top of the protective structure;

d) in the case of multiple nozzles:

   1) forces are applied uniformly over their combined projected area if the reinforcement zones of the nozzle, as defined in E2.3.1, of the AAR *Specifications for Tank Cars* publication, have a positive overlap; and

   2) if there is no overlap of the reinforcement zones, each nozzle shall be protected so that it can withstand the applied loads independent of the other nozzles.

e) Calculations shall use the minimum specified tensile strength of the material for the tank, nozzle(s), unprotected service equipment, and protective device (where applicable); and

f) stresses shall not exceed the critical buckling stress of the assembly under consideration.

8.2.2.4.1.1 The design stresses shall not exceed the minimum specified tensile stress for the tank, nozzle, and protective housing, provided that the critical buckling stresses are not exceeded.

8.2.2.4.1.2 The protective structure shall not reduce the pressure-relief device flow capacity below the minimum required.

8.2.2.4.1.3 The protective structure shall provide a means of drainage with a minimum flow area equivalent to six holes, each having a diameter of 25.4 mm (1 in.).

8.2.2.4.1.4 The strength of the attachment of the protective structure to its base structure shall not exceed 70% of the attachment strength of the base structure to its associated base structure. For example, if the protective structure is attached to the nozzle, the strength of the attachment of the protective structure to the nozzle shall not exceed 70% of the strength of the attachment of the nozzle to the tank.

8.2.2.4.1.5 Individual fittings may be unprotected if there is no loss of lading when subjected to the design loads in 8.2.2.4.1.1. If unprotected fittings are used in conjunction with a protective structure, the design loads are shared in proportion to the projected area of the protective structure and the fittings.

8.2.2.4.1.6 Discontinuity protection is not required for manway covers that have internal or external shear rings designed to resist the horizontal loads defined in 8.2.2.4.1.1.

8.2.2.4.1.7 No discontinuity protection is required for internal pressure relief devices, cover plates, blind flanges, or plugs.

8.2.2.4.2 Despite 8.2.2.4.1, the protective housing for a specification TC117R or retrofitted TC117P tank car may meet the following requirements:

a) has a thickness equal to or greater than 12.7 mm (1/2 in.);

b) is made of a material having a tensile strength not less than 448 MPa (65 000 psi);

c) is as tall as the tallest valve or fitting involved and the height of a valve or fitting within the protective housing shall be kept to the minimum compatible with their proper operation;

d) shall not reduce the flow capacity of the pressure relief device below the minimum required;

e) provide a means of drainage with a minimum flow area equivalent to six holes, each having a diameter of 25.4 mm (1 in.);

f) when connected to the nozzle or fitting cover plate and subject to a horizontal force applied perpendicular to and uniformly over the projected plane of the protective housing, the tensile connection strength of any protective housing shall be designed to be:

    1) no greater than 70% of the nozzle to tank tensile connection strength;

    2) no greater than 70% of the cover plate to nozzle connection strength; and

    3) no less than either 40% of the nozzle to tank tensile connection strength or the shear strength of twenty 12.7 mm (1/2 in.) nominal diameter bolts;

g) pressure relief device is located as follows:

    1) inside the protective housing, unless space does not permit and in that case, only one pressure relief device can be located outside of a protective housing;

    2) highest point of any pressure relief device that is located outside of a protective housing shall not be more than 305 mm (12 in.) above the tank jacket; and,

    3) highest point on the closure of any unused pressure relief device nozzle shall not be more than 152 mm (6 in.) above the tank jacket.

8.2.2.4.3 As an alternative to the requirements of 8.2.2.4.2 for specification TC117R or retrofitted TC117P tank cars, the tank car may be equipped with a system that prevents the release of contents from any top fitting under accident conditions where any top fitting may be sheared off.

8.2.2.5 Top rollover protective system for dangerous goods toxic by inhalation tank cars

Except for tank cars meeting 10.5.1.5, each tank car manufactured for the transportation of dangerous goods toxic by inhalation shall, in addition to the requirements prescribed in 8.2.2.2, enclose the service equipment within a protective housing and cover.

a) Each tank car shall be equipped with a protective system for service equipment and nozzle capable of sustaining, without failure, a rollover accident at a speed of 14.5 km/h (9 mph), in which the rolling protective housing strikes a stationary surface assumed to be flat, level and rigid and the speed is determined as a linear velocity, measured at the geometric center of the loaded tank car as a transverse vector. Failure is deemed to occur when the deformed protective housing contacts any of the service equipment or when the lading retention capability is compromised.

b) As an alternative to the tank car protective system for service equipment in 8.2.2.5 a), the tank car may be equipped with a system that prevents the release of product from any of the top fittings in the case of an accident where any top fitting would be sheared off, and only internal, spring-loaded check valve devices designed to remain closed during transportation are authorized. The tank nozzle shall meet the performance standard in 8.2.2.5 a).

8.2.3 Tank car capacity

A tank car shall not be manufactured or modified to exceed a capacity of 130 596 L (34 500 US gal).

8.2.4 Coupler vertical restraint system

8.2.4.1 Performance standard

Each tank car shall be equipped with couplers capable of sustaining, without disengagement or material failure, vertical loads equal to or greater than 889.6 kN (200 000 lbf) applied in upward and downward directions in combination with horizontal coupler compressive loads of 8.896 kN (2000 lbf), when coupled to railway vehicles which may or may not be equipped with couplers having this vertical restraint capability.

8.2.4.2 Test verification

Compliance with the requirements of 8.2.4.1 shall be verified by testing of a representative prototype of the coupler vertical restraint system in accordance with 8.2.4.3.

8.2.4.3 Coupler vertical restraint test

A coupler vertical restraint system shall be tested under the following conditions:

a) test coupler shall be tested with another coupler or simulated coupler having only frictional vertical force resistance at the mating interface; or having the capabilities described in 8.2.4.1;

b) testing apparatus shall simulate the vertical coupler performance at the mating interface and shall not interfere with coupler failure or otherwise inhibit failure resulting from force applications and reactions; and

c) test shall be conducted as follows:

    1) vertical downward load of not less than 889.6 kN (200 000 lbf) shall be applied continuously for not less than 5 min to the test coupler head simultaneously with the application of a nominal horizontal coupler compressive load of 8.896 kN (2000 lbf);

    2) procedures set out in 8.2.4.3 c) 1) shall be repeated with a vertical upward load equal to or greater than 889.6 kN (200 000 lbf); and

3) for each load combination specified in the two preceding clauses, not less than three consecutive successful tests shall be performed. A test is successful if a vertical disengagement or material failure does not occur during the application of any of the loads specified in this 8.2.4.3 c) 3).

8.2.5 Pressure-relief devices

8.2.5.1 Performance requirements

Except for class 113 and AAR 204W tank cars, tank car tanks shall be equipped with one or more pressure-relief devices with sufficient flow capacity so that pressure buildup in the tank car tank, in fire conditions set out in Appendix A of the AAR *Specifications for Tank Cars* publication, does not exceed the flow rating pressure of the pressure-relief device.

8.2.5.2 Material

The pressure-relief device shall be made of material compatible with the dangerous goods.

8.2.5.3 Settings for reclosing pressure-relief devices

A reclosing pressure-relief device shall have a start-to-discharge pressure:

a) greater than the working pressure;

b) equal to or less than 33% of the minimum tank car tank burst pressure; and

c) equal to or greater than 517 kPa (75 psi).

If a pressure-relief device has a start-to-discharge pressure that is higher than the tank specification test pressure, the tank shall be tested at or above the pressure-relief device start-to-discharge pressure.

8.2.5.4 Flow rating

The flow capacity and rating of pressure-relief devices shall conform to the following requirements:

a) each reclosing or non-reclosing pressure-relief device shall conform to the requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication;

b) the manufacturer of a reclosing or non-reclosing pressure-relief device shall verify conformity of any pressure-relief device to the requirement of Appendix A of the AAR *Specifications for Tank Cars* publication by testing a representative prototype of each pressure-relief device design; and

c) the nominal flow rating pressure shall be:

    1) for tank car tanks having a minimum burst pressure greater than 3447 kPa (500 psi), 110% of the start-to-discharge pressure; and

    2) for tank car tanks having a minimum burst pressure less than or equal to 3447 kPa (500 psi), not less than 110% and not greater than 130% of the start-to-discharge pressure.

8.2.5.5 Tolerances

Reclosing pressure-relief devices shall conform to the following requirements:

a) for new and re-built devices, the tolerance for the start-to-discharge pressure is ± 21 kPa (± 3 psi) for devices with a nominal start-to-discharge pressure equal to or less than 689 kPa (100 psi) and ± 3% for devices with a nominal start-to-discharge pressure greater than 689 kPa (100 psi);

b) vapour-tight pressure shall be equal to or greater than 80% of the start-to-discharge pressure; and

c) for in-service devices, the tolerance for the start-to-discharge pressure is -5% to +10% provided the start-to-discharge pressure is equal to or less than the working pressure, otherwise the allowable tolerance is -3% to +10%.

8.2.5.6 Non-reclosing pressure-relief devices

A non-reclosing pressure-relief device shall:

a) incorporate a rupture disc designed to burst at 33% of the tank car tank minimum burst pressure;

b) have an approach channel and a discharge channel that do not reduce the minimum flow capacity of the pressure-relief device;

c) be designed to not be interchangeable with other fittings installed on the tank car;

d) have a structure that encloses and clamps the rupture disc in position in order to prevent, when properly applied, any distortion or damage to the rupture disc; and

e) have a cover designed to direct any discharge of the dangerous goods downward and with a means of preventing misplacement.

8.2.5.7 Rupture disc

A rupture disc shall:

a) be compatible with the dangerous goods;

b) be manufactured in accordance with the requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication;

c) not have an opening; and

d) have an actual burst pressure within ± 5% of the burst pressure marked on the disc.

8.2.5.8 Pressure-relief devices in combination

a) If a non-reclosing pressure-relief device is used in series with a reclosing pressure-relief device, the reclosing pressure-relief device shall be located outboard of the non-reclosing pressure-relief device.

b) If a breaking pin device is used in combination with a reclosing pressure-relief device, the breaking pin device shall be designed to fail at the pressure set out in 8.2.5.3 and the reclosing pressure-relief device shall be set to start discharging at a pressure no greater than 96% of that pressure.

c) If a rupture disc is used in combination with a reclosing pressure-relief device:

   1) rupture disc shall be designed to burst at the pressure set out in 8.2.5.3;

   2) reclosing pressure-relief device shall be set to start to discharge at a pressure no greater than 96% of the pressure set out in 8.2.5.3;

   3) needle valve, try cock, or telltale indicator shall be installed to allow detection of any accumulation of pressure between the rupture disc and the reclosing pressure-relief device; and

4) vapour-tight pressure and the tolerance of the start-to-discharge pressure of the reclosing pressure-relief device shall be based on the discharge setting of that device.

8.2.5.9 Location of pressure-relief devices

A pressure-relief device shall communicate with the vapour space above the dangerous goods and be located as near as practicable on the longitudinal centreline and centre of the tank.

8.2.5.10 Marking of pressure-relief devices

A pressure-relief device shall be permanently marked in accordance with the requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication.

8.2.6 Thermal protection systems

8.2.6.1 Performance standard

If a thermal protection system is specified by this standard, the system shall be capable of preventing the release of any dangerous goods from a tank car filled to its authorized loading limit, except release through the pressure-relief device, when subjected to the following conditions:

a) pool-fire for 100 min; and

b) torch-fire for 30 min.

8.2.6.2 System survivability and thermal analysis

Compliance with the requirements set out in 8.2.6.1 shall be verified first by testing the system for survivability in accordance with Appendix D and be verified then by analyzing the behaviour of the tank car and dangerous goods when subjected to fire conditions set out in 8.2.6.1, and such analysis shall take into account the following parameters acting in combination:

a) the fire effects on and heat flux through tank discontinuities, protective housings, underframes, metal jackets, insulation, and thermal protection;

b) an upright and a 120° roll over orientation along the longitudinal axis of the tank car;

c) pool-fire which completely engulfs the tank car with fire temperatures equal to or greater than 815.6 °C (1500 °F) and a torch-fire temperature equal to or greater than 1204.4 °C (2200 °F);

d) tank external surface emissivity being equal to or greater than 0.9;

e) discharge coefficient of the pressure-relief device of 0.8 for vapour and 0.6 for liquids or the use of other values, provided the use of such other values is supported by actual test data;

f) heat transfer properties of the thermal protection or insulation material as a function of temperature, as established by actual test data;

g) dangerous goods being at an initial temperature of 46.1 °C (115 °F) or, if lower, the highest temperature at which the dangerous goods can exist in the liquid state within the tank;

h) maximum volumetric filling limit specified for the dangerous goods excluding any modified filling limit applicable during winter; and

i) composition and thermal properties of the dangerous goods.

8.2.6.3 Thermal protection systems for class 117 tank cars

For class 117 tank cars, the thermal protection system shall include at least a 12.7 mm (1/2 in.) thick ceramic fibre blanket.

8.2.6.4 Record retention

A complete record of each analysis shall be made and retained by the owner of the tank car.

8.2.7 Tank-head puncture resistance systems

8.2.7.1 Performance standard

If a tank-head puncture-resistance system is specified, it shall be capable of sustaining the coupler-to-tank-head impacts specified in Annex C, at relative tank car speeds of 29 km/h (18 mph) without any loss of dangerous goods when:

a) mass of the impacting car is equal to or greater than 119 295 kg (263 000 lb);

b) impacted tank car is coupled to one or more stationary backup cars that have a total mass equal to or greater than 217 724 kg (480 000 lb) and the hand brake is applied on the last backup car; and

c) internal pressure of the impacted tank car is equal to or greater than 698 kPa (100 psi).

8.2.7.2 Verification

Conformance with the requirements of 8.2.7.1 shall be verified by full-scale testing in accordance with Annex C or, as an alternative, compliance with the requirements of 8.2.7.1 is considered to be achieved by installing a full-head protection shield or a full tank-head jacket on each end of the tank car that conforms to the following requirements:

a) shield or jacket shall be equal to or greater than 12.7 mm (1/2 in.) in thickness, shaped to the contour of the tank-head and made from steel that has a minimum specified tensile strength equal to or greater than 379 MPa (55 000 psi);

b) design and test requirements of the shield or jacket shall conform to the impact test requirements set out in 5.3, of the AAR *Specifications for Tank Cars* publication; and

c) workmanship for the shield or jacket shall conform to the requirements set out in chapter 5 of the AAR *Design, Fabrication, and Construction of Freight Cars* publication.

8.2.7.3 Deeming provision

Unless otherwise specified in this standard, a class 105 tank car that has a tank test pressure equal to or greater than 3447 kPa (500 psi) is deemed to conform to the tank-head puncture-resistance system requirements of 8.2.7.

8.3 General requirements applicable to TC class 111 tank car tanks, TC class 117 tank car tanks and TC pressure tank car tanks

8.3.1 General

A TC specification 111, 117 or pressure tank car tank shall conform to the requirements set out in 8.3, except where otherwise provided by the individual specification.

8.3.2 Pressure tank car tanks

A pressure tank car tank shall:

a) be fusion-welded with formed convex outward heads;

b) be circular in cross-section;

c) be provided with a manway nozzle on top;

d) have a manway cover where all valves, measuring devices and sampling devices are mounted, subject to 8.3.23;

e) have a protective housing conforming to 8.2.2.2;

f) only have openings in the tank that are permitted in the specification; and

g) have normalized shell and heads when made from carbon steel. Heads shall be normalized after forming unless the AAR Tank Car Committee specifically approved otherwise.

8.3.3 TC specification 111 and 117 tank car tanks

A TC specification 111 or 117 tank car tank shall:

a) be fusion-welded with formed convex outward heads;

b) be circular in cross-section; and

c) have at least one manway.

8.3.4 Welding

Welders shall comply with and welding procedures shall conform to the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.3.5 Metal plate

8.3.5.1 Carbon and low alloy steel plate used shall conform to Appendix M of the AAR *Specifications for Tank Cars* publication.

8.3.5.2 For aluminum alloy plate:

a) alloys shall be used in one of the following tempers: 0, H112, or H32, except for alloy 5083 which shall be used in the 0 temper only;

b) filler material alloy conforming to Unified Numbering System (UNS) A95556 shall not be used; and

c) plate shall conform to one of the specifications and corresponding minimum tensile strength set out in Table 2.

Table 2 – Minimum tensile strength – aluminum alloy plate

Specification	Minimum tensile strength MPa (psi)
ASTM B209M or B209, Alloy 5052	172 (25 000)
ASTM B209M or B209, Alloy 5083	262 (38 000)
ASTM B209M or B209, Alloy 5086	241 (35 000)
ASTM B209M or B209, Alloy 5154	207 (30 000)
ASTM B209M or B209, Alloy 5254	207 (30 000)
ASTM B209M or B209, Alloy 5454	214 (31 000)
ASTM B209M or B209, Alloy 5652	172 (25 000)

8.3.5.3 For high alloy steel plate:

a) plate shall conform to one of the specifications and corresponding minimum tensile strength set out in Table 3;

Table 3 – Minimum tensile strength – high alloy steel plate

Specification	Minimum tensile strength MPa (psi)
ASTM A240/A240M, Type 304L	483 (70 000)
ASTM A240/A240M, Type 316L	483 (70 000)
ASTM A240/A240M, Type 304	517 (75 000)
ASTM A240/A240M, Type 316	517 (75 000)

b) the plate shall be tested in accordance with the procedure indicated for the plate material and, after sensitizing treatment, shall exhibit a corrosion rate in testing no greater than the corresponding value indicated in Table 4.

Table 4 – Corrosion rate test procedure – high alloy steel plate

ASTM A262 test procedure	Material	Corrosion rate mm (in.) per month
Practice B	Types 304, 304L, 316 and 316L	0.1016 (0.0040)
Practice C	Type 304L	0.0508 (0.0020)

8.3.6 Minimum thickness

8.3.6.1 The minimum thickness, in millimetres (inches), measured after forming of the tank shell and of 2:1 ellipsoidal heads shall be the greater of:

a) minimum plate thickness specified in 8.3.22 or 8.3.25; and

b) the plate thickness calculated using the following formula:

$$t = \frac{Pd}{2SE}$$

where:

t = minimum thickness of plate, in mm (in.), after forming;

P = minimum burst pressure, in MPa (psi);

d = inside diameter, in mm (in.);

S = minimum tensile strength of plate material, in MPa (psi), as specified in 8.3.5;

E = 0.9, a factor representing the efficiency of welded joints, except that for welds that are 100% radiographed, E = 1.0.

8.3.6.2 If cladding material having minimum tensile strength properties equal to or greater than the base plate is used, the cladding may be considered to be a part of the base plate when determining thickness. However, if cladding material that has lower tensile strength is used, the base plate alone shall conform to the thickness requirement.

8.3.7 Tank heads

8.3.7.1 External tank heads shall have the form of an ellipsoid of revolution in which the major axis is equal to the diameter of the shell and the minor axis is equal to one-half the major axis.

8.3.7.2 Internal compartment tank heads on a specification 111 or 117 tank car tank shall either have the form of a 2:1 ellipsoid or be flanged and dished to a thickness, as set out in 8.3.6. A flanged and dished internal head shall have:

a) main inside radius equal to or less than 3048 mm (120 in.); and

b) an inside knuckle radius equal to or greater than:

   1) 95.3 mm (3.75 in.) for steel, alloy steel, or nickel tanks; and

   2) 127 mm (5 in.) for aluminum alloy tanks.

8.3.7.3 Subject to 8.3.7.4, each tank head made from steel which is required to be “fine grain” or “fine grain practice” by the material specification and which is hot-formed at a temperature equal to or greater than 926.7 °C (1700 °F) shall be normalized after forming by heating the steel to a temperature between 843.3 °C and 926.7 °C (1550 °F and 1700 °F), holding at that temperature for at least the greater of 30 min and 1 h per 25.4 mm (1 in.) of thickness, and then by cooling in air.

8.3.7.4 If the material specification requires quenching and tempering, the treatment requirements set out in that specification shall be used instead of the one set out in 8.3.7.3.

8.3.8 Compartmented specification 111 and 117 tank car tanks

8.3.8.1 If a tank is divided into compartments by inserting internal heads:

a) internal heads shall be inserted in conformance with the requirements set out in E6.0 of the AAR *Specifications for Tank Cars* publication and shall conform to the requirements specified in 8.3.25 of this standard;

b) voids between compartment heads shall be provided with at least one tapped drain hole at their lowest point and a tapped hole at the top of the tank and the tapped holes shall not be less than 3/4 and not greater than 1 1/2 NPT nominal size; and

c) top and bottom holes shall be closed with solid NPT plugs.

8.3.8.2 If a tank is divided into compartments by manufacturing each compartment as a separate tank:

a) separate tanks shall be joined together by a cylinder made of plate having a thickness equal to or greater than that required for the tank shell; and

b) the cylinder shall:

   1) be applied to the outside surface of the tank head flanges;

   2) fit the straight flange portion of the compartment tank head tightly;

   3) contact the head flange for a distance of at least two times the plate thickness or a minimum of 25.4 mm (1 in.), whichever is greater; and

   4) be joined to the head flange by a full fillet weld;

c) distance from head seam to cylinder shall be equal to or greater than 38.1 mm (1.5 in.) or three times the plate thickness, whichever is greater;

d) voids created by the space between heads of tanks joined together to form a compartment tank shall be provided with a tapped drain hole at their lowest point and a tapped hole at the top of the tank and the tapped holes shall not be less than 3/4 and not greater than 1-1/2 NPT nominal size; and

e) top and bottom holes shall be closed with solid NPT plugs.

8.3.9 Attachments

8.3.9.1 Tanks shall have reinforcing pads between external brackets and tank if the attachment welds to tank are equal to or greater than 152 linear mm (6 linear in.) of 6.35 mm (1/4 in.) fillet or equivalent weld per bracket or bracket leg. Reinforcing pads are not required for the following attachments:

a) thin attachments, such as exterior heater coils and drip ledges;

b) cast bottom outlet skids that are attached to tanks over a broad area;

c) full-girth attachments, such as compartmented tank attachment rings and tank stiffening rings, that are continuously attached to tanks; or

d) tank bottom reinforcing plates or bars and attachments welded thereto.

8.3.9.2 Reinforcing pads are required for:

a) any air brake equipment support attachments; and

b) any other bracket or attachment, regardless of weld length, if they could cause damage to the tank either through fatigue, over-stressing, denting or puncturing in the event of an accident.

8.3.9.3 Reinforcing pads shall:

a) be equal to or greater than 6.35 mm (1/4 in.) in thickness;

b) not exceed the thickness of the tank shell to which they are welded, by more than 15%;

c) have each corner rounded to a radius equal to or greater than 25.4 mm (1 in.);

d) be attached to the tank by continuous fillet welds, except for venting provisions; and

e) pad-to-tank fillet weld leg size not exceeding the tank shell thickness.

8.3.9.4 The distance between a bracket and the edge of the reinforcing pad to which it is attached shall not be less than three times the thickness of the pad.

8.3.9.5 The ultimate shear strength of the bracket-to-reinforcing pad weld shall be equal to or less than 85% of the ultimate shear strength of the reinforcing pad-to-tank weld.

8.3.10 Bottom outlets

8.3.10.1 The bottom outlet shall not extend from the tank shell more than that authorized in Appendix E of the AAR Specifications for Tank Cars publication.

8.3.10.2 Each bottom outlet reducer and secondary closure and their attachments shall be secured by, at least, a 9.53 mm (3/8 in.) chain or its equivalent, except that outlet closure plugs may be secured by a 6.35 mm (1/4 in.) chain or its equivalent.

8.3.10.3 If the bottom outlet closure is of the combination cap-and-valve type, the pipe connection to the valve shall be closed by a plug, cap, or quick-coupling device.

8.3.10.4 The bottom outlet shall include only the valve, reducer, and closures that are necessary for the attachment to handling equipment.

8.3.10.5 Each bottom outlet shall be provided with a liquid-tight closure at its lower end.

8.3.10.6 On tank cars with continuous centre sills, a ball valve may be welded to the outside bottom of the tank or mounted on a pad or nozzle that is attached to the outside bottom of the tank using a tongue-and-groove or male-and-female flange attachment. The breakage groove or its equivalent shall not extend below the bottom flange of the centre sill.

8.3.10.7 On tank cars without continuous centre sills, a ball valve may be welded to the outside bottom of the tank or mounted on a pad using a tongue-and-groove or male-and-female flange attachment. The pad shall be attached to the outside bottom of the tank.

8.3.10.8 The pad referred to in 8.3.10.6 and 8.3.10.7, shall have a maximum thickness of 63.5 mm (2.5 in.) measured on the longitudinal centreline of the tank.

8.3.10.9 The valve operating mechanism shall:

a) include a means of locking the valve in the closed position during transport; and

b) in the case of a TC class 117 or 120 tank car, or an enhanced class 111 tank car, that is equipped with a bottom outlet valve handle, the valve handle – unless stowed separately – shall be designed to bend, break free or be protected on impact without the valve opening or is designed so that all of the handle is located within the bottom discontinuity protective structure.

Note: An enhanced class 111 tank car is also known as a CPC-1232 tank car.

8.3.10.10 To provide for the attachment of handling connections, the bottom of the main portion of the outlet nozzle or valve body of exterior valves, or any fixed attachment thereto, shall be provided with:

a) bolted flange closure arrangement including a 25.4 mm (1 in.)NPT pipe plug or including an auxiliary valve with a threaded closure;

b) threaded cap closure arrangement including a 25.4 mm (1 in.) NPT pipe plug or including an auxiliary valve with a threaded closure;

c) a quick-coupling device that has a threaded plug closure equal to or greater than 25.4 mm (1 in.) NPT or has a threaded cap closure with a 25.4 mm (1 in.) NPT pipe plug. A minimum 25.4 mm (1 in.) nominal size auxiliary test valve with a threaded closure may be substituted for the 25.4 mm (1 in.) NPT pipe plug. If the threaded cap closure does not have a pipe plug or integral auxiliary test valve, a 25.4 mm (1 in.) NPT pipe plug shall be installed in the outlet nozzle above the closure; or

d) a two-piece quick-coupling device using a clamped dust cap shall include an in-line auxiliary valve either integral with the quick-coupling device or located between the primary bottom outlet valve and the quick-coupling device. The quick-coupling device closure dust cap or outlet nozzle shall be fitted with a 25.4 mm (1 in.) NPT closure.

8.3.10.11 If the outlet nozzle extends 152 mm (6 in.) or more from the shell of the tank, the outlet nozzle shall conform to the following requirements:

a) breakage “V” groove shall be cut, not cast, into the upper part of the outlet nozzle at a point immediately below the lowest part of the valve to a depth that leaves the thickness of the nozzle wall at the root of the “V” equal to or less than 6.35 mm (1/4 in.);

b) if the outlet nozzle on interior valves or the valve body on exterior valves is steam-jacketed, the breakage groove or its equivalent shall be below the steam chamber but above the bottom of the centre sill for tank cars with continuous center sills;

c) if the outlet nozzle is not a single piece or if exterior valves are applied, provision shall be made for the equivalent of the breakage groove;

d) on tank cars without continuous centre sills, the breakage groove or its equivalent shall be equal to or less than 381 mm (15 in.) below the tank shell; and

e) on tank cars with continuous centre sills, the breakage groove or its equivalent shall be above the bottom of the centre sill.

8.3.10.12 The thickness of the flange on the outlet nozzle or the valve body of exterior valves shall be sufficient to:

a) prevent distortion of the valve or valve seat by any change in contour of the shell resulting from the expansion of the dangerous goods or from the expansion due to other causes; and

b) ensure that accidental breakage of the outlet nozzle will occur at or below the breakage “V” groove or its equivalent.

8.3.10.13 The valve shall have no wings or stem projecting below the breakage “V” groove or its equivalent. The valve and valve seat shall be readily accessible or removable for repairs, including grinding.

8.3.11 Bottom washouts

8.3.11.1 The bottom washout shall not extend from the tank shell more than that authorized in Appendix E of the AAR *Specifications for Tank Cars* publication.

8.3.11.2 If the washout nozzle extends 152 mm (6 in.) or more from the tank shell, the washout nozzle shall conform to the following requirements:

a) a breakage “V” groove shall be cut, not cast, in the upper part of the washout nozzle at a point immediately below the lowest part of the inside closure seat or plug to a depth that leaves the thickness of the nozzle wall at the root of the “V” equal to or less than 6.35 mm (1/4 in.);

b) if the washout nozzle is not a single piece, provision shall be made for the equivalent of the breakage groove;

c) thickness of the washout nozzle shall be sufficient to ensure that accidental breakage will occur at or below the breakage “V” groove or its equivalent;

d) on tank cars without continuous centre sills, the breakage “V” groove or its equivalent shall be equal to or less than 381 mm (15 in.) below the tank shell; and

e) on tank cars with continuous centre sills, the breakage “V” groove or its equivalent shall be above the bottom of the centre sill.

8.3.11.3 The closure of the washout nozzle shall be equipped with a 19.1 mm (3/4 in.) NPT solid plug. The plug shall be attached to its nozzle by, at least, a 6.35 mm (1/4 in.) chain.

8.3.12 Manway nozzles and covers on a TC pressure tank car tank

8.3.12.1 A manway nozzle shall be manufactured of forged or rolled steel for steel tanks or of aluminum alloy for aluminum tanks and shall have an access opening with an inside diameter equal to or greater than 457 mm (18 in.) or at least 356 x 457 mm (14 x 18 in.) obround or oval. The nozzle shall be welded to the tank and the opening reinforced in conformance with the requirements set out in Appendix E of the AAR *Specifications for Tank Cars* publication.

8.3.12.2 The manway cover shall be attached to the manway nozzle by bolts or studs not entering the tank.

8.3.13 Manway flanges, safety device flanges, bottom outlet nozzle flanges, bottom washout nozzle flanges, and other attachments and openings on a specification 111 and 117 tank car tank

8.3.13.1 The attachments shall be fusion-welded to the tank and reinforced in conformance with the requirements set out in Appendix E of the AAR *Specifications for Tank Cars* publication.

8.3.13.2 The opening in the manway shall have a diameter equal to or greater than 406 mm (16 in.), except that lined manways shall have a diameter equal to or greater than 457 mm (18 in.) before lining.

8.3.13.3 The manway flange shall be made of cast, forged, or fabricated metal that is weldable to the metal of the tank shell.

8.3.13.4 Openings for manways or for other service equipment shall be reinforced.

8.3.13.5 For TC specification 117 tank cars, all top shell service equipment – except for a hinged and bolted manway – is mounted on the cover plate and enclosed in a protective housing that meets the requirements set out in 8.2.2.4.

8.3.14 Post-weld heat treatment

8.3.14.1 After welding is completed, steel tanks and all attachments welded thereto shall be post-weld heat-treated as a unit in conformance with the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.3.14.2 For aluminum tanks, post-weld heat treatment is prohibited.

8.3.14.3 Tanks and welded attachments fabricated from high alloy steel materials do not require post-weld heat treatment.

8.3.15 Manway covers on a specification 111 or 117 tank car tank

Manway covers shall conform to the design requirements for non pressure cars set out in Appendix E of the AAR *Specifications for Tank Cars* publication.

8.3.16 Venting valves, loading and unloading valves, gauging, measuring, and sampling devices on a TC pressure tank car tank

8.3.16.1 The venting valves and loading and unloading valves shall be made of metal compatible with the dangerous goods and shall withstand the tank test pressure without leakage.

8.3.16.2 The venting valves and loading and unloading valves shall be bolted directly to the seatings on the manway cover, except as provided in 8.3.23.

8.3.16.3 The outlets of venting valves and loading and unloading valves shall be closed with screw plugs or other closures fastened to prevent misplacement.

8.3.16.4 The interior pipes of the loading and unloading valves shall be anchored.

8.3.16.5 Gauging devices, sampling devices, and thermometer wells shall conform to the following requirements:

a) be made of metal compatible with the dangerous goods and withstand the tank test pressure without leakage;

b) interior pipe of the thermometer well shall be anchored in a manner to prevent breakage; and

c) thermometer well shall be closed by a cap attached near the manway cover. Other arrangements that permit testing the thermometer well for leaks without complete removal of the closure may be used.

8.3.16.6 A sump or siphon bowl, welded or pressed into the shell, shall conform to the following requirements:

a) sump or siphon bowl shall be made of cast, forged, or fabricated metal that is weldable to the metal of the tank shell;

b) if the sump or siphon bowl is pressed into the bottom of the tank shell, the wall thickness of the pressed section shall be equal to or greater than that specified for the shell;

c) section of a tank of circular cross-section to which the sump or siphon bowl is attached need not conform to the out-of-roundness requirement set out in W13.5 of the AAR *Specifications for Tank Cars* publication; and

d) any portion of the sump or siphon bowl not forming a part of a cylinder of revolution shall have walls of such thickness and be so reinforced that the stresses in the walls caused by internal pressure are equal to or less than the circumferential stress caused by the same internal pressure in the wall of a tank of circular cross-section designed in conformance with the requirements set out in 8.3.6. The wall thickness shall be equal to or greater than that specified in 8.3.22.

8.3.17 Gauging devices, top loading and unloading devices, venting, and air inlet devices for a specification 111 or 117 tank car tank

8.3.17.1 Each device shall be of a design that will prevent interchange with any other service equipment.

8.3.17.2 Unloading pipes shall be securely anchored within the tank.

8.3.17.3 When the device is equipped with valves or fittings to permit the loading and unloading, each device, including valves or fittings, shall be provided with a protective housing.

8.3.17.4 Protective housings are not required when plug or ball-type valves are used and their operating handles are removed.

8.3.17.5 Provision shall be made for closing the pipe connections of valves.

8.3.17.6 A protective housing is not required for a vacuum-relief valve.

8.3.17.7 When a tank car with a hinged manway cover is equipped with a fixed internal gauging bar, an outage indicator visible through the manway opening shall be provided.

8.3.17.8 If loading devices are applied to permit tank loading with the cover closed, a telltale pipe may be used. The telltale pipe shall be capable of indicating that the required outage is provided. The pipe shall be equipped with a control valve equal to or less than 1/4 NPT nominal size mounted outside the tank and enclosed within a protective housing.

8.3.17.9 Other devices may be used instead of the outage indicator or telltale pipe referred to in 8.3.17.7 or 8.3.17.8.

8.3.17.10 A sump or siphon bowl, welded or pressed into the shell, shall conform to the following requirements:

a) the sump or siphon bowl shall be made of cast, forged, or fabricated metal that is weldable to the metal of the tank shell;

b) if the sump or siphon bowl is pressed into the bottom of the tank shell, the wall thickness of the pressed section shall be equal to or greater than that specified for the shell;

c) the section of a tank of circular cross-section to which the sump or siphon bowl is attached need not conform to the out-of-roundness requirement set out in W13.5 of the AAR *Specifications for Tank Cars* publication; and

d) any portion of the sump or siphon bowl not forming a part of a cylinder of revolution shall have walls of such thickness and be so reinforced that the stresses in the walls caused by internal pressure are equal to or less than the circumferential stress caused by the same internal pressure in the wall of a tank of circular cross-section designed in conformance with the requirements set out in 8.3.6. The wall thickness shall be equal to or greater than that specified in 8.3.25.

8.3.17.11 If top loading, discharge, venting or air inlet devices are installed at a location remote from the manway and with exposed piping:

a) shut-off valves shall be applied directly to reinforcing pads or nozzles at their communication through the tank shell and shall be enclosed in a protective housing with provision for a seal;

b) piping shall include breakage grooves and suitable bracing;

c) relief valves shall be applied to liquid lines for protection in case dangerous goods are trapped; and

d) provision shall be made to ensure closure of the shut-off valves during transport.

8.3.18 Plugs for openings

8.3.18.1 Each plug shall be solid, with NPT threads, and shall be of a length that will screw at least six threads inside the face of the fitting or tank.

8.3.18.2 Each plug, if inserted from the outside of a specification 111A tank head, shall have the letter “S” equal to or greater than 9.53 mm (3/8 in.) in height stamped or cast on the outside surface. The letter “S” indicates that the plug is solid.

8.3.19 Insulation

Specification 105 and 120 tank cars require insulation. When insulation is required, the insulation shall conform to the following requirements:

a) tank shell and head shall be insulated;

b) insulation shall be covered with a metal jacket that has a thickness equal to or greater than 3.04 mm (11 gauge) and shall be flashed around all openings so as to be weather tight;

c) exterior surface of a carbon steel tank and the inside surface of a carbon steel jacket shall be given a coating to protect against corrosion;

d) if exterior heaters are attached to the tank, the thickness of the insulation over each heater element may be reduced to one-half that required for the shell; and

e) insulation shall be of sufficient thickness so that the overall thermal conductance at 15.6 °C (60 °F) is equal to or less than 4.599 kJ/h·m^{2}·°C (0.225 Btu/h·ft.^{2}·°F) for specification 111 and 117 tank car tanks, or 1.533 kJ/h·m^{2}·°C (0.075 Btu/h·ft.^{2}·°F) for pressure tank car tanks.

8.3.20 Permanent markings

Subject to 7.3, a tank car tank shall conform to the following marking requirements:

8.3.20.1 Each tank shall have permanent markings, including:

a) tank car tank specification;

b) month and year of the original tank test;

c) tank manufacturer’s identifying mark;

d) tank car assembler’s identifying mark, if different from the tank manufacturer; and

e) material specification of the tank wall, including separate material specifications for the shell and heads if they are different and the cladding material specification if the tank is internally clad.

8.3.20.2 The permanent markings shall be stamped in letters and figures equal to or greater than 9.53 mm (3/8 in.) in height into the metal on the external surface and near the centre of both heads.

8.3.20.3 In the case of a TC specification 111 or 117 tank car tank, the last numeral of the specification number may be omitted from the marking; for example, a “TC 111A100W” marking for a specification 111A100W2 tank car. The following is an example of the required markings:

TC 105A100W

12-2001

ABC

Assembler/Assembleur: DEF

Head/Tête: ASTM A516-70

Shell/Coque: TC128B

Cladding/Revêtement: ASTM A 204-304 clad

8.3.21 Pressure testing of tanks

8.3.21.1 Each tank shall be tested by:

a) filling the tank to the top of the manway nozzle with water or other liquid having similar viscosity, at a temperature equal to or less than 37.8 °C (100 °F) during the test; and

b) applying a pressure equal to or greater than the tank car tank test pressure for at least 10 minutes.

8.3.21.2 Tanks shall be tested before insulation is applied.

8.3.21.3 Tanks shall be tested before any lining or coating is applied.

8.3.21.4 Repairs shall be made in conformance with the requirements set out in Appendix R of the AAR *Specifications for Tank Cars* publication.

8.3.21.5 Testing of exterior heaters is not required.

8.3.21.6 For a successful pressure test, there shall be no evidence of tank yielding or leakage, either liquid or gas, during the 10 minutes hold period.

8.3.22 Additional requirements for TC pressure tank car tank specifications

The requirements of column II to VIII of Table 5 apply to the corresponding specification indicated in the first column:

Table 5 – Individual specification minimum requirements – TC pressure tank car tanks

I	II	III	IV	V	VI	VII	VIII
TC specification	**Minimum plate thickness mm (in.)**	**Tank burst pressure kPa (psi)**	**Tank test pressure kPa (psi)**	**Minimum manway cover thickness mm (in.)**	**Bottom outlet**	**Bottom washout**	**Specific requirement**
105A100ALW	15.9 (5/8)	3447 (500)	689 (100)	63.5 (2 1/2)	No	No	8.3.22.1
105A200ALW	15.9 (5/8)	3447 (500)	1379 (200)	63.5 (2 1/2)	No	No	8.3.22.1
105A300ALW	15.9 (5/8)	5171 (750)	2068 (300)	66.7 (2 5/8)	No	No	8.3.22.1
105A100W	14.3 (9/16)	3447 (500)	689 (100)	57.2 (2 1/4)	No	No	8.3.22.2
105A200W	14.3 (9/16)	3447 (500)	1379 (200)	57.2 (2 1/4)	No	No	8.3.22.2
105A300W	17.5 (11/16)	5171 (750)	2068 (300)	57.2 (2 1/4)	No	No	8.3.22.2 8.3.22.3 8.3.22.4
105A400W	17.5 (11/16)	6894 (1000)	2758 (400)	57.2 (2 1/4)	No	No	8.3.22.2 8.3.22.3 8.3.22.4
105A500W	17.5 (11/16)	8618 (1250)	3447 (500)	57.2 (2 1/4)	No	No	8.3.22.2 8.3.22.3
105A600W	17.5 (11/16)	10342 (1500)	4137 (600)	57.2 (2 1/4)	No	No	8.3.22.2 8.3.22.3
112A200W	14.3 (9/16)	3447 (500)	1379 (200)	57.2 (2 1/4)	No	No	8.3.22.2 8.3.22.5
112A340W	17.5 (11/16)	5860 (850)	2344 (340)	57.2 (2 1/4)	No	No	8.3.22.2 8.3.22.3
112A400W	17.5 (11/16)	6894 (1000)	2758 (400)	57.2 (2 1/4)	No	No	8.3.22.2 8.3.22.3
112A500W	17.5 (11/16)	8618 (1250)	3447 (500)	57.2 (2 1/4)	No	No	8.3.22.2 8.3.22.3
120A200ALW	15.9 5/8	3447 (500)	1379 (200)	63.5 (2 1/2)	Optional	Optional	8.3.10.9 8.3.22.1

I	II	III	IV	V	VI	VII	VIII
TC specification	**Minimum plate thickness mm (in.)**	**Tank burst pressure kPa (psi)**	**Tank test pressure kPa (psi)**	**Minimum manway cover thickness mm (in.)**	**Bottom outlet**	**Bottom washout**	**Specific requirement**
120A100W	14.3 (9/16)	3447 (500)	689 (100)	57.2 (2 1/4)	Optional	Optional	8.3.10.9 8.3.22.2
120A200W	14.3 (9/16)	3447 (500)	1379 (200)	57.2 (2 1/4)	Optional	Optional	8.3.10.9 8.3.22.2
120A300W	17.5 (11/16)	5171 (750)	2068 (300)	57.2 (2 1/4)	Optional	Optional	8.3.10.9 8.3.22.2 8.3.22.3
120A400W	17.5 (11/16)	6894 (1000)	2758 (400)	57.2 (2 1/4)	Optional	Optional	8.3.10.9 8.3.22.2 8.3.22.3
120A500W	17.5 (11/16)	8618 (1250)	3447 (500)	57.2 (2 1/4)	Optional	Optional	8.3.10.9 8.3.22.2 8.3.22.3

8.3.22.1 If material other than aluminum alloys are used, the manway cover thickness shall be equal to or greater than 57.2 mm (2.25 in.).

8.3.22.2 The steel of the shell and heads shall be in the normalized condition.

8.3.22.3 If carbon steel of 483 to 558 MPa (70 000 to 81 000 psi) minimum tensile strength is used, the plate thickness shall be equal to or greater than 16.7 mm (21/32 in.). If high-alloy steel of 483 to 558 MPa (70 000 to 81 000 psi) minimum tensile strength is used, the plate thickness shall be equal to or greater than 15.9 mm (5/8 in.). If steel of 558 MPa (81 000 psi) minimum tensile strength is used, the plate thickness shall be equal to or greater than 14.3 mm (9/16 in.).

8.3.22.4 If the characteristics of the dangerous goods require the use of nickel or nickel alloy, other than high alloy (stainless) steel, the manway cover thickness shall be equal to or greater than 50.8 mm (2 in.).

8.3.22.5 For a tank car tank having an inside diameter equal to or less than 2210 mm (87 in.), the plate thickness shall be equal to or greater than 12.7 mm (1/2 in.).

8.3.22.6 The requirements set out in 8.3.23.2 and E3.1 of the AAR *Specifications for Tank Cars* publication apply.

8.3.23 Additional requirements for TC specification 120 pressure tank car tanks

8.3.23.1 Service equipment and openings

Service equipment need not be mounted on the manway cover and one opening may be provided in each head for use in purging the tank interior.

8.3.23.2 Manway cover

A protective housing is not required if no service equipment is mounted on the manway cover and the manway cover is adequately protected by an adjacently located protective structure.

Manway covers that conform to the requirements of clause 8.3.15 are authorized for specification 120A100W and 120A200W tank cars.

8.3.23.3 Venting valves, loading and unloading valves, and measuring and sampling devices

Venting valves, loading and unloading valves, and measuring and sampling devices shall conform to the following requirements:

a) if used, they shall be attached to a nozzle or nozzles on the tank shell or heads;

b) they shall be grouped in one location and, except as provided in 8.3.12, shall be equipped with a protective housing with cover or shall be recessed into the tank shell with cover. An additional set of venting valves, loading and unloading valves, and measuring and sampling devices grouped in another location is permitted;

c) the protective housing with cover, if used, shall have steel sidewalls of a thickness equal to or greater than 19.1 mm (3/4 in.) and a metal cover that can be securely closed and has a thickness equal to or greater than 6.35 mm (1/4 in.); and

d) for service equipment recessed into the tank shell with cover, the cover shall be made of metal having a thickness equal to or greater than 6.35 mm (1/4 in.).

8.3.23.4 Pressure-relief devices and pressure regulators

Pressure-relief devices and pressure regulators shall conform to both of the following requirements:

a) they shall be located on top of the tank near the centre of the car on a nozzle, mounting plate, or recessed in the shell. Any bolt or stud, if used, shall not enter the tank; and

b) metal guards shall be provided to protect pressure-relief devices and pressure regulators from damage.

8.3.24 Enhanced class 111 tank cars

8.3.24.1 A class 111 tank car is an enhanced class 111 tank car with a jacket if the following conditions are met:

a) all the top shell service equipment is enclosed in a protective housing that meets the requirements set out in 8.2.2.4.1;

b) the tank shell and heads are made of carbon or low-alloy steel plate, in the normalized condition, that is AAR TC128 Grade B steel or ASTM A516 Grade 70 steel, or high alloy steel plate;

c) tank heads made of AAR TC128 Grade B or ASTM A516 Grade 70 steel are normalized after forming;

d) in the case of a tank shell and heads made of AAR TC128 Grade B steel, the shell and heads have a thickness equal to or greater than 11.1 mm (7/16 in.);

e) in the case of a tank shell and heads made of ASTM A516 Grade 70 steel, the shell and heads have a thickness equal to or greater than 12.7 mm (1/2 in.);

f) in the case of a tank shell and heads made of high alloy steel, the shell and heads shall be at least 11.1 mm (7/16 in.) thick and be equipped with 12.7 mm (1/2 in.) thick jacket heads at a minimum;

g) the tank car is equipped with a jacket that:

   1) is made of ASTM A1011/A1011M steel, or steel of an equivalent standard;

   2) has a thickness equal to or greater than 3 mm (11 gauge); and

   3) is weather-resistant;

h) the tank is insulated or fitted with a thermal protection blanket;

i) the tank car is equipped with one or more reclosing pressure relief devices, each with a start-to-discharge pressure that is equal to or greater than 517 kPa (75 psi); and

j) the tank car is equipped at each end with a head shield that:

   1) is made with structural or pressure vessel steel plate that has a thickness equal to or greater than 12.7 mm (1/2 in.); and

   2) covers at least the lower half of the tank head.

8.3.24.2 A class 111 tank car is an enhanced class 111 tank car without a jacket if the following conditions are met:

a) the tank car meets the conditions set out in 8.3.24.1 a) to c) and i) to j);

b) in the case of a tank shell and heads made of AAR TC128 Grade B steel, the shell and heads have a thickness equal to or greater than 12.7 mm (1/2 in.);

c) in the case of a shell and heads made of ASTM A516 Grade 70 steel, the shell and heads have a thickness equal to or greater than 14.3 mm (9/16 in.); and

d) in the case of a tank shell and heads made of high alloy steel, the shell and heads have a thickness equal to or greater than 12.7 mm (1/2 in.) and be equipped with at least 12.7 mm (1/2 in.) thick half-head shields applied on the lower half of the head.

8.3.25 Additional requirements for TC 111 and TC 117 tank car tank specifications

The requirements of column II to VII of Table 6 apply to the corresponding specification indicated in the first column:

Table 6 – Individual specification minimum requirements – TC 111 and TC 117 tank car tanks

I	II	III	IV	V	VI	VII
TC specification	**Minimum plate thickness mm (in.)**	**Tank burst pressure kPa (psi)**	**Tank test pressure kPa (psi)**	**Bottom outlet**	**Bottom washout**	**Specific requirement**
111A60ALW1	12.5 (1/2)	1654 (240)	414 (60)	Optional	Optional	8.3.25.5.1
111A60ALW2	12.5 (1/2)	1654 (240)	414 (60)	No	Optional	—

I	II	III	IV	V	VI	VII
TC specification	**Minimum plate thickness mm (in.)**	**Tank burst pressure kPa (psi)**	**Tank test pressure kPa (psi)**	**Bottom outlet**	**Bottom washout**	**Specific requirement**
111A100ALW1	15.8 (5/8)	3447 (500)	689 (100)	Optional	Optional	8.3.25.5.1
111A100ALW2	15.8 (5/8)	3447 (500)	689 (100)	No	Optional	—
111A100W1	11.1 (7/16)	3447 (500)	689 (100)	Optional	Optional	8.3.25.5.1
111A100W2	11.1 (7/16)	3447 (500)	689 (100)	No	Optional	—
111A100W5	11.1 (7/16)	3447 (500)	689 (100)	No	No	8.3.25.3 8.3.25.5.2
111A100W6	11.1 (7/16)	3447 (500)	689 (100)	Optional	Optional	8.3.25.4 8.3.25.5.1 8.3.25.5.3
111A100W7	11.1 (7/16)	3447 (500)	689 (100)	No	No	8.3.25.3 8.3.25.5.3
117A100W1	14.3 (9/16)	3447 (500)	689 (100)	Optional	Optional	8.3.25.5.1 8.3.10.9
117A100W5	14.3 (9/16)	3447 (500)	689 (100)	No	No	8.3.25.3 8.3.25.5.2
117A100W6	14.3 (9/16)	3447 (500)	689 (100)	Optional	Optional	8.3.25.4 8.3.10.9 8.3.25.5.3

8.3.25.1 TC specification 111 and 117 suffixes

a) TC specification 111 tank car tank listed in the table of 8.3.25 shall conform to the following requirements:

1) “ALW” TC specification tank car tank shall be manufactured from aluminum alloy plate;

2) “W1” through “W5” TC specification tank car tank shall be manufactured from carbon steel plate;

3) “W6” and “W7” TC specification tank car tank shall be manufactured from high alloy steel plate; and

4) “W5” TC specification tank car tank shall have an interior lining that conforms to the requirements set out in 8.3.25.3.

b) TC specification 117 tank car tank listed in the table of 8.3.25 shall conform to the following requirements:

1) “W1” through “W5” TC specification tank car tank shall be manufactured from AAR TC128B normalized steel plate;

2) “W5” TC specification tank car tank shall have an interior lining that conforms to the requirements set out in 8.3.25.3; and

3) “W6” TC specification tank car tank shall be manufactured from high alloy steel plate.

8.3.25.2 Additional requirements for class TC 117 tank cars

a) Tank car shall be equipped with a thermal protection system that meets the requirements of 8.2.6, subject to 8.3.25.2 e) 3).

b) Tank car shall be equipped with a reclosing pressure device that meets the requirements of 8.2.5.

c) TC class 117 tank cars, other than specification TC117P, shall be equipped with a jacket that:

1) is manufactured using ASTM A1011/A1011M steel, or steel of an equivalent standard;

2) has a thickness equal to or greater than 3.04 mm (11 gauge); and

3) is weather resistant.

d) TC class 117 tank cars, other than specification TC117R or TC117P, shall be equipped with a tank head puncture resistance system that meets the requirements of 8.2.7.

e) For TC specification 117R (retrofit) tank cars, the following additional requirements apply:

1) the tank car shall be equipped at both ends with a full head shield that is made with structural or pressure vessel steel plate that has a thickness equal to or greater than 12.7 mm (1/2 in.);

2) the tank car tank shall have been manufactured prior to October 1, 2015, comply with the class 111 specification that was in force at the time of its manufacture, have a tank test pressure of 689 kPa (100 psi) and have a tank burst pressure of 3447 kPa (500 psi); and

3) a tank car that was in compliance with the requirements for an enhanced class 111 with a jacket prior to conversion to TC117R, was equipped with a fibreglass insulation system and does not comply with the thermal protection system requirements of 8.2.6, shall comply with the following:

i) be restricted to class 3, flammable liquid dangerous goods that have an API gravity less than or equal to 50 degrees, as determined by one of the test methods in Table 7:

Table 7– Test standards for determining the API gravity of flammable liquids [8.3.25.2 e) 3) i)]

Standard	Method
MPMS 9.1 (ASTM D1298)	density by hydrometer
MPMS 9.3 (ASTM D6822)	density by thermohydrometer
ASTM D4052	density by digital density meter

Standard	Method
ASTM D5002	density by digital density analyzer
ASTM D7042	density and viscosity by Stabinger viscometer
ASTM D7777	density by portable digital density meter
ASTM D287	density by hydrometer

ii) The fiberglass insulation system shall be capable of satisfying the performance standard for thermal protection systems in clause 8.2.6.1 for the dangerous goods.

iii) The tank car shall satisfy the thermal analysis requirements of clause 8.2.6.2 for the dangerous goods through computer analysis using AFFTAC model version 4.00 or later, subject to at least the model inputs specified in Table 8.

Table 8 – AFFTAC model inputs [(8.3.25.2 e) 3) iii)]

AFFTAC parameter	Value
TPS model	
Thermal conductivity - Steel (k)	60.6 W/m-°C (35 Btu/h-ft-°F)
Thermal conductivity - Degraded glass wool blanket (k)	0.744 W/m-°C (0.43 Btu/h-ft-°F)
TPS components	
Tank wall (Interior emissivity)	0.9
Tank wall (Exterior emissivity)	0.9
Tank wall width	11.2 mm (0.44 in.)
Degraded glass wool blanket (Interior emissivity)	0.9
Degraded glass wool blanket (Exterior emissivity)	0.9
Degraded glass wool blanket width	Tank specific
Coverage	Range (0-120) = 5, Range (120-180) = 100
Jacket (Interior emissivity)	0.9
Jacket (Exterior emissivity)	0.9
Jacket width	3.038 mm (0.1196 in.)
Analysis conditions	
Fire conditions	Special Conditions

AFFTAC parameter	Value
Flame temperature	815.6 °C (1500 °F)
Fire emissivity	1
Fraction exposed to fire	1
Length of simulation (min)	5000
Angle of rollover (degree)	120
Time increment (min)	0.1
How often output written (min)	1
Tank geometry	
Nominal capacity	Tank specific
Inside diameter	Tank specific
Wall thickness	11.113 mm (0.4375 in.)
Tank material	AAR TC128-70 Grades A&B Min. tensile strength 558 MPa (81 Kpsi)
Nominal bursting pressure	3447 kPa (500 psig)
Emissivity of tank surfaces	0.9
Safety relief device	
Rated flow capacity	Tank specific
Rating pressure	621 kPa (90 psig)
PRV start to discharge	517 kPa (75 psig)
Vapor discharge coefficient	0.8
Liquid discharge coefficient	0.6
Valve area	AFFTAC calculated
F (full close)	0.9
F (elbow)	0.93
F (full open)	1.03
f (elbow)	0.85
General	
Discontinuities	123.4 W/°C (234 Btu/h °F)
Fraction filled	0.97
Initial temperature	21.1 °C (70 °F)

AFFTAC parameter	Value
Padding gas present	Yes
Pressure	Atmospheric

iv) The statement:

"**NOT FOR CLASS 3 FLAMMABLE LIQUIDS WITH API GRAVITY GREATER THAN 50 DEGREES**", and/or

« **PAS POUR LES LIQUIDES INFLAMMABLES DE CLASSE 3 AVEC UNE GRAVITÉ D'API SUPÉRIEURE À 50 DEGRÉS** »,

is marked on each long side of the tank car in characters no less than 100 mm (4 in.) in height and on the manway cover in characters no less than 13 mm (1/2 in.) in height.

f) For TC specification 117P (performance standard) tank cars, the following additional requirements apply:

1) in the case of a retrofitted tank car, the tank car tank shall have been manufactured prior to October 1, 2015, comply with the class 111 specification that was in force at the time of its manufacture, have a tank test pressure of 689 kPa (100 psi) and have a tank burst pressure of 3447 kPa (500 psi);

2) tank car shall pass a side impact test and a head impact test carried out in accordance with Annexes A and B. A tank car passes the impact test if, at rest, there is no leak visible from the tank shell or head within at least one hour of the side impact test and within at least one hour of the head impact test; and

3) in addition to the approval requirements of 6.2, the design of the tank car shall be approved by the TC Director.

8.3.25.3 Lined tanks

8.3.25.3.1 Tanks lined with rubber

a) Commodities requiring a tank car tank to be lined with rubber shall use a rubber or other rubber compound that is either vulcanized or bonded directly to the metal to provide a non-porous laminated lining compatible with the intended commodity. The thickness of the lining shall be a minimum of 3.97 mm (5/32 in.).

b) Before a tank car tank is lined, a report certifying that the tank car and its equipment are in compliance with TC specification 111A100W5 or 117A100W5 shall be furnished by the tank car owner to the tank car facility who is to apply the lining. A copy of this report, certifying that the tank car tank has been lined in conformance with all requirements of TC specification 111A100W5 or 117A100W5 shall be furnished by the tank car facility lining the tank car tank to the lining owner. The lining owner shall retain reports of the latest lining application until the next relining has been accomplished and recorded.

c) Seams joining the rubber shall:

1) overlap at a minimum of 38.1 mm (1.5 in.) at all edges and the edges shall be straight and beveled to an angle of approximately 45° or, if the edges of the lining are butted, the butted edges shall be sealed with a minimum 76.2 mm (3 in.) strip of lining having approximately 45° beveled edges; or

2) has a thickness equal to or greater than 3.04 mm (11 gauge); and

3) be joined with a skived butt seam and then capped with a separate strip of lining having a width of 76.2 mm (3 in.) and having approximately 45° beveled edges.

d) Lining shall have an additional reinforcing pad applied on the bottom of the tank car tank directly under the manway opening. The reinforcing pad:

   1) shall be vulcanized to the lining on the bottom of the tank;

   2) shall have a minimum area of 0.418 m^2 (4.5 ft^2);

   3) shall make up a total minimum thickness with the lining of 12.7 mm (1/2 in.);

   4) edges shall be beveled at an angle of approximately 45°; and

   5) may have an opening for sump if so equipped.

e) Interior of the tank car tank shall be free from scale, oxidation, moisture, and all foreign matter during the lining operation. No part of the lining or reinforcing pad shall be under tension when applied; and

f) lining application shall be inspected in accordance with 9.5.11.

8.3.25.3.2 Tanks lined with other materials

a) Other lining materials may be used provided the material is compatible with the dangerous goods and is suitable for the service temperatures;

b) tank car tank or each compartment of a tank car tank may be lined with elastomeric polyvinyl-chloride having a lining thickness equal to or greater than 2.38 mm (3/32 in.);

c) tank car tank or each compartment of a tank car tank may be lined with elastomeric polyurethane having a lining thickness equal to or greater than 1.59 mm (1/16 in.);

d) hard rubber or polyvinyl chloride may be used for the pressure-retaining parts of safety vents provided the material is compatible with the dangerous goods and is suitable for the service temperatures; and

e) all surfaces of attachments or service equipment and their closures that are exposed to the dangerous goods shall be covered with acid-resistant material having a thickness equal to or greater than 3.18 mm (1/8 in.). Attachments made of metal that are not affected by the dangerous goods need not be covered with rubber or other acid-resistant material.

8.3.25.4 Material

All service equipment, tubes, castings, and all projections and their closures, but not protective housings, shall conform to the requirements specified in ASTM A262, except that when preparing the specimen for testing, the carburized surface may be finished by grinding or machining.

8.3.25.5 Manways and manway closures

8.3.25.5.1 The manway cover shall be designed to make it impossible to remove the cover while the interior of the tank is under pressure.

8.3.25.5.2 In the case of a TC specification 111A100W5 or 117A100W5 tank car tank:

a) the manway cover shall be made of metal;

b) the bottom of the manway cover shall be lined with an acid-resistant material applied in accordance with the requirements set out in 8.3.25.3 unless it is made of metal that is compatible with the dangerous goods; and

c) through-bolt holes shall be lined with acid-resistant material having a thickness equal to or greater than 3.18 mm (1/8 in.).

8.3.25.5.3 The manway flange and cover shall conform to the requirements set out in M3.3 of the AAR *Specifications for Tank Cars* publication.

8.4 General requirements applicable to TC class 115 tank car tanks consisting of an inner container supported within an outer shell

8.4.1 General

TC specification 115 tank car tanks shall conform to the requirements set out in 8.4, except where otherwise provided by the individual specification.

8.4.2 TC specification 115 tank car tanks

TC specification 115 tank car tanks shall consist of an inner container, a support system for the inner container, and an outer shell.

8.4.3 Inner container and outer shell

8.4.3.1 The inner container shall:

a) be a fusion-welded tank of circular cross section with formed convex outward heads; and

b) have a manway on top of the tank conforming to the requirements set out in this section.

8.4.3.2 If the inner container is divided into compartments, each compartment is considered to be a separate container.

8.4.3.3 The outer shell shall be a fusion-welded tank with formed convex outward heads.

8.4.4 Insulation

The annular space between the inner container and the outer shell shall contain insulation material. The insulation material shall be of sufficient thickness so that the overall thermal conductance at 15.6 °C (60 °F) is equal to or less than 0.777 kJ/h·m^{2}·°C (0.038 Btu/h·ft.^{2}·°F).

8.4.5 Minimum thickness

8.4.5.1 The minimum thickness, in millimetres (inches), after forming of the inner container shell and of 2:1 ellipsoidal heads shall be the greater of:

a) the minimum plate thickness specified in 8.4.23.1; and

b) the plate thickness calculated using the following formula:

$$t = \frac{Pd}{2SE}$$

where:

t = minimum thickness of plate, in mm (in.), after forming;

P = minimum burst pressure, in MPa (psi);

d = inside diameter, in mm (in.);

S = minimum tensile strength of plate material, in MPa (psi), as specified in 8.4.6;

E = 0.9, a factor representing the efficiency of welded joints, except that for welds that are 100% radiographed, E = 1.0.

8.4.5.2 The minimum thickness, in millimetres (inches), after forming of the inner container heads, if the heads are flanged and dished, shall be the greater of:

a) the minimum plate thickness specified in 8.4.23.1; and

b) the plate thickness calculated using the following formula:

$$t = \frac{5PL}{6SE}$$

where:

t = minimum thickness of plate, in mm (in.), after forming;

P = minimum burst pressure, in MPa (psi);

L = main inside radius to which the head is dished, measured on the concave side, in mm (in.);

S = minimum tensile strength of plate material, in MPa (psi), as specified in 8.4.6;

E = 0.9, a factor representing the efficiency of welded joints, except that for welds that are 100% radiographed, E = 1.0.

8.4.5.3 The wall thickness, after forming, of the cylindrical section and heads of the outer shell shall be equal to or greater than 11.1 mm (7/16 in.).

8.4.5.4 If the inner container is divided into compartments, the thickness shall conform to the requirements specified in 8.4.9 and 8.4.10.

8.4.6 Metal plate for inner container and nozzles

8.4.6.1 Carbon and low alloy steel plate:

a) shall conform to one of the following specifications and grades: ASTM A516/A516M, Grade 70/485 or AAR TC128, Grade B;

b) shall have a maximum carbon content of 0.31%; and

c) may be clad with other materials authorized in Appendix M of the AAR *Specifications for Tank Cars* publication.

8.4.6.2 Aluminum alloy plate:

a) shall be used in one of the following tempers: 0, H112, or H32, except for alloy 5083 that shall be used in the 0 temper only;

b) filler material alloy conforming to unified Numbering System UNS A95556 shall not be used; and

c) plate shall conform to one of the specifications and corresponding minimum tensile strength set out in Table 9:

Table 9 – Minimum tensile strength – aluminum alloy plate for inner container and nozzles

Specification	Minimum tensile strength MPa (psi)
ASTM B209M or B209, Alloy 5052	172 (25 000)
ASTM B209M or B209, Alloy 5083	262 (38 000)
ASTM B209M or B209, Alloy 5086	241 (35 000)
ASTM B209M or B209, Alloy 5154	207 (30 000)
ASTM B209M or B209, Alloy 5254	207 (30 000)
ASTM B209M or B209, Alloy 5454	214 (31 000)
ASTM B209M or B209, Alloy 5652	172 (25 000)

8.4.6.3 High alloy steel plate

In the case of high alloy steel plate, the plate shall conform to one of the following types: ASTM A240/A240M Type 304, 304L, 316, or 316L.

8.4.6.4 Manganese-molybdenum steel plate

In the case of manganese-molybdenum steel plate, the manganese-molybdenum steel plate shall conform to specification ASTM A302/A302M, Grade B.

8.4.7 Metal plate for outer shell

8.4.7.1 The cylindrical section and heads of the outer shell shall be manufactured from the materials listed in 8.4.6, and, in the case of steel plate materials, listed in 8.4.6.1, 8.4.6.3, or 8.4.6.4;

a) maximum carbon content is 0.31%; and

b) steel plate may be clad with other materials authorized in Appendix M of the AAR *Specifications for Tank Cars* publication.

8.4.8 Material for service equipment

All service equipment on the inner container in contact with the dangerous goods shall be made with materials that are compatible with the plate material of the inner container and be compatible with the dangerous goods or shall be coated or lined with suitable corrosion-resistant material. Materials for castings and fittings shall conform to the requirements set out in M4.5 of the AAR *Specifications for Tank Cars* publication.

8.4.9 Tank heads

8.4.9.1 Heads of the inner container, the compartments of the inner container, and the outer shell shall be flanged and dished or have the form of an ellipsoid and shall be convex outward.

8.4.9.2 Ellipsoidal heads shall be an ellipsoid of revolution in which the major axis is equal to the diameter of the shell and the minor axis is equal to one-half the major axis.

8.4.9.3 Flanged and dished heads shall have:

a) main inside radius equal to or less than 3048 mm (120 in.); and

b) inside knuckle radius equal to or greater than:

   1) 95.3 mm (3.75 in.) for steel and alloy steel tanks; and

   2) 127 mm (5 in.) for aluminum alloy tanks.

8.4.10 Compartmented tanks

8.4.10.1 The inner container may be divided into compartments by:

a) inserting interior heads;

b) manufacturing each compartment as a separate container and joining the compartments with a cylinder; or

c) manufacturing each compartment as a separate tank without joining the compartments with a cylinder.

8.4.10.2 Each compartment shall be capable of withstanding, without evidence of yielding or leakage, the required tank test pressure applied in each compartment separately or in any combination of compartments.

8.4.10.3 If the inner container is divided into compartments by manufacturing each compartment as a separate container and joining the compartments with a cylinder:

a) cylinder shall have a plate thickness equal to or greater than that required for the inner container shell;

b) cylinder shall be applied to the outside surface of the straight flange portion of the container head;

c) cylinder shall fit the straight flange tightly for a distance of at least two times the plate thickness or 25.4 mm (1 in.), whichever is greater;

d) cylinder shall be joined to the straight flange by a full fillet weld; and

e) distance from fillet weld seam to container head seam shall be equal to or greater than 38.1 mm (1.5 in.) or three times the plate thickness, whichever is greater.

8.4.11 Welding

8.4.11.1 Welders shall comply with and welding procedures shall conform to the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.4.11.2 Radiography of the outer shell is not a specification requirement.

8.4.12 Post-weld heat treatment

8.4.12.1 Post-weld heat treatment of the inner container is not required.

8.4.12.2 Post-weld heat treatment of the cylindrical portions of the outer shell to which the anchorage or draft sills are attached shall conform to the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.4.12.3 If cold-formed heads are used on the outer shell and post-weld heat treatment is not practicable due to assembly procedures, the cold-formed heads shall be heat-treated before welding to the cylindrical section of the outer shell.

8.4.13 Inner container manway nozzle and cover

8.4.13.1 A manway nozzle shall be designed with an access opening having an inside diameter equal to or greater than 457 mm (18 in.) or at least 356 x 457 mm (14 x 18 in.) obround or oval.

8.4.13.2 The design of the manway nozzle and its cover shall ensure a secure closure and shall prevent the removal of the cover while the tank interior is under pressure.

8.4.13.3 All joints between manway covers and their seats shall be made vapour-tight and liquid-tight by the use of suitable gaskets.

8.4.13.4 Manway covers shall be of cast, forged, or fabricated metal and shall conform to the requirements of 8.4.8.

8.4.13.5 A seal shall be provided between the manway nozzle of the inner container and the opening in the outer shell.

8.4.14 Opening in the tanks

Openings in the inner container and the outer shell shall be reinforced in conformance with Appendix E of the AAR *Specifications for Tank Cars* publication. In calculating the required reinforcement area for openings in the outer shell, the calculated required shell thickness “t” shall be equal to 6.35 mm (1/4 in.).

8.4.15 Support system for inner container

8.4.15.1 The inner container shall be supported within the outer shell by a support system of such strength and ductility that, at the operating temperature of the support system, the system is capable of supporting the inner container when filled with liquid dangerous goods to any level.

8.4.15.2 The support system shall be designed to support, without yielding, impact loads producing accelerations of the following magnitudes and directions when:

a) inner container is loaded so that the tank car is at its rail load limit; and

b) tank car is equipped with a conventional draft gear:

   1) longitudinal 7g;

   2) transverse 3g;

   3) vertical 3g.

Note: g is the standard acceleration due to gravity. For calculation purposes, g = 9.81 m/s^2 (32.2 ft/s^2).

8.4.15.3 The longitudinal acceleration may be reduced to 3g if a cushioning device, which has been tested to demonstrate its ability to limit tank car tank forces to a maximum of 1779 kN (400 000 lbf) at an impact speed of 16.1 km/h (10 mph), is used between the coupler and the tank structure.

8.4.15.4 The inner container shall be thermally isolated from the outer shell to the maximum practical extent.

8.4.15.5 The inner container and outer shell shall be electrically bonded to each other, either by the support system used, by piping, or by a separate electrical connection.

8.4.16 Gauging devices, top loading and unloading devices, venting and air inlet devices

8.4.16.1 Each device shall be designed to prevent interchange with any other service equipment.

8.4.16.2 Each pipe shall be securely anchored within the inner container.

8.4.16.3 Each inner container or compartment of an inner container may be equipped with one separate air connection.

8.4.16.4 If the dangerous goods are such that a device shall be equipped with valves or fittings to permit the loading and unloading of the dangerous goods, each device, including valves or fittings, shall be enclosed within a protective housing.

8.4.16.5 Protective housings are not required when plug or ball-type valves are used and their operating handles are removed.

8.4.16.6 Provision shall be made for closing the pipe connections of valves.

8.4.16.7 An inner container may be equipped with a vacuum-relief valve and, if an inner container is so equipped, a protective housing is not required.

8.4.16.8 When a gauging device is required, an outage indicator visible through the manway opening shall be provided.

8.4.16.9 If loading devices are applied to permit tank loading with the cover closed, a telltale pipe may be used. The telltale pipe shall be capable of indicating that the required outage is provided. The pipe shall be equipped with a control valve equal to or less than 6.35 mm (1/4 in.) NPT mounted outside the tank and enclosed within a protective housing.

8.4.16.10 Other devices may be used instead of the outage indicator or a telltale pipe referred to in 8.4.16.8 or 8.4.16.9.

8.4.16.11 A sump or siphon bowl, welded or pressed into the shell, shall conform to the following requirements:

a) sump or siphon bowl shall be made of cast, forged, or fabricated metal that is weldable to the metal of the tank shell;

b) if the sump or siphon bowl is pressed into the bottom of the inner container shell, the wall thickness of the pressed section shall be equal to or greater than that specified for the shell;

c) section of a tank of circular cross-section to which the sump or siphon bowl is attached need not conform to the out-of-roundness requirement set out in W13.5 of the AAR *Specifications for Tank Cars* publication; and

d) any portion of the sump or siphon bowl not forming a part of a cylinder of revolution shall have walls of such thickness and be so reinforced that the stresses in the walls caused by a given internal pressure are equal to or less than the circumferential stress that would exist under the same internal pressure in the wall of a tank of circular cross section designed in conformance with the requirements set out in 8.4.5.1 and, if applicable, 8.4.10. The wall thickness shall be equal to or greater than that specified in 8.4.23.1.

e) Protective housing, if required, shall have a cover and sidewalls having a thickness equal to or greater than 3.02 mm (0.119 in.).

8.4.17 Bottom outlets and outer shell openings

8.4.17.1 The bottom outlet shall not extend from the outer shell more than that authorized in Appendix E of the AAR *Specifications for Tank Cars* publication.

8.4.17.2 Each bottom outlet reducer and secondary closure and their attachments shall be secured to the tank car by, at least, a 9.53 mm (3/8 in.) chain or its equivalent, except that outlet closure plugs may be secured by a 6.35 mm (1/4 in.) chain or its equivalent.

8.4.17.3 If the bottom outlet closure is of the combination cap-and-valve type, the pipe connection to the valve shall be closed by a plug, cap, or quick-coupling device.

8.4.17.4 The bottom outlet equipment shall include only the valve, reducer, and closures that are necessary for the attachment to unloading equipment.

8.4.17.5 Each bottom outlet shall be provided with a liquid-tight closure at its lower end.

8.4.17.6 The valve and its operating mechanism shall be applied to the outside bottom of the inner container and the valve operating mechanism shall include a means of locking the valve in the closed position during transport.

8.4.17.7 To provide for the attachment of unloading connections, the bottom of the main portion of the outlet nozzle or valve body, or any fixed attachment thereto, shall be provided with a threaded cap closure arrangement or bolted flange closure arrangement having a maximum 1 NPT solid plug.

8.4.17.8 If the outlet nozzle and its closure extend below the bottom of the outer shell, the outlet nozzle shall conform to the following requirements:

a) breakage “V” groove or its equivalent shall be cut, not cast, into the upper part of the outlet nozzle at a point immediately below the lowest part of the valve to a depth that leaves the thickness of the nozzle wall at the root of the “V” equal to or less than 6.35 mm (1/4 in.);

b) if the outlet nozzle on interior valves or the valve body on exterior valves is steam-jacketed, the breakage groove or its equivalent shall be below the steam chamber but above the bottom of the centre sill for tank cars with continuous center sills;

c) if the outlet nozzle is not a single piece or if exterior valves are applied, provision shall be made for the equivalent of the breakage groove;

d) on tank cars without continuous centre sills, the breakage groove or its equivalent shall be equal to or less than 381 mm (15 in.) below the outer shell; and

e) on tank cars with continuous centre sills, the breakage groove or its equivalent shall be above the bottom of the centre sill.

8.4.17.9 The thickness of the valve body shall be such that it is capable of:

a) preventing distortion of the valve or valve seat by any change in contour of the inner container shell resulting from the expansion of the dangerous goods or from other causes; and

b) ensuring that accidental breakage of the outlet nozzle will occur at or below the breakage “V” groove or its equivalent.

8.4.17.10 The valve shall have no wings or stem projecting below the breakage “V” groove or its equivalent. The valve and valve seat shall be readily accessible or removable for repairs, including grinding.

8.4.18 Bottom washouts

8.4.18.1 The bottom washout equipment shall not extend from the outer shell more than that authorized in Appendix E of the AAR *Specifications for Tank Cars* publication.

8.4.18.2 If the washout nozzle extends below the bottom of the outer shell, the washout nozzle shall conform to the following requirements:

a) breakage “V” groove shall be cut, not cast, in the upper part of the washout nozzle at a point immediately below the lowest part of the inside closure seat or plug to a depth that leaves the thickness of the nozzle wall at the root of the “V” equal to or less than 6.35 mm (1/4 in.);

b) if the washout nozzle is not a single piece, provision shall be made for the equivalent of the breakage groove;

c) thickness of the washout nozzle shall be sufficient to ensure that accidental breakage will occur at or below the breakage “V” groove or its equivalent;

d) on tank cars without continuous centre sills, the breakage “V” groove or its equivalent shall be equal to or less than 381 mm (15 in.) below the outer shell; and

e) on tank cars with continuous centre sills, the breakage “V” groove or its equivalent shall be above the bottom of the centre sill.

8.4.18.3 The closure plug and seat shall be readily accessible or removable for repairs, including grinding.

8.4.18.4 The closure of the washout nozzle shall be equipped with a 19.1 mm (3/4 in.) NPT solid plug. The plug shall be attached to its nozzle by, at least, a 6.35 mm (1/4 in.) chain.

8.4.18.5 Joints between closures and their seats shall be gasketed with suitable material.

8.4.19 Plugs for openings

8.4.19.1 Each plug shall be solid, with NPT threads, and shall be of a length that will screw at least six threads inside the face of the fitting or tank.

8.4.19.2 Each plug, if inserted from the outside of the outer shell tank heads, shall have the letter “S” equal to or greater than 9.53 mm (3/8 in.) in height stamped with a steel stamp or cast on the outside surface. The letter “S” indicates that the plug is solid.

8.4.20 Pressure testing of the inner container

8.4.20.1 Each inner container or compartment shall be tested hydrostatically to a pressure equal to or greater than the specification test pressure.

8.4.20.2 The temperature of the pressurizing medium shall be equal to or less than 37.8 °C (100 °F) during the test.

8.4.20.3 The inner container shall hold the specified pressure for at least 10 min without evidence of yielding or leakage.

8.4.20.4 Pressure-relief devices shall be removed during the test.

8.4.20.5 The inner container shall be pressure-tested before installation within the outer shell.

8.4.20.6 Items that, because of assembly sequence, shall be welded to the inner container after its installation within the outer shell shall have their attachment welds thoroughly inspected by a non destructive evaluation method conforming to Appendix T of the AAR *Specifications for Tank Cars* publication.

8.4.21 Permanent markings

8.4.21.1 Subject to 7.3, each outer shell shall have permanent markings, including:

a) tank car tank specification;

b) month and year of the original pressure test of the inner container;

c) inner container manufacturer's identifying mark;

d) material specification of the inner container;

e) as-built thickness of the shell and heads of the inner container;

f) material specification of the outer shell;

g) outer shell manufacturer's identifying mark; and

h) tank assembler's identifying mark, if different from the inner container or outer shell manufacturer.

8.4.21.2 The permanent markings shall be stamped in letters and figures equal to or greater than 9.53 mm (3/8 in.) in height into the metal near the centre of both outside heads. The inner container heads shall not be stamped. The following is an example of the required markings:

TC 115A60W6

12-2001

ABC

Inner/Int. ASTM A240 316L

Head/Tête 3.81 mm 0.150 in./po

Shell/Coque 4.24 mm 0.167 in./po

Outer/Ext. ASTM A516 -70

Outer/Ext. DEF

Assembler/Assembleur KLM

8.4.22 Stencilling

8.4.22.1 The outer shell shall be stencilled in conformance with 7.2.1.

8.4.22.2 The safe upper temperature limit, if applicable, for the inner tank, insulation and support system shall be applied by stencilling on both sides of the outer shell near the centre in letters and figures equal to or greater than 38.1 mm (1.5 in.) in height.

8.4.23 Individual specification requirements applicable to TC specification 115 tank car tanks

8.4.23.1 Individual specification minimum requirements

In addition to the applicable requirements set out in 8.4.1, the inner container shall conform to the individual specification requirements corresponding to the TC specification set out in Table 10:

Table 10 – Individual specification minimum requirements – TC 115 tank car tanks

TC specification	Minimum inner container thickness mm (in.)	Tank burst pressure kPa (psi)	Tank test pressure kPa (psi)	Bottom outlet	Bottom washout
115A60ALW	4.76 (3/16)	1654 (240)	414 (60)	Optional	Optional
115A60W1	3.18 (1/8)	1654 (240)	414 (60)	Optional	Optional
115A60W6	3.18 (1/8)	1654 (240)	414 (60)	Optional	Optional

8.5 General requirements applicable to class TC 113 vacuum-insulated tank car tanks for cryogenic liquids

8.5.1 General

A TC specification 113 vacuum-insulated tank car shall conform to the requirements set out in 8.5 and any other applicable requirements of this standard.

8.5.2 Type

A specification 113 tank car tank shall conform to the following requirements:

a) consists of an inner tank of circular cross-section supported essentially concentric within an outer shell of circular cross-section, with the out-of-roundness of both the inner tank and outer shell limited in accordance with the requirements set out in Section VIII, Division I, par. UG-80 of the ASME *Boiler and Pressure Vessel Code*;

b) have the annular space evacuated, after application of insulating material within the annular space;

c) have the inner tank heads concave to pressure;

d) have the outer shell heads convex outward; and

e) be equipped with piping systems for the venting of vapour and the transfer of the dangerous goods and with pressure-relief devices and other service equipment as specified in this section.

8.5.3 Insulation system and performance standard

A specification 113 tank car tank shall conform to the following requirements.

8.5.3.1 Nomenclature

a) Standard heat transfer rate (SHTR), expressed in kJ/d/kg (Btu/d/lb) of water capacity, means the rate of heat transfer used for determining the satisfactory performance of the insulation system, as set out in the table of 8.5.23.1;

b) test refrigerated liquid means the refrigerated liquid, which may be different from the dangerous goods intended to be shipped in the tank car tank, being used during the performance tests of the insulation system;

c) normal evaporation rate (NER), expressed in kg (lb) of the refrigerated liquid per day, means the rate of evaporation, determined by test, known as the NER test, of a test refrigerated liquid in a tank maintained at a pressure of approximately one bar (atmosphere), absolute;

d) stabilization period means the lapsed time after a tank car tank is filled with the test refrigerated liquid until the NER has stabilized or 24 h has passed, whichever is the greater; and

e) the calculated heat transfer rate (CHTR) is calculated using the following formula which uses test data obtained during the NER test:

$$q = \frac{N \cdot \Delta h \cdot \left(T - t_1\right)}{V \cdot \rho \cdot \left(t_s - t_f\right)}$$

where:

q = CHTR, in kJ/d/kg (Btu/d/lb) of water capacity;

N = NER, determined by NER test, in kg/d (lb/d);

Δh = latent heat of vaporization of the test refrigerated liquid at the NER test pressure of approximately one bar (atmosphere), absolute, in kJ/kg (Btu/lb);

T = ambient temperature of 32.2 °C (90 °F);

t_1 = equilibrium temperature of the intended dangerous goods at maximum shipping pressure, in degrees Celsius (Fahrenheit);

V = water volume, at 15.6 °C (60 °F), of the inner tank, in L (US gallons);

ρ = specific gravity of water at 15.6 °C (60 °F), 0.999007 kg/L (8.33712 lb/US gal);

t_s = average temperature of the outer shell, determined by averaging jacket temperatures at various locations on the jacket at regular intervals during the NER test, in °C (°F);

t_f = equilibrium temperature of the test refrigerated liquid at the NER test pressure of approximately 100 kPa (1 atmosphere), absolute, in °C (°F).

8.5.3.2 Specification 113A60W9 tank cars shall:

a) be filled with the cryogenic liquid intended for transport to the maximum permitted filling density specified in special provision 64 f), schedule 1, Annex E, before the NER test is conducted; and

b) have a CHTR equal to or less than the SHTR specified in the table of 8.5.23.1 for a specification 113A60W9 tank car.

8.5.3.3 Specification 113A90W tank cars shall:

a) be filled with the cryogenic liquid intended for transport to the maximum permitted filling density specified in special provision 65 f), schedule 1, Annex E, before the NER test is conducted; and

b) have a CHTR equal to or less than the SHTR specified in the table of 8.5.23.1 for a specification 113A90W tank car.

8.5.3.4 Specification 113C120W9 and 113C140W9 tank cars shall:

a) be filled with:

1) the cryogenic liquid intended for transport to the maximum permitted filling density specified in special provision 64 f), schedule 1, Annex E, before the NER test is conducted; or

2) nitrogen, refrigerated liquid to 90% of the volumetric capacity of the inner tank before the NER test is conducted; and

b) have a CHTR equal to or less than 75% of the SHTR specified in the table of 8.5.23.1 for the tank car specification.

8.5.3.5 If the insulation consists of a powder susceptible to settlement, the entire top of the cylindrical portion of the inner tank shall be insulated with a layer of glass fibre insulation equal to or greater than 25.4 mm (1 in.) nominal thickness or equivalent, held in position and covering an area extending 25° to each side of the top centreline of the inner tank.

8.5.3.6 The outer shell shall be equipped with service equipment to permit evacuation of the annular space between the outer shell and the inner tank.

8.5.3.7 The outer shell shall be equipped with a system to measure the absolute pressure in the annular space. The system shall be permanently positioned so as to be easily visible or provide an easily accessible connection for the use of a portable device.

8.5.4 Metal plate

8.5.4.1 Stainless steel of ASTM specification A240/A240M, type 304, or 304L shall be used for the inner tank and its service equipment, as set out in Appendix M of the AAR *Specifications for Tank Cars* publication and shall be in the annealed condition prior to fabrication, forming and fusion welding.

8.5.4.2 The outer shell and heads shall be made from steel specified in 8.3.5. Any steel casting, steel forging, steel structural shape, attached to the outer shell or heads shall be as set out in Appendix M of the AAR *Specifications for Tank Cars* publication.

8.5.4.3 Impact tests shall be:

a) conducted in accordance with the requirements set out in W8.1 of the AAR *Specifications for Tank Cars* publication;

b) performed on specimens of the material taken in the longitudinal direction of rolling;

c) performed at a temperature equal to or less than the tank design service temperature; and

d) performed on test plate welds and materials that are used to manufacture the inner tank and service equipment and that are subject to the refrigerated liquid temperatures.

8.5.4.4 Impact test results shall be equal to or greater than those set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.5.4.5 The report of impact tests shall include the absorbed energy results and the lateral expansion data for each tested specimen.

8.5.4.6 Tank car specifications with a delimiter of "W9" shall have the outer shell and heads be made of AAR TC–128B normalized steel plate. Any steel casting, steel forging, steel structural shape, attached to the outer shell or heads shall be as set out in Appendix M of the AAR *Specifications for Tank Cars* publication.

8.5.5 Burst and buckling pressure

8.5.5.1 The inner tank shall have a burst pressure equal to or greater than that specified in 8.5.23.1.

8.5.5.2 The outer shell shall be designed in accordance with the requirements set out in 8.5.7.4 and 8.5.7.5, and shall conform to the design loads and stresses specified in 6.2 of the AAR *Design, Fabrication and Construction of Freight Cars* publication. The designs and calculations shall take into account the loads transferred to the outer shell through the support system.

8.5.6 Heads

8.5.6.1 A tank head of the inner tank and outer shell shall be flanged and dished, or have the form of an ellipsoid of revolution.

8.5.6.2 A flanged and dished head shall have:

a) main inside dish radius equal to or less than the outside diameter of the straight flange;

b) an inside knuckle radius equal to or greater than 6% of the outside diameter of the straight flange; and

c) an inside knuckle radius equal to or greater than three times the head thickness.

8.5.7 Minimum thickness

8.5.7.1 The minimum wall thickness, after forming, of the inner tank shell and any 2:1 ellipsoidal inner tank head shall be the greater of:

a) applicable minimum plate thickness of the shell and the applicable minimum head thickness specified in 8.5.23.1; and

b) thickness calculated using the following formula:

$$t = \frac{Pd}{2SE}$$

where:

t = minimum thickness of plate material, in mm (in.), after forming;

P = minimum burst pressure, in MPa (psi);

d = inside diameter, in mm (in.);

S = minimum tensile strength of the plate material, as set out in Table M.10.3, of the AAR *Specifications for Tank Cars* publication, in MPa (psi);

E = 0.9, a factor representing the efficiency of welded joints, except that for seamless heads, E = 1.0.

8.5.7.2 The minimum wall thickness, measured after forming, of any 3:1 ellipsoidal inner tank head shall be the greater of:

a) minimum head thickness specified in 8.5.23.1; and

b) thickness calculated using the following formula:

$$t = \frac{1.83Pd}{2SE}$$

where:

t = minimum thickness of plate material, in mm (in.), after forming;

P = minimum burst pressure, in MPa (psi);

d = inside diameter, in mm (in.);

S = minimum tensile strength of the plate material, as set out in Table M.10.3, of the AAR *Specifications for Tank Cars* publication, in MPa (psi);

E = 0.9, a factor representing the efficiency of welded joints, except that for seamless heads, E = 1.0.

8.5.7.3 The minimum wall thickness, after forming, of a flanged and dished head for the inner tank shall be the greater of:

a) minimum head thickness specified in 8.5.23.1; and

b) thickness calculated using the following formula:

$$t = \frac{PL\left[3 + \left(L/r\right)^{0.5}\right]}{8SE}$$

where:

t = minimum thickness of plate, in mm (in.), after forming;

P = minimum burst pressure, in MPa (psi);

L = main inside radius of dished head, in mm (in.);

r = inside knuckle radius, in mm (in.);

S = minimum tensile strength of plate material, as set out in Table M.10.3, of the AAR *Specifications for Tank Cars* publication, in MPa (psi);

E = 0.9, a factor representing the efficiency of welded joints, except that for seamless heads, E = 1.0.

8.5.7.4 The minimum wall thickness, after forming, of the outer shell shall be equal to or greater than specified in 8.5.23.1.

8.5.7.5 The minimum wall thickness, after forming, of the outer shell heads shall be equal to or greater than specified in 8.5.23.1.

8.5.7.6 The annular space shall be evacuated and the cylindrical portion of the outer shell between the heads, or between the stiffening rings if stiffening rings are used, shall be designed to withstand an external critical collapsing pressure equal to or greater than 0.259 MPa (37.5 psi), as calculated using the following formula:

$$P_c = \frac{2.6E\left(t/D\right)^{2.5}}{\left(L/D\right)-0.45\left(t/D\right)^{0.5}}$$

where:

P_c = critical collapsing pressure equal to or greater than 0.259 MPa (37.5 psi);

E = modulus of elasticity of outer shell material, in MPa (psi);

t = minimum thickness of outer shell material, in mm (in.), after forming;

D = outside diameter of outer shell, in mm (in.);

L = distance between stiffening ring centres, in mm (in.).

For the purpose of the calculations in this clause, the outer shell heads may be considered as stiffening rings located one-third the head depth from the head-to-shell tangent line.

8.5.8 Stiffening rings

8.5.8.1 If stiffening rings are used in designing the outer shell for external pressure:

a) stiffening rings shall be attached to the outer shell by means of fillet welds;

b) outside stiffening ring attachment welds shall be continuous on each side of the ring;

c) inside stiffening ring attachment welds may be intermittent welds on each side of the ring and the total length of weld on each side shall be equal to or greater than one-third of the circumference of the tank; and

d) maximum space between welds shall not exceed eight times the outer shell wall thickness.

8.5.8.2 A portion of the outer shell may be included when calculating the moment of inertia of the ring.

8.5.8.3 The effective width of jacket plate on each side of the attachment of the stiffening ring shall be the width calculated using the following formula:

$$W = 0.78 \times \sqrt{Rt}$$

where:

W = width of jacket effective on each side of the stiffening ring, in mm (in.);

R = outside radius of the outer shell, in mm (in.);

t = plate thickness of the outer shell, in mm (in.), after forming.

8.5.8.4 If a stiffening ring is used that consists of a closed section having two webs attached to the outer shell:

a) jacket plate between the webs may be included up to the limit of twice the value of “W,” as defined in 8.5.8.3;

b) outer flange of the closed section, if not a steel structural shape, is subject to the same limitations of “W” as in 8.5.8.4 a), based on the “R” and “t” values of the flange as defined in 8.5.8.3;

c) if two separate members, such as two angles, are located less than twice the value of “W” apart, as defined in 8.5.8.3, they may be treated as a single stiffening ring member;

d) maximum length of plate, which may be considered effective, is four times the value of “W”, as defined in 8.5.8.3; and

e) closed section between an external ring and the outer shell shall be provided with an opening for drainage.

8.5.8.5 The stiffening ring shall have a moment of inertia large enough to support the critical collapsing pressure, as calculated using one of the following formulas:

$$I = \frac{0.035\, D^3 L\, P_c}{E}$$

or

$$I' = \frac{0.046\, D^3 L\, P_c}{E}$$

where:

I = required moment of inertia of stiffening ring about the centroidal axis parallel to the outer shell axis, in mm (in.) to the fourth power;

I' = required moment of inertia of combined section of stiffening ring and effective width of jacket plate about the centroidal axis parallel to the outer shell axis, in mm (in.) to the fourth power;

D = outside diameter of the outer shell, in mm (in.);

L = one-half of the distance from the centre line of the stiffening ring to the next line of support on one side plus one-half of the distance from the centreline to the next line of support on the other side of the stiffening ring. Both distances are to be measured parallel to the axis of the vessel, in mm (in.). A line of support is:

1) a stiffening ring that conforms to the requirements of this paragraph; or

2) a circumferential line of a head at one-third the depth of the head from the tangent line.

P_c = critical collapsing pressure equal to or greater than 0.259 MPa (37.5 psi);

E = modulus of elasticity of stiffening ring material, in MPa (psi).

8.5.8.6 If loads are applied to the outer shell or to stiffening rings from the supports of the inner tank, additional stiffening rings or an increased moment of inertia of the stiffening rings designed for the external pressure shall be provided to carry the support loads.

8.5.9 Sump or siphon bowl

A sump or siphon bowl shall not be installed unless it is located in the bottom of the inner tank shell and conforms to the following requirements:

a) is formed directly into the inner tank shell or if it is formed and welded to the inner tank shell, it shall be made of metal that is weldable to the metal of the inner tank shell;

b) stress in any orientation under any condition is equal to or less than the circumferential stress in the inner tank shell; and

c) wall thickness is equal to or greater than that specified in 8.5.23.1.

8.5.10 Welding

8.5.10.1 Except for closure of openings and a maximum of two circumferential closing joints in the outer shell, each joint of an inner tank and the outer shell shall be a fusion, double-welded butt joint.

8.5.10.2 The closure for openings and the circumferential closing joints in the outer shell, including head-to-shell joints, may be a single-welded butt joint using a backing strip on the inside of the joint.

8.5.10.3 Each joint shall be welded in accordance with the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.5.11 Post-weld heat treatment

8.5.11.1 Post-weld heat treatment of the inner tank is not required.

8.5.11.2 The outer shell, with the exception of the circumferential closing seams, shall be post-weld heat-treated as set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.5.11.3 Any item to be welded to the outer shell shall be welded before post-weld heat treatment.

8.5.11.4 Welds securing the following need not be post-weld heat-treated if such post-weld heat treatment is not practical due to final assembly procedures:

a) the inner tank support system to the outer shell;

b) connections at piping penetrations;

c) closures for access openings; and

d) circumferential closing joints of head-to-shell joints.

8.5.11.5 If cold-formed heads are used on the outer shell and post-weld heat treatment is not practical due to assembly procedures, the cold-formed heads shall be heat-treated before they are welded to the outer shell.

8.5.12 Support system for inner tank

8.5.12.1 The inner tank shall be supported within the outer shell by a support system.

8.5.12.2 The strength and ductility, at operating temperatures, of the support system and its areas of attachment to the outer shell shall be capable of supporting the inner tank when filled with the dangerous goods to any level during normal conditions of transport.

8.5.12.3 The support system shall be designed to support, without yielding, impact loads producing accelerations of the following magnitudes and directions when the inner tank is fully loaded and the tank car is equipped with a conventional draft gear:

a) longitudinal 7g;

b) transverse 3g;

c) vertical 3g.

Note: g is the standard acceleration due to gravity. For calculation purposes, g = 9.81 m/s^2 (32.2 ft/s^2).

8.5.12.4 The longitudinal acceleration may be reduced to 3g if a cushioning device, which has been tested to demonstrate its ability to limit tank car tank forces to a maximum of 1779 kN (400 000 lbf) at an impact speed of 16.1 km/h (10 mph), is used between the coupler and the tank structure.

8.5.12.5 The inner tank and outer shell shall be electrically bonded to each other by the support system used, by piping, or by a separate electrical connection.

8.5.13 Radiography

Each longitudinal and circumferential joint of the inner tank and each longitudinal and circumferential double-welded butt joint of the outer shell shall be examined along its entire length in conformance with the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.5.14 Access to inner tank

8.5.14.1 The inner tank shall be provided with an access opening having a minimum inside diameter of 406 mm (16 in.). Reinforcement of the access opening shall be made of the same material used for the inner tank.

8.5.14.2 If a welded closure is used, the closure shall be designed to allow it to be reopened by grinding or chipping and to be closed again by re-welding without a need for new parts. A cutting torch shall not be used.

8.5.15 Inner tank piping

The inner tank shall be equipped with piping lines for the liquid and gas phases of the refrigerated liquid which conform to the following requirements:

a) the piping system or vapour and liquid-phase transfer and venting system shall be made of materials that are compatible with the dangerous goods and that are suitable for use at the temperature of the dangerous goods;

b) the outlets of all vapour-phase and liquid phase lines shall be located so that accidental discharge from the lines will not impinge on any metal of the outer shell, car structures, trucks, or safety appliances; and

c) provision shall be made to allow for thermal expansion and contraction.

8.5.15.1 A loading and unloading line shall be provided that consists of:

a) a liquid-phase transfer line that has a manually-operated shut-off valve located as close as practicable to the outer shell plus a secondary closure that is liquid-tight and gas-tight;

b) a secondary closure that permits any trapped pressure to bleed off before the closure can be removed completely; and

c) a vapour trap incorporated into the line and located as close as practicable to the inner tank.

On a specification 113A60W9 tank car tank, any loading and unloading line shall be vacuum-jacketed between the outer shell and the shut-off valve and the shut-off valve shall also be vacuum-jacketed.

8.5.15.2 A vapour-phase line shall be provided that conforms with the following:

a) the vapour-phase line shall be connected to the inner tank and shall be of sufficient size to permit the pressure-relief devices that are specified in 8.6.18 and that are connected to the vapour-phase line to operate at their design capacity without excessive pressure build-up in the tank;

b) the vapour-phase line shall have a manually operated shut-off valve located as close as practicable to the outer shell plus a secondary closure that is liquid-tight and gas-tight; and

c) the secondary closure shall permit any trapped pressure to bleed off before the closure can be removed completely.

8.5.15.3 A vapour-phase blowdown line shall be provided that conforms to the following requirements:

a) the blowdown line shall be attached to the vapour-phase line specified in 8.5.15.2, upstream of the shut-off valve in that line;

b) a by-pass line with a manually operated shut-off valve shall be provided to allow a reduction of the inner tank pressure when the vapour-phase line is connected to a closed system; and

c) the discharge from the by-pass line shall be outside the housing and shall be directed upward and away from operating personnel.

8.5.16 Pressure testing of the inner tank

8.5.16.1 After all required items have been welded in place to the inner tank, the inner tank shall be pressure-tested at the tank test pressure specified in 8.5.23.1.

8.5.16.2 The temperature of the pressurizing medium shall be equal to or less than 37.8 °C (100 °F) during the test.

8.5.16.3 The inner tank shall hold the specified tank test pressure for a period of not less than 10 min without evidence of yielding or leakage.

8.5.16.4 After a hydrostatic test, the inner tank and piping shall be emptied of all water and purged of all water vapour.

8.5.16.5 Repairs to welded joints that have developed leaks during the test shall be made in conformance with the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.5.17 Valves and gauges

8.5.17.1 Manually operated shut-off valves and control valves shall be provided wherever needed for the control of vapour-phase pressure, vapour-phase venting, liquid transfer and liquid-flow rates.

8.5.17.2 Valves shall conform to the following requirements:

a) all valves shall be made from materials that are compatible with the dangerous goods and that are suitable for use at the temperature of the dangerous goods;

b) liquid control valves shall have an extended stem design;

c) packing, if used, shall be compatible with the dangerous goods and be of materials that will seal the valve stem without causing difficulty of operation; and

d) each control valve and shut-off valve shall be readily operable. These valves shall be mounted so that their operation will not transmit excessive forces to the piping system.

8.5.17.3 Gauges shall conform to the following requirements:

a) gauges, except portable units, shall be securely mounted within suitable protective housings;

b) a liquid-level gauge that indicates the quantity of liquid within the inner tank shall be provided;

c) the liquid level gauge shall be:

    1) a permanent gauge mounted where it will be readily visible during handling or storage;

    2) a portable gauge with a readily accessible connection; or

    3) a fixed length dip tube that:

        i) has a manually operated shut-off valve located as close as practicable to the outer shell;

        ii) indicates the maximum liquid level for the allowable filling density; and

        iii) has the inner end of the dip tube located on the longitudinal centreline of the inner tank and within 1219 mm (48 in.) of the transverse centreline of the inner tank;

d) vapour-phase pressure gauge that indicates the vapour pressure within the inner tank shall be provided; and

e) vapour-phase pressure gauge shall:

    1) have a manually operated shut-off valve located as close as practicable to the outer shell;

    2) be mounted where it will be readily visible; and

    3) have an additional fitting for the use of a test gauge.

8.5.18 Pressure-relief devices

8.5.18.1 General

The tank car tank and its piping system shall be protected by the installation of pressure-relief devices and shall conform to the following requirements:

a) the discharge from the pressure-relief devices shall be directed away from operating personnel, principal load-bearing members, and attachments of the outer shell, trucks, and safety appliances;

b) vent or weep holes in the pressure-relief devices are prohibited; and

c) all main pressure-relief devices shall discharge to the outside of the protective housing in which they are located, except that this requirement does not apply to pressure-relief devices installed to protect isolated sections of lines between the final valve and the end closure.

8.5.18.2 Materials

Materials used in pressure-relief devices shall be compatible with the dangerous goods and suitable for use at the temperature of the dangerous goods.

8.5.18.3 Inner tank

The following requirements apply to the use of pressure-relief devices and safety vents for the inner tank:

a) pressure-relief devices for the inner tank shall be attached to vapour-phase piping and mounted so as to remain at ambient temperature before operation;

b) the inner tank shall be equipped with one or more pressure-relief devices and one or more safety vents, except as provided in 8.5.18.3 e) 4), and installed without an intervening shut-off valve, except as provided in 8.5.18.3 e) 3);

c) the safety vent shall:

   1) function at the pressure specified in 8.5.23.1;

   2) be flow-rated in conformance with the applicable requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication; and

   3) provide sufficient capacity to conform to the requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication;

d) pressure-relief device shall:

   1) be set to start-to-discharge at the pressure specified in 8.5.23.1; and

   2) conform to the requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication.

e) Installation of safety vent and pressure-relief device

   1) Inlet piping

      i) The opening through all piping and other service equipment between the inner tank and its pressure-relief devices shall have a cross-sectional area equal to or greater than that of the pressure-relief device inlet and the flow characteristics of this upstream system shall be such that the pressure drop will not adversely affect the relieving capacity or the proper operation of the pressure-relief device; and

      ii) if the required relief capacity is met by the use of a multiple pressure-relief device placed on one connection, the inlet internal cross-sectional area of this connection shall be sufficient to provide the required flow capacity for the proper operation of the pressure-relief device system.

   2) Outlet piping

      i) The opening through the discharge lines shall have a cross-sectional area equal to or greater than that of the pressure-relief device outlet and shall not reduce the relieving capacity below that required to properly protect the inner tank; and

      ii) if the required relieving capacity is met by the use of multiple pressure-relief devices placed on a common discharge manifold, the manifold outlet internal cross-sectional area shall be equal to or greater than to the combined outlet areas of the pressure-relief devices.

3) Duplicate pressure-relief devices may be used if a three-way selector valve is installed to provide for relief through either pressure-relief device. The three-way selector valve shall be included in the mounting set out in A5.2.6 of the AAR *Specifications for Tank Cars* publication, when conducting the flow capacity test on the safety vent set out in A5.1 of the AAR *Specifications for Tank Cars* publication. Flow capacity tests shall be performed with the three-way valve at both of the extreme positions as well as at the mid-position and the flow capacity shall be in conformance with the requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication.

4) An alternate pressure-relief device in conformance with the requirements set out in 8.5.23.1 may be used in lieu of the safety vent, provided it conforms to the flow capacity set out in Appendix A of the AAR *Specifications for Tank Cars* publication at a flow rating pressure of 110% of its start-to-discharge pressure. Installation shall:

i) prevent moisture accumulation at the seat by providing drainage away from that area;

ii) permit periodic drainage of the vent piping; and

iii) prevent accumulation of foreign material in the vent system.

f) Evaporation control — The normal release of vaporized dangerous goods may be controlled with a pressure controlling and mixing device. A pressure controlling and mixing device is required on a specification 113A60W9 tank car tank. Any pressure controlling and mixing device shall:

1) be set to start to discharge at a pressure equal to or less than that specified in 8.5.23.1;

2) have sufficient capacity to limit the pressure within the inner tank to that pressure specified in 8.5.23.1, when the discharge is equal to twice the normal venting rate during transport, with normal vacuum and the outer shell at 54.4 °C (130 °F); and

3) prevent the discharge of a gas mixture greater than 50% of the lower flammability limit to the atmosphere under normal conditions of handling or transport.

g) Safety interlock — If a safety interlock is provided for the purpose of allowing transfer of dangerous goods at a pressure greater than the pressure-control valve setting and less than the pressure-relief device setting, the design shall be such that the safety interlock will not affect the discharge path of the pressure-relief device or safety vent at any time. The safety interlock shall automatically provide an unrestricted discharge path for the pressure-control device at all times during transport.

8.5.18.4 Outer shell

The outer shell shall be provided with a suitable system to prevent build-up of annular space pressure to a pressure greater than 110 kPa (16 psi) or greater than the external pressure value for which the inner tank was designed, whichever is the lesser. The total relief area provided by the system shall be equal to or greater than 161 cm^2 (25 $in.^2$) and means shall be provided to prevent clogging of any system opening and to provide for adequate communication to all areas of the insulation space. If a safety vent is a part of the system, it shall be designed to prevent distortion of the rupture disc when the annular space is evacuated.

8.5.18.5 Piping system

If a piping circuit can be isolated by closing a valve, means for relieving any trapped pressure shall be provided.

8.5.19 Test of pressure-relief valves

Each valve, before being put into service, shall be tested with air or another gas for conformance with the requirements set out in 8.5.23.1.

8.5.20 Operating instructions

8.5.20.1 All valves and gauges shall be clearly identified with corrosion-resistant nameplates.

8.5.20.2 A plate of corrosion-resistant material bearing precautionary instructions for the safe operation of the equipment during handling operations shall be securely mounted so as to be readily visible.

8.5.20.3 The instruction plate shall be mounted in each housing that contains service equipment and controls.

8.5.20.4 The precautionary instructions on the plate shall include a diagram of the tank and its piping system with the various gauges, control valves, and pressure-relief devices clearly identified and located.

8.5.21 Permanent markings

Subject to 7.3, the marking on a specification 113 tank car tank shall conform to the following requirements.

8.5.21.1 Each tank shall have permanent markings, including:

a) tank specification;

b) design service temperature;

c) material specification of the inner tank;

d) as-built thickness of the shell and heads of the inner tank;

e) inside diameter (ID);

f) inner tank manufacturer’s identifying mark;

g) month and year of the original tank test of the inner tank;

h) water capacity of the inner tank in accordance with 8.5.23 c);

i) material specification of the outer shell;

j) thickness of the shell and heads of the outer shell;

k) initials assigned to the outer shell manufacturer; and

l) identifying mark of the tank car assembler if different from the inner tank or outer shell manufacturer.

8.5.21.2 The permanent markings shall be stamped in the order set out in 8.5.22.1 in letters and figures equal to or greater than 9.53 mm (3/8 in.) in height into the metal near the centre of the head of the outer shell located at the B-end of the tank car. The inner container heads shall not be stamped. The following is an example of the required markings:

TC 113A60W9

-253 °C/-423 °F

Inner/Int.

ASTM A240 304L

Head/Tête: 4.76 mm

Shell/Coque: 4.76 mm

ID/DI 2718 mm

ABC

12-2020

000000 kg

Outer/Ext.

AAR TC-128B

Head/Tête 14.3 mm

Shell/Coque 14.3 mm

PQR

DEF

8.5.22 Stencilling

Each tank car shall be stencilled in conformance with the requirements set out in Appendix C of the AAR *Specifications for Tank Cars* publication. The stencilling shall include the following information:

a) date on which the rupture disc was last replaced and the initials of the person making the replacement, on the outer shell in letters and figures equal to or greater than 38.1 mm (1.5 in.) in height;

b) design service temperature and maximum dangerous goods mass, adjacent to the dangerous goods identification stencil in letters and figures equal to or greater than 38.1 mm (1.5 in.) in height;

c) water capacity of the inner tank, i.e. the mass of water at 15.6 °C (60 °F) that the tank will hold at the design service temperature, with a deduction for the volume above the inlet to the pressure-relief device or pressure-control valve, structural members, baffles, piping, and other service equipment inside the tank, in letters and figures equal to or greater than 38.1 mm (1.5 in.) in height;

d) statement “DO NOT HUMP OR CUT OFF WHILE IN MOTION” and/or “DÉFENSE DE PASSER SUR LA BUTTE DE TRIAGE OU DE DÉTELER EN MOUVEMENT,” on both sides of the tank car, in letters equal to or greater than 38.1 mm (1.5 in.) in height; and

e) statement “VACUUM-JACKETED” and/or “CHEMISE SOUS VIDE,” on the outer shell below the specification stencil, in letters equal to or greater than 38.1 mm (1.5 in.) in height.

8.5.23 Individual specification requirements applicable to TC Specification 113 vacuum-insulated tank cars for cryogenic liquids

8.5.23.1 Individual specification minimum requirements

The inner tank, outer shell and service equipment for a tank car for cryogenic liquids shall conform to the individual TC specification requirements corresponding to the specification set out in Table 11:

Table 11 – Specification minimum requirements – tank car for cryogenic liquids

TC specification	113A60W9	113C120W	113C120W9	113C140W9	113A90W
Design service temperature	-252.8 °C (-423 °F)	-162.2 °C (-260 °F)	-162.2 °C (-260 °F)	-162.2 °C (-260 °F)	-195.5 °C (-320 °F)
Inner tank material	8.5.4.1	8.5.4.1	8.5.4.1	8.5.4.1	8.5.4.1
Outer shell material	8.5.4.6	8.5.4.2	8.5.4.6	8.5.4.6	8.5.4.2
Impact test (inner tank weld and plate material)	8.5.4.3	8.5.4.3	8.5.4.3	8.5.4.3	8.5.4.3
Impact test values	8.5.4.4	8.5.4.4	8.5.4.4	8.5.4.4	8.5.4.4
Standard heat transfer rate, kJ/d/kg (Btu/d/lb) of water capacity, maximum (see 8.5.3)	0.2256 (0.097)	0.9585 (0.4121)	0.9585 (0.4121)	0.9585 (0.4121)	1.163 (0.5)
Inner tank burst pressure, minimum, kPa (psi)	1654 (240)	2068 (300)	2068 (300)	2482 (360)	1654 (240)
Inner tank plate thickness shell, minimum, mm (in.) (see 8.5.7.1)	4.76 (3/16)	4.76 (3/16)	4.76 (3/16)	4.76 (3/16)	4.76 (3/16)
Inner tank head thickness, minimum, mm (in.) (see 8.5.6)	4.76 (3/16)	4.76 (3/16)	4.76 (3/16)	4.76 (3/16)	4.76 (3/16)
Outer shell thickness, minimum mm (in.)	14.3 (9/16)	11.1 (7/16)	14.3 (9/16)	14.3 (9/16)	11.1 (7/16)
Outer shell head thickness, minimum, mm (in.)	14.3 (9/16)	12.7 (1/2)	14.3 (9/16)	14.3 (9/16)	12.7 (1/2)
Inner tank test pressure, kPa (psi) (see 8.5.16)	414 (60)	827 (120)	827 (120)	965 (140)	621 (90)
Safety vent bursting pressure, maximum, kPa (psi)	414 (60)	827 (120)	827 (120)	965 (140)	621 (90)
Pressure-relief device start-to-discharge pressure ± 20 kPa (± 3 psi)	207 (30)	517 (75)	517 (75)	621 (90)	414 (60)

TC specification	113A60W9	113C120W	113C120W9	113C140W9	113A90W
Pressure-relief device vapour-tight pressure, minimum, kPa (psi)	165 (24)	414 (60)	414 (60)	496 (72)	331 (48)
Pressure-relief device flow rating pressure, maximum, kPa (psi)	276 (40)	586 (85)	586 (85)	689 (100)	455 (66)
Alternate pressure-relief device start-to-discharge pressure, ± 20 kPa (± 3 psi)	—	621 (90)	621 (90)	745 (108)	496 (72)
Alternate pressure-relief device vapour-tight pressure, minimum, kPa (psi)	—	496 (72)	496 (72)	593 (86)	400 (58)
Alternate pressure-relief device flow rating pressure, maximum, kPa (psi)	—	689 (100)	689 (100)	827 (120)	552 (80)
Pressure-control valve start-to-vent, maximum, kPa (psi) [see 8.5.18.3 f)]	117 (17)	Not required	Not required	Not required	Not required
Pressure-relief device discharge restrictions	8.5.18	8.5.18	8.5.18	8.5.18	8.5.18
Transfer line insulation	8.5.15	Not required	Not required	Not required	Not required

9 Qualification and maintenance of tank cars

9.1 Scope

The requirements specified in this section apply to any person who manufactures, fabricates, marks, maintains, repairs, inspects, or services tank cars to ensure continuing qualification.

9.2 General requirements

9.2.1 Tank cars

A tank car facility or person performing a function on a tank car shall comply with the requirements of the owner concerning qualification and maintenance and the applicable requirements of this standard and of the AAR *Specifications for Tank Cars* publication. In case of conflict, the requirements of this standard apply.

9.3 Tank car qualification

Unless otherwise specified in this section and for the purpose of tank car qualification, column II of Table 12 indicates the inspections and tests that are required for the corresponding qualification item of column I.

Table 12 – Qualification – inspections and tests – tank cars

I	II
Qualification items	**Inspections and tests**
Tank car	Visual inspection Structural integrity inspection Safety systems inspection
Thickness	Thickness test
Service equipment	Service equipment inspection Leak testing
Lining or coating	Lining or coating inspection
Stub sills	Stub sill inspection

9.4 Requirements for qualification and maintenance of tank car stub sills

9.4.1 Inspections

All tank cars of stub sill design shall receive inspections of the stub sills by a tank car facility at the time of manufacture and periodically thereafter to ensure structural integrity of the sills, using inspection procedures specified in 9.4.3.

9.4.2 Intervals

The inspection interval shall not exceed 10 years, nor the interval established for the tank structural integrity inspection. Inspections shall occur no later than when:

a) tank car reaches 321 869 km (200 000 miles) from the build date or the last stub sill inspection; or

b) tank car reaches 804 672 km (500 000 miles) from the build date or the last stub sill inspection, if the stub sill is designed and built to equal or greater than the one-million mile fatigue life requirement.

Inspections shall be performed at shorter intervals when a reliability assessment of a stub sill design indicates a tendency to rapidly develop rejectable defects.

9.4.3 Inspection procedures and records

9.4.3.1 The inspections shall include all weld attachments of stub sill-to-pad, stub sill-to-head brace (if used), bolster-to-sill, and head brace-to-pad. Inspections shall be made both inboard and outboard of the body bolster.

9.4.3.2 The inspections shall include the surfaces of the sill top flange, sill webs, sill bottom flanges and sill pads in the vicinity of the attachment welds referred to in 9.4.3.1 for the presence of parent metal cracks and fractures or other significant damage both inboard and outboard of the body bolsters.

9.4.3.3 Inspection personnel, procedures and techniques for attachment welds shall conform to Appendix T of the AAR *Specifications for Tank Cars* publication.

9.4.3.4 Appropriate inspection ports shall be provided in jackets and head shields and other equipment removed, such as draft gear as required to provide sufficient access for adequate inspections. Welds and other surfaces as required shall be cleaned and made accessible consistent with the inspection method and technique requirements.

9.4.3.5 The year in which a stub sill inspection is performed and the inspection due date shall be applied in the location specified on the qualification stencil per the AAR *Specifications for Tank Cars*, Appendix C in numerals at least 25.4 mm (1 in.) in height. A code indicating the tank car facility having performed the inspection shall also be applied.

9.4.3.6 Results of inspections shall be documented and kept by the tank car owner throughout the period of ownership of the tank car plus one year after a change of ownership. The stub sill inspection results shall be transmitted electronically to the AAR's electronic database (TCID), referred to in the AAR *Specifications for Tank Cars* (M-1002) publication.

9.4.4 Maintenance, modification and repairs

Repairs to parent metal cracks in stub sill structural components or attachment welds referred to in 9.4.3.1 shall be performed in accordance with AWS D15.1. Repairs shall be performed in accordance with the tank car owner's documentation and procedures.

9.4.5 Acceptable results of stub sill inspection

A tank car successfully passes the stub sill inspection if the inspection reveals no visible parent metal crack or other defect that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.5 Requirements for qualification of tank cars

9.5.1 Owner's responsibilities, general

An owner of a tank car, a lining or coating, or service equipment is responsible for:

a) qualifying the tank car including stub sills as per 9.4, the lining or coating, or the service equipment in conformance with the requirements set out in this section;

b) scheduling and the performance of inspections and tests of the tank car including stub sills, the lining or coating, or the service equipment;

c) developing, implementing, and evaluating a qualification program for the tank car including stub sills, the lining or coating, or the service equipment;

d) validating and specifying the methods and procedures for the non-destructive examination of the tank car including stub sills, the lining or coating, or the service equipment. Such methods and procedures shall be adequate to detect defects and conditions that could compromise the reliability of the tank car, the lining or coating, or the service equipment; and

e) developing the documentation relative to the requirements set out in this section.

9.5.2 Owner's responsibilities regarding tank car facilities

An owner of a tank car, lining or coating, or service equipment is responsible for ensuring that each tank car facility complies with the owner's qualification program developed in accordance with the requirements of this section, through periodic analysis and surveillance of the qualification activities of the tank car facility, including:

a) inspection and testing of the tank car including stub sills, the lining or coating, or the service equipment in accordance with the requirements set out in 9.5;

b) evaluating the results of inspections and tests in accordance with the requirements related to qualification set out in 9.6;

c) marking of the tank car in accordance with the requirements set out in 7.4; and

d) preparing of the documentation in accordance with the requirements set out in 9.8.

The tank car owner is responsible for overseeing the entire qualification program of the tank car. The tank car owner, lining or coating owner and service equipment owner shall facilitate the communication of pertinent tank car information regarding the tank car's qualification between all concerned parties.

9.5.3 Responsibilities of tank car facility

A tank car facility shall obtain the permission of the equipment owner before performing work affecting modification, repair, or qualification of the owner's equipment. For the purposes of qualification and maintenance, the tank car facility shall use the written instructions, respecting all applicable requirements, furnished by the owner or have written confirmation from the owner allowing the use of written instructions furnished by another. A tank car facility shall report all work performed to the owner. The tank car facility shall also report observed damage, deterioration, failed components, or non-compliant parts to the owner.

9.5.4 Qualification of tank cars

9.5.4.1 The maximum interval for inspection and tests shall not exceed the requirements set out in column III of Table 13 for each corresponding inspection and test set out in column II, except where an adjustment is required in 9.5.13.1 and 9.5.13.2.

Table 13 – Maximum interval for inspection and tests – tank cars

I	II	III	IV
Qualification of:	**Inspections and tests**	**Maximum interval (years)**	**Reference**
Tank	Visual inspection	10	9.5.6
	Structural integrity inspection	10	9.5.7
	Thickness test	10	9.5.8 and 9.5.9
	Safety systems inspection	10	9.5.10
Coating/lining	Lining or coating inspection, for lining or coating applied for the protection of the tank	as per 9.5.11	9.5.11
Service equipment	Service equipment inspection	10	9.5.12
Stub sills	Stub sill inspection	as per 9.4	9.4

9.5.4.2 The inner container of a specification 115 tank car shall have a hydrostatic tank test conforming to the applicable requirements set out in 8.4.20 of this standard and Appendix D of the AAR *Specifications for Tank Cars* publication at a maximum interval of ten years. The hydrostatic test pressure shall be equal to or greater than the specification test pressure of the tank car tank.

9.5.4.3 For a tank car designed for cryogenic liquids, including a specification 113 or AAR 204W tank car, only the following minimum inspections and tests and maximum intervals apply:

a) visual inspection of the exterior surface of the outer shell in conformance with the requirements set out in 9.2.1 and 9.5.6 a), at a maximum interval of ten years;

b) visual inspection in conformance with the requirements set out in 9.2.1 and 9.5.6 c), d), e), f), and h) at a maximum interval of ten years;

c) structural integrity inspection in conformance with the requirements set out in 9.2.1 and 9.5.7.1 at all locations susceptible to damage that could compromise the reliability of the tank car, at a maximum interval of ten years. At a minimum, the inspection shall include:

    1) all outer shell transverse fillet welds with dimensions greater than 6.35 mm (1/4 in.) within 1219 mm (48 in.) of the bottom longitudinal centerline, except body bolster pad attachment welds;

    2) termination of longitudinal fillet welds with dimensions greater than 6.35 mm (1/4 in.) within 1219 mm (48 in.) of the bottom longitudinal centerline on the outer shell; and

    3) non-reinforced exposed outer shell butt welds within 610 mm (24 in.) of the bottom longitudinal centerline.

9.5.4.4 All qualification requirements need not be performed at the same time.

9.5.4.5 Pressure-relief devices on tank cars used in the handling, offering for transport or transporting of anhydrous ammonia shall be qualified at an interval not exceeding five years. Non-coated carbon steel springs shall be replaced with a stainless steel spring or a spring coated to protect against ammonia stress corrosion cracking, at the time of qualification.

9.5.5 Other conditions requiring inspections and tests

Before a tank car is used in the handling, offering for transport, or transporting of dangerous goods and despite the maximum intervals for qualification set out in the table of 9.5.4.1, the owner of the tank car or the lining or coating is responsible for:

a) performance of a visual inspection, a structural integrity inspection in conformance with the requirements set out in 9.5.6 and 9.5.7, and any other appropriate inspection and test in conformity with this section, if the tank car shows evidence of structural damage or has been subjected to loads in excess of its design requirements;

b) performance of a visual inspection and thickness test in conformance with the requirements set out in 9.5.6 and 9.5.8, and any other appropriate inspection and test in conformance with this section, if the tank car shows evidence of damage caused by fire;

c) performance of a lining or coating inspection in conformance with the requirements set out in 9.5.11 if the lining or coating that was applied for the protection of the tank:

    1) has failed;

    2) was put in contact with a product not compatible with the lining or coating; or

    3) was subjected to a temperature outside the service temperature range of the lining or coating; and

d) tank car that has been used for dangerous goods with a primary or subsidiary classification of class 8 shall not be used in the handling, offering for transport or transporting of class 2 dangerous goods until the tank car is qualified in accordance with the requirements set out in this section.

9.5.6 Visual inspection

At a minimum, the visual inspection performed under this section shall include the following items for the purpose of detecting defects or other conditions that could compromise the reliability of the tank car:

a) subject to 9.5.6 i), the interior and exterior surface of the tank car tank, except in areas where an insulation system, a safety system, or an internal lining or coating precludes inspection;

b) internal surface of the tank car tank after removing an interior lining or coating or before applying a new lining or coating;

c) service equipment, including gaskets;

d) fasteners;

e) all bolted, threaded, and quick-coupling closures and their fasteners;

f) protective housings;

g) excess-flow valves with threaded seats, including an inspection for tightness and operability;

h) compliance markings required by the standard for legibility and correctness; and

i) for a specification 115 tank car, the interior of the inner container and the exterior shell and heads.

9.5.7 Structural integrity inspection

9.5.7.1 Inspection personnel, procedures and techniques for structural integrity inspections shall conform to Appendix T of the AAR Specifications for Tank Cars publication.

9.5.7.2 At a minimum, the structural integrity inspection shall include all of the locations susceptible to damage that could compromise the reliability of the tank car tank, nozzles, welds, and welded attachments, including:

a) all transverse fillet welds with dimensions greater than 6.35 mm (1/4 in.) within 1219 mm (48 in.) of the bottom longitudinal centreline, except body bolster pad attachment welds;

b) termination of longitudinal fillet welds with dimensions greater than 6.35 mm (1/4 in.) within 1219 mm (48 in.) of the bottom longitudinal centreline; and

c) the tank shell butt welds within 610 mm (24 in.) of the bottom longitudinal centreline unless the tank car owner can determine by analysis, such as damage tolerance analysis and finite element stress analysis that the tank car will not develop defects or other conditions that could compromise its reliability. The analysis shall include a determination of the probable locations and modes of damage to the tank car due to fatigue, corrosion, or accidental damage. As an alternative, service reliability assessment may be used, provided it is supported by analysis of systematically collected data.

9.5.7.3 For a specification 115 tank car, 9.5.7.2 applies only to the outer shell fillet welds and to the non-reinforced, exposed, outer shell butt welds.

9.5.7.4 In the case of tank cars with a lining, the inspection requirements of 9.5.7.2 c) do not apply to a tank shell butt weld covered on the outside by a reinforcing plate, exterior heater coils or any other structural element welded to the tank shell until the time of lining removal or application.

9.5.7.5 In the case of a tank car with an internal patch plate, the structural integrity inspection requirements of 9.5.7 do not apply to a tank shell butt weld covered on the inside by the patch plate and on the outside by a reinforcing plate or any other structural element welded to the tank shell.

9.5.8 Thickness test

9.5.8.1 The equipment and procedures used to measure thickness shall be capable of an accuracy of ± 0.05 mm (± 0.002 in.). Inspection personnel, procedures and techniques for thickness test inspections shall conform to Appendix T of the AAR *Specifications for Tank Cars* publication.

9.5.8.2 At a minimum, the thickness test shall include measurement of the tank wall thickness at the shell and heads, sumps, nozzles, and nozzle reinforcing pads.

9.5.8.3 Subject to 9.5.8.4, the thickness test shall be performed at the following intervals:

a) at the time of applying or replacing a lining or coating;

b) at least once every ten years if the tank does not have a lining or coating; and

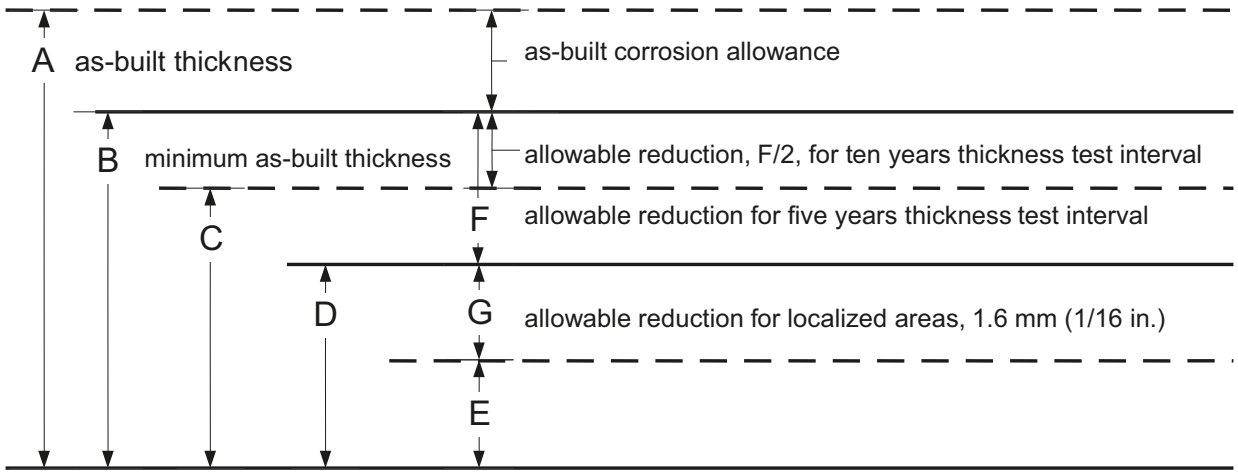
c) at least once every five years if:

1) the tank does not have a lining or a coating;

2) the tank car is used in the handling, offering for transport, or transporting of dangerous goods that are corrosive to the tank; and

3) the remaining shell and head thickness of the tank is at or below line C of Figure 1.

Figure 1 – Thickness reduction limits for unlined/uncoated tank cars in corrosive service



where:

A = as-built tank shell or head thickness;

B = design minimum tank shell or head thickness, after forming, as set out in section 8;

C = inspection frequency adjustment point calculated by subtracting half the value found in the table entitled Allowable thickness reductions, as set out in 9.5.9 from B, the minimum as-built thickness;

D = limit for shell or head thickness (design minimum shell or head thickness minus the allowable shell thickness reduction as set out in 9.5.9);

E = limit for shell or head localized thickness (design minimum shell or head thickness minus both the allowable shell thickness reduction as set out in 9.5.9 and 1.6 mm [1/16 in.]);

F = allowable shell or head thickness reduction as set out in 9.5.9;

G = additional thickness reduction for localized shell or head areas as set out in 9.5.9.

9.5.8.4 A thickness test shall be performed to verify conformance with the requirements set out in 9.5.9 if a material corrosive to the tank has contacted the tank wall and a localized repair of a lining or coating applied for the protection of the tank is performed. The thickness test applies only to the repaired area.

9.5.8.5 Thickness reductions in sumps, nozzles and nozzle reinforcing pads shall not cause a condition or release of dangerous goods from the tank car that could endanger public safety or compromise their reliability.

9.5.8.6 After any modification or maintenance activity that results in a reduction of the wall thickness of a tank car, a thickness test shall be performed in the areas affected by the reduction.

9.5.8.7 A tank car with a lining or coating shall be marked with either

a) “LNG RMVL” as the test due date to indicate that the thickness test is required at the time of lining removal or replacement; or

b) a test due date that is identical to the tank car qualification due date to denote that a thickness test is required at the same time the tank car is requalified.

9.5.9 Allowable thickness reductions

The allowable thickness reductions of a tank shell and head are specified in Table 14. Subject to 9.5.9.1 to 9.5.9.3, a tank car tank with a thickness below the minimum thickness specified in section 8 may continue in service provided any reduction to the design minimum thickness is not greater than the reductions specified in columns II and III corresponding to the tank test pressures specified in column I.

Table 14 – Allowable thickness reductions – tank shell and head

I	II	III
Tank test pressure, TP kPa (psi)	**Top shell and tank head mm (in.)**	**Bottom shell mm (in.)**
414 (60) ≤ TP < 1379 (200)	3.18 (1/8)	1.59 (1/16)
TP ≥ 1379 (200)	0.794 (1/32)	0.794 (1/32)

9.5.9.1 An extra 1.59 mm (1/16 in.) may be added to the values in the table for local reductions. Local reductions are those that do not exceed twenty linear centimetres (eight linear inches), measured at the longest dimension, and are separated from any other local reduction by at least 406 mm (16 in.).

9.5.9.2 The structural strength of the tank shall not be affected by any reduction in the tank car tank wall thickness to the extent that the tank car structure is no longer capable of withstanding the minimum loads and stresses to which it was designed.

9.5.9.3 Shell thickness reductions apply only to the outer shell for specification 115 tank cars. There is no reduction below the design minimum thickness authorized for the inner container.

9.5.10 Safety systems inspection

A safety systems inspection shall include all safety systems. A safety systems inspection shall ensure that all the systems conform to their design requirements and shall be adequate to detect defects or other conditions that could compromise the reliability of the safety system. An inspection is not required for a foam or cork insulation system or an insulation system that does not meet the definition of a safety system or that has not been taken into account when establishing the pressure relief devices minimum flow capacities.

9.5.10.1 Acceptable level of defects in thermal protection systems

a) Maximum permissible void size or total void area is described in Table 15:

Table 15 – Maximum permissible void size or total void area

Void	Size / Area	Condition
Single isolated void	Maximum allowable void is 1219 mm (48 in.) on the longitudinal axis of the tank by 406 mm (16 in.) on the circumferential axis.	Voids shall be separated from other voids by more than one half of the largest dimension or shall be considered a single void.
Total void area	Maximum allowable total void area is 9% of the total tank surface area.	—

b) Inspection method, technique and procedure shall be capable of detecting single square voids of 406 mm (16 in.) x 406 mm (16 in.) at any location on the tank car tank surface.

c) Areas of defects other than voids, such as deteriorated thermal protection material, significantly reducing the thermal performance of the material shall be considered the same as voids.

9.5.11 Lining or coating inspection

9.5.11.1 For the purpose of 9.5.11, commodity pairing means a specific lining or coating that is used in combination with specific dangerous goods.

9.5.11.2 At a minimum, a lining or coating applied for the protection of the tank shall have a lining or coating inspection that is adequate to detect defects or other conditions that could compromise the reliability of the lining or coating.

9.5.11.3 The owner of the lining or coating shall monitor and maintain a record of the performance of the commodity pairings. The owner of the lining or coating shall determine an appropriate lining and coating inspection interval based on the knowledge and experience of the lining or coating owner with respect to the commodity pairing and the information in the records.

9.5.11.4 The inspection interval shall be established by the owner of the lining or coating through documentation and scientific analysis of the commodity pairing so that the coating or lining inspection interval would not compromise the reliability of the tank car. The owner of the lining or coating shall also take measures to prevent corrosion when possible.

9.5.11.5 Any person who offers for transport dangerous goods in a tank car shall provide, upon request by the owner of the lining or coating or the owner of the tank car, commodity pairing information to the requesting party.

9.5.11.6 The owner of the lining or coating shall provide the inspection procedures and the acceptance criteria for the lining or coating to the tank car owner and to the tank car facility responsible for qualifying the lining or coating. The tank car facility responsible for inspecting the lining or coating shall follow the qualification requirements established by the owner of the lining or coating.

9.5.12 Service equipment inspection

9.5.12.1 At a minimum, the service equipment inspection shall ensure that all of the service equipment conforms to the requirement set out in this standard and be adequate to detect defects or other conditions that could compromise their reliability.

9.5.12.2 Procedures for the inspection and testing of service equipment, including interior heater systems and pressure-relief devices shall conform to the requirements set out in Appendix D of the AAR *Specifications for Tank Cars* publication.

9.5.12.3 The tank, service equipment, and closures installed, replaced or reinstalled shall be leak tested in accordance with 9.7.3.

9.5.13 Adjustments in inspection and test protocols

9.5.13.1 Each tank car owner shall implement a system for the continuing analysis and surveillance of the performance and effectiveness of their inspection and maintenance programs. This system shall include a means for the collection and analysis of data relative to the inspection and maintenance requirements set out in this section.

9.5.13.2 The tank car owner shall use the collected data to evaluate the maintenance program, inspection intervals and tank car including stub sills, attachments to the bottom shell, service equipment, and lining or coating designs for the purpose of determining appropriate action for the minimization of failure, damage, and deterioration that could compromise the reliability of the tank car.

9.5.13.3 The maximum inspection intervals shall not be increased and the qualification requirements set out in 9.5.4 shall not be reduced unless an equivalency certificate regarding an increase in inspection interval or a reduction in qualification requirements has been issued in conformance with the requirements of the TDG Regulations.

9.5.13.4 When seeking a modification to the interval or requirements of a structural integrity inspection, an owner shall provide an engineering analysis, such as damage tolerance analysis or finite element stress analysis. The analysis shall include a determination of the probable locations and modes of damage to the tank car due to fatigue, corrosion, or accidental damage. As an alternative, service reliability assessment may be used, provided it is supported by analysis of systematically collected data.

9.6 Acceptable results of inspections and tests

9.6.1 Qualification

A tank car is qualified if it successfully passes the inspection and test requirements set out in this section.

9.6.2 Visual inspection

A tank car successfully passes the visual inspection if the inspection reveals no defect that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.6.3 Structural integrity inspection

A tank car successfully passes the structural integrity inspection if the inspection reveals no visible parent metal crack or other defect that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.6.4 Thickness test

A tank car successfully passes the thickness test when the tank shell and heads show no thickness reduction greater than that specified in 9.5.9.

9.6.5 Safety system inspection

A tank car successfully passes the safety system inspection if each safety system of the tank car, including:

a) thermal protection system;

b) tank-head puncture-resistance system;

c) coupler vertical restraint system;

d) insulation system used to control pressure or outage; or

e) system used to protect top or bottom discontinuities;

conforms to the requirements set out in this standard including 8.3.19 or a special provision of schedule 1 for insulation systems and the inspection reveals no defect larger than the limits specified in 9.5.10.1 or that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.6.6 Lining or coating inspection

A tank car successfully passes the lining and coating inspection if the inspection reveals no defect that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.6.7 Service equipment

A tank car successfully passes the service equipment inspection when the equipment conforms to this standard and the applicable provisions of Appendix D of the AAR *Specifications for Tank Cars* publication and the inspection reveals no defect that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.6.8 Tank test

A specification 115 tank car successfully passes the tank test if the tested tank does not show evidence of yielding, leakage or other defect that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.7 Maintenance

9.7.1 Periodic analysis and surveillance

An owner of a tank car, lining or coating, or service equipment is responsible for ensuring that each tank car facility conforms to the owner’s maintenance program through periodic analysis and surveillance of the maintenance activities of the tank car facility.

9.7.2 Coating of tank exterior and jacket interior

If the jacket of a tank car is completely removed for maintenance purposes, the exterior surface of the tank car tank and the interior surface of the tank car jacket shall have a protective coating applied or renewed if either of these surfaces is found to be inadequately protected against corrosion.

9.7.3 Leak testing

9.7.3.1 Subject to 11.3.1.1, a successful leak test conforming to Appendix T of the AAR *Specifications for Tank Cars* publication is required at the time of service equipment qualification or after any modification or any maintenance activity involving the removal of any service equipment, unless the tank car service equipment arrangement precludes it. The leak test shall verify that service equipment closures, including auxiliary devices when so equipped and its connection to the tank car tank do not show evidence of leakage. The leak test shall be performed on a tank car with all service equipment in place and functional.

9.7.3.2 In addition to the requirements of 9.7.3.1, maintenance and qualification of service equipment, involving resealing, rebuilding or remanufacturing shall conform to Appendices D and T of the AAR *Specifications for Tank Cars* publication.

9.7.3.3 A leak test is not required when a pressure-control valve or a pressure-relief valve on a tank car transporting a cryogenic liquid, or a pressure-regulating valve on a tank car transporting carbon dioxide, has leaked because of ice build-up and is subsequently made to reseat properly.

9.7.4 Exception to leak testing

A leak test is not required if the removal of the service equipment is for the sole purpose of loading or unloading the dangerous goods and the service equipment is designed for loading or unloading, including the removal of pipe plugs and caps, quick disconnects and their closures, hinged manway covers, and fill hole covers.

9.7.5 Access openings in jackets and tank-head puncture-resistance systems

a) When sections of tank-head puncture-resistance systems are cut out for any reason, the sections shall be replaced using a full penetration weld or other method approved by the AAR Executive Director, to restore the full strength of the original system.

b) When sections of the tank jacket are cut out for any reason, the sections shall be replaced to restore the original integrity, and made weather-tight.

c) When sections of thermal protection are removed for any reason, the sections shall be replaced with a system providing equivalent thermal performance and fire resistance.

9.8 Reporting and record retention requirements

9.8.1 Certification and representation

The manufacturer of a tank car shall certify that all of the requirements set out in this standard, including inspections and tests that are required for the qualification of the tank car, have been performed by signing the certificate of construction, form AAR 4-2, and by marking the tank with the appropriate tank car specification to which the tank car was manufactured. The manufacturer shall retain the reports relating to the manufacture and qualification of the tank car. The owner of the tank car shall retain, throughout the period of ownership of the tank car plus one year after the change of ownership, the certificate of construction and any documents relating to subsequent approvals, which certify that the tank car identified in the documentation conforms to the requirements set out in the applicable specification.

9.8.2 Qualification and stub sill inspection reporting

A written or electronic report shall be provided for a tank car that has been inspected or qualified in conformance with the requirements set out in this section. The owner of the tank car shall retain a copy of the report until the next qualification or stub sill inspection record has been produced. The report shall include the following information:

a) inspection or qualification items;

b) results for each inspection or qualification item;

c) tank car reporting mark and number;

d) tank car specification;

e) qualification date for each qualification item;

f) inspection date;

g) location and description of defects and method used to repair each defect;

h) name and address of the tank car facility and the name of the inspector; and

i) facility registration symbol.

The stub sill inspection results shall be transmitted electronically to the AAR in accordance with 9.4.3.6.

10 Selection and use of containers for the handling, offering for transport, or transporting of dangerous goods by rail

10.1 Scope

This section applies to all containers handled, offered for transport or transported in Canada.

10.2 Selection and use

10.2.1 General

A container shall not be used in the handling, offering for transport, or transporting of dangerous goods unless 4.4 or schedules 1 and 2 of Annex E specify that the container is permitted to contain the dangerous goods and the container and dangerous goods conform to all other applicable requirements set out in this standard. In the case of a tank car, the dangerous goods shall be specified on the certificate of construction, form AAR 4-2, or by addendum on form R1.

10.2.2 Due date for qualification

Unless otherwise specified in this standard:

a) when a container is due for a qualification, the container shall not be loaded; and

b) when a tank car becomes due for a qualification after loading, unloading or during transport, the tank car shall not be transported to one or more destinations, except for the purposes of unloading, cleaning and qualification within one year after becoming due for the qualification.

10.2.3 Localized dents and buckles

Except for localized dents or buckles in the shell that are within the limits of 10.2.3, a tank car that has dents or buckles in its shell or heads shall not be used to handle, offer for transport or transport dangerous goods. A tank car with a localized dent or buckle in its shell may be used if:

a) localized dent or buckle in the tank shell has a depth no greater than 19.1 mm (3/4 in.) at its deepest point, when that depth is measured relative to the surrounding un-deformed external surface of the tank shell; and

b) where any portion of the localized dent or buckle is in the bottom shell, the dent or buckle has a depth no greater than 12.7 mm (1/2 in.) at its deepest point when that depth is measured relative to the surrounding un-deformed external surface of the tank shell.

10.2.4 Minimum test pressure

10.2.4.1 A tank car shall have a tank test pressure equal to or greater than the greatest of the following:

a) 133% of the working pressure;

b) 133% of the maximum loading or unloading pressure, whichever is greater;

c) 2068 kPa (300 psi) for dangerous goods toxic by inhalation;

d) minimum test pressure for the specification in section 8 of this standard; and

e) minimum test pressure specified for the specific dangerous goods in the applicable special provision in schedule 1 of Annex E.

10.2.4.2 Higher test pressure

Unless otherwise specified in this standard, when a tank car with a given specification and tank test pressure is authorized, a tank car with the same specification and a higher marked tank test pressure may be used.

10.2.5 Air-enriched mixture

Air pressure in excess of ambient atmospheric pressure shall not be used to load or unload dangerous goods if this could create a flammable mixture within the vapour space of the container.

10.2.6 Prohibition against certain stub sill tank cars

A class 111 or AAR 211 tank car of stub sill design shall not be used to handle, offer for transport or transport dangerous goods if:

a) tank car has a shell manufactured of non-normalized ASTM A515 grade 70 steel;

b) bottom shell does not have exterior heater coils; and

c) bottom shell has not been continuously reinforced between the end of one of the stub sill's reinforcing plate (stub sill cradle pad) to the end of the other stub sill's reinforcing plate by reinforcing steel bars, steel plate or other structural shapes or by other structural elements such as a bottom discontinuity protection device.

10.3 Safety systems

10.3.1 Bottom-discontinuity protection

10.3.1.1 General requirement

Subject to 10.3.1.2, 10.3.1.3 and 10.3.1.4, a tank car that is or may be used in the handling, offering for transport, or transporting of dangerous goods shall be equipped with bottom-discontinuity protection that conforms to the requirements set out in *Appendix E* of the AAR *Specifications for Tank Cars* publication.

10.3.1.2 Exceptions

The requirements of 10.3.1 do not apply to tank cars built prior to 1979 transporting:

a) UN2448, MOLTEN SULFUR;

b) UN3257, ELEVATED TEMPERATURE LIQUID, N.O.S.; or

c) UN3258, ELEVATED TEMPERATURE SOLID, N.O.S.

10.3.2 Coupler vertical restraint system

A tank car that is or may be used in the handling, offering for transport, or transporting of dangerous goods by rail shall be equipped with a coupler vertical restraint system that conforms to the requirements set out in 8.2.4.

10.3.3 Pressure-relief devices on a tank car

Unless otherwise specified in this standard, a tank car shall be equipped with one or more pressure-relief devices that conform to the requirements set out in clause 8.2.5.

10.3.3.1 Non-reclosing prohibition

Subject to 10.3.3.2, 10.3.3.3 and special provisions of schedule 1 in Annex E, a tank car that is or may be used in the handling, offering for transport or transporting of division 6.1, packing groups I or II, class 2, class 3, or class 4 dangerous goods shall not be equipped with a non-reclosing pressure-relief device.

10.3.3.2 Exception regarding tank cars manufactured before 1991

If the dangerous goods are division 6.1 or class 4 and are not toxic by inhalation, a tank car that is equipped with a non-reclosing pressure-relief device and that was manufactured before 1991 may be used in the handling, offering for transport, or transporting of the dangerous goods.

10.3.3.3 Exception regarding chloroprene

In the case of a shipment of chloroprene, inhibited, in a specification 115 tank car, 10.3.3.1 does not apply.

10.3.3.4 Rupture disc

The rupture disc of a non-reclosing pressure-relief device shall not have an opening.

10.3.4 Tank-head puncture-resistance system

A tank car that is or may be used in the handling, offering for transport, or transporting of class 2 gases or that is manufactured from aluminum or nickel plate and is or may be used in the handling, offering for transport, or transporting of dangerous goods shall have a tank-head puncture-resistance system installed that conforms to the requirements set out in 8.2.7 or to the corresponding requirements in effect at the time of installation.

10.3.5 Thermal protection system

10.3.5.1 Application

Subject to 9.5.10.1 and 10.3.5.2, a tank car that is or may be used in the handling, offering for transport, or transporting of class 2 gases, other than cryogenic liquids, shall have a thermal protection system that conforms to 8.2.6.

10.3.5.2 Exception for some insulated tank cars

10.3.5.2.1 The requirement for a thermal protection system does not apply in the case of a tank car for which this standard specifies that an insulation system having an overall thermal conductance equal to or less than 0.613 kJ/h·m^{2}·°C (0.03 Btu/h·ft.^{2}·°F) is required and the tank car is equipped with the required system.

10.3.6 Safety systems delimiter

10.3.6.1 Except for a specification 113 tank car or unless otherwise prohibited, if this standard permits or requires the use of a tank car with a specification delimiter, a tank car of equivalent specification with an alternate delimiter in accordance with Table 16 may also be used:

Table 16 – Specification delimiters and equivalents

Specified delimiter	Delimiters also permitted
A	S, T, J, P, H
S	T, J, P, H
T	J, P, H
J	P, H
P	J, H
H	none

10.4 Loading limits and outage

10.4.1 Loading limits

10.4.1.1 Application

A container shall not be loaded with dangerous goods in excess of the loading limits specified in this standard or those otherwise applicable to the container.

10.4.1.2 Association of American Railroads limit

Subject to 10.4.1.3, a tank car shall not be loaded in excess of the total mass on rail limits per applicable axle size specified in the *Field Manual of the Association of American Railroads Interchange Rules*.

10.4.1.3 Gross mass

Except as otherwise provided in 10.4.1.4, 10.4.1.5, 10.4.1.6, and 10.4.1.7, a tank car shall not be loaded in excess of the total mass on rail limits per applicable axle size specified in the *Field Manual of the Association of American Railroads Interchange Rules* or 119 295 kg (263 000 lb) gross mass, whichever is less.

10.4.1.4 Increased gross masses

A class DOT or TC 105, 111, 112, 113, 115, 117 or 120 tank car with a steel tank car tank manufactured in accordance with 2.5 of the AAR *Specifications for Tank Cars* publication, may exceed 119 295 kg (263 000 lb) gross mass, but may not exceed 129 727 kg (286 000 lb) gross mass provided that:

a) tank capacity conforms to 8.2.3;

b) tank car is equipped with one or more pressure-relief devices conforming to 8.2.5. Reclosing pressure-relief devices shall be used unless the tank car owner can demonstrate that the use of such a device decreases the level of safety below that afforded by a non-reclosing pressure-relief device; and

c) tank car conforms to all other applicable requirements of this standard, including qualification and maintenance.

10.4.1.5 AAR tank cars

A tank car with a carbon steel tank car tank permanently marked (i.e. stamped, etched, embossed or otherwise marked) to a TC 111 or DOT 111 specification and stencilled to an AAR 211 specification used in the handling, offering for transport, or transporting of dangerous goods referenced to special provision 2 or 67 may exceed 119 295 kg (263 000 lb) gross mass, but may not exceed 129 727 kg (286 000 lb) gross mass provided that:

a) tank capacity conforms to 8.2.3;

b) tank conforms to all other requirements of this standard applicable to the TC or DOT as-built specification with gross mass equal to or less than 119 295 kg (263 000 lb), including qualification and maintenance;

c) tank car tank is manufactured from ASTM A516, Grade 70 material, or AAR TC-128, Grade B material;

d) non-jacketed tank car has a minimum shell and head thickness of 12.7 mm (1/2 in.) for ASTM A516, Grade 70 material, or 11.1 mm (7/16 in.) for AAR TC-128, Grade B material;

e) jacketed tank car has a minimum shell and head thickness of 11.1 mm (7/16 in.);

f) tank car is equipped with one or more pressure-relief devices conforming to 8.2.5. Reclosing pressure-relief devices shall be used unless the tank car owner can demonstrate that the use of such a device decreases the level of safety below that afforded by a non-reclosing pressure-relief device;

g) tank car meets all the requirements of AAR S-286;

h) tank car design meets all Road Environment Percent Occurrence Spectrum (REPOS) loading, including horizontal and vertical coupler loads, increased by a factor of 1.09 above the loading used for cars having a gross mass of 119 295 kg (263 000 lb); and

i) tank car is subject to a qualification and maintenance program that identifies the required inspection items, inspection methods, acceptance criteria and inspection frequencies and provides written procedures that ensure the work on the tank car conforms to the applicable regulations, industry and car owner’s requirements.

10.4.1.6 Equivalency certificates

A tank car that was previously authorized to exceed 119 295 kg (263 000 lb), but not to exceed 129 727 kg (286 000 lb) gross mass under equivalency certificate SR 5144, SR 5206, SR 6753, SR 7677, SR 7790, SR 8841, or SR 9292, may continue in service provided that:

a) tank car conforms to all the conditions specified in the most current revision of the applicable equivalency certificate and all other requirements of this standard applicable to tank cars with gross mass equal to or less than 119 295 kg (263 000 lb), including qualification and maintenance; and

b) tank car is equipped with a pressure-relief device conforming to 8.2.5 and the pressure-relief device is installed as described in the document submitted to support the equivalency certificate application and on file with the TC Director.

If a tank car authorized for transport under an equivalency certificate is determined to meet all the requirements of the standard, the equivalency certificate stencil shall be removed at the next tank qualification.

10.4.2 Outage

10.4.2.1 Vacant space for outage

Vacant space shall be left in the shell of the tank to provide the required outage.

10.4.2.2 Filling limit

When a container is being filled with liquids, outage shall be provided so that, under normal conditions of transport, including handling, no condition or release of dangerous goods that could endanger public safety occurs or may reasonably be expected to occur, including leakage or permanent distortion of the container, as a result of an expansion of the liquid.

10.4.2.3 Minimum outage

Unless otherwise specified in this standard, for liquids and liquefied gases that are loaded into a container, the outage shall be:

a) equal to or greater than 1% of the total capacity of a tank or a compartment of the tank at one of the following reference temperatures:

   1) 46.1 °C (115 °F) for a non-insulated tank;

   2) 43.3 °C (110 °F) for insulated tanks or tanks having a thermal protection system incorporating a metal jacket that provides at 15.6 °C (60 °F) an overall thermal conductance equal to or less than 10.2 kJ/h·m^{2}·°C (0.50 Btu/h·ft.^{2}·°F); or

   3) 40.6 °C (105 °F) for an insulated tank when the overall thermal conductance is equal to or less than 1.533 kJ/h·m^{2}·°C (0.075 Btu/h·ft.^{2}·°F).

b) For dangerous goods toxic by inhalation, the outage shall be equal to or greater than 5% of the total capacity of the tank or a compartment of the tank, at one of the following reference temperatures:

   1) 46.1 °C (115 °F) for a non-insulated tank;

   2) 43.3 °C (110 °F) for insulated tanks or tanks having a thermal protection system incorporating a metal jacket that provides at 15.6 °C (60 °F) an overall thermal conductance equal to or less than 10.2 kJ/h·m^{2}·°C (0.50 Btu/h·ft.^{2}·°F); or

   3) 40.6 °C (105 °F) for an insulated tank when the overall thermal conductance is equal to or less than 1.533 kJ/h·m^{2}·°C (0.075 Btu/h·ft.^{2}·°F).

10.5 Specific dangerous goods

10.5.1 Dangerous goods toxic by inhalation

10.5.1.1 General requirements

A tank car that is or may be used in the handling, offering for transport, or transporting of dangerous goods toxic by inhalation shall:

a) not have interior heater coils or bottom outlets;

b) unless otherwise specified in this standard, have a tank test pressure of 2068 kPa (300 psi) or greater, a tank-head puncture-resistance system, and a metal jacket;

   i) if the tank car conforms with the tank-head puncture resistance system requirements through the deeming provision of 8.2.7.3, it shall also be equipped with a full height head shield on each end that is equal to or greater than 12.7 mm (0.5 in.) in thickness and made from steel having a minimum specified tensile strength equal to or greater than 379 MPa (55,000 psi);

c) meet the applicable authorized tank car specification and standard listed in 10.5.1.2 a) and 10.5.1.2 b) and special provisions 57, 59, 60, 75, 76, 77, or 78 of schedule 1 of Annex E; and

d) have normalized shell and heads when manufactured from carbon steel.

10.5.1.2 Tank cars for dangerous goods toxic by inhalation other than class 2, Gases

a) Subject to 10.5.1.2 b), tank cars that are or may be used in the handling, offering for transport, or transporting of dangerous goods toxic by inhalation, other than class 2, Gases, set out in column I of Table 17 shall conform to the applicable tank car specification set out in column II.

Table 17 – Tank cars used in the handling, offering for transport, or transporting of dangerous goods toxic by inhalation, other than class 2, Gases - specification

I	II
Dangerous goods	**Authorized tank car specification**
ACETONE CYANOHYDRIN, STABILIZED	105H500W 112H500W
ACROLEIN	105H600W
ALLYL ALCOHOL	105H500W 112H500W
BROMINE OR BROMINE SOLUTIONS	105H500W
CHLOROPICRIN	105H500W 112H500W
CHLOROSULPHONIC ACID	105H500W 112H500W
Dangerous goods toxic by inhalation, hazard zone A, not specifically identified in this table	105H600W
Dangerous goods toxic by inhalation, hazard zone B, not specifically identified in this table	105H500W 112H500W
DIMETHYL SULPHATE	105H500W 112H500W
ETHYL CHLOROFORMATE	105H500W 112H500W
HEXACHLOROCYCLOPENTADIENE	105H500W 112H500W
HYDROCYANIC ACID, AQUEOUS SOLUTION or HYDROGEN CYANIDE, AQUEOUS SOLUTION, with not more than 20% hydrogen cyanide	105H500W 112H500W

I	II
Dangerous goods	**Authorized tank car specification**
HYDROGEN CYANIDE, STABILIZED	105H600W
HYDROGEN FLUORIDE, ANHYDROUS	105H500W 112H500W
PHOSPHORUS TRICHLORIDE	105H500W 112H500W
SULPHUR TRIOXIDE, STABILIZED	105H500W 112H500W
SULPHURIC ACID, FUMING (where the free sulphur trioxide content is greater than or equal to 30%)	105H500W 112H500W
TITANIUM TETRACHLORIDE	105H500W 112H500W

b) As an alternative to the authorized tank car specifications listed in the table in 10.5.1.2 a), a tank car of the same specification but of the next lower test pressure, as prescribed in the table in 8.3.22, may be used provided that both of the following conditions are met:

1) difference between the alternative and the required minimum plate thicknesses, based on the calculation using the formula in 8.3.6.1, shall be added to the alternative tank car jacket and head shield. When the jacket and head shield are made from steel with a minimum tensile strength from 483 to 558 MPa (70 000 psi to 81 000 psi), but the required minimum plate thickness calculation is based on steel with a minimum tensile strength of 558 MPa (81 000 psi), the thickness to be added to the jacket and head shield shall be increased by a factor of 1.157. Forming allowances for heads are not required to be considered when calculating thickness differences; and

2) tank car jacket and head shields are manufactured from carbon steel plates as prescribed in 8.3.5.1. The steel shall meet the Charpy requirements of 2.2.1.2 of the AAR *Specifications for Tank Cars* publication and head shields shall be normalized after forming.

c) Higher test pressure is required if otherwise specified elsewhere in this standard.

10.5.1.3 Service equipment protection

A tank car that is or may be used in the handling, offering for transport or transport of dangerous goods toxic by inhalation shall have a protective system that complies with 8.2.2.5.

10.5.1.4 Performance requirement for alternative tank cars

An application for approval by the AAR Executive Director of a tank car manufactured in accordance with the alternatives authorized in 10.5.1.2 b) or special provision 78 of schedule 1 of Annex E shall include a demonstration through engineering analysis, that the tank jacket and support structure system, including any anchors and support devices, is capable of withstanding a 9.6 km/h (6 mph) coupling without jacket shift such that results in damage to the nozzle.

10.5.1.5 Tank cars manufactured prior to January 15, 2015

Despite the requirements of 10.5.1.1 c), 10.5.1.2 and 10.5.1.3, a tank car may be used in the handling, offering for transport or transport of dangerous goods toxic by inhalation in accordance with the following requirements:

a) the tank car was manufactured prior to January 15, 2015;

b) the tank car is used in the handling, offering for transport or transport of dangerous goods toxic by inhalation no later than December 31, 2027; and

c) in the case of a tank car used for dangerous goods toxic by inhalation other than class 2:

   1) dangerous goods that meet the criteria for hazard zone A shall be handled, offered for transport or transported in tank cars having a test pressure equal to or greater than 3447 kPa (500 psi) and conform to class 105J;

   2) dangerous goods that meet the criteria for hazard zone B shall be handled, offered for transport or transported in tank cars having a test pressure equal to or greater than 2068 kPa (300 psi) and conform to classes 105S, 112J, 114J or 120S; and

   3) hydrogen fluoride, anhydrous shall be handled, offered for transport or transported in tank cars having a test pressure equal to or greater than 2068 kPa (300 psi) and conform to classes 105, 112, 114 or 120.

10.5.2 Assignment of hazard zones for dangerous goods toxic by inhalation

10.5.2.1 Division 2.3

For the purposes of this standard, the hazard zone of class 2, division 2.3 dangerous goods is assigned in schedule 2 of Annex E.

10.5.2.2 Liquid dangerous goods other than class 2 gases

For the purposes of this standard, the hazard zone of liquid dangerous goods other than class 2 gases is assigned in schedule 2 of Annex E.

10.5.2.3 Determination

a) If schedule 2 in Annex E does not provide a hazard zone or provides more than one hazard zone for class 2, division 2.3 dangerous goods, or indicates that the hazard zone shall be determined on the basis of the grouping criteria for division 2.3, the hazard zone shall be determined by applying the criteria in Table 18.

Table 18 – Hazard zones for dangerous goods toxic by inhalation - determination

Hazard zone	Inhalation toxicity
A	LC_{50} less than or equal to 200 ppm
B	LC_{50} greater than 200 ppm and less than or equal to 1000 ppm
C	LC_{50} greater than 1000 ppm and less than or equal to 3000 ppm
D	LC_{50} greater than 3000 ppm or less than or equal to 5000 ppm

b) If schedule 2 in Annex E does not provide a hazard zone or provides more than one hazard zone for liquid dangerous goods other than class 2 gases, or indicates that the hazard zone shall be determined, the hazard zone shall be determined by applying the following criteria:

1) Hazard zone A: $V \geq 500\ LC_{50}$ and $LC_{50} \leq 200$ mL/m^3;

2) Hazard zone B: $V \geq 10\ LC_{50}$; $LC_{50} \leq 1000$ mL/m^3; and the criteria for hazard zone A are not met,

where V is the saturated vapor concentration in air of the material in mL/m^3 at 20 °C and at 101.3 kPa.

10.5.3 Dangerous goods in packing groups I or II

10.5.3.1 A class 111 tank car built after October 1, 2015 and used in the handling, offering for transport, or transporting of dangerous goods in packing groups I or II, other than dangerous goods toxic by inhalation and class 3, Flammable liquids, shall conform with the requirements for an enhanced class 111 with a jacket or an enhanced class 111 without a jacket (8.3.24). An enhanced class 111 tank car manufactured prior to July 2, 2019 need not comply with the requirement of clause 8.3.10.9 b).

10.5.4 Cryogenic liquids

The interior of the inner tank of a cryogenic liquid tank car and all connecting lines shall be thoroughly cleaned, dried, and protected from further contamination before use.

10.5.5 Dangerous goods in class 3, Flammable liquids

Subject to 10.5.5.1, a tank car that is or may be used to import, offer for transport, handle or transport dangerous goods included in class 3, Flammable liquids that are assigned special provision 81 in Annex E, shall be in compliance with specification 117J, 117P, 105J, 112J, 114J or 120J. If the tank car is specification 114J or 120J and is equipped with a bottom outlet valve, the tank car shall be compliant with 8.3.10.9.

10.5.5.1 Tank cars manufactured prior to October 1, 2015

10.5.5.1.1 A tank car that was manufactured prior to October 1, 2015, may be used to import, offer for transport, handle or transport dangerous goods that are:

a) UN1265, PENTANES;

b) UN1267, PETROLEUM CRUDE OIL;

c) UN1268, PETROLEUM DISTILLATES, N.O.S., or PETROLEUM PRODUCTS, N.O.S. that are crude oil or a condensate;

d) UN1993, FLAMMABLE LIQUID, N.O.S. that are a condensate;

e) UN3295, HYDROCARBONS, LIQUID, N.O.S. that are a condensate; or

f) UN3494, PETROLEUM SOUR CRUDE OIL, FLAMMABLE, TOXIC,

if the tank car is in compliance with:

1) specification 117R; or

2) specification for an enhanced class 111 tank car with a jacket and is used no later than April 30, 2025.

10.5.5.1.2 A tank car that was manufactured prior to October 1, 2015, may be used to import, offer for transport, handle or transport dangerous goods that are:

a) UN1170, ETHANOL more than 24% ethanol, by volume;

b) UN1987, ALCOHOLS, N.O.S.;

c) UN1993, FLAMMABLE LIQUID, N.O.S., that is ethanol, solutions comprised mostly of ethanol, denatured ethanol or ethanol and gasoline mixtures; or

d) UN3475, ETHANOL AND GASOLINE MIXTURE with more than 10% ethanol, ETHANOL AND MOTOR SPIRIT MIXTURE with more than 10% ethanol, or ETHANOL AND PETROL MIXTURE with more than 10% ethanol,

if the tank car is in compliance with:

1) specification 117R;

2) specification for an enhanced class 111 tank car with a jacket and is used no later than April 30, 2025;

3) specification for an enhanced class 111 tank car without a jacket and is used no later than June 30, 2023; or

4) class 111, not in compliance with 10.5.5.1.2 (2) or (3), and is used no later than April 30, 2023.

10.5.5.1.3 A tank car that was manufactured prior to October 1, 2015, may be used to import, offer for transport, handle or transport dangerous goods that are assigned special provision 81 in Annex E, other than the dangerous goods listed in 10.5.5.1.1 and 10.5.5.1.2, if the tank car is in compliance with:

a) specification 117R;

b) class 111 or specification 112S and is used no later than April 30, 2025.

10.5.5.1.4 An enhanced class 111 tank car that was manufactured prior to October 1, 2015 and is selected pursuant to 10.5.5.1.1 (2), 10.5.5.1.2 (2), 10.5.5.1.2 (3), or 10.5.5.1.3 (b) need not comply with the requirement of 8.3.10.9 b).

Note: The selection and use of specification 117R equipped with fibreglass-only insulation systems may be restricted as per 8.3.25.2 e) 3) i).

10.5.6 Combustible liquids

Despite 10.5.6, combustible liquids (i.e., liquids that are not dangerous goods but have a flash point greater than 60 °C and less than or equal to 93 °C and are transported at a temperature below their flashpoint) may be imported, handled, offered for transport or transported in any tank car meeting this standard, including specification TC/DOT 111 and AAR 211.

10.6 Loading and unloading railway vehicles

10.6.1 Prohibition against movement

During the period of time when dangerous goods are being loaded into or onto a railway vehicle or unloaded from a railway vehicle, that railway vehicle and any railway vehicle to which it is attached shall not be moved.

10.6.2 General loading/unloading conditions

Dangerous goods shall not be loaded into or onto a railway vehicle or unloaded from a railway vehicle unless the following requirements are met. Except for 10.6.2 b), c) and d), the following requirements do not apply to a railway vehicle that is a boxcar, flatcar or hopper car.

a) Dangerous goods with a primary or subsidiary classification of class 3, 4, 5 or division 2.1 shall take fire safety measures to prevent the ignition of the dangerous goods, including grounding and bonding the tank cars, before any loading or unloading related activities have begun and shall remain until all loading or unloading activities have concluded.

b) Ensure that the railway vehicle or coupled string of railway vehicles are immobilized by using hand brakes and by blocking the wheels. As a minimum, the hand brakes shall be applied and at least one wheel shall be blocked in both directions on at least:

    1) one car for a one or two car coupled string; or

    2) two cars for a three to nine car coupled string plus one additional car for every block and any fraction of block of ten cars in excess of the first nine cars in the coupled string, including the first and last cars of the string.

c) Ensure that the section of track is protected by one or more of the following:

    1) locked switches;

    2) locked derails;

    3) bumper blocks;

    or other such equipment controlled by the loading or unloading facility.

d) Caution signs are displayed to warn approaching railway vehicle operators. Caution signs shall be manufactured of metal or other durable material having dimensions equal to or greater than 300 mm x 380 mm (12 in. x 15 in.) and bear the words “STOP” or “ARRÊT” in white capital letters equal to or greater than 100 mm (4 in.) in height on a blue background. Alternatively, blue signal protection may be displayed per rule 26 of the *Canadian Rail Operating Rules*.

e) Despite d), the loading or unloading of a railway vehicle on a main track shall display red signal protection per rule 42 of the *Canadian Rail Operating Rules*.

f) The immediate vicinity of the railway vehicle is kept free of combustible materials or other dangerous goods not compatible with the commodity being loaded or unloaded.

g) In the case of a tank car, precautions are taken to prevent the release of dangerous goods while the tank car is being loaded or unloaded. When the loading or unloading is completed, all closures are secured and the connections made between the tank car service equipment and the loading or unloading components are disconnected.

h) If loading or unloading is discontinued, the loading or unloading connections may remain attached provided that the shutoff valves and the facility’s first fixed isolation valve, when so equipped, are closed and secured in the closed position and all other conditions of 10.6.2 are met, including 10.6.2 i).

i) Loading/unloading operations are directly, remotely or automatically monitored to ensure safety and prompt response in the event of an emergency.

j) If applicable, measures are taken to minimize the release of dangerous goods when interconnecting pipes are used.

k) Measures are taken to control the pressure inside the tank car during loading and unloading operations, including avoiding an excessive vacuum condition.

l) Hoses, and their connectors, used to temporarily connect to the railway vehicle to load or unload dangerous goods shall be visually inspected prior to each use. Loading and unloading hoses and their connectors shall be tested annually unless complying with an interval in accordance with the manufacturer's recommendations. A test report shall be generated and kept until the next report is produced. Hoses and connectors found to have signs of damage, deterioration, or other conditions making them unsafe for use shall be removed from service and replaced.

m) When it is safe to do so, the interior pressure is relieved before the removal of the manhole cover or valve outlet cap.

10.7 Loading and unloading containers

10.7.1 Before loading

A container shall not be loaded with dangerous goods if:

a) the container does not conform to the requirements for selection and use set out in this standard;

b) the required safety marks per the TDG Act (including but not limited to placards, stencilling, packaging specification marking) are not in place;

c) a qualification due date is not in conformance with the provisions of 10.2.2;

d) the container is manufactured from a material, or has a lining or coating, that is not compatible with the dangerous goods being loaded;

e) the container already contains dangerous goods or other substances that could react with the dangerous goods to be loaded;

f) the dangerous goods are at a temperature outside the design temperature range of the container or outside the service temperature range of the lining or coating.

10.7.1.1 Before loading a tank car, other than a tank car used in the handling, offering for transport of transporting of class 2 gases, a person shall conduct an external visual inspection that includes inspecting pressure-relief devices, including the removal and inspection of rupture discs on safety vents, for any condition that could alter the intended operation of the device or endanger public safety, including corrosion or damage.

10.7.1.2 Before loading through a bottom outlet valve, a person shall ensure that:

a) valves, hoses, pipes and couplers are properly designed and rated for loading the lading;

b) mechanisms are in place to safely deal with hazards such as overloads, overpressures, leaks and fires; and

c) mechanisms are in place to safely evacuate the lading from the valves, hoses, pipes and couplers to avoid causing a dangerous goods release.

10.7.2 During loading

During the period of time that tank cars equipped with bottom discharge outlets are being loaded, the caps and plugs shall be removed from the outlets and secondary valves.

10.7.3 After unloading

After unloading a dangerous goods container intended for transport with residue or a greater quantity of dangerous goods, a person shall conduct an external visual inspection that includes:

a) inspecting the container for required safety marks per the TDG Act (including but not limited to placards, stencilling, container specification marking) to ensure they are in place and legible; and

b) inspecting the qualification due date markings to ensure compliance with the provisions of 10.2.2.

10.8 Before offering for transport

Before offering to transport a container that contains a load or residue of dangerous goods, a person shall, after the completion of any loading or unloading operation prior to transport, conduct an external visual inspection that includes:

a) except where insulation or a thermal protection system precludes an inspection, an examination of the tank shell and heads for abrasion, corrosion, cracks, dents, distortions, defects in welds, damage or any other condition that makes the container unsafe for transportation;

b) inspecting the piping, valves, fittings and gaskets for corrosion, damage, or any other condition that makes the container unsafe for transportation;

c) ensuring that there are no missing or loose bolts, nuts or elements that make the container unsafe for transportation;

d) ensuring that all closures, as well as the fasteners securing them on the container, are in good condition and secured to achieve conformance with 4.10.2;

    i) in the case of a bottom-loaded tank car, the bottom load valve cap shall be torqued to the specification of the gasket, based on the gasket manufacture maximum torque specification for the type of product and tank car, and the bottom valve shall be tagged to indicate the specified torque and the torque applied;

e) for a combination pressure-relief device incorporating a rupture disc, inspecting and opening each detection device including a needle valve, trycock or telltale indicator to ensure the integrity of the rupture disc;

f) in the case of a tank car, inspecting the external thermal protection system, tank-head puncture-resistance system, coupler vertical restraint system, and bottom discontinuity protection for any condition that makes the tank car unsafe for transportation;

g) inspecting for spillage of dangerous goods on the exterior surface of the container and ensuring that it is removed, except for dried molten sulphur residue as described in the Sulphur Institute's "*Molten Sulphur Rail Tank Car Guidance*" document;

h) in the case of a loaded tank car, inspecting the external surface of ceramic type filters on tank cars equipped with a venting device and transporting sodium chlorite solution or hydrogen peroxide, aqueous solution with more than 40% hydrogen peroxide, stabilized.

10.9 Before transporting

Before transporting a container containing dangerous goods, the person who will be transporting the container shall conduct an external visual inspection of the container, to the extent practicable, from the ground level to ensure that:

a) required dangerous goods safety marks are in place and in conformance with the TDG Regulations;

b) closures are in good condition and properly secured.

10.10 Rail operating restrictions

10.10.1 Highway tanks

Highway tanks may be transported on railway vehicles if the rail destination is in a remote area not accessible by road, and provided that all applicable conditions are complied with:

a) dangerous goods are in class 3, 8 or 9;

b) the tank and any compartment of the tank contain a volume of liquid dangerous goods that is equal to or less than 5% of the tank or compartment's volumetric capacity respectively;

c) the highway tank is selected and used in accordance with the requirements of the standard CSA B621, except that the use of non-specification highway tanks is not authorized;

d) in the case of a tank truck, the tank truck is secured to the railway vehicle in accordance with the requirements of *AAR Open Top Loading Rules Manual* for four or six wheel truck or other motor vehicle;

e) in the case of a tank trailer, the forward end of the trailer is secured to the railway vehicle with an AAR approved intermodal trailer hitch, the rail carrier personnel has verified that the king pin of the trailer is engaged and locked in the trailer hitch, the rear end is secured in accordance with the requirements of the *AAR Open Top Loading Rules Manual* for trailers, all types, and the landing gear and bumper are not used for securing the trailer to the railway vehicle;

f) in the case of a tank trailer transported with its tractor, the tractor is transported on a separate railway vehicle;

g) before the person responsible for the road transport of the dangerous goods releases the highway tank to the rail carrier, that person inspects the attachment points of the tank to the truck or trailer frame to detect any condition that may compromise the integrity of the securement of the tank to the frame, ensure that the highway tank has all valves and closures, at the exclusion of the pressure-relief device, securely closed and capped as applicable, and reports the results of this inspection and this verification to the rail carrier; and

h) unless it is likely to have a serious impact on train dynamics, the railway vehicle on which the highway tank is transported is separated by at least one railway vehicle from a railway vehicle for which a placard is required to be displayed in accordance with Part 4 of the TDG Regulations, is separated by at least one railway vehicles from the locomotive and is located at the tail end or as close as possible to the tail end of the train and behind any loaded railway vehicle.

10.10.2 Transportation of dangerous goods in or on hi-rail equipment

Tank trucks transporting class 2 gases or class 3 flammable liquids shall comply with the requirements of CSA B621 or CSA B622, be properly secured, filled, and closed so that during the course of normal transportation, there will be no release of dangerous goods that could endanger public safety, as well as:

a) hi-rail vehicle equipment is authorized by the operating railway, and is not physically connected to any other railway vehicle; and

b) hi-rail vehicle shall be in the control of a railway employee qualified under the *Canadian Rail Operating Rules*.

10.10.3 Handling of tank cars conforming to specification 113 and AAR 204W

A tank car conforming to specification 113 and AAR 204W shall not be:

a) uncoupled while in motion;

b) coupled into with more force than is necessary to complete the coupling; or

c) struck by any railway vehicle moving under its own motion.

11 Provisions for the one time movement of non-conforming containers presenting low safety risks

11.1 Scope

The purpose of this section is to authorize the one time movement within Canada of certain non-conforming containers where the non-conformance is relatively minor in nature or where measures have been taken to reduce the safety risks to a minimal level. In all cases, the movement shall be for the purposes of cleaning, testing, repairing, dismantling or unloading containers that are not actively leaking and only when it is not possible or unsafe to remedy the non-conformance at the location where it was discovered. Railway vehicles shall be in conformance with the standard prior to the discovery of a non-conformity requiring the use of the clauses in section 11 of this standard.

Note 1: The movement of a non-conforming container where the non-conformance is not covered by the provisions of Section 11 requires carrier permission and an application for a Temporary Certificate pursuant to subsection 31(2.1) of the TDG Act; this is like the United States Federal Railroad Administration's one-time movement approval category OTMA-1. Non-conformities covered by 11.2 are like category OTMA-2 and non-conformities covered by 11.3 are like category OTMA-3. Details on how to apply for a Temporary Certificate can be found here: https://tc.canada.ca/en/dangerous-goods/how-apply-temporary-certificate.

Note 2: The movement of non-conforming tank cars and other railway vehicles for which a One-Time Movement Approval (OTMA) has been issued by the Federal Railroad Administration's Associate Administrator for Railroad Safety is permitted in Canada provided the movement is compliant with all applicable requirements in 49 CFR, the conditions of the OTMA and sections 10.1 and 10.1.1 of the *Transportation of Dangerous Goods Regulations*.

11.2 Written notifications

Written notifications may be sought for the one-time movement of overloaded railway vehicles by weight. Applicants may apply for written notification if:

a) tank car is found to be overloaded by weight in transport by 1361 kg (3000 lb) or less when measured on a weight-in-motion scale or 454 kg (1000 lb) or less when measured on a static scale as long as the outage is within regulatory limits; or

b) railway vehicle other than a tank car carrying solid dangerous goods is found to be overloaded by weight in transport by 2268 kg (5000 lb) or less when measured by a scale.

Applicants shall submit the following information to Transport Canada to obtain written notifications:

a) scale tickets;

b) loading temperature and specific gravity of commodity at the loading temperature;

c) specific gravity of commodity at appropriate reference temperature;

d) capacity and tare weight of the container;

e) innage/outage table for the tank car;

f) any additional information that can be used to demonstrate that the tank car is not overloaded by volume; and

g) permission from the carrier(s) to transport the railway vehicle in its overloaded state.

Application details shall be submitted to MOCregister-Registrecontenant@tc.gc.ca.

11.3 Low safety risk approvals

11.3.1 Maintenance of defective tank car service equipment in transportation

11.3.1.1 Maintenance to stop a leak

If maintenance or temporary repair of service equipment is performed during transport to stop a leak and a leak test is required, the tank car may continue to destination without a leak test. Instances where the leak test is required would include restoration of the joint integrity between the tank car tank and service equipment, repairs or other similar maintenance such as rebuilding of service equipment. The person having conducted the maintenance or temporary repair shall:

a) tag, label, or mark the service equipment in such a way as to convey the need for a leak test before the tank car is offered for transportation in the loaded condition; and

b) notify the owner of the tank car of the need for a leak test before the tank car is offered for transportation in the loaded condition.

11.3.1.2 Leak test required

A tank car that is identified as being in need of a leak test in accordance with the requirements set out in 11.3.1.1 shall not be offered for transportation in the loaded condition before acceptable results from the leak test have been obtained.

11.3.1.3 Maintenance validation

When the maintenance or temporary repair referred to in 11.3.1.1 is not performed by a tank car facility, or is not in accordance with the owner's procedures, the maintenance or temporary repair shall be validated, and the service equipment shall be leak tested by a tank car facility before the tank car is next loaded.

11.3.2 Movement of certain non-conforming tank cars and other railway vehicles in Canada

Non-conforming tank cars and hopper cars in one of the situations described below may be transported for the purposes of cleaning, repairing, testing, dismantling or unloading, and only when it is not possible or unsafe to remedy the situation at the location where it was discovered. These situations are standing approvals that do not require further written authorization from Transport Canada.

11.3.2.1 Non-dangerous goods, residue hopper cars and clean tank cars

Subject to 11.3.3, a non-dangerous goods railway vehicle, a clean or residue hopper car, or a clean tank car with a non-conformity other than structural damage that could affect its product retention capability or capability to withstand normal train loads.

11.3.2.2 Tank car with missing or damaged service equipment parts

Subject to 11.3.3, a tank car with missing or damaged parts of service equipment may be transported provided the integrity of the service equipment closure(s) or its capability to prevent a release is not affected. For example, missing magnetic gauging device rod, valve handle or pipe plug chain.

11.3.2.3 Tank car with a defective closure with other than class 2 dangerous goods

Subject to 11.3.3, a tank car containing a residue of dangerous goods other than class 2, that is empty of liquid, with a defective primary or secondary closure, but the functional primary or secondary closure is closed and properly secured and would prevent a release in transportation in accordance with 4.10 and the service equipment has been tagged, labelled or marked in such a way as to convey the need for repair and for a leak test before the tank car is offered for transportation in the loaded condition.

11.3.2.4 Tank car with a defective closure with a residue of class 2 dangerous goods

Subject to 11.3.3, a tank car that has a defective closure that resulted or could have resulted in a release and that has been depressurized to 6.9 kPa (1 psi) or less, from which all liquid dangerous goods has been removed, and that would not develop any detectable release if the pressure rose slightly as a result of ambient temperature variation during transport and corrective action or maintenance has been performed. In addition, any other closure associated with the defective closure is closed and properly secured in accordance with 4.10.

11.3.2.5 Tank car with damage to a required jacket

Subject to 11.3.3, a tank car that has incurred damage solely to its jacket such that the jacket is deformed or no longer “weather tight” and the tank car retains its minimum insulation or thermal protection properties.

11.3.2.6 Tank car with damage to a non-mandatory insulation system

Subject to 11.3.3, a tank car with jacket or insulation damage where insulation is not a specification requirement and the outage is no less than that authorized for a non-insulated tank car.

11.3.2.7 Tank car with a defective lining or coating

Subject to 11.3.3, a tank car, containing a residue of dangerous goods, with a defective internal lining or coating that has not resulted in damage to the tank shell or head.

11.3.2.8 Tank car with defective exterior heater coils

Subject to 11.3.3, a tank car with a defective exterior heater coil provided the defect does not compromise the integrity of the tank.

11.3.2.9 Tank car with defective interior heater coils

Subject to 11.3.3, a tank car with defective interior heater coils and containing a dangerous goods residue. In addition, all end caps are placed on the coils when so equipped.

11.3.2.10 Structurally damaged tank car

Subject to 11.3.3, a residue tank car with structural damage that does not affect its product retention capability, which is loaded on another railway vehicle and properly secured with all necessary blocks, chains and binders in accordance with applicable AAR loading and securement practices.

11.3.2.11 Tank car with a damaged stub sill

Subject to 11.3.3, a tank car with a damaged stub sill at one end where the damage does not or is not likely to affect the tank car tank when the tank car is placed at the end of a train with the damaged end trailing.

11.3.2.12 Tank car with non-critically cracked attachment welds

Subject to 11.3.3, a tank car with a transverse or longitudinal crack in a weld attaching pads to tank or sills to pads or head braces to pads or sills. In most instances a single transverse crack equal to or less than 76 mm (3 in.) in length or a single longitudinal crack equal to or less than 152 mm (6 in.) in length will not be considered critical. If it cannot be determined with certainty that a crack resides in the weld only then the above criteria do not apply.

11.3.2.13 Tank car with inadequate safety marks

Subject to 11.3.3, a tank car with incorrect stencilled or stamped specification marks, qualification marks or marks required by an equivalency certificate.

11.3.2.14 Damaged or defective protective housing

Subject to 11.3.3, a class 111, 117 or AAR211 tank car with a damaged or defective protective housing or manway cover assembly and that is leaktight.

11.3.2.15 Tank car with defective closure with elevated temperature dangerous goods

Subject to 11.3.3, a tank car with a defective primary or secondary closure and containing only elevated temperature dangerous goods that have adequately solidified to preclude any release. In addition, any other closure associated with the defective closure is closed and properly secured in accordance with 4.10.

11.3.3 Additional requirements

11.3.3.1 Stencilling

The railway vehicle shall be stencilled on each side adjacent to the car number in 76.2 mm (3 in.) minimum size letters with the words “DEFECTIVE CAR MOVING FOR REPAIR – DO NOT LOAD” and/or “WAGON DÉFECTUEUX DÉPLACÉ À DES FINS DE RÉPARATION – NE PAS CHARGER” or words/markings conveying a similar message. In addition, for tank cars with defective service equipment, the specific component shall be tagged with the above wording or wording conveying a similar message.

11.3.3.2 Shipping documents

The shipping document that accompanies the dangerous goods shall indicate that the railway vehicle is moving under the authority of this section and indicate the nature of the defect.

11.3.3.3 Carrier permission

The railway vehicle shall not be transported unless it is permitted by the carrier to be transported in its non-conforming state.

11.3.4 Incomplete tank cars

Incomplete tank cars are partially manufactured tank cars meeting minimum design requirements for safe movement but are not completely manufactured for the transportation of dangerous goods.

11.3.4.1 Final specification stenciling for incomplete tank cars

Manufactured tank cars meeting minimum safety requirements for movement may be stenciled with the final specification of the tank car despite not being completely manufactured for the transport of dangerous goods.

11.3.4.2 Stenciling

The tank car shall be stenciled on each side adjacent to the car number in 76.2 mm (3 in.) minimum size letters with the words “CAR MOVING FOR MANUFACTURE – DO NOT LOAD” and/or “WAGON DÉPLACÉ À DES FINS DE FABRICATION – NE PAS CHARGER” or words/markings conveying a similar message.

11.3.4.3 Manufacturing completion deadline

The tank car shall be completely manufactured for dangerous goods transport in accordance with the final specification stencil within 6 months after the stencils have been initially applied to the tank car.

11.3.5 Transportation between two properties in proximity

Prior to an authorized one-time movement for the purpose of cleaning, repairing, testing, dismantling or unloading a non-conforming tank car or hopper car with dangerous goods, the railway vehicle may be transported between two properties owned or leased by the manufacturer, producer, carrier or user of the dangerous goods for the purpose of temporary storage if

a) the railway vehicle is not leaking and all closures are closed and secured in accordance with 4.10;

b) the distance of the movement is less than or equal to 10 km;

c) the railway vehicle does not have structural damage that could affect its product retention capability or capability to withstand normal train loads; and

d) the additional requirements of 11.3.3 are complied with.

Annex A
(normative)

Side impact test for TC 117P

The TC 117P side impact test is carried out as follows:

a) the tank car is restrained in the direction of impact;

b) the tank is filled, with no more than 4% outage and with no internal pressure, with lading of the same density as the dangerous goods that the tank car is intended to carry;

c) the tank may be filled with water if the dangerous goods that the tank car is intended to carry have a specific gravity of 1.1 or less;

d) the tank car is hit by a proxy object;

e) the proxy object has a mass equal to or greater than 129 727 kg (286 000 lb) and is fitted with a rigid punch that

   1) protrudes at least 1524 mm (60 in.) from the base of the proxy object, and

   2) has a cross-section 305 mm (12 in.) high by 305 mm (12 in.) wide, with a 25.4 mm (1 in.) radius on each edge of the impact face.

Note: The proxy object is intended to approximate a loaded freight car, including the coupler with the knuckle removed.

f) At the instant of impact:

   1) the centre of the impact face of the punch is aligned with the intersection of the vertical and longitudinal centrelines of the tank; and

   2) the horizontal centreline of the punch is perpendicular to the point of impact; and

g) at the instant of impact, the speed of the punch face is equal to or greater than 19.3 km/h (12 mph).

Annex B
(normative)

Head impact test for TC 117P

The TC 117P head impact test is carried out as follows:

a) the tank car is restrained in the direction of impact;

b) the tank is filled, with no more than 4% outage and with no internal pressure, with lading of the same density as the dangerous goods that the tank car is intended to carry;

c) the tank may be filled with water if the dangerous goods that the tank car is intended to carry have a specific gravity of 1.1 or less;

d) the tank car is hit by a proxy object;

e) the proxy object has a mass equal to or greater than 129 727 kg (286 000 lb) and is fitted with a rigid punch that

   1) protrudes at least 1524 mm (60 in.) from the base of the proxy object, and

   2) has a cross-section 305 mm (12 in.) high by 305 mm (12 in.) wide, with a 25.4 mm (1 in.) radius on each edge of the impact face.

Note: The proxy object is intended to approximate a loaded freight car, including the coupler with the knuckle removed.

f) At the instant of impact:

   1) the centre of the impact face of the punch is aligned with the centre of the tank head; and

   2) the horizontal centreline of the punch is perpendicular to the point of impact; and

g) at the instant of impact, the speed of the punch face is equal to or greater than 29 km/h (18 mph).

Annex C
(normative)

Procedures for tank-head puncture-resistance testing

C.1 Tank-head puncture-resistance systems

C.1.1 This test procedure is designed to verify the integrity of new or untried tank-head puncture-resistance systems and to test for system survivability after coupler-to-tank head impacts at relative speeds of 29 km/h (18 mph). Tank-head puncture-resistance is a function of one or more of the following: head thickness, jacket thickness, insulation thickness, and material of manufacture.

C.1.1.1 Tank-head puncture-resistance test

a) Tank-head puncture-resistance system shall be tested under the following conditions:

1) the ram car used shall be at least 119 295 kg (263 000 lb), shall be equipped with a coupler, and shall duplicate the condition of a conventional draft sill including the draft yoke and draft gear. The coupler shall protrude from the end of the ram car so that it is the leading location of perpendicular contact with the impacted test car;

2) the impacted test car shall be loaded with water at 6% outage with internal pressure of at least 689 kPa (100 psi) and coupled to one or more backup cars which have a total mass of 217 724 kg (480 000 lb) with hand brakes applied on the last backup car; and

3) at least two separate tests shall be conducted with the coupler on the vertical centreline of the ram car. One test shall be conducted with the coupler at a height of 533 ± 25 mm (21 ± 1 in.), above the top of the sill; the other test shall be conducted with the coupler height at 790 ± 25 mm (31 ± 1 in.), above the top of the sill. If the combined thickness of the tank head and any additional shielding material is less than the combined thickness on the vertical centreline of the car, a third test shall be conducted with the coupler positioned so as to strike the thinnest point of the tank head.

b) One of the following test conditions in Table C.1 shall be applied:

Table C.1 – Tank-head puncture-resistance - test conditions

Mass of attached ram cars, minimum kg (lb)	Velocity of impact, minimum km/h (mph)	Restrictions
119 295 (263 000)	29 (18)	One ram car only
155 582 (343 000)	25.7 (16)	One ram car or one car plus one rigidly attached car
311 164 (686 000)	22.5 (14)	One ram car plus one or more rigidly attached cars

c) Test is successful if there is no visible leak from the standing tank car for a minimum of one hour after impact.

Annex D
(normative)

Procedures for simulated pool-fire and torch-fire testing

D.1 Thermal protection systems

D.1.1 This test procedure is designed to measure the thermal effects of new or untried thermal protection systems and to test for system survivability when exposed to a 100 minutes pool fire and a 30 minutes torch fire.

D.1.1.1 Simulated pool-fire test

a) Pool-fire environment shall be simulated in the following manner:

1) the source of the simulated pool fire shall be a hydrocarbon fuel with a flame temperature of 870 ± 56 °C (1600 ± 100 °F), throughout the duration of the test;

2) a square bare plate with thermal properties equivalent to the material of manufacture of the tank car shall be used. The plate dimensions shall be at least 305 x 305 mm (12 x 12 in.) by nominal 15.9 mm (5/8 in.) thick. The bare plate shall be instrumented with not less than nine thermocouples to record the thermal response of the bare plate. The thermocouples shall be attached to the surface not exposed to the simulated pool fire and shall be divided into nine equal squares with a thermocouple placed in the centre of each square;

3) the pool-fire simulator shall be manufactured in a manner that results in total flame engulfment of the front surface of the bare plate. The apex of the flame shall be directed at the centre of the plate;

4) the bare plate holder shall be manufactured so that the only heat transfer to the back side of the bare plate is by heat conduction through the plate and not by other heat paths;

5) before the bare plate is exposed to the simulated pool fire, none of the temperature recording devices may indicate a plate temperature in excess of 37.8 °C (100 °F) nor less than 0 °C (32 °F); and

6) a minimum of two thermocouples shall indicate 427 °C (800 °F) after 13 ± 1 min of simulated pool-fire exposure.

b) Thermal protection system shall be tested in the simulated pool-fire environment described in D.1.1.1 a) in the following manner:

1) the thermal protection system shall cover one side of a bare plate as described in D.1.1.1 a) 2);

2) the non-protected side of the bare plate shall be instrumented with not less than nine thermocouples placed as described in D.1.1.1 a) 2) to record the thermal response of the plate;

3) before exposure to the pool-fire simulation, none of the thermocouples on the thermal protection system configuration may indicate a plate temperature in excess of 37.8 °C (100 °F) nor less than 0 °C (32 °F);

4) the entire surface of the thermal protection system shall be exposed to the simulated pool-fire environment;

5) the pool-fire simulation test shall run for a minimum of 100 minutes. The thermal protection system shall retard the heat flow to the plate so that none of the thermocouples on the non-protected side of the bare plate indicate a plate temperature in excess of 427 °C (800 °F); and

6) a minimum of three consecutive successful pool-fire simulation tests shall be performed for each thermal protection system.

D.1.1.2 Simulated torch-fire test

a) Torch-fire environment shall be simulated in the following manner:

1) the source of the simulated torch fire shall be a hydrocarbon fuel with a flame temperature of 1200 ± 56 °C (2200 ± 100 °F), throughout the duration of the test. Furthermore, torch velocities shall be 64 ± 16 km/h (40 ± 10 mph) throughout the duration of the test;

2) a square bare plate with thermal properties equivalent to the material of manufacture of the tank car shall be used. The plate dimensions shall be at least 1219 x 1219 mm (48 x 48 in.) by nominal 15.9 mm (5/8 in.) thick. The bare plate shall be instrumented with not less than nine thermocouples to record the thermal response of the bare plate. The thermocouples shall be attached to the surface not exposed to the simulated torch fire and shall be divided into nine equal squares with a thermocouple placed in the centre of each square;

3) the bare plate holder shall be manufactured so that the only heat transfer to the back side of the bare plate is by heat conduction through the plate and not by other heat paths. The apex of the flame shall be directed at the centre of the plate;

4) before the bare plate is exposed to the simulated torch fire, none of the temperature recording devices may indicate a plate temperature in excess of 37.8 °C (100 °F) or less than 0 °C (32 °F); and

5) a minimum of two thermocouples shall indicate 427 °C (800 °F) after 4 min ± 30 s of simulated torch-fire exposure.

b) Thermal protection system shall be tested in the simulated torch-fire environment described in D.1.1.2 a) in the following manner:

1) the thermal protection system shall cover one side of a bare plate as described in D.1.1.2 a) 2);

2) the non-protected side of the bare plate shall be instrumented with not less than nine thermocouples placed as described in D.1.1.2 a) 2) to record the thermal response of the plate;

3) before exposure to the torch-fire simulation, none of the thermocouples on the thermal protection system configuration may indicate a plate temperature in excess of 37.8 °C (100 °F) nor less than 0 °C (32 °F);

4) the entire surface of the thermal protection system shall be exposed to the simulated torch-fire environment;

5) a torch-fire simulation test shall be run for a minimum of 30 minutes. The thermal protection system shall retard the heat flow to the plate so that none of the thermocouples on the non-protected side of the bare plate indicate a plate temperature in excess of 427 °C (800 °F); and

6) a minimum of two consecutive successful torch-fire simulation tests shall be performed for each thermal protection system.

Annex E
(normative)

Schedules

E.1 Schedule 1 – special provisions

E.1.1 This schedule lists the special provisions that apply to dangerous goods and that correspond to the number set out in column VI of schedule 2. For any given dangerous goods listed in schedule 2 only the container types listed in the applicable special provision shall be used. When more than one container type is authorized in one or more applicable special provision, the container selected shall be listed in the applicable special provision and shall conform to all other applicable requirements of this standard.

1. The dangerous goods may be handled, offered for transport, or transported in a metal railway vehicle that is closed and sift-proof.

2. The dangerous goods may be handled, offered for transport, or transported in a class 105, 111, 112, 114, 115, 117, 120, AAR 203W, AAR 206W, or AAR 211W tank car.

3. The dangerous goods may be handled, offered for transport, or transported in a class 105, 111, 112, 114, 115, 117, 120, or AAR 206W tank car.

4. The dangerous goods may be handled, offered for transport, or transported in a class 105, 112, 114, or 120 fusion-welded tank car.

5. The dangerous goods may be handled, offered for transport, or transported in a class 105 tank car.

6. The dangerous goods may be handled, offered for transport, or transported in a class 105, 111, 112, 114, 115, 117, or 120 tank car.

7. The dangerous goods, if dry, may be handled, offered for transport or transported in a water-tight, sift-proof, closed-top, metal-covered hopper car.

8. The dangerous goods may be handled, offered for transport, or transported in a class 112 tank car.

9. The dangerous goods may be handled, offered for transport, or transported in a class 114 or 120 tank car.

10. The tank car shall conform to the following requirements:

    a) the tank car shall be a:

        1) specification 105A300W tank car;

        2) specification 105A500W tank car; or

        3) specification 105A500W tank car equipped with the cover plates, pressure-relief devices, vent valves, and loading and unloading valves that are required on a specification 105A300W tank car;

    b) the tank car shall be manufactured from nickel-clad or lead-lined steel plate;

    c) the tank car shall have nickel cladding or lead lining on the inside of the tank;

    d) at least 20% of the required minimum total thickness of the tank car tank shall be nickel cladding;

e) the nickel cladding shall conform to ASTM B162;

f) the lead lining shall be equal to or greater than 4.78 mm (0.188 in.) in thickness;

g) service equipment in contact with the dangerous goods shall be lined or manufactured from metal compatible with the dangerous goods;

h) maximum filling density shall be 300% and the minimum filling density shall be 287%;

i) maximum water capacity of the tank car shall be:

1) 9 253 kg (20 400 lb) for a specification 105A300W tank car; and

2) 16 964 kg (37 400 lb) for a specification 105A500W tank car;

j) maximum quantity of dangerous goods in the tank car shall be:

1) 27 216 kg (60 000 lb) in a specification 105A300W tank car; and

2) 49 895 kg (110 000 lb) in a specification 105A500W tank car;

k) a tank car built after December 31, 1990 shall be equipped with a tank-head puncture-resistance system that conforms to the requirements set out in 8.2.7 or to the corresponding requirements in effect at the time of installation; and

l) except as provided in 10.5.1.2 b) or 10.5.1.5, a tank car used in the handling, offering for transport or transporting of bromine or bromine solutions shall conform to the applicable authorized tank car specification listed in the table in 10.5.1.2 a).

11. The dangerous goods may be handled, offered for transport, or transported in a class 105J tank car, which shall conform to the following requirements:

a) tank car shall have a tank test pressure equal to or greater than 2068 kPa (300 psi);

b) in determining outage, the temperature of the dangerous goods, the solubility of inert gas padding in ethylene oxide, and the partial pressure exerted by the gas padding shall be taken into account;

c) tank car shall be:

1) equipped with a reclosing pressure-relief device having a start-to-discharge pressure of 517 kPa (75 psi);

2) padded with dry nitrogen or other suitable inert gas that is:

i. of sufficient quantity to render the vapour space of the tank non-flammable up to 40.6 °C (105 °F); and

ii. free of impurities that may cause the ethylene oxide to polymerize, decompose, or undergo other violent chemical reactions;

3) equipped with a thermometer well; and

4) equipped with packing and gaskets that are manufactured of materials that do not react with or do not lower the auto-ignition temperature of the dangerous goods;

d) neoprene, natural rubber, and asbestos gaskets are prohibited; and

e) no part of the tank car and its service equipment, normally in contact with the dangerous goods, shall be manufactured of copper, silver, mercury, magnesium, or any of their alloys.

12. If the dangerous goods are in dispersion in organic liquid, the organic liquid shall have a flash point greater than 50 °C (122 °F).

13. The container shall be manufactured of steel.

14. The container shall be manufactured of:

    a) nickel or stainless steel; or

    b) steel that is lined with nickel, stainless steel, lead, or other such corrosion-resistant metallic material.

15. The tank shall not be equipped with bottom outlets.

16. The tank car tank shall have a test pressure equal to or greater than 2068 kPa (300 psi).

17. Each container except a tank car shall be insulated with an insulating material so that the overall thermal conductance at 15.6 °C (60 °F) is equal to or less than 1.53 kJ/h·m^{2}·°C (0.075 Btu/h·ft.^{2}·°F). Insulating materials shall not promote corrosion of steel when wet.

18. The container shall be protected from corrosion:

    a) by lining or coating the container with a non-metallic lining or coating compatible with the dangerous goods; or

    b) by manufacturing the container to a thickness that provides an allowance for the corrosive effects of the dangerous goods such that no danger to public safety occurs or may reasonably be expected to occur.

19. The dangerous goods in the container shall be completely covered with nitrogen, inert gas, or other inert materials.

20. The dangerous goods may be handled, offered for transport, or transported in an open steel container.

21. The tank shall be manufactured of steel and:

    a) lined or coated with a non-metallic lining or coating compatible with the dangerous goods; or

    b) if the tank is not so lined or coated, the dangerous goods in the tank shall be inhibited so that the corrosive effect on the steel is not greater than that of hydrofluoric acid of 65% concentration and the tank shall be passivated before being used in the handling, offering for transport, or transporting of dangerous goods, including being re-passivated if cleaned with water.

22. The container shall be manufactured of nickel or nickel-copper alloy or steel that is clad with nickel or nickel-copper alloy.

23. The tank shall:

    a) be insulated with a material of a thickness equal to or greater than 99.1 mm (3.9 in.) except that the thickness of the insulation may be reduced to 50.8 mm (2 in.) over exterior heater coils;

    b) not be equipped with interior heating coils; and

    c) after unloading, contain a padding of inert gas that covers the dangerous goods or be filled with water.

24. The tank shall:

    a) have a minimum tank test pressure of 1379 kPa (200 psi); and

    b) contain a padding of dry inert gas at a pressure equal to or less than 103 kPa (15 psi).

25. The container shall be manufactured of stainless steel.

26. Each tank car shall be a class 105 tank car that:

    a) has a tank test pressure equal to or greater than 3447 kPa (500 psi); and

    b) is equipped with a reclosing pressure-relief device with a start-to-discharge pressure of 1034 kPa (150 psi).

27. Valves and pressure-relief devices that are in contact with the dangerous goods shall be manufactured of materials that will not cause the formation of acetylides.

28. Pressure-relief devices shall be equipped with stainless steel or platinum rupture discs.

29. The tank shall not be equipped with interior heater coils, and a tank car shall be equipped with a reclosing pressure-relief device with a start-to-discharge pressure equal to or less than 1551 kPa (225 psi).

30. The tank shall be manufactured of stainless steel or aluminum.

31. The dangerous goods may be handled, offered for transport, or transported in an open-top, sift-proof railway vehicle.

32. The dangerous goods may be handled, offered for transport, or transported in a water-tight, sift-proof, closed-top, metal-covered hopper car that is equipped with a venting arrangement, including flame arrestors.

33. The dangerous goods may be handled, offered for transport, or transported in a water-tight, sift-proof, closed-top, metal-covered hopper car if the particle size of the dangerous goods is equal to or greater than 149 mm.

34. The dangerous goods may be handled, offered for transport, or transported in a class 115A tank car that is equipped with:

    a) safety vent that has a diameter equal to or greater than 305 mm (12 in.); and

    b) rupture disc that has a start-to-discharge pressure equal to or less than 310 kPa (45 psi).

35. The dangerous goods may be handled, offered for transport, or transported in a covered hopper car with nitrogen padding.

36. Each tank car shall:

    a) be class 105;

    b) have a minimum tank test pressure of 3447 kPa (500 psi); and

    c) be equipped with a reclosing pressure-relief device that has a start-to-discharge pressure equal to 1551 kPa (225 psi).

37. The tank shall:

    a) be equipped with gas-tight valve protection caps;

    b) have a minimum tank test pressure of 3447 kPa (500 psi); and

    c) be filled to an outage capable of preventing the tank from becoming liquid full at 54.4 °C (130 °F).

38. The tank car shall be a class 105 tank car that:

    a) is equipped with exterior heating coils that are fusion-welded to the tank shell and that have been post-weld heat treated;

    b) has a tank test pressure equal to or greater than 2068 kPa (300 psi);

    c) is filled such that the outage shall be equal to or greater than 5% at a product temperature equal to 98 °C (208 °F); and

    d) is loaded when the dangerous goods are in liquid form and transported only after the dangerous goods are in solid form.

39. The dangerous goods may be handled, offered for transport, or transported in a sift-proof, water-tight, metal-covered hopper car.

40. The tank car shall conform to the applicable requirements of 10.5.1.

41. Each tank car shall:

    a) have a tank test pressure equal to or greater than 2068 kPa (300 psi); and

    b) be equipped with a reclosing pressure-relief device with a start-to-discharge pressure equal to 1034 kPa (150 psi).

42. The dangerous goods may be handled, offered for transport, or transported in a class 105, 111, 112, 114, or 120 tank car that:

    a) has a tank test pressure equal to or greater than 414 kPa (60 psi); and

    b) is equipped with welded heater pipes designed for a test pressure of 3447 kPa (500 psi).

43. If hydrogen peroxide solution with more than 40% hydrogen peroxide, the tank shall be equipped with venting devices, including filters, and the venting devices shall be liquid-tight at pressures equal to or less than 138 kPa (20 psi).

44. Containers other than tank cars are prohibited.

45. Bottom outlets are prohibited on a tank car that is or may be used in the handling, offering for transport, or transporting of sulphuric acid in concentrations greater than 65.25%, except a tank car with bottom outlets may be used for sulphuric acid in concentrations greater than 65.25% if the tank car conforms to the following conditions:

    a) the tank car conforms to a specification 111A100W2 tank car and is equipped with a bottom outlet that conforms to the requirements set out in 8.3.10 and E9.0 of the AAR Specifications for Tank Cars publication;

b) the tank car forms part of a train, commonly known as a “unit train” that:

1) is comprised only of motive power units, tank cars, and possibly a caboose;

2) is not switched during transport;

3) travels from a single consignor to a single consignee; and

4) is comprised of tank cars that contain only sulphuric acid in concentrations greater than 65.25%;

c) if, during transport, one of the tank cars referred to in 45 b) requires repair or has been repaired, the tank car may be separated from the “unit train” and proceed to destination in a regular freight train;

d) the bottom outlet cap shall be secured;

e) the bottom outlet cap shall be locked in place with a retractable pin that engages the hammer lugs if the outlet cap is equipped with hammer lugs;

f) the bottom outlet cap, when secured and locked, shall provide a liquid-tight seal that is maintained, under normal conditions of transport, including handling, throughout the time that the dangerous goods are transported between consignor and consignee; and

g) before offering the dangerous goods for transport, the rupture discs shall be removed and inspected on a representative sampling of the tank cars.

46. The container shall be protected from corrosion:

a) by lining or coating the container with a non-metallic lining or coating compatible with the dangerous goods; or

b) by manufacturing the container to a thickness that provides an allowance for the corrosive effects of sulphuric acid in concentrations up to 65.25% or spent sulphuric acid in concentrations up to 65.25%.

47. The tank shall be filled to a filling density less than or equal to 125%.

48. The dangerous goods may be handled, offered for transport, or transported in a class 105 tank car that is filled to a filling density less than or equal to 124%.

49. The tank shall be filled to a filling density less than or equal to 120%.

50. The minimum outage shall be such that the liquefied portion of the gas does not completely fill the tank prior to reaching the greater of either the setting of the pressure-regulating valve with the lowest setting that is fitted on the tank car or 2413 kPa (350 psi).

51. The tank car shall conform to the following requirements:

a) tank plates, manway nozzles and, subject to 51 c), anchorages of the tank shall be manufactured of carbon steel that conforms to:

1) ASTM A516/A516M, Grade 55/380, 60/415, 65/450, or 70/485 steel that conforms to the Charpy V-notch impact test requirements of ASTM A20/A20M, in longitudinal direction of rolling; or

2) AAR TC128, Grade B steel that conforms to the Charpy V-notch impact test requirement of ASTM A370. The test shall be conducted at a temperature equal to or less than -46 °C (-50 °F) in the longitudinal direction of rolling. The minimum average energy absorption result for three test specimens shall be 20 J (15 ft.-lb) and the minimum energy absorption result for any individual test specimen shall be 13.5 J (10 ft.-lb);

b) production welded test plates shall:

1) be prepared in conformance with the test plate requirements set out in Appendix W of the AAR Specifications for Tank Cars publication;

2) include impact test specimens of the weld metal and of base metal from the heat-affected zone that are prepared and tested in conformance with the requirements set out in W8.0, of the AAR Specifications for Tank Cars publication; and

3) conform to the same impact requirements as the plate material;

c) anchor legs may be manufactured of stainless steel, ASTM A240/A240M, type 304, 304L, 316, or 316L, in which case impact tests are not required;

d) tank car tank shall be insulated such that the overall thermal conductance is equal to or less than 0.61 kJ/h·m^{2}·°C (0.03 Btu/h·ft^{2}·°F);

e) tank car shall be equipped with:

1) reclosing pressure-relief device having a start-to-discharge pressure equal to or less than 75% of the tank test pressure;

2) rupture disc set to burst at a pressure less than the tank test pressure and more than the reclosing pressure-relief device start-to-discharge pressure;

3) pressure-relief devices that have a discharge capacity capable of preventing the pressure in the tank from exceeding 82.5% of the tank test pressure;

4) two regulating valves having start-to-discharge pressures equal to or less than:

i. 2413 kPa (350 psi) on a specification 105A500W tank car; and

ii. 2758 kPa (400 psi) on a specification 105A600W tank car; and

5) regulating valves and pressure-relief devices that have their discharge directed outside the protective housing;

f) tank car shall have a tank test pressure equal to or greater than 3447 kPa (500 psi).

52. The tank shall be filled to a filling density equal or greater than 80.1% and less than or equal to 89% at a maximum pressure of 621 kPa (90 psi).

53. The tank shall be filled to a filling density equal to or greater than 53.6% and less than or equal to 59.6% at a maximum pressure of 724 kPa (105 psi).

54. The tank car shall conform to the following requirements:

a) tank car shall be a specification 105J600W tank car;

b) all plates for the tank car tank shall be manufactured of steel listed in 54 b) 2) and service equipment shall be manufactured of steel listed in 54 b) 1) or 2):

   1) stainless steel that conforms to ASTM A240/A240M, type 304, 304L, 316, or 316L, in which case impact tests are not required; or

   2) steel that conforms to ASTM A516/A516M, Grade 70/485, ASTM A537/A537M, class 1, or AAR TC128, Grade B, in which case impact tests shall be performed as follows:

      i. ASTM A516/A516M, Grade 70/485 and ASTM A537/A537M, class 1 steel shall conform to the Charpy V-notch impact test requirements of ASTM A20/A20M, in the longitudinal direction of rolling; and

      ii. AAR TC128, Grade B steel shall conform to the Charpy V-notch impact test requirement of ASTM A370. The test shall be conducted at a temperature equal to or less than -46 °C (-50 °F) in the longitudinal direction of rolling. The minimum average energy absorption result for three test specimens shall be 20 J (15 ft.-lb) and the minimum energy absorption result for any individual test specimen shall be 13.5 J (10 ft.-lb);

c) production welded test plates shall:

   1) be prepared in conformance with the requirements set out in W3.0, of the AAR Specifications for Tank Cars publication;

   2) Include impact test specimens of the weld metal and of base metal from the heat-affected zone that are prepared and tested in conformance with the requirements set out in W8.0, of the AAR Specifications for Tank Cars publication; and

   3) conform to the same impact requirements as the plate material;

d) tank car shall be equipped with at least one reclosing pressure-relief device that conforms to the requirements set out in 8.2.5;

e) discharge from each pressure-relief device shall be directed outside the protective housing;

f) excess-flow valves shall be installed under all liquid and vapour valves;

g) thermometer well may be installed;

h) gauging device may be installed;

i) pressure gauge may be installed;

j) aluminum, copper, silver, zinc, or an alloy of any of these metals shall not be used in the manufacture of the tank car tank or any part of the service equipment that is in contact with the dangerous goods;

k) jacket of the tank car shall be stencilled adjacent to the stencil for water capacity, as follows:

   MINIMUM OPERATING TEMPERATURE — °C (°F)

   and/or

   TEMPÉRATURE MINIMALE EN SERVICE — °C (°F)

l) tank car and insulation shall be designed to prevent the vapour pressure of the dangerous goods from reaching the start-to-discharge pressure of the pressure-relief device on or before thirty days after loading the tank car. The conditions to be considered include an ambient temperature equal to 32.2 °C (90 °F) and the tank car filled to its maximum allowable filling density.

55. Liquefied gas shall be loaded so that the outage is equal to or greater than 2% of the total capacity of the tank at one of the following reference temperatures:

a) 46.1 °C (115 °F) for a non-insulated tank;

b) 43.3 °C (110 °F) for tanks having a thermal protection system incorporating a metal jacket that provides at 15.6 °C (60 °F) an overall thermal conductance less than or equal to 10.22 kJ/h·m^{2}·°C (0.5 Btu/h·ft.^{2}·°F); and

c) 40.6 °C (105 °F) for an insulated tank when the overall thermal conductance is equal to or less than the minimum required of a class 105 or 120.

56. For liquefied petroleum gas and anhydrous ammonia loaded in tank cars, during the winter months of November through March, the following winter reference temperatures may be used if:

a) the tank car is shipped directly to a consumer for unloading and not stored in transit, except for normal rail switching operations to allow the car to move from its original location to the consumer's intended destination;

b) offeror of the tank car informs each customer and carrier that winter reference temperatures were used at the time that the tank car was filled;

c) the tank car is unloaded as soon as possible and no later than 15 days after the month of March (April 15) in order to retain the specified outage and to prevent a release of dangerous goods which might occur due to the tank car becoming liquid full at higher temperatures; and

d) winter reference temperatures are:

1) 38 °C (100 °F) for a non-insulated tank car;

2) 32 °C (90 °F) for a tank car having a thermal protection system incorporating a metal jacket that provides at 15.6 °C (60 °F) an overall thermal conductance less than or equal to 10.2 kJ/h·m^{2}·°C (0.50 Btu/h·ft.^{2}·°F); or

3) 29 °C (85 °F) for an insulated tank car when the overall thermal conductance is equal to or less than the minimum required of a class 105 or 120.

57. The tank car shall conform to the following requirements:

a) tank car shall be a specification 105H600W tank car, except as provided in special provision in 78, and shall be equipped with a tank-head puncture resistance system that conforms to the requirements of 8.2.7, with 8.2.7.3 excluded;

b) tank car shall be designed for loading at a temperature equal to or less than -45.6 °C (-50 °F);

c) all plates for the tank car tank shall be manufactured of steel listed in 57 c) 2), and service equipment shall be manufactured of steel listed in 57 c) 1) or c) 2):

1) stainless steel that conforms to ASTM A240/A240M, type 304, 304L, 316, or 316L, in which case impact tests are not required; or

2) steel that conforms to ASTM A516/A 516M, Grade 70/485, ASTM A537/A537M, class 1, or AAR TC128, Grade B, in which case impact tests shall be performed as follows:

i. ASTM A516/A516M, Grade 70/485 and ASTM A537/A537M, class 1 steel shall conform to the Charpy V-notch impact test requirements of ASTM A20/A20M, in the longitudinal direction of rolling; and

ii. AAR TC128, Grade B steel shall conform to the Charpy V-notch impact test requirement of ASTM A370. The test shall be conducted at a temperature equal to or less than 46 °C (50 °F) in the longitudinal direction of rolling. The minimum average energy absorption result for three test specimens shall be 20.3 J (15 ft.-lb) and the minimum energy absorption result for any individual test specimen shall be 13.5 J (10 ft.-lb);

d) production welded test plates shall:

1) be prepared in conformance with the requirements set out in W3.0 of the AAR Specifications for Tank Cars publication;

2) include impact test specimens of the weld metal and of base metal from the heat-affected zone that are prepared and tested in conformance with the requirements set out in W8.0 of the AAR Specifications for Tank Cars publication; and

3) conform to the same impact requirements as the plate material;

e) reclosing pressure-relief devices shall be trimmed with nickel-copper alloy or other material approved by the AAR Executive Director and be equipped with a rupture disc of silver, polytetrafluoroethylene-coated nickel-copper alloy, or tantalum. Pressure-relief devices shall be equipped with a suitable auxiliary valve for the purpose of venting the space between the rupture disc and the relief valve;

f) discharge from each pressure-relief device shall be directed outside the protective housing;

g) loading and unloading valves shall be:

1) trimmed with nickel-molybdenum alloys UNS N10001 or N10002, nickel-copper, or other material approved by the AAR Executive Director; and

2) identified as “Vapours” or “Vapours/Vapeurs,” “Liquid” or “Liquid/Liquide”;

h) excess-flow valves or spring loaded check valves shall be installed under all liquid and vapour valves, but an excess-flow valve shall not be installed in conjunction with a pressure-relief device;

i) thermometer well may be installed;

j) gauging device may be installed;

k) sump shall be installed in the bottom of the tank under the liquid pipes;

l) all gaskets shall be made of, or coated with, polytetrafluoroethylene or other materials approved by the AAR Executive Director;

m) tank car may be equipped with exterior cooling coils on top of the shell;

n) jacket of the tank car shall be stencilled adjacent to the stencil for water capacity, as follows:

MINIMUM OPERATING TEMPERATURE — °C (°F)

and/or

TEMPÉRATURE MINIMALE EN SERVICE — °C (°F)

o) tank car and insulation shall be designed to prevent the vapour pressure of the dangerous goods from reaching the start-to-discharge pressure of the pressure-relief device on or before thirty days after loading the tank car. The conditions to be considered include an ambient temperature equal to 32.2 °C (90 °F) and the tank car filled to its maximum allowable filling density;

p) tank car shall be unloaded to such an extent that the vapour pressure of the dangerous goods remaining in the tank, at a reference temperature equal to 32.2 °C (90 °F), will not reach the start-to-discharge pressure of the pressure-relief device;

q) auxiliary valve on the pressure-relief device shall be closed during transport; and

r) despite 57 a), a tank car conforming to specification 105J600W may be used in accordance with the requirements of 10.5.1.5.

58. The tank car shall conform to the following requirements:

a) Interior pipes of the loading and unloading valves and sampling valves, as well as the gauging device if it provides a means for passage of the dangerous goods from the interior to the exterior of the tank shall be equipped with excess-flow valves or spring loaded check valves. If the opening for passage of the dangerous goods through the gauging device is less than 1.52 mm (0.060 in.) in diameter, an excess-flow valve is not required.

b) Cover of the protective housing shall be provided with an opening that is located above each pressure-relief device. The opening shall be provided with a weatherproof cover designed for vertical discharge. The opening with weatherproof cover shall be concentric with the discharge of the pressure-relief device and shall have an area equal to or greater than the valve outlet area.

59. The tank car shall comply with the following requirements:

a) the tank car shall be a specification 105H600W, except as provided in special provision 83, and shall be equipped with a tank-head puncture-resistance system that conforms to 8.2.7, with 8.2.7.3 excluded;

b) is insulated with 50.8 mm (2 in.) glass fibre placed over 50.8 mm (2 in.) of ceramic fibre, if the tank car was manufactured after September 30, 1991;

c) has excess-flow valves or spring loaded check valves on the interior pipes of liquid discharge valves; and

d) despite 59 a), a class 105 tank car that has a tank test pressure equal to or greater than 3447 kPa (500 psi) may be used in accordance with the requirements of 10.5.1.5.

60. The tank car shall conform to the following requirements:

    a) the tank car shall be a specification 105H600W, except as provided in special provision 78, and shall be equipped with a tank-head puncture-resistance system that conforms to 8.2.7, with 8.2.7.3 excluded;

    b) water content of the dangerous goods shall be equal to or less than 0.10% by mass;

    c) outage shall be equal to or greater than 1% of the total volumetric capacity of the tank at the reference temperature of 40.6 °C (105 °F); and

    d) despite 60 a), a specification 105J600W tank car may be used in accordance with the requirements of 10.5.1.5.

61. The tank car shall conform to the following requirements:

    a) subject to 61 b) the tank car shall have a head puncture-resistance system, a metal jacket, and a tank test pressure equal to or greater than 1379 kPa (200 psi), except that:

        1) no metal jacket is required if:

            i. tank test pressure is equal to or greater than 2344 kPa (340 psi); or

            ii. tank shell and head are manufactured from AAR TC128, Grade B steel, normalized;

        2) higher tank test pressure is required if such higher tank test pressure is otherwise specified in this standard;

    b) when a reference to this special provision is made in column VI of Table E.2-1 in Schedule 2 for generic shipping names, the requirements of 61 a) apply only to the following generic shipping names and descriptions of dangerous goods:

        1) organochlorine pesticide, solid, toxic, or organochlorine pesticide, liquid, toxic, flammable, or organochlorine pesticide, liquid, toxic, if those pesticides include any one of the following chemicals or their solutions or mixtures: aldrin, chlordane, DDT, dieldrin, alpha-endosulfan, beta-endosulfan, endrin, heptachlor, isodrin, metoxychlor, pentachlorophenol, TDE, toxaphene, 2,4,5 trichlorophenol, or 2,4,6-trichlorophenol;

        2) chloroanilines, solid containing p-chloroaniline;

        3) chlorocresols, solid containing p-chloro-m-cresol;

        4) flammable liquid, n.o.s. containing 2-chloroethyl vinyl ether or 1,2 dichloroethane or 1,2-dichloropropane or 1,3-dichloropropene or 1,2,4-trichlorobenzene or 1,1,2-trichloroethane;

        5) chlorophenols, liquid containing o-chlorophenol;

        6) toxic liquid, n.o.s. containing 3-chloropropionitrile or m-dichlorobenzene or p-dichlorobenzene or hexachloropropene or tetrachloroethane;

        7) dibromochloropropanes containing 1,2-dibromo-3-chloropropane;

        8) toxic liquid, flammable, n.o.s. containing 1,4-dichloro-2-butene; and

        9) toxic solid, n.o.s. containing 2,4-diclorophenol or kepone or 1,2,4,5-tetrachlorobenzene.

62. The dangerous goods may be handled, offered for transport, or transported in a container that conforms to the following requirements:

    a) container shall be a class 105, 111, 112, 114, 115 or 117 tank car or a specification AAR203W, AAR206W, or AAR211W tank car; or

    b) non-specification tank, other than a tank car, equivalent in structural design and accident damage resistance to a specification container.

63. Dangerous goods that meet the definition of solid elevated temperature dangerous goods are exempted from all requirements of this standard.

64. The dangerous goods may be handled, offered for transport, or transported in a tank car that conforms to the following requirements:

    a) a tank car containing a flammable cryogenic liquid shall not be shipped unless the tank car was loaded by, or with the consent of, the owner of the tank car;

    b) the amount of flammable cryogenic liquid loaded into a tank car shall be determined either by direct measurement or by calculation based on mass to verify that the tank has not been filled to a level in excess of the limits specified in special provision 64 f). The mass of any flammable cryogenic liquid loaded, except hydrogen, shall be checked by the use of scales after disconnecting the loading line;

    c) a tank car shall not be loaded with any flammable cryogenic liquid:

        1) if the tank car already contains dangerous goods or other substance that is not compatible with the dangerous goods to be loaded;

        2) that is colder than the design service temperature of the tank; or

        3) if the average daily pressure rise in the tank exceeded 20.7 kPa (3 psi) during any prior shipment;

    d) when a tank car containing a flammable cryogenic liquid is offered for transport:

        1) the outage shall be equal to or greater than 0.5% and the liquid level shall be below the inlet of the pressure-relief valve or pressure-control valve at the start-to-discharge pressure setting of the valve, with the tank car in a level attitude; and

        2) absolute pressure in the annular space shall be less than 10 Pa (75 mm of mercury);

    e) a flammable cryogenic liquid shall be loaded into a tank car at such a temperature that the average daily pressure rise during transport will be equal to or less than 20.7 kPa (3 psi);

    f) a class 113 tank car is authorized for the shipment of ethylene, methane, natural gas or hydrogen (minimum 95% parahydrogen) in the state of cryogenic liquids. Such a tank car shall be selected, loaded and shipped in accordance with the applicable requirements set out in Table E.1-1:

Table E.1-1 – Pressure-control valve setting or relief-valve setting – Class 113 tank cars for the shipment of ethylene, methane, natural gas or hydrogen (minimum 95% parahydrogen) in the state of cryogenic liquids

Authorized specifications and loading requirements	113D60W[a] 113C60W[a]	113C120W[a] 113C120W9	113D120W[a]	113A175W[a] 113A60W[a] 113A60W9	113C120W9	113C140W9	113C140W9
	Ethylene	Ethylene	Ethylene	Hydrogen	Methane or natural gas	Ethylene	Methane or natural gas
Design service temperature	-162.2 °C (-260 °F)	-162.2 °C (-260 °F)	-103.9 °C (-155 °F)	-252.8 °C (-423 °F)	-162.2 °C (-260 °F)	-162.2 °C (-260 °F)	-162.2 °C (-260 °F)
Maximum permitted filling density (% by mass)	52.8 (at 310 kPa [45 psi] maximum start-to-discharge)	50.7 (at 517 kPa [75 psi] maximum start-to-discharge)	50.7 (at 517 kPa [75 psi] maximum start-to-discharge)	6.60 (at 117 kPa [17 psi] maximum start-to discharge)	37.3 (at 517 kPa [75 psi] maximum start-to-discharge)	50.1 (at 620 kPa [90 psi] maximum start-to-discharge)	36.8 (at 620 kPa [90 psi] maximum start-to-discharge)
Maximum pressure when offered for transport, kPa (psi)	68.9 (10)	68.9 (10)	137.9 (20)	—	68.9 (10)	68.9 (10)	68.9 (10)

[a] Tank car specification may continue in use, but new construction is not authorized.

g) Each shipment of division 2.1 dangerous goods shall be remotely monitored for pressure and location. A tank car manufactured prior to the coming into force of this standard in the TDG Regulations may be monitored for average daily pressure rise as an alternative to remote monitoring for pressure and location. If the pressure rise during any shipment is greater than 21 kPa (3 psi) over any 24-hour period, the offeror shall notify the carrier of the pressure rise and the tank car shall be retested for thermal integrity before any subsequent shipment. Either of the following alternative thermal integrity retests may be used:

1) Pressure rise retest — pressure rise in the tank shall not exceed 34.5 kPa (5 psi) in 24 h. If the pressure rise retest is performed, the absolute pressure in the annular space of the loaded tank car shall not exceed 10 Pa (75 mm of mercury) at the beginning of the retest and shall not increase more than 3.33 Pa (25 mm of mercury) during the 24 h period; or

2) Calculated heat transfer rate retest — insulation system shall be performance tested as specified in 8.6.3. If the calculated heat transfer rate retest is performed, the absolute pressure in the annular space of the loaded tank car shall not exceed 10 Pa (75 mm of mercury) at the beginning of the retest and shall not increase more than 3.33 Pa (25 mm of mercury) during the 24 h period. The calculated heat transfer rate in 24 h shall not exceed:

i. 120% of the appropriate standard heat transfer rate specified in 8.5.23.1, for a specification 113A60W, 113A60W9, 113C120W, 113C120W9 or 113C140W9 tank car;

ii. 0.2707 kJ/kg/d (0.1164 Btu/d/lb) of inner tank water capacity for a specification 113A175W tank car;

iii. 0.7610 kJ/kg/d (0.3272 Btu/d/lb) of inner tank water capacity for a specification 113C60W and specification 113D60W tank car; or

iv. 1.1025 kJ/kg/d (0.4740 Btu/d/lb) of inner tank water capacity for a specification 113D120W tank car;

h) if a class 113 tank car fails either of the retests specified in 64 g) 1) or 2), the tank car shall be removed from service and shall not be placed back in service until one of the applicable retests in 64 g) 1) or 2), is completed successfully;

i) the rupture disc of a class 113 tank car shall be replaced every twelve months, and the replacement date stencilled on the car adjacent to marking for the pressure-relief device;

j) if a class 113 tank car is used in the handling, offering for transport, or transporting of a flammable cryogenic liquid, an alternate pressure-relief device shall be retested at the same time interval specified for the required pressure-relief device. The start-to-discharge pressure and vapour-tight pressure requirements for the alternate pressure-relief device shall be as specified in 8.5.23.1. The alternate pressure-relief device values specified in 8.5.23 for the specification 113C120W tank car apply to the specification 113D120W tank car; and

k) tank car transporting a flammable cryogenic liquid shall not be:

1) uncoupled while in motion;

2) coupled into with more force than is necessary to complete the coupling; or

3) struck by any railway vehicle moving under its own momentum.

65. Atmospheric gases, helium, and mixtures thereof, or cryogenic liquids may be handled, offered for transport, or transported in a tank car provided the tank car conforms to the following requirements, as applicable:

a) if the internal pressure is to be maintained at values equal to or less than 174 kPa (25.3 psi) during transport, the tank car shall be a class 113 tank car or a specification AAR 204W tank car when authorized for such service by the AAR Executive Director and the filling level of the dangerous goods is equal to or less than 95% of the volumetric capacity of the tank;

b) conditions specified by the AAR for such tank cars;

c) pressure setting for a pressure-control valve, if used, shall be equal to or greater than 103 kPa (15 psi);

d) absolute pressure in the annular space is less than 26.7 Pa (200 µm of mercury);

e) internal tank pressure in a specification AAR 204W at the time of offering for transport is equal to or less than 69 kPa (10 psi);

f) if the internal pressure is to be maintained at values greater than 174 kPa (25.3 psi) during transport, the tank car shall be a class 113 tank car selected, loaded and shipped in accordance with the applicable requirements set out in Table E.1-2:

Table E.1-2 – Pressure-control valve setting or relief-valve setting – Class 113 tank cars for the shipment of atmospheric gases, helium, and mixtures thereof, or cryogenic liquids when the internal pressure is to be maintained at values greater than 174 kPa (25.3 psi)

Authorized specifications and loading requirements	113A90W	113A90W	113A90W
	Nitrogen	Oxygen	Argon
Design service temperature	-195.5 °C (-320 °F)	-195.5 °C (-320 °F)	-195.5 °C (-320 °F)
Maximum permitted filling density (% by mass)	72.0 (at 414 kPa [60psi] maximum start-to-discharge)	104.0 (at 414 kPa [60 psi] maximum start-to-discharge)	126.0 (at 414 kPa [60 psi] maximum start-to discharge)

g) Tank car transporting cryogenic liquid shall not be:

1) uncoupled while in motion;

2) coupled into with more force than is necessary to complete the coupling; or

3) struck by any railway vehicle moving under its own motion.

66. The container for asbestos shall conform to the general requirements of section 4 of this standard. The asbestos shall be handled, offered for transport, or transported in a rigid, watertight, and sift-proof container such as a portable tank or a hopper-type railway vehicle. Asbestos that is immersed or fixed in a natural or artificial binder material, such as cement, plastic, asphalt, resins, or mineral ore, and manufactured products containing asbestos are not subject to the requirements of this standard.

67. This dangerous good is toxic by inhalation in hazard zone A.

68. This dangerous good is toxic by inhalation in hazard zone B.

69. This dangerous good is toxic by inhalation in hazard zone C.

70. This dangerous good is toxic by inhalation in hazard zone D.

71. This dangerous good is toxic by inhalation.

72. Liquefied petroleum gas shall be odorized to allow detection of the liquefied petroleum gas in the atmosphere at any concentration above one-fifth of its lower explosive limit in air unless the addition of any odorant would be harmful to further use or processing of the liquefied petroleum gas.

73. The dangerous goods may be handled, offered for transport, or transported in a railway vehicle or a non-specification container. The container shall be water-tight, sift-proof, and provided with a venting arrangement that is capable of preventing any accumulation of gaseous emissions that could endanger public safety. Before and during loading, the dangerous goods shall be dry, shall not come in contact with water, and shall not be offered for transport if the temperature of the dangerous goods exceeds 40 °C (104 °F).

74. The pressure-relief devices on tank cars shall have been qualified within the last five years. The pressure-relief devices on tank cars shall be equipped with a stainless steel spring or a spring coated to protect against ammonia stress corrosion cracking.

75. Except as provided in special provision 78, tank cars shall conform to specification 105H500W, subject to 10.5.1.5. When special provision 76 is also set out in schedule 2 for the specific dangerous goods a 112H500W is also authorized. Tank cars shall be equipped with a tank-head puncture-resistance system that conforms to 8.2.7, with 8.2.7.3 excluded.

76. Except as provided in special provision 78, tank cars shall conform to specification 112H500W, subject to 10.5.1.5. When special provision 75 is also set out in schedule 2 for the specific dangerous goods a 105H500W is also authorized. Tank cars shall be equipped with a tank-head puncture-resistance system that conforms to 8.2.7, with 8.2.7.3 excluded.

77. Except as provided in special provision 78, tank cars shall conform to specification 105H600W, subject to 10.5.1.5, and shall be equipped with a tank-head puncture-resistance system that conforms to 8.2.7, with 8.2.7.3 excluded.

78. As an alternative to the tank car specifications authorized in special provisions 57, 59, 60, 75, 76, or 77 a tank car of the same authorized specification but of the next lower test pressure, as prescribed in column III of Table 5 in 8.3.22 may be used provided that both of the following conditions are met:

    a) the difference between the alternative and the required minimum plate thicknesses, based on the calculation using the formula in 8.3.6.1, shall be added to the alternative tank car jacket and head shield. When the jacket and head shield are made from steel with a minimum tensile strength from 483 to 558 MPa (70 000 to 81 000 psi), but the required minimum plate thickness calculation is based on steel with a minimum tensile strength of 558 MPa (81 000 psi), the thickness to be added to the jacket and head shield shall be increased by a factor of 1.157. Forming allowances for heads are not required to be considered when calculating thickness differences; and

    b) the tank car jacket and head shields are manufactured from carbon steel plates as prescribed in 8.3.5. The steel shall meet the Charpy requirements of 2.2.1.2 of the AAR *Specifications for Tank Cars* publication and head shields shall be normalized after forming.

79. The tank shall be filled to a filling density less than or equal to 104%.

80. Despite 10.6.2 a), the tank car does not need to be grounded during loading and unloading as long as fire safety measures have been taken to prevent the exposure of the dangerous goods to fire hazards, including sources of ignition, intense heat and flammable materials.

81. The dangerous goods may be handled, offered for transport, or transported in a tank car in accordance with 10.5.5.

82. If the free sulphur trioxide content in the dangerous goods is 30% or greater, the following requirements apply:

    a) dangerous goods is toxic by inhalation in hazard zone B;

    b) tank car shall be fusion-welded, conform to class 105, 112, 114 or 120, and conform to the applicable requirements of 10.5.1;

    c) despite anything to the contrary in special provision 45, the tank shall not be equipped with bottom outlets; and

    d) each container, except a tank car, shall be insulated with an insulating material so that the overall thermal conductance at 15.6 °C (60 °F) is equal to or less than 1.53 kJ/h·m^{2}·°C (0.075 Btu/h·ft.^{2}·°F). Insulating materials shall not promote corrosion of steel when wet.

E.2 Schedule 2 – list of dangerous goods

Legend

Column I Shipping name - This column gives the shipping names for dangerous goods in alphabetical order within each primary class and within each packing group. The alphabetical order has been determined by ignoring all numerical digits and all lower case letters that precede the first capital letter in the shipping name. The most appropriate designation for the dangerous goods shall be selected based on each class, UN number and packing group established per the classification requirements of 4.5.

Column II Primary class - This column gives the primary class of the dangerous goods.

Column III Subsidiary class - This column gives the subsidiary class(es), if applicable, of the dangerous goods.

Column IV UN number - This column gives the UN number assigned to the dangerous goods under the UN system.

Column V Packing group - This column gives the packing groups of the dangerous goods.

Column VI Special provisions - This column gives the special provisions that apply to the dangerous goods.

Symbol P The symbol P used in this schedule means that the handling, offering for transport, and transporting of the dangerous goods by rail is prohibited.

Table E.2-1 – Schedule 2 – List of dangerous goods

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
Class 2.1 dangerous goods					
ACETYLENE, DISSOLVED	2.1	—	UN1001	—	P
BUTANE	2.1	—	UN1011	—	4, 56, 58, 72
BUTYLENE	2,1	—	UN1012	—	4, 56, 58, 72
1,1-DIFLUOROETHYLENE or REFRIGERANT GAS R 1132A	2.1	—	UN1959	—	P
DEUTERIUM, COMPRESSED	2.1	—	UN1957	—	P
DIMETHYLAMINE, ANHYDROUS	2.1	—	UN1032	—	5, 8, 58
ETHYLAMINE	2.1	—	UN1036	—	4, 58
ETHYLENE, REFRIGERATED LIQUID	2.1	—	UN1038	—	64
HYDROGEN, COMPRESSED	2.1	—	UN1049	—	P
HYDROGEN, REFRIGERATED LIQUID	2.1	—	UN1966	—	64
ISOBUTANE	2.1	—	UN1969	—	4, 56, 58, 72
ISOBUTYLENE	2.1	—	UN1055	—	4, 56, 58, 72
METHANE, COMPRESSED or NATURAL GAS, COMPRESSED, with high methane content	2.1	—	UN1971	—	5, 8, 9
METHANE, REFRIGERATED LIQUID OR NATURAL GAS, REFRIGERATED LIQUID, with high methane content	2.1	—	UN1972	—	64
METHYLACETYLENE and PROPADIENE MIXTURE, STABILIZED	2.1	—	UN1060	—	4, 27, 58
METHYLAMINE, ANHYDROUS	2.1	—	UN1061	—	5, 8, 58
METHYL CHLORIDE or REFRIGERANT GAS R 40	2.1	—	UN1063	—	5, 8, 58
PETROLEUM GASES, LIQUEFIED	2.1	—	UN1075	—	4, 56, 58, 72
PROPANE	2.1	—	UN1978	—	4, 56, 58, 72

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
PROPYLENE	2.1	—	UN1077	—	4, 56, 58, 72
SILANE	2.1	—	UN2203	—	P
TETRAFLUOROETHYLENE, STABILIZED	2.1	—	UN1081	—	P
VINYL CHLORIDE, STABILIZED	2.1	—	UN1086	—	4, 27, 58
VINYL FLUORIDE, STABILIZED	2.1	—	UN1860	—	5, 53, 54, 58
VINYL METHYL ETHER, STABILIZED	2.1	—	UN1087	—	4, 27, 58
Dangerous goods of class 2.1, not listed above, non-cryogenic, other than articles and machines	2.1	—	—	—	4, 58
Dangerous goods of class 2.1, not listed above, articles or machines	2.1	—	—	—	P
Class 2.2 dangerous goods					
AIR, COMPRESSED, with not more than 23.5% oxygen, by volume	2.2	—	UN1002	—	P
AIR, REFRIGERATED LIQUID	2.2	5.1	UN1003	—	65
AMMONIA SOLUTION, relative density less than 0.880 at 15 °c (59 °f) in water, with more than 35% but not more than 50% ammonia	2.2	—	UN2073	—	5, 8, 9
ARGON, REFRIGERATED LIQUID	2.2	—	UN1951	—	65
CARBON DIOXIDE, REFRIGERATED LIQUID	2.2	—	UN2187	—	5, 50, 51
COMPRESSED GAS, TOXIC, OXIDIZING, N.O.S.	2.2	5.1	UN3303	—	P
GASES, REFRIGERATED LIQUID, N.O.S.	2.2	—	UN3158	—	65
HELIUM, COMPRESSED	2.2	—	UN1046	—	P
HELIUM, REFRIGERATED LIQUID	2.2	—	UN1963	—	65
KRYPTON, REFRIGERATED LIQUID	2.2	—	UN1970	—	P
LIQUEFIED GASES, non-flammable, charged with nitrogen, carbon dioxide or air	2.2	—	UN1058	—	P

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
NEON, REFRIGERATED LIQUID	2.2	—	UN1913	—	P
NITROGEN, COMPRESSED	2.2	—	UN1066	—	P
NITROGEN, REFRIGERATED LIQUID	2.2	—	UN1977	—	65
NITROUS OXIDE, REFRIGERATED LIQUID	2.2	5.1	UN2201	—	5, 13, 50, 51
NITROGEN TRIFLUORIDE	2.2	5.1	UN2451	—	P
OXYGEN, COMPRESSED	2.2	5.1	UN1072	—	P
OXYGEN, REFRIGERATED LIQUID	2.2	5.1	UN1073	—	65
REFRIGERANT GAS R 14; OR TETRAFLUOROMETHANE	2.2	—	UN1982	—	P
SULPHUR HEXAFLUORIDE	2.2	—	UN1080	—	4, 79
XENON	2.2	—	UN2036	—	P
XENON, REFRIGERATED LIQUID	2.2	—	UN2591	—	P
Dangerous goods of class 2.2, not listed above, non-cryogenic	2.2	—	—	—	4
Dangerous goods of class 2.2, not listed above, articles or machines	2.2	—	—	—	P
Class 2.3 dangerous goods					
AMMONIA, ANHYDROUS	2.3	8	UN1005	—	5, 8, 9, 55, 56, 70,74, 75, 76, 78
AMMONIA SOLUTION, relative density less than 0.880 at 15 °c (59 °f) in water, with more than 50% ammonia	2.3	8	UN3318	—	5, 8, 9, 55, 70, 74, 75, 76, 78
BORON TRICHLORIDE	2.3	8	UN1741	—	5, 15, 17, 69
BORON TRIFLUORIDE	2.3	8	UN1008	—	4, 15, 17, 68
CARBON MONOXIDE, COMPRESSED	2.3	2.1	UN1016	—	4, 15, 70, 75, 76, 78
CHLORINE	2.3	5.1, 8	UN1017	—	5, 17, 47, 59, 68, 78

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
CHLOROPICRIN AND METHYL BROMIDE MIXTURE, with more than 2% chloropicrin	2.3	—	UN1581	—	4, 15, 17, 68
COAL GAS, COMPRESSED	2.3	2.1	UN1023	—	4, 15, 69, 75, 78
Dangerous goods of class 2.3, not specifically listed, meeting the definition of dangerous goods toxic by inhalation, hazard zone B	2.3	—	—	—	4, 17, 68, 77, 78
Dangerous goods of class 2.3, not specifically listed, meeting the definition of dangerous goods toxic by inhalation, hazard zone C	2.3	—	—	—	4, 15, 17, 69, 76, 78
Dangerous goods of class 2.3, not specifically listed, meeting the definition of dangerous goods toxic by inhalation, hazard zone D	2.3	—	—	—	4, 15, 17, 70, 75, 76, 78
DINITROGEN TETROXIDE or NITROGEN DIOXIDE	2.3	5.1, 8	UN1067	—	5, 17, 28, 37, 67, 75, 78
ETHYLENE OXIDE AND CARBON DIOXIDE MIXTURE with more than 87% ethylene oxide	2.3	2.1	UN3300	—	4, 15, 70, 75, 76, 78
ETHYLENE OXIDE or ETHYLENE OXIDE WITH NITROGEN, up to a total pressure of 1 MPa (10 bar) at 50 °C	2.3	2.1	UN1040	—	11, 70, 75, 78
HYDROGEN BROMIDE, ANHYDROUS	2.3	8	UN1048	—	4, 15, 17, 69, 75, 78
HYDROGEN CHLORIDE, REFRIGERATED LIQUID	2.3	8	UN2186	—	5, 13, 52, 57, 69, 78
HYDROGEN SULPHIDE	2.3	2.1	UN1053	—	5, 15, 17, 58, 60, 68, 78
METHYL BROMIDE, with not more than 2% chloropicrin	2.3	—	UN1062	—	5, 6, 17, 69, 75, 78
METHYLCHLOROSILANE	2.3	2.1, 8	UN2534	—	4, 15, 17, 58, 68

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
METHYL MERCAPTAN	2.3	2.1	UN1064	—	5, 17, 58, 69, 75, 78
NITROSYL CHLORIDE	2.3	8	UN1069	—	5, 17, 48, 69, 75, 78
OIL GAS, COMPRESSED	2.3	2.1	UN1071	—	4, 15, 71
SULPHUR DIOXIDE	2.3	8	UN1079	—	5, 17, 47, 69, 75, 78
SULPHURYL FLUORIDE	2.3	—	UN2191	—	5, 49, 70
TRIFLUOROACETYL CHLORIDE	2.3	8	UN3057	—	4, 15, 17, 68
TRIFLUOROCHLOROETHYLENE, STABILIZED (REFRIGERANT GAS R 1113)	2.3	2.1	UN1082	—	4, 17, 58, 69
Dangerous goods of class 2.3, not listed above	2.3	—	—	—	P
Class 3 with no packing group dangerous goods					
Dangerous goods of class 3 with no packing group	3	—	—	—	P
Class 3 packing group I dangerous goods					
ACETALDEHYDE	3	—	UN1089	I	19, 81
ACRYLONITRILE, STABILIZED	3	6.1	UN1093	I	15, 81
ALLYL CHLORIDE	3	6.1	UN1100	I	61, 81
CARBON DISULPHIDE	3	6.1	UN1131	I	19, 81
CHLOROPRENE, STABILIZED	3	6.1	UN1991	I	34, 81
DESENSITIZED EXPLOSIVE, LIQUID, N.O.S.	3	—	UN3379	I	P
ETHYL NITRITE SOLUTION	3	—	UN1194	I	P
FLAMMABLE LIQUID, N.O.S.	3	—	UN1993	I	81
ORGANOCHLORINE PESTICIDE, LIQUID, FLAMMABLE, TOXIC, flash point less than 23 °C (73 °F)	3	6.1	UN2762	I	61, 81

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
PETROLEUM CRUDE OIL	3	—	UN1267	I	81
PETROLEUM SOUR CRUDE OIL, FLAMMABLE, TOXIC	3	6.1	UN3494	I	81
ZIRCONIUM SUSPENDED IN A FLAMMABLE LIQUID	3	—	UN1308	I	P
Dangerous goods of class 3, packing group I, not listed above	3	—	—	I	81
Class 3 packing group II dangerous goods					
ALCOHOLS, N.O.S.	3	—	UN1987	II	81
1,1-DICHLOROETHANE	3	—	UN2362	II	61, 81
1,2-DICHLOROETHYLENE	3	—	UN1150	II	61, 81
ETHANOL AND GASOLINE MIXTURE or ETHANOL AND MOTOR SPIRIT MIXTURE or ETHANOL AND PETROL MIXTURE, with more than 10 percent ethanol	3	—	UN3475	II	81
ETHYLENE DICHLORIDE	3	6.1	UN1184	II	61, 81
FLAMMABLE LIQUID, N.O.S.	3	—	UN1993	II	81
4-METHYLMORPHOLINE or N-METHYLMORPHOLINE	3	8	UN2535	II	13, 81
METHYLTRICHLOROSILANE	3	8	UN1250	II	13, 81
ORGANOCHLORINE PESTICIDE, LIQUID, FLAMMABLE, TOXIC, flashpoint less than 23 °C (73 °F)	3	6.1	UN2762	II	61, 81
PETROLEUM CRUDE OIL	3	—	UN1267	II	81
PETROLEUM SOUR CRUDE OIL, FLAMMABLE, TOXIC	3	6.1	UN3494	II	81
VINYLTRICHLOROSILANE	3	8	UN1305	II	13, 81
Dangerous goods of class 3, packing group II, not listed above	3	—	—	II	81

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
Class 3 packing group III dangerous goods					
ALCOHOLS, N.O.S.	3	—	UN1987	III	81
CHLOROBENZENE	3	—	UN1134	III	61, 81
ELEVATED TEMPERATURE LIQUID, FLAMMABLE, N.O.S., with flash point above 60 °C, at or above its flashpoint	3	—	UN3256	III	62
FLAMMABLE LIQUID, N.O.S.	3	—	UN1993	III	81
PETROLEUM CRUDE OIL	3	—	UN1267	III	81
PETROLEUM SOUR CRUDE OIL, FLAMMABLE, TOXIC	3	6.1	UN3494	III	81
Dangerous goods of class 3, packing group III, not listed above	3	—	—	III	81
Class 4.1 with no packing group dangerous goods					
Dangerous goods of class 4.1 with no packing group	4.1	—	—	—	P
Class 4.1 packing group I dangerous goods					
Dangerous goods of class 4.1, packing group I	4.1	—	—	I	P
Class 4.1 packing group II dangerous goods					
ALUMINUM POWDER, COATED	4.1	—	UN1309	II	1
CERIUM, slabs, ingots or rods	4.1	—	UN1333	II	1
FERROCERIUM	4.1	—	UN1323	II	1
FLAMMABLE SOLID, CORROSIVE, ORGANIC, N.O.S.	4.1	8	UN2925	II	1
FLAMMABLE SOLID, ORGANIC, N.O.S.	4.1	—	UN1325	II	1
FLAMMABLE SOLID, TOXIC, ORGANIC, N.O.S.	4.1	6.1	UN2926	II	3
LEAD PHOSPHITE, DIBASIC	4.1	—	UN2989	II	1

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
METAL HYDRIDES, FLAMMABLE, N.O.S.	4.1	—	UN3182	II	1
METAL POWDER, FLAMMABLE, N.O.S.	4.1	—	UN3089	II	1
PHOSPHORUS SESQUISULPHIDE, free from yellow and white phosphorus	4.1	—	UN1341	II	1
RUBBER SCRAP OR RUBBER SHODDY, powdered or granulated, not exceeding 840 microns and rubber content exceeding 45%	4.1	—	UN1345	II	1
SOLIDS CONTAINING FLAMMABLE LIQUID, N.O.S.	4.1	—	UN3175	II	1
TITANIUM HYDRIDE	4.1	—	UN1871	II	2
Dangerous goods of class 4.1, packing group II, not listed above	4.1	—	—	II	P
Class 4.1 packing group III dangerous goods					
ALUMINUM POWDER, COATED	4.1	—	UN1309	III	1
ALUMINUM RESINATE	4.1	—	UN2715	III	1
BORNEOL	4.1	—	UN1312	III	1
CALCIUM RESINATE	4.1	—	UN1313	III	1
CALCIUM RESINATE, FUSED	4.1	—	UN1314	III	1
CAMPHOR, SYNTHETIC	4.1	—	UN2717	III	1
CELLULOID in block, rods, rolls, sheets, tubes, etc., except scrap	4.1	—	UN2000	III	1
COBALT NAPHTHENATES, POWDER	4.1	—	UN2001	III	1
COBALT RESINATE PRECIPITATED	4.1	—	UN1318	III	1
DICYCLOHEXYLAMMONIUM NITRITE	4.1	—	UN2687	III	1
FABRICS IMPREGNATED WITH WEAKLY NITRATED NITROCELLULOSE, N.O.S.; or FIBRES IMPREGNATED WITH WEAKLY NITRATED NITROCELLULOSE, N.O.S.	4.1	—	UN1353	III	1
FLAMMABLE SOLID, CORROSIVE, INORGANIC, N.O.S.	4.1	8	UN3180	III	3

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
FLAMMABLE SOLID, CORROSIVE, ORGANIC, N.O.S.	4.1	8	UN2925	III	3
FLAMMABLE SOLID, INORGANIC, N.O.S.	4.1	—	UN3178	III	1
FLAMMABLE SOLID, ORGANIC, MOLTEN, N.O.S.	4.1	—	UN3176	III	1
FLAMMABLE SOLID, ORGANIC, N.O.S.	4.1	—	UN1325	III	1
FLAMMABLE SOLID, TOXIC, INORGANIC, N.O.S.	4.1	6.1	UN3179	III	3
FLAMMABLE SOLID, TOXIC, ORGANIC, N.O.S.	4.1	6.1	UN2926	III	3
HEXAMETHYLENETETRAMINE	4.1	—	UN1328	III	1
ISOSORBIDE-5-MONONITRATE, with less than 30% non-volatile, non-flammable phlegmatizer	4.1	—	UN3251	III	1
LEAD PHOSPHITE, DIBASIC	4.1	—	UN2989	III	1
MAGNESIUM or MAGNESIUM ALLOYS, with more than 50% magnesium, in pellets, turnings or ribbons	4.1	—	UN1869	III	1
MANGANESE RESINATE	4.1	—	UN1330	III	1
METALDEHYDE	4.1	—	UN1332	III	1
METAL HYDRIDES, FLAMMABLE, N.O.S.	4.1	—	UN3182	III	1
METAL POWDER, FLAMMABLE, N.O.S.	4.1	—	UN3089	III	1
METAL SALTS OF ORGANIC COMPOUNDS, FLAMMABLE, N.O.S.	4.1	—	UN3181	III	1
NAPHTHALENE, CRUDE OR NAPHTHALENE, REFINED	4.1	—	UN1334	III	1
NAPHTHALENE, MOLTEN	4.1	—	UN2304	III	2
NITRONAPHTHALENE	4.1	—	UN2538	III	1
PHOSPHORUS, AMORPHOUS	4.1	—	UN1338	III	6, 7, 24

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
PARAFORMALDEHYDE	4.1	—	UN2213	III	1
POLYMERIZING SUBSTANCE, LIQUID, STABILIZED, N.O.S.	4.1	—	UN3532	III	2
POLYMERIZING SUBSTANCE, SOLID, STABILIZED, N.O.S.	4.1	—	UN3531	III	1
POLYMERIZING SUBSTANCE, LIQUID, TEMPERATURE CONTROLLED, N.O.S.	4.1	—	UN3534	III	2
POLYMERIZING SUBSTANCE, SOLID, TEMPERATURE CONTROLLED, N.O.S.	4.1	—	UN3533	III	1
SILICON POWDER, AMORPHOUS	4.1	—	UN1346	III	1
SULPHUR	4.1	—	UN1350	III	1, 2
SULPHUR, MOLTEN	4.1	—	UN2448	III	62
TITANIUM SPONGE GRANULES or TITANIUM SPONGE POWDERS	4.1	—	UN2878	III	1
ZINC RESINATE	4.1	—	UN2714	III	1
ZIRCONIUM, DRY, coiled wire, finished metal sheets, strip (thinner than 254 microns but not thinner than 18 microns)	4.1	—	UN2858	III	1
Dangerous goods of class 4.1, packing group III, not listed above	4.1	—	—	III	P
Class 4.2 with no packing group dangerous goods					
Dangerous goods of class 4.2 with no packing group	4.2	—	—	—	P
Class 4.2 packing group I dangerous goods					
ORGANOMETALLIC SUBSTANCE, SOLID, PYROPHORIC	4.2	—	UN3391	I	4
ORGANOMETALLIC SUBSTANCE, SOLID, PYROPHORIC, WATER-REACTIVE	4.2	4.3	UN3393	I	4, 16
ORGANOMETALLIC SUBSTANCE, LIQUID, PYROPHORIC	4.2	—	UN3392	I	4, 16

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
ORGANOMETALLIC SUBSTANCE, LIQUID, PYROPHORIC, WATER-REACTIVE	4.2	4.3	UN3394	I	4, 15, 16
PHOSPHORUS WHITE, MOLTEN	4.2	6.1	UN2447	I	3, 15, 23
PHOSPHORUS, WHITE OR YELLOW, DRY OR UNDER WATER OR IN SOLUTION	4.2	6.1	UN1381	I	3, 15, 23
PYROPHORIC LIQUID, INORGANIC, N.O.S.	4.2	—	UN3194	I	4
PYROPHORIC LIQUID, ORGANIC, N.O.S.	4.2	—	UN2845	I	4, 16
PYROPHORIC SOLID, INORGANIC, N.O.S.	4.2	—	UN3200	I	3
TITANIUM POWDER, DRY	4.2	—	UN2546	I	3
TITANIUM TRICHLORIDE MIXTURE, PYROPHORIC or TITANIUM TRICHLORIDE, PYROPHORIC	4.2	8	UN2441	I	4
TRIBUTYLPHOSPHANE	4.2	—	UN3254	I	3
Dangerous goods of class 4.2, packing group I, not listed above	4.2	—	—	I	P
Class 4.2 packing group II dangerous goods					
ALKALINE EARTH METAL ALCOHOLATES, N.O.S.	4.2	—	UN3205	II	2
ALKALI METAL ALCOHOLATES, SELF-HEATING, CORROSIVE, N.O.S.	4.2	8	UN3206	II	3
CALCIUM DITHIONITE; CALCIUM HYDROSULFITE; or CALCIUM HYDROSULPHITE	4.2	—	UN1923	II	2
CARBON, ANIMAL OR VEGETABLE ORIGIN	4.2	—	UN1361	II	3
CYCLOOCTADIENE PHOSPHINES; or 9-PHOSPHABICYCLONONANES	4.2	—	UN2940	II	2
FISH MEAL, UNSTABILIZED; or FISH SCRAP, UNSTABILIZED	4.2	—	UN1374	II	2

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
HAFNIUM POWDER, DRY	4.2	—	UN2545	II	2
KRILL MEAL	4.2	—	UN3497	II	3
MAGNESIUM DIAMIDE	4.2	—	UN2004	II	2
METAL CATALYST, DRY	4.2	—	UN2881	II	3
METAL POWDER, SELF-HEATING, N.O.S.	4.2	—	UN3189	II	2
ORGANIC PIGMENTS, SELF-HEATING	4.2	—	UN3313	II	2
ORGANOMETALLIC SUBSTANCE, SOLID, SELF-HEATING	4.2	—	UN3400	II	3
P-NITROSODIMETHYLANILINE	4.2	—	UN1369	II	2
POTASSIUM DITHIONITE; POTASSIUM HYDROSULFITE; or POTASSIUM HYDROSULPHITE	4.2	—	UN1929	II	2
POTASSIUM SULPHIDE, ANHYDROUS or POTASSIUM SULPHIDE, with less than 30% water of crystallization	4.2	—	UN1382	II	2, 19
SELF-HEATING LIQUID, CORROSIVE, INORGANIC, N.O.S.	4.2	8	UN3188	II	6
SELF-HEATING LIQUID, CORROSIVE, ORGANIC, N.O.S.	4.2	8	UN3185	II	6
SELF-HEATING LIQUID, INORGANIC, N.O.S.	4.2	—	UN3186	II	3
SELF-HEATING LIQUID, ORGANIC, N.O.S.	4.2	—	UN3183	II	3
SELF-HEATING LIQUID, TOXIC, INORGANIC, N.O.S.	4.2	6.1	UN3187	II	6
SELF-HEATING LIQUID, TOXIC, ORGANIC, N.O.S.	4.2	6.1	UN3184	II	6
SELF-HEATING SOLID, CORROSIVE, INORGANIC, N.O.S.	4.2	8	UN3192	II	3
SELF-HEATING SOLID, CORROSIVE, ORGANIC, N.O.S.	4.2	8	UN3126	II	2

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
SELF-HEATING SOLID, INORGANIC, N.O.S.	4.2	—	UN3190	II	2
SELF-HEATING SOLID, ORGANIC, N.O.S.	4.2	—	UN3088	II	2
SELF-HEATING SOLID, TOXIC, INORGANIC, N.O.S.	4.2	6.1	UN3191	II	3
SELF-HEATING SOLID, TOXIC, ORGANIC, N.O.S.	4.2	6.1	UN3128	II	3
SODIUM DITHIONITE or SODIUM HYDROSULPHITE	4.2	—	UN1384	II	2
SODIUM HYDROSULFIDE with less than 25% water of crystallization or SODIUM HYDROSULPHIDE with less than 25% water of crystallization	4.2	—	UN2318	II	2
SODIUM METHYLATE	4.2	8	UN1431	II	2
SODIUM SULPHIDE, ANHYDROUS or SODIUM SULPHIDE, with less than 30% water of crystallization	4.2	—	UN1385	II	2
THIOUREA DIOXIDE	4.2	—	UN3341	II	2
XANTHATES	4.2	—	UN3342	II	2
ZIRCONIUM POWDER, DRY	4.2	—	UN2008	II	2
Dangerous goods of class 4.2, packing group II, not listed above	4.2	—	—	II	P
Class 4.2 packing group III dangerous goods					
ALKALINE EARTH METAL ALCOHOLATES, N.O.S.	4.2	—	UN3205	III	2
ALKALI METAL ALCOHOLATES, SELF-HEATING, CORROSIVE, N.O.S.	4.2	8	UN3206	III	3
CARBON, ACTIVATED	4.2	—	UN1362	III	2
CARBON, ANIMAL OR VEGETABLE ORIGIN	4.2	—	UN1361	III	2
CELLULOID, SCRAP	4.2	—	UN2002	III	2

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
COPRA	4.2	—	UN1363	III	2
COTTON, WET	4.2	—	UN1365	III	2
FERROUS METAL BORINGS, SHAVINGS, TURNINGS or CUTTINGS in a form liable to self-heating	4.2	—	UN2793	III	2
FIBRES or FABRICS, ANIMAL or VEGETABLE or SYNTHETIC, N.O.S., with oil	4.2	—	UN1373	III	2
HAFNIUM POWDER, DRY	4.2	—	UN2545	III	2
IRON OXIDE, SPENT or IRON SPONGE, SPENT, obtained from coal gas purification	4.2	—	UN1376	III	1, 20
KRILL MEAL	4.2	—	UN3497	III	3
MANEB or MANEB PREPARATION with not less than 60% maneb	4.2	4.3	UN2210	III	3
METAL CATALYST, DRY	4.2	—	UN2881	III	2
METAL POWDER, SELF-HEATING, N.O.S.	4.2	—	UN3189	III	2
ORGANIC PIGMENTS, SELF-HEATING	4.2	—	UN3313	III	2
ORGANOMETALLIC SUBSTANCE, SOLID, SELF-HEATING	4.2	—	UN3400	III	3
PAPER, UNSATURATED OIL TREATED, INCOMPLETELY DRIED (including carbon paper)	4.2	—	UN1379	III	2
SEED CAKE, with more than 1.5% oil and not more than 11% moisture	4.2	—	UN1386	III	2
SEED CAKE, with not more than 1.5% oil and not more than 11% moisture	4.2	—	UN2217	III	2
SELF-HEATING SOLID, CORROSIVE, INORGANIC, N.O.S.	4.2	8	UN3192	III	3
SELF-HEATING SOLID, CORROSIVE, ORGANIC, N.O.S.	4.2	8	UN3126	III	3

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
SELF-HEATING SOLID, INORGANIC, N.O.S.	4.2	—	UN3190	III	2
SELF-HEATING SOLID, ORGANIC, N.O.S.	4.2	—	UN3088	III	2
SELF-HEATING SOLID, TOXIC, INORGANIC, N.O.S.	4.2	—	UN3191	III	3
SELF-HEATING SOLID, TOXIC, ORGANIC, N.O.S.	4.2	6.1	UN3128	III	3
THIOUREA DIOXIDE	4.2	—	UN3341	III	2
TITANIUM DISULFIDE or TITANIUM DISULPHIDE	4.2	—	UN3174	III	2
TITANIUM POWDER, DRY	4.2	—	UN2546	III	2
XANTHATES	4.2	—	UN3342	III	2
ZIRCONIUM, DRY, FINISHED SHEETS, STRIP OR COILED WIRE	4.2	—	UN2009	III	1
ZIRCONIUM POWDER, DRY	4.2	—	UN2008	III	2
ZIRCONIUM SCRAP	4.2	—	UN1932	III	1
Dangerous goods of class 4.2, packing group III, solids, not listed above	4.2	—	—	III	P
Dangerous goods of class 4.2, packing group III, liquids, not listed above	4.2	—	—	III	2
Class 4.3 with no packing group dangerous goods					
Dangerous goods of class 4.3 with no packing group	4.3	—	—	—	P
Class 4.3 packing group I dangerous goods					
ALUMINUM PHOSPHIDE	4.3	6.1	UN1397	I	3
BORON TRIFLUORIDE DIMETHYL ETHERATE	4.3	3, 8	UN2965	I	3
CALCIUM CARBIDE	4.3	—	UN1402	I	2, 32, 35
ETHYLDICHLOROSILANE	4.3	3, 8	UN1183	I	4

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
METALLIC SUBSTANCE, WATER-REACTIVE, N.O.S.	4.3	—	UN3208	I	3
METALLIC SUBSTANCE, WATER-REACTIVE, SELF-HEATING, N.O.S.	4.3	4.2	UN3209	I	3
METHYLDICHLOROSILANE	4.3	3, 8	UN1242	I	3, 13
METHYL MAGNESIUM BROMIDE IN ETHYL ETHER	4.3	3	UN1928	I	3
ORGANOMETALLIC SUBSTANCE, LIQUID, WATER-REACTIVE	4.3	—	UN3398	I	4
ORGANOMETALLIC SUBSTANCE, LIQUID, WATER-REACTIVE, FLAMMABLE	4.3	3	UN3399	I	4
ORGANOMETALLIC SUBSTANCE, SOLID, WATER-REACTIVE	4.3	—	UN3395	I	3
ORGANOMETALLIC SUBSTANCE, SOLID, WATER-REACTIVE, FLAMMABLE	4.3	4.1	UN3396	I	3
ORGANOMETALLIC SUBSTANCE, SOLID, WATER-REACTIVE, SELF-HEATING	4.3	4.2	UN3397	I	3
POTASSIUM	4.3	—	UN2257	I	4, 24
POTASSIUM METAL ALLOYS, LIQUID	4.3	—	UN1420	I	4, 24
POTASSIUM METAL ALLOYS, SOLID	4.3	—	UN3403	I	4
POTASSIUM SODIUM ALLOYS, LIQUID	4.3	—	UN1422	I	4, 24
POTASSIUM SODIUM ALLOYS, SOLID	4.3	—	UN3404	I	4
RUBIDIUM	4.3	—	UN1423	I	3, 12
SODIUM	4.3	—	UN1428	I	5, 38
TRICHLOROSILANE	4.3	3, 8	UN1295	I	4
Dangerous goods of class 4.3, packing groups I, not listed above	4.3	—	—	I	P

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
Class 4.3 packing group II dangerous goods					
ALKALINE EARTH METAL ALLOY, N.O.S.	4.3	—	UN1393	II	2
ALKALI METAL AMIDES	4.3	—	UN1390	II	2
ALUMINUM CARBIDE	4.3	—	UN1394	II	3
ALUMINUM FERROSILICON POWDER	4.3	6.1	UN1395	II	3
ALUMINUM SMELTING BY-PRODUCTS or ALUMINUM REMELTING BY-PRODUCTS	4.3	—	UN3170	II	3, 73
BARIUM	4.3	—	UN1400	II	2
CALCIUM	4.3	—	UN1401	II	2
CALCIUM CARBIDE	4.3	—	UN1402	II	2, 32, 35
CALCIUM SILICIDE	4.3	—	UN1405	II	2
CERIUM, turnings or gritty powder	4.3	—	UN3078	II	3
LITHIUM FERROSILICON	4.3	—	UN2830	II	2
LITHIUM HYDRIDE, FUSED SOLID	4.3	—	UN2805	II	2
LITHIUM SILICON	4.3	—	UN1417	II	2
MAGNESIUM POWDER or MAGNESIUM ALLOYS POWDER	4.3	4.2	UN1418	II	2, 33
MAGNESIUM SILICIDE	4.3	—	UN2624	II	2
METAL HYDRIDES, WATER-REACTIVE, N.O.S.	4.3	—	UN1409	II	3
METALLIC SUBSTANCE, WATER-REACTIVE, N.O.S.	4.3	—	UN3208	II	3
METALLIC SUBSTANCE, WATER-REACTIVE, SELF-HEATING, N.O.S.	4.3	4.2	UN3209	II	3
ORGANOMETALLIC SUBSTANCE, LIQUID, WATER-REACTIVE	4.3	—	UN3398	II	6
ORGANOMETALLIC SUBSTANCE, LIQUID, WATER-REACTIVE, FLAMMABLE	4.3	3	UN3399	II	6

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
ORGANOMETALLIC SUBSTANCE, SOLID, WATER-REACTIVE	4.3	—	UN3395	II	3
ORGANOMETALLIC SUBSTANCE, SOLID, WATER-REACTIVE, FLAMMABLE	4.3	4.1	UN3396	II	3
ORGANOMETALLIC SUBSTANCE, SOLID, WATER-REACTIVE, SELF-HEATING	4.3	4.2	UN3397	II	3
PHOSPHORUS PENTASULPHIDE, FREE FROM YELLOW AND WHITE PHOSPHORUS	4.3	4.1	UN1340	II	3, 35
SODIUM ALUMINIUM HYDRIDE	4.3	—	UN2835	II	3
WATER-REACTIVE LIQUID, CORROSIVE, N.O.S.	4.3	8	UN3129	II	6
WATER-REACTIVE LIQUID, N.O.S.	4.3	—	UN3148	II	6
WATER-REACTIVE LIQUID, TOXIC, N.O.S.	4.3	6.1	UN3130	II	6
WATER-REACTIVE SOLID, CORROSIVE, N.O.S.	4.3	8	UN3131	II	3
WATER-REACTIVE SOLID, FLAMMABLE, N.O.S.	4.3	4.1	UN3132	II	3
WATER-REACTIVE SOLID, N.O.S.	4.3	—	UN2813	II	3
WATER-REACTIVE SOLID, SELF-HEATING, N.O.S.	4.3	4.2	UN3135	II	3
WATER-REACTIVE SOLID, TOXIC, N.O.S.	4.3	6.1	UN3134	II	3
ZINC DUST or ZINC POWDER	4.3	4.2	UN1436	II	3
Dangerous goods of class 4.3, packing groups II, not listed above	4.3	—	—	II	P
Class 4.3 packing group III dangerous goods					
ALUMINUM POWDER, UNCOATED	4.3	—	UN1396	III	2
ALUMINUM SMELTING BY-PRODUCTS or ALUMINUM REMELTING BY-PRODUCTS	4.3	—	UN3170	III	3, 73
ALUMINUM SILICON POWDER, UNCOATED	4.3	—	UN1398	III	2

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
CALCIUM CYANAMIDE, with more than 0.1% calcium carbide	4.3	—	UN1403	III	2
CALCIUM MANGANESE SILICON	4.3	—	UN2844	III	2
CALCIUM SILICIDE	4.3	—	UN1405	III	2
FERROSILICON, with 30% or more but less than 90% silicon	4.3	6.1	UN1408	III	1
MAGNESIUM GRANULES, COATED, particle size not less than 149 microns	4.3	—	UN2950	III	1
MAGNESIUM POWDER or MAGNESIUM ALLOYS POWDER	4.3	4.2	UN1418	III	2, 33
MANEB PREPARATION, STABILIZED against self-heating or MANEB, STABILIZED against self-heating	4.3	—	UN2968	III	3
METALLIC SUBSTANCE, WATER-REACTIVE, N.O.S.	4.3	—	UN3208	III	2
METALLIC SUBSTANCE, WATER-REACTIVE, SELF-HEATING, N.O.S.	4.3	4.2	UN3209	III	3
ORGANOMETALLIC SUBSTANCE, LIQUID, WATER-REACTIVE	4.3	—	UN3398	III	3
ORGANOMETALLIC SUBSTANCE, LIQUID, WATER-REACTIVE, FLAMMABLE	4.3	3	UN3399	III	3
ORGANOMETALLIC SUBSTANCE, SOLID, WATER-REACTIVE	4.3	—	UN3395	III	2
ORGANOMETALLIC SUBSTANCE, SOLID, WATER-REACTIVE, FLAMMABLE	4.3	4.1	UN3396	III	2
ORGANOMETALLIC SUBSTANCE, SOLID, WATER-REACTIVE, SELF-HEATING	4.3	4.2	UN3397	III	2
WATER-REACTIVE LIQUID, N.O.S.	4.3	—	UN3148	III	3
WATER-REACTIVE LIQUID, CORROSIVE, N.O.S.	4.3	8	UN3129	III	3
WATER-REACTIVE LIQUID, TOXIC, N.O.S.	4.3	6.1	UN3130	III	3

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
WATER-REACTIVE SOLID, N.O.S.	4.3	—	UN2813	III	2
WATER-REACTIVE SOLID, CORROSIVE, N.O.S.	4.3	8	UN3131	III	2
WATER-REACTIVE SOLID, FLAMMABLE, N.O.S.	4.3	4.1	UN3132	III	2
WATER-REACTIVE SOLID, SELF-HEATING, N.O.S.	4.3	4.2	UN3135	III	2
WATER-REACTIVE SOLID, TOXIC, N.O.S.	4.3	6.1	UN3134	III	2
ZINC ASHES	4.3	—	UN1435	III	2
ZINC DUST or ZINC POWDER	4.3	4.2	UN1436	III	3
Dangerous goods of class 4.3, packing group III, not listed above	4.3	—	—	III	P
Class 5.1 with no packaging group dangerous goods					
AMMONIUM NITRATE, LIQUID (hot concentrated solution)	5.1	—	UN2426	—	5
Dangerous goods of class 5.1 with no packing group	5.1	—	—	—	P
Class 5.1 packing group I dangerous goods					
BROMINE PENTAFLUORIDE	5.1	6.1, 8	UN1745	I	5, 15, 17, 40, 67
BROMINE TRIFLUORIDE	5.1	6.1, 8	UN1746	I	4, 15, 17, 40, 68
HYDROGEN PEROXIDE, STABILIZED or HYDROGEN PEROXIDE, AQUEOUS SOLUTIONS, STABILIZED, with more than 60% hydrogen peroxide	5.1	8	UN2015	I	3, 30, 43, 80
IODINE PENTAFLUORIDE	5.1	6.1, 8	UN2495	I	3
OXIDIZING LIQUID, CORROSIVE, N.O.S.	5.1	8	UN3098	I	4
OXIDIZING LIQUID, N.O.S.	5.1	—	UN3139	I	6
OXIDIZING LIQUID, TOXIC, N.O.S.	5.1	6.1	UN3099	I	4

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
OXIDIZING SOLID, CORROSIVE, N.O.S.	5.1	8	UN3085	I	3
OXIDIZING SOLID, N.O.S.	5.1	—	UN1479	I	3
OXIDIZING SOLID, TOXIC, N.O.S.	5.1	6.1	UN3087	I	3
PERCHLORIC ACID with more than 50% but not more than 72% acid, by mass	5.1	8	UN1873	I	6
Dangerous goods of class 5.1, packing group I, not listed above	5.1	—	—	I	P
Class 5.1 packing group II dangerous goods					
AMMONIUM NITRATE EMULSION, intermediate for blasting explosives; AMMONIUM NITRATE GEL, intermediate for blasting explosives; or AMMONIUM NITRATE SUSPENSION, intermediate for blasting explosives	5.1	—	UN3375	II	P
BARIUM CHLORATE SOLUTION	5.1	6.1	UN3405	II	6
BARIUM PERCHLORATE SOLUTION	5.1	6.1	UN3406	II	6
CALCIUM HYPOCHLORITE, HYDRATED, CORROSIVE, with not less than 5.5% but not more than 16% water or CALCIUM HYPOCHLORITE MIXTURE, HYDRATED, CORROSIVE, with not less than 5.5% but not more than 16% water	5.1	8	UN3487	II	1
CALCIUM HYPOCHLORITE, HYDRATED or CALCIUM HYPOCHLORITE, HYDRATED MIXTURE, with not less than 5.5% but not more than 16% water	5.1	—	UN2880	II	1
CHLORATE AND BORATE MIXTURE	5.1	—	UN1458	II	1
CHLORATE AND MAGNESIUM CHLORIDE MIXTURE, SOLID	5.1	—	UN1459	II	1
DICHLOROISOCYANURIC ACID, DRY or DICHLOROISOCYANURIC ACID SALTS	5.1	—	UN2465	II	1
HYDROGEN PEROXIDE AND PEROXYACETIC ACID MIXTURE with acid(s), water and not more than 5% peroxyacetic acid, stabilized	5.1	8	UN3149	II	6

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
HYDROGEN PEROXIDE, AQUEOUS SOLUTION, with not less than 20% but not more than 60% hydrogen peroxide (stabilized as necessary)	5.1	8	UN2014	II	3, 28, 43, 80
HYPOCHLORITES, INORGANIC, N.O.S.	5.1	—	UN3212	II	1
LEAD PERCHLORATE SOLUTION	5.1	6.1	UN3408	II	6
LITHIUM HYPOCHLORITE, DRY or LITHIUM HYPOCHLORITE MIXTURE	5.1	—	UN1471	II	1
NITRATES, INORGANIC, N.O.S.	5.1	—	UN1477	II	1
OXIDIZING SOLID, N.O.S.	5.1	—	UN1479	II	1
POTASSIUM CHLORATE, AQUEOUS SOLUTION	5.1	—	UN2427	II	2
POTASSIUM NITRATE AND SODIUM NITRITE MIXTURE	5.1	—	UN1487	II	42
POTASSIUM PERMANGANATE	5.1	—	UN1490	II	1
SODIUM CARBONATE PEROXYHYDRATE	5.1	—	UN3378	II	1
SODIUM CHLORATE	5.1	—	UN1495	II	1
SODIUM CHLORATE, AQUEOUS SOLUTION	5.1	—	UN2428	II	2, 13
SODIUM PEROXOBORATE, ANHYDROUS	5.1	—	UN3247	II	1
TRICHLOROISOCYANURIC ACID, DRY	5.1	—	UN2468	II	1
ZINC NITRATE	5.1	—	UN1514	II	1
Dangerous goods of class 5.1, packing group II, not listed above	5.1	—	—	II	3
Class 5.1 packing group III dangerous goods					
CALCIUM HYPOCHLORITE, DRY with more than 39% available chlorine (8.8% available oxygen) or CALCIUM HYPOCHLORITE MIXTURE, DRY with more than 39% available chlorine (8.8% available oxygen)	5.1	—	UN1748	III	P

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
Dangerous goods of class 5.1, packing group III, liquids	5.1	—	—	III	2
Dangerous goods of class 5.1, packing group III, solids	5.1	—	—	III	1
Class 5.2 packing group I goods					
Dangerous goods of class 5.2, packing group I	5.2	—	—	I	P
Class 5.2 packing group II goods					
Dangerous goods of class 5.2, packing group II	5.2	—	—	II	P
Class 5.2 packing group III goods					
Dangerous goods of class 5.2, packing group III	5.2	—	—	III	P
Class 6.1 with no packing group dangerous goods					
Dangerous goods of class 6.1 with no packing group	6.1	—	—	—	P
Class 6.1 packing group I dangerous goods					
ACETONE CYANOHYDRIN, STABILIZED	6.1	—	UN1541	I	4, 15, 17, 40, 41, 68
ACROLEIN, STABILIZED	6.1	3	UN1092	I	5, 15, 17, 26, 40, 67
ALLYL ALCOHOL	6.1	3	UN1098	I	4, 15, 17, 40, 68
ALLYLAMINE	6.1	3	UN2334	I	4, 15, 17, 40, 68
ALLYL CHLOROFORMATE	6.1	3, 8	UN1722	I	4, 15, 17, 40, 68
ARSENIC COMPOUND, LIQUID, N.O.S., INORGANIC, including: arsenates, n.o.s.; arsenites, n.o.s.; and arsenic sulphides, n.o.s.	6.1	—	UN1556	I	P
ARSENIC COMPOUND, SOLID, N.O.S., INORGANIC, including: arsenates, n.o.s.; arsenites, n.o.s.; and arsenic sulphides, n.o.s.	6.1	—	UN1557	I	P

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
ARSENIC TRICHLORIDE	6.1	—	UN1560	I	4, 15, 17, 40, 68
N-BUTYL ISOCYANATE	6.1	3	UN2485	I	4, 15, 17, 40, 68
TERT-BUTYL ISOCYANATE	6.1	3	UN2484	I	4, 15, 17, 40, 67
CALCIUM CYANIDE	6.1	—	UN1575	I	P
CHLOROACETONE, STABILIZED	6.1	3, 8	UN1695	I	4, 15, 17, 40, 68
CHLOROACETONITRILE	6.1	3	UN2668	I	4, 15, 17, 40, 68
CHLOROACETYL CHLORIDE	6.1	8	UN1752	I	4, 14, 15, 17, 40, 68
2-CHLOROETHANAL	6.1	—	UN2232	I	4, 15, 17, 40, 68
CHLOROPICRIN	6.1	—	UN1580	I	4, 15, 17, 40, 68
CROTONALDEHYDE OR CROTONALDEHYDE, STABILIZED	6.1	3	UN1143	I	4, 15, 17, 40, 68
CYANOGEN BROMIDE	6.1	8	UN1889	I	P
CYCLOHEXYL ISOCYANATE	6.1	3	UN2488	I	4, 15, 17, 40, 68
DIKETENE, STABILIZED	6.1	3	UN2521	I	4, 15, 17, 40, 68
DIMETHYLHYDRAZINE, SYMMETRICAL	6.1	3	UN2382	I	4, 15, 17, 40, 68
DIMETHYLHYDRAZINE, UNSYMMETRICAL	6.1	3, 8	UN1163	I	4, 15, 17, 40, 68
DIMETHYL SULPHATE	6.1	8	UN1595	I	4, 15, 17, 40, 68
DIPHENYLAMINE CHLOROARSINE	6.1	—	UN1698	I	P

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
DIPHENYLCHLOROARSINE, LIQUID	6.1	—	UN1699	I	P
DIPHENYLCHLOROARSINE, SOLID	6.1	—	UN3450	I	P
EPIBROMOHYDRIN	6.1	3	UN2558	I	6
ETHYL CHLOROFORMATE	6.1	3, 8	UN1182	I	4, 15, 17, 40, 68
ETHYLDICHLOROARSINE	6.1	—	UN1892	I	4, 15, 17, 40, 68
ETHYL ISOCYANATE	6.1	3	UN2481	I	4, 15, 17, 40, 67
ETHYLENE CHLOROHYDRIN	6.1	3	UN1135	I	4, 15, 17, 40, 68
ETHYLENE DIBROMIDE	6.1	—	UN1605	I	4, 15, 17, 40, 68
ETHYLENEIMINE, STABILIZED	6.1	3	UN1185	I	4, 15, 17, 40, 67
HEXACHLOROCYCLOPENTADIENE	6.1	—	UN2646	I	4, 15, 17, 40, 68
HYDROCYANIC ACID, AQUEOUS SOLUTION, with not more than 20% hydrogen cyanide or HYDROGEN CYANIDE, AQUEOUS SOLUTION, with not more than 20% hydrogen cyanide	6.1	—	UN1613	I	4, 7, 36, 40, 68
HYDROGEN CYANIDE, SOLUTION IN ALCOHOL, with not more than 45 percent hydrogen cyanide	6.1	3	UN3294	I	4, 15, 17, 40, 68
HYDROGEN CYANIDE, STABILIZED, containing less than 3% water	6.1	3	UN1051	I	5, 36, 40, 44, 67
HYDROGEN CYANIDE, STABILIZED, containing less than 3% water and absorbed in a porous inert material	6.1	—	UN1614	I	P
IRON PENTACARBONYL	6.1	3	UN1994	I	5, 15, 17, 40, 67
ISOBUTYL ISOCYANATE	6.1	3	UN2486	I	5, 15, 17, 40, 67

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
ISOPROPYL CHLOROFORMATE	6.1	3, 8	UN2407	I	5, 15, 17, 40, 68
ISOPROPYL ISOCYANATE	6.1	3	UN2483	I	5, 15, 17, 40, 67
METHACRYLONITRILE, STABILIZED	6.1	3	UN3079	I	5, 15, 17, 40, 68
METHANESULPHONYL CHLORIDE	6.1	8	UN3246	I	5, 15, 17, 40, 68
METHOXYMETHYL ISOCYANATE	6.1	3	UN2605	I	5, 15, 17, 40, 67
METHYL BROMIDE AND ETHYLENE DIBROMIDE MIXTURE, LIQUID	6.1	—	UN1647	I	5, 15, 17, 40, 68
METHYL CHLOROFORMATE	6.1	3, 8	UN1238	I	5, 15, 17, 40, 67
METHYL CHLOROMETHYL ETHER	6.1	3	UN1239	I	5, 15, 17, 40, 67
2-METHYL-2-HEPTANETHIOL	6.1	3	UN3023	I	5, 15, 17, 40, 68
METHYLHYDRAZINE	6.1	3, 8	UN1244	I	5, 15, 17, 40, 67
METHYL IODIDE	6.1	—	UN2644	I	5, 15, 17, 40, 68
METHYL ISOCYANATE	6.1	3	UN2480	I	5, 15, 17, 40, 67
METHYL ISOTHIOCYANATE	6.1	3	UN2477	I	5, 15, 17, 40, 68
METHYL ORTHOSILICATE	6.1	3	UN2606	I	5, 15, 17, 40, 68
METHYL VINYL KETONE, STABILIZED	6.1	3, 8	UN1251	I	5, 15, 17, 40, 67
MOTOR FUEL ANTI-KNOCK MIXTURE	6.1	—	UN1649	I	4, 15

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
MOTOR FUEL ANTI-KNOCK MIXTURE, FLAMMABLE, with a flash point of not more than 60 °C	6.1	3	UN3483	I	4
NICKEL CARBONYL	6.1	3	UN1259	I	P
ORGANOARSENIC COMPOUND, LIQUID, N.O.S.	6.1	—	UN3280	I	3
ORGANOCHLORINE PESTICIDE, LIQUID, TOXIC	6.1	—	UN2996	I	3, 61
ORGANOCHLORINE PESTICIDE, LIQUID, TOXIC, FLAMMABLE, flashpoint not less than 23 °C (73 °F)	6.1	3	UN2995	I	3, 61
ORGANOCHLORINE PESTICIDE, SOLID, TOXIC	6.1	—	UN2761	I	3, 61
OSMIUM TETROXIDE	6.1	—	UN2471	I	P
PERCHLOROMETHYL MERCAPTAN	6.1	—	UN1670	I	4, 15, 17, 40, 68
PHENYLCARBYLAMINE CHLORIDE	6.1	—	UN1672	I	4, 15, 17, 40, 68
PHENYL ISOCYANATE	6.1	3	UN2487	I	4, 15, 17, 40, 68
PHENYL MERCAPTAN	6.1	3	UN2337	I	4, 15, 17, 40, 68
PHOSPHORUS OXYCHLORIDE	6.1	8	UN1810	I	4, 15, 17, 40, 68
PHOSPHORUS TRICHLORIDE	6.1	8	UN1809	I	4, 15, 17, 20, 40, 68
POTASSIUM CYANIDE, SOLID	6.1	—	UN1680	I	3, 39
N-PROPYL CHLOROFORMATE	6.1	3, 8	UN2740	I	4, 15, 17, 40, 68
N-PROPYL ISOCYANATE	6.1	3	UN2482	I	5, 15, 17, 40, 68
SODIUM CYANIDE, SOLID	6.1	—	UN1689	I	3, 39

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
SULPHURYL CHLORIDE	6.1	8	UN1834	I	5, 13, 15, 17, 40, 67
TEAR GAS SUBSTANCE, LIQUID, N.O.S.	6.1	—	UN1693	I	P
TEAR GAS SUBSTANCE, SOLID, N.O.S.	6.1	—	UN3448	I	P
TETRANITROMETHANE	6.1	5.1	UN1510	I	P
THIOPHOSGENE	6.1	—	UN2474	I	4, 15, 17, 40, 68
TITANIUM TETRACHLORIDE	6.1	8	UN1838	I	4, 15, 17, 40, 68
TOXIC BY INHALATION LIQUID, FLAMMABLE, CORROSIVE, N.O.S., with an LC_{50} lower than or equal to 200 mL/m^3 and saturated vapour concentration greater than or equal to 500 LC_{50}	6.1	3, 8	UN3488	I	4, 15, 17
TOXIC BY INHALATION LIQUID, FLAMMABLE, CORROSIVE, N.O.S., with an LC_{50} lower than or equal to 1000 mL/m^3 and saturated vapour concentration greater than or equal to 10 LC_{50}	6.1	3, 8	UN3489	I	4, 15, 17
TOXIC BY INHALATION LIQUID, WATER-REACTIVE, FLAMMABLE, N.O.S., with an LC_{50} lower than or equal to 200 mL/m^3 and saturated vapour concentration greater than or equal to 500 LC_{50}	6.1	4.3, 3	UN3490	I	4, 15, 17
TOXIC BY INHALATION LIQUID, WATER-REACTIVE, FLAMMABLE, N.O.S., with an LC_{50} lower than or equal to 1000 mL/m^3 and saturated vapour concentration greater than or equal to 10 LC_{50}	6.1	4.3, 3	UN3491	I	4, 15, 17
TOXIC LIQUID, FLAMMABLE, ORGANIC, N.O.S.	6.1	3	UN2929	I	3, 61
TOXIC, LIQUID, ORGANIC, N.O.S.	6.1	—	UN2810	I	3, 61
TOXIC, SOLID, ORGANIC, N.O.S.	6.1	—	UN2811	I	3, 61
TOXIC SOLID, SELF-HEATING, N.O.S.	6.1	4.2	UN3124	I	P

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
TOXIC SOLID, WATER-REACTIVE, N.O.S.	6.1	4.3	UN3125	I	P
TOXIC BY INHALATION LIQUID, N.O.S., with an LC_{50} lower than or equal to 200 mL/m^3 and saturated vapour concentration greater than or equal to 500 LC_{50}	6.1	—	UN3381	I	5, 15, 17, 40, 67
TOXIC BY INHALATION LIQUID, N.O.S., with an LC_{50} lower than or equal to 1000 mL/m^3 and saturated vapour concentration greater than or equal to 10 LC_{50}	6.1	—	UN3382	I	4, 15, 17, 40, 68
TOXIC BY INHALATION LIQUID, FLAMMABLE, N.O.S., with an LC_{50} lower than or equal to 200 mL/m^3 and saturated vapour concentration greater than or equal to 500 LC_{50}	6.1	3	UN3383	I	5, 15, 17, 40, 67
TOXIC BY INHALATION LIQUID, FLAMMABLE, N.O.S., with an LC_{50} lower than or equal to 1000 mL/m^3 and saturated vapour concentration greater than or equal to 10 LC_{50}	6.1	3	UN3384	I	4, 15, 17, 40, 68
TOXIC BY INHALATION LIQUID, WATER REACTIVE, N.O.S., with an LC_{50} lower than or equal to 200 mL/m^3 and saturated vapour concentration greater than or equal to 500 LC_{50}	6.1	4.3	UN3385	I	5, 15, 17, 40, 67
TOXIC BY INHALATION LIQUID, WATER REACTIVE, N.O.S., with an LC_{50} lower than or equal to 1000 mL/m^3 and saturated vapour concentration greater than or equal to 10 LC_{50}	6.1	4.3	UN3386	I	4, 15, 17, 40, 68
TOXIC BY INHALATION LIQUID, OXIDIZING, N.O.S., with an LC_{50} lower than or equal to 200 mL/m^3 and saturated vapour concentration greater than or equal to 500 LC_{50}	6.1	5.1	UN3387	I	5, 15, 17, 40, 67
TOXIC BY INHALATION LIQUID, OXIDIZING, N.O.S., with an LC_{50} lower than or equal to 1000 mL/m^3 and saturated vapour concentration greater than or equal to 10 LC_{50}	6.1	5.1	UN3388	I	4, 15, 17, 40, 68

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
TOXIC BY INHALATION LIQUID, CORROSIVE, N.O.S., with an LC_{50} lower than or equal to 200 mL/m^3 and saturated vapour concentration greater than or equal to 500 LC_{50}	6.1	8	UN3389	I	5, 15, 17, 40, 67
TOXIC BY INHALATION LIQUID, CORROSIVE, N.O.S., with an LC_{50} lower than or equal to 1000 mL/m^3 and saturated vapour concentration greater than or equal to 10 LC_{50}	6.1	8	UN3390	I	4, 15, 17, 40, 68
TOXINS, EXTRACTED FROM LIVING SOURCES, SOLID, N.O.S. (toxins from plant, animal or bacterial sources that contain infectious substances, or toxins that are contained in infectious substances must be classified in division 6.2)	6.1	—	UN3462	I	6
TRIMETHYLACETYL CHLORIDE	6.1	3, 8	UN2438	I	4, 15, 17, 40, 68
Dangerous goods of class 6.1, packing group I, liquids, not listed above	6.1	—	—	I	6
Dangerous goods of class 6.1, packing group I, solids, not listed above	6.1	—	—	I	3
Class 6.1 packing group II dangerous goods					
ALLYL ISOTHIOCYANATE, STABILIZED	6.1	3	UN1545	II	4, 15, 17
ARSENIC COMPOUND, LIQUID, N.O.S., INORGANIC, including: arsenates, n.o.s.; arsenites, n.o.s.; and arsenic sulphides, n.o.s.	6.1	—	UN1556	II	P
ARSENIC COMPOUND, SOLID, N.O.S., INORGANIC, including: arsenates, n.o.s.; arsenites, n.o.s.; and arsenic sulphides, n.o.s.	6.1	—	UN1557	II	P
BENZYL CHLORIDE	6.1	8	UN1738	II	3
BROMOACETONE	6.1	3	UN1569	II	P
N-BUTYL CHLOROFORMATE	6.1	3, 8	UN2743	II	4, 15, 17, 40, 68

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
CARBON TETRACHLORIDE	6.1	—	UN1846	II	3, 61
CHLOROACETOPHENONE, SOLID	6.1	—	UN1697	II	P
CHLOROANILINES, SOLID	6.1	—	UN2018	II	3, 61
CHLOROCRESOLS SOLUTION	6.1	—	UN2669	II	3, 61
CHLOROCRESOLS, SOLID	6.1	—	UN3437	II	3, 61
DIBROMOCHLOROPROPANES	6.1	—	UN2872	II	3, 61
DICHLOROISOPROPYL ETHER	6.1	—	UN2490	II	3, 61
MEDICINE, SOLID, TOXIC, N.O.S.	6.1	—	UN3249	II	P
ORGANOARSENIC COMPOUND, LIQUID, N.O.S.	6.1	—	UN3280	II	3
ORGANOCHLORINE PESTICIDE, LIQUID, TOXIC	6.1	—	UN2996	II	3, 66
ORGANOCHLORINE PESTICIDE, LIQUID, TOXIC, FLAMMABLE, flashpoint not less than 23°C (73°F)	6.1	3	UN2995	II	3, 66
ORGANOCHLORINE PESTICIDE, SOLID, TOXIC	6.1	—	UN2761	II	3, 66
ORGANOMETALLIC COMPOUND, LIQUID, TOXIC, N.O.S.	6.1	—	UN3282	II	3
PENTACHLOROETHANE	6.1	—	UN1669	II	3, 61
PHENOL, MOLTEN	6.1	—	UN2312	II	3, 17
POTASSIUM CYANIDE SOLUTION	6.1	—	UN3413	II	6, 7
SODIUM CYANIDE SOLUTION	6.1	—	UN3414	II	6, 7
SOLIDS CONTAINING TOXIC LIQUID, N.O.S.	6.1	—	UN3243	II	1
TEAR GAS SUBSTANCE, LIQUID, N.O.S.	6.1	—	UN1693	II	P
TEAR GAS SUBSTANCE, SOLID, N.O.S.	6.1	—	UN3448	II	P
TETRAETHYL DITHIOPYROPHOSPHATE	6.1	—	UN1704	II	3

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
TOLUIDINES, LIQUID	6.1	—	UN1708	II	2
TOXIC LIQUID, FLAMMABLE, ORGANIC, N.O.S.	6.1	3	UN2929	II	3, 61
TOXIC LIQUID, ORGANIC, N.O.S.	6.1	—	UN2810	II	3, 61
TOXIC SOLID, ORGANIC, N.O.S.	6.1	—	UN2811	II	3, 61
TOXIC SOLID, SELF-HEATING, N.O.S.	6.1	4.2	UN3124	II	P
TOXIC SOLID, WATER-REACTIVE, N.O.S.	6.1	4.3	UN3125	II	P
TOXINS, EXTRACTED FROM LIVING SOURCES, SOLID, N.O.S. (toxins from plant, animal or bacterial sources that contain infectious substances, or toxins that are contained in infectious substances must be classified in division 6.2)	6.1	—	UN3462	II	6
XYLYL BROMIDE, LIQUID	6.1	—	UN1701	II	P
XYLYL BROMIDE, SOLID	6.1	—	UN3417	II	P
Dangerous goods of class 6.1, packing group II, liquids, not listed above	6.1	—	—	II	6
Dangerous goods of class 6.1, packing group II, solids, not listed above	6.1	—	—	II	3
Class 6.1 packing group III dangerous goods					
BROMOFORM	6.1	—	UN2515	III	3, 61
CHLOROCRESOLS SOLUTION	6.1	—	UN2669	III	3, 61
CHLOROFORM	6.1	—	UN1888	III	3, 61
CHLOROPHENOLS, LIQUID	6.1	—	UN2021	III	3, 61
DIBROMOCHLOROPROPANES	6.1	—	UN2872	III	3, 61
DIBROMOMETHANE	6.1	—	UN2664	III	3, 61
o-DICHLOROBENZENE	6.1	—	UN1591	III	3, 61
DICHLOROMETHANE	6.1	—	UN1593	III	3, 61

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
HEXACHLOROBENZENE	6.1	—	UN2729	III	3, 61
HEXACHLOROBUTADIENE	6.1	—	UN2279	III	3, 61
HEXACHLOROPHENE	6.1	—	UN2875	III	3, 61
ORGANOCHLORINE PESTICIDE, LIQUID, TOXIC	6.1	—	UN2996	III	3, 61
ORGANOCHLORINE PESTICIDE, LIQUID, TOXIC, FLAMMABLE, flashpoint not less than 23 °C (73 °F)	6.1	3	UN2995	III	3, 61
ORGANOCHLORINE PESTICIDE, SOLID, TOXIC	6.1	—	UN2761	III	3, 61
PHENOXYACETIC ACID DERIVATIVE PESTICIDE, LIQUID, FLAMMABLE, flash point not less than 23 °C	6.1	3	UN3347	III	2
POTASSIUM CYANIDE SOLUTION	6.1	—	UN3413	III	2, 7
PYRETHROID PESTICIDE, LIQUID, TOXIC, FLAMMABLE, flash point not less than 23 °C	6.1	3	UN3351	III	2
SODIUM CYANIDE SOLUTION	6.1	—	UN3414	III	2, 7
TETRACHLOROETHYLENE	6.1	—	UN1897	III	3, 61
TOXIC LIQUID, ORGANIC, N.O.S.	6.1	—	UN2810	III	3, 61
TOXIC SOLID, ORGANIC, N.O.S.	6.1	—	UN2811	III	3, 61
TOXINS, EXTRACTED FROM LIVING SOURCES, SOLID, N.O.S. (toxins from plant, animal or bacterial sources that contain infectious substances, or toxins that are contained in infectious substances must be classified in division 6.2)	6.1	—	UN3462	III	2
1,1,1-TRICHLOROETHANE	6.1	—	UN2831	III	3, 61
TRICHLOROETHYLENE	6.1	—	UN1710	III	3, 61
Dangerous goods of class 6.1, packing group III, liquids, not listed above	6.1	—	—	III	2

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
Dangerous goods of class 6.1, packing group III, solids, not listed above	6.1	—	—	III	1
Dangerous goods of class 6.1, packing group III, not listed above, with a subsidiary classification other than 9	6.1	—	—	III	3
Class 8 with no packing group dangerous goods					
Dangerous goods of class 8 with no packing group	8	—	—	—	P
Class 8 packing group I dangerous goods					
ALKYLPHENOLS, SOLID, N.O.S. (including c2-c12 homologues)	8	—	UN2430	I	3
AMINES, SOLID, CORROSIVE, N.O.S. or POLYAMINES, SOLID, CORROSIVE, N.O.S.	8	—	UN3259	I	3
BORON TRIBROMIDE	8	—	UN2692	I	4, 15, 17, 40, 68
BROMINE or BROMINE SOLUTION	8	6.1	UN1744	I	10, 15, 67
BROMINE SOLUTION (that does not meet the criteria for hazard zone A)	8	6.1	UN1744	I	10, 15, 68
CHLOROSULPHONIC ACID (with or without sulphur trioxide)	8	—	UN1754	I	4, 15, 17, 40, 68
CHROMOSULPHURIC ACID	8	—	UN2240	I	3, 13
CORROSIVE SOLID, ACIDIC, INORGANIC, N.O.S.	8	—	UN3260	I	3
CORROSIVE SOLID, ACIDIC, ORGANIC, N.O.S.	8	—	UN3261	I	3
CORROSIVE SOLID, BASIC, INORGANIC, N.O.S.	8	—	UN3262	I	3
CORROSIVE SOLID, BASIC, ORGANIC, N.O.S.	8	—	UN3263	I	3
CORROSIVE SOLID, FLAMMABLE, N.O.S.	8	4.1	UN2921	I	3
CORROSIVE SOLID, N.O.S.	8	—	UN1759	I	3

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
DYE INTERMEDIATE, SOLID, CORROSIVE, N.O.S. or DYE, SOLID, CORROSIVE, N.O.S.	8	—	UN3147	I	3
FLUOROSULPHONIC ACID	8	—	UN1777	I	3, 13
HYDRAZINE, ANHYDROUS	8	3, 6.1	UN2029	I	3, 19, 30
HYDRAZINE, AQUEOUS SOLUTION, FLAMMABLE, with more than 37% hydrazine, by mass	8	3, 6.1	UN3484	I	6, 30
HYDRAZINE, AQUEOUS SOLUTION, with more than 37% hydrazine, by mass	8	6.1	UN2030	I	3, 19, 30
HYDROFLUORIC ACID AND SULPHURIC ACID MIXTURE	8	6.1	UN1786	I	3, 18, 21
HYDROFLUORIC ACID SOLUTION, more than 60% hydrogen fluoride	8	6.1	UN1790	I	3, 18, 21
HYDROGEN FLUORIDE, ANHYDROUS	8	6.1	UN1052	I	4, 40, 69
NITRATING ACID Mixture, with more than 50% nitric acid	8	5.1	UN1796	I	3
NITRIC ACID, other than red fuming, with more than 70% nitric acid	8	5.1	UN2031	I	3, 30
NITRIC ACID, RED FUMING	8	5.1, 6.1	UN2032	I	4, 15, 40, 68
SELENIC ACID	8	—	UN1905	I	3
SULPHURIC ACID, FUMING	8	6.1	UN1831	I	3, 45, 82
SULPHUR TRIOXIDE, STABILIZED	8	—	UN1829	I	4, 15, 17, 29, 40, 68
THIONYL CHLORIDE	8	—	UN1836	I	3, 13
Dangerous goods of class 8, packing group I, not listed above	8	—	—	I	6
Class 8 packing group II dangerous goods					
ACETIC ACID, GLACIAL or ACETIC ACID SOLUTION, more than 80% acid, by mass	8	3	UN2789	II	6
ACETIC ANHYDRIDE	8	3	UN1715	II	6

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
ACRYLIC ACID, STABILIZED	8	3	UN2218	II	6
ALLYLTRICHLOROSILANE, STABILIZED	8	3	UN1724	II	3, 13
AMINES, LIQUID, CORROSIVE, FLAMMABLE, N.O.S. or POLYAMINES, LIQUID, CORROSIVE, FLAMMABLE, N.O.S.	8	3	UN2734	II	6
AMMONIUM HYDROGENDIFLUORIDE SOLUTION	8	6.1	UN2817	II	6
AMMONIUM POLYSULFIDE SOLUTION or AMMONIUM POLYSULPHIDE SOLUTION	8	6.1	UN2818	II	6
AMMONIUM SULFIDE SOLUTION or AMMONIUM SULPHIDE SOLUTION	8	3, 6.1	UN2683	II	6
AMYLTRICHLOROSILANE	8	—	UN1728	II	3, 13
ANTIMONY PENTAFLUORIDE	8	6.1	UN1732	II	6
SULPHURIC ACID, with not more than 51% acid, or BATTERY FLUID, ACID	8	—	UN2796	II	3, 18
BENZYLDIMETHYLAMINE	8	3	UN2619	II	6
BORON TRIFLUORIDE ACETIC ACID COMPLEX, LIQUID	8	—	UN1742	II	3, 13
BUTYLTRICHLOROSILANE	8	3	UN1747	II	3, 13
CHLOROPHENYLTRICHLOROSILANE	8	—	UN1753	II	3, 13
CHLOROSILANES, CORROSIVE, FLAMMABLE, N.O.S.	8	3	UN2986	II	6
CORROSIVE LIQUID, FLAMMABLE, N.O.S.	8	3	UN2920	II	6
CORROSIVE LIQUID, OXIDIZING, N.O.S.	8	5.1	UN3093	II	6
CORROSIVE LIQUID, TOXIC, N.O.S.	8	6.1	UN2922	II	6
CORROSIVE LIQUID, WATER-REACTIVE, N.O.S.	8	4.3	UN3094	II	6
CUPRIETHYLENEDIAMINE SOLUTION	8	6.1	UN1761	II	6

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
CYCLOHEXYLAMINE	8	3	UN2357	II	6
DICHLOROACETYL CHLORIDE	8	—	UN1765	II	3, 13
DICHLOROPHENYLTRICHLOROSILANE	8	—	UN1766	II	3, 13
2-DIETHYLAMINOETHANOL	8	3	UN2686	II	6
N,N-DIETHYLETHYLENEDIAMINE	8	3	UN2685	II	6
DIETHYLDICHLOROSILANE	8	3	UN1767	II	3, 13
2-DIMETHYLAMINOETHANOL	8	3	UN2051	II	6
DIMETHYLCYCLOHEXYLAMINE	8	3	UN2264	II	6
DI-N-BUTYLAMINE	8	3	UN2248	II	6
DIPHENYLDICHLOROSILANE	8	—	UN1769	II	4, 8
DODECYLTRICHLOROSILANE	8	—	UN1771	II	3, 13
ETHYLENEDIAMINE	8	3	UN1604	II	6
ETHYL CHLOROTHIOFORMATE	8	3	UN2826	II	4, 15, 17, 40, 68
FLUOROBORIC ACID	8	—	UN1775	II	3, 18
FLUOSILICIC ACID	8	—	UN1778	II	3, 18
FORMIC ACID, with more than 85% acid by mass	8	3	UN1779	II	3, 25
HEXADECYLTRICHLOROSILANE	8	—	UN1781	II	3, 13
HEXYLTRICHLOROSILANE	8	—	UN1784	II	3, 13
HYDRAZINE AQUEOUS SOLUTION, with more than 37% hydrazine, by mass	8	6.1	UN2030	II	3, 19, 30
HYDROBROMIC ACID	8	—	UN1788	II	3, 18
HYDROCHLORIC ACID	8	—	UN1789	II	3, 18
HYDROFLUORIC ACID, with not more than 60% hydrogen fluoride	8	6.1	UN1790	II	3, 18

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
HYPOCHLORITE SOLUTION	8	—	UN1791	II	3, 18
IODINE MONOCHLORIDE, SOLID	8	—	UN1792	II	3, 13
NITRATING ACID MIXTURES, with not more than 50% nitric acid	8	—	UN1796	II	3
NITRIC ACID, other than red fuming, with at least 65%, but not more than 70% nitric acid	8	5.1	UN2031	II	3, 30
NITRIC ACID, other than red fuming, with less than 65% nitric acid	8	—	UN2031	II	3, 30
NONYLTRICHLOROSILANE	8	—	UN1799	II	3, 13
OCTADECYLTRICHLOROSILANE	8	—	UN1800	II	3, 13
OCTYLTRICHLOROSILANE	8	—	UN1801	II	3, 13
PAINT, CORROSIVE, FLAMMABLE (including paint, lacquer, enamel, stain, shellac, varnish, polish, liquid filler and liquid lacquer base), with not more than 20 % nitrocellulose, by mass, if the nitrogen content of the nitrocellulose is not more than 12.6%, by mass or PAINT RELATED MATERIAL, CORROSIVE, FLAMMABLE (including paint thinning or reducing compound), with not more than 20% nitrocellulose, by mass, if the nitrogen content of the nitrocellulose is not more than 12.6%, by mass	8	3	UN3470	II	6
PERCHLORIC ACID with not more than 50% acid, by mass	8	5.1	UN1802	II	6
PHENYLPHOSPHORUS DICHLORIDE	8	—	UN2798	II	3, 18
PHENYLPHOSPHORUS THIODICHLORIDE	8	—	UN2799	II	3, 18
PHENYLTRICHLOROSILANE	8	—	UN1804	II	3, 13
PHOSPHORUS OXYBROMIDE	8	—	UN1939	II	1, 14
PHOSPHORUS OXYBROMIDE, MOLTEN	8	—	UN2576	II	3, 14
PHOSPHORUS TRIBROMIDE	8	—	UN1808	II	3, 22

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
POTASSIUM HYDROGEN DIFLUORIDE SOLUTION	8	6.1	UN3421	II	6
PROPIONIC ACID, with not less than 90% acid, by mass	8	3	UN3463	II	6
1,2-PROPYLENEDIAMINE	8	3	UN2258	II	6
PROPYLTRICHLOROSILANE	8	3	UN1816	II	3, 13
SILICON TETRACHLORIDE	8	—	UN1818	II	3, 13
SULPHURIC ACID, SPENT	8	—	UN1832	II	3, 45, 46
SULPHURIC ACID, with more than 51% acid	8	—	UN1830	II	3, 45, 46
THIOPHOSPHORYL CHLORIDE	8	—	UN1837	II	3, 14, 22
TRICHLOROACETYL CHLORIDE	8	—	UN2442	II	4, 15, 17, 40, 68
VALERYL CHLORIDE	8	3	UN2502	II	6
VANADIUM OXYTRICHLORIDE	8	—	UN2443	II	3, 19
Dangerous goods of class 8, packing group II, liquids, not listed above	8	—	—	II	3
Dangerous goods of class 8, packing group II, solids, not listed above	8	—	—	II	1
Class 8 packing group III dangerous goods					
FERRIC CHLORIDE SOLUTION	8	—	UN2582	III	2, 18
HYDRAZINE AQUEOUS SOLUTION, with more than 37% hydrazine, by mass	8	6.1	UN2030	III	3, 19, 30
HYDROBROMIC ACID	8	—	UN1788	III	3, 18
HYDROCHLORIC ACID	8	—	UN1789	III	3, 18
ISOPROPYL ACID PHOSPHATE	8	—	UN1793	III	1
MALEIC ANHYDRIDE, MOLTEN	8	—	UN2215	III	1

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
Dangerous goods of class 8, packing group III, liquids, not listed above	8	—	—	III	2
Dangerous goods of class 8, packing group III, solids, not listed above	8	—	—	III	1
Class 9 with no packing group dangerous goods					
CARBON DIOXIDE, SOLID or DRY ICE	9	—	UN1845	—	1
Dangerous goods of class 9 with no packing group	9	—	—	—	P
Class 9 packing group I dangerous goods					
Dangerous goods of class 9, packing group I, liquids	9	—	—	I	2
Dangerous goods of class 9, packing group I, solids	9	—	—	I	1
Class 9 packing group II dangerous goods					
ASBESTOS, AMPHIBOLE (amosite, tremolite, actinolite, anthophyllite, crocidolite)	9	—	UN2212	II	1, 66
POLYCHLORINATED BIPHENYLS, LIQUID	9	—	UN2315	II	3, 61
POLYHALOGENATED BIPHENYLS, SOLID, regulated only when the concentration is more than 50 ppm, by mass; or halogenated monomethyldiphenylmethanes, solid, regulated only when the concentration is more than 50 ppm, by mass or POLYHALOGENATED TERPHENYLS, SOLID, regulated only when the concentration is more than 50 ppm, by mass	9	—	UN3152	II	2
Dangerous goods of class 9, packing group II, liquids, not listed above	9	—	—	II	2
Dangerous goods of class 9, packing group II, solids, not listed above	9	—	—	II	1
Class 9 packing group III dangerous goods					
ELEVATED TEMPERATURE LIQUID, N.O.S., at or above 100 °C (212 °F) and below its flashpoint (including molten metals, molten salts, etc.)	9	—	UN3257	III	62

I Shipping name and description	II Primary class	III Subsidiary class	IV UN number	V Packing group	VI Special provision
ELEVATED TEMPERATURE SOLID, N.O.S., at or above 240 °C (464 °F)	9	—	UN3258	III	63
ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S.	9	—	UN3077	III	1, 31
ASBESTOS, CHRYSOTILE	9	—	UN2590	III	1, 66
Dangerous goods of class 9, packing group III, liquids, not listed above	9	—	—	III	2
Dangerous goods of class 9, packing group III, solids, not listed above	9	—	—	III	1