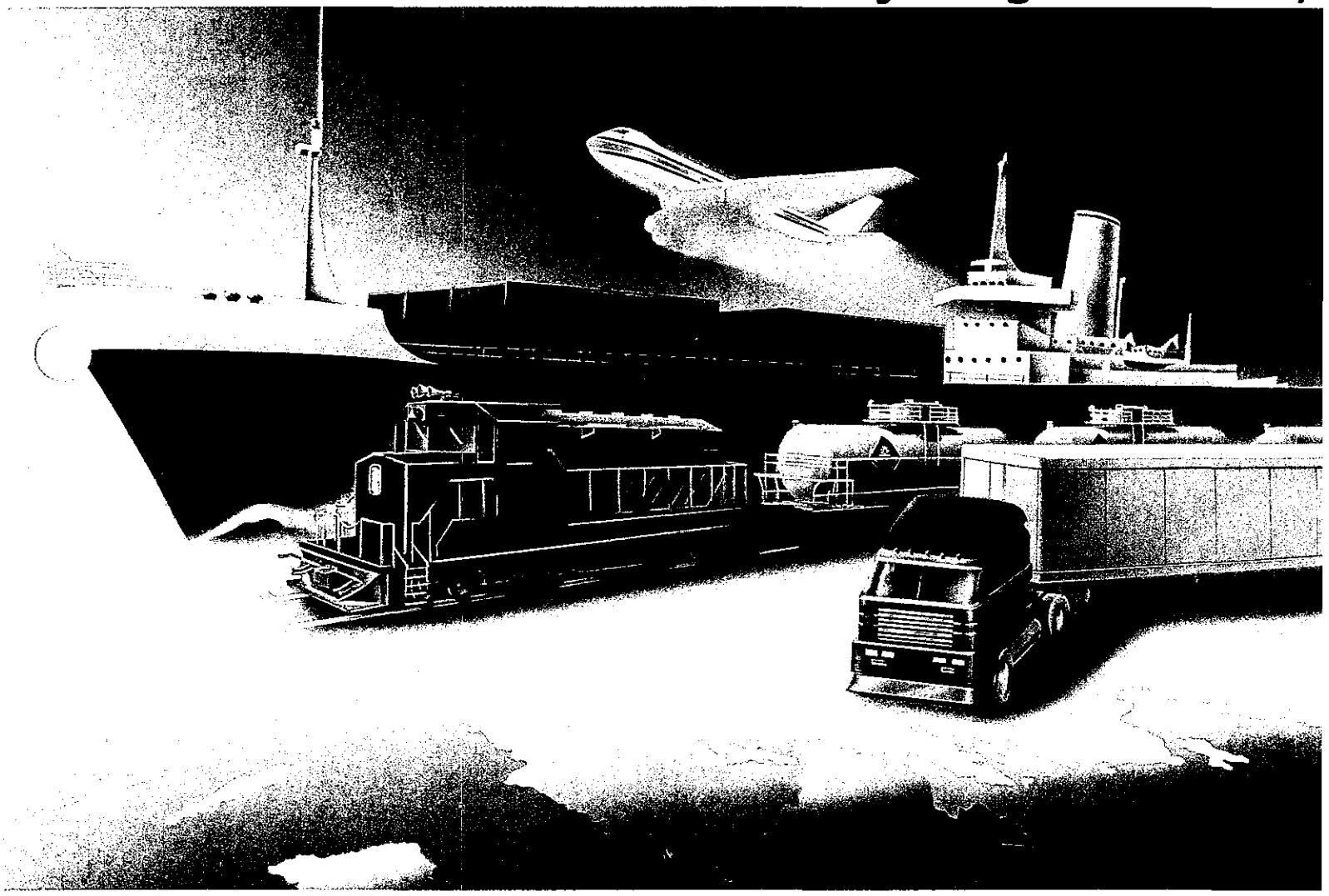
Canadian Standards Association

Preliminary Standard
B620-1987

# Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods

(Formerly designated B338)



Materials Handling and Distribution

# General Instruction No. 1

B620-1987
October 1987

CSA Preliminary Standard B620-1987, Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods, consists of **106** pages, each dated **October 1987.**

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Preliminary Standard
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# Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods

(Formerly designated B338)

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# Contents

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# Preface

This first edition of CSA Preliminary Standard B620, *Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods,* replaces and supersedes Preliminary Standard B338, of the same title, published in 1982, and Supplement No. 1, published in 1984.

This Standard was prepared as a result of the Transportation of Dangerous Goods Act proclaimed by the Governor in Council in 1980, which authorized the Minister of Transport to develop a Code on the Transportation of Dangerous Goods consisting of regulations, standards, accepted practices, and information.

A CSA Committee was formed to develop a technical standard covering the design, construction, testing, inspection, retesting and certification of tanks for the transportation of dangerous goods. This Standard specifies requirements for highway tanks, portable and intermodal portable tanks, multi-unit tank car tanks, reinforced plastic (RP) highway tanks, and pressure/vacuum liquid waste highway tanks for the transportation of dangerous goods.

This Standard follows the CSA format and numbering system and incorporates appropriate sections of the *US Code of Federal Regulations, Title 49,* on tank specifications, which have been reproduced in this Standard in part or in whole with the permission of the Director of Hazardous Materials Regulations, US Department of Transport. Where tank specifications have been reproduced, the CFR paragraph system and identification has been retained, eg, §178.340-7, §178.343-8, etc, and where some parts have been modified or rewritten, such changes are summarized in Clause 4.4. This Standard differs from the first edition of CSA Standard B338 and Supplement No. 1 in that, along with editorial changes, it incorporates the requirements of Specifications TC 338 and TC 341 tanks and the registration of facilities to manufacture, repair, test, inspect, and certify such tanks.

It is the intent of the CSA Technical Committee to further develop this Standard in the future in cooperation with the industry representation and the regulatory authorities in Canada and the USA to meet the needs in Canada and to achieve a maximum degree of uniformity with the USA.

This Standard was prepared by the Technical Committee on Highway Tanks. Authorization to publish it as a Preliminary Standard was granted by the Standards Steering Committee on Materials Handling and Distribution.

*October 1987*

**Notes:**

**(1)** *Use of the masculine gender in this Standard is not meant to exclude the feminine gender when applied to persons. Similarly, use of the singular does not exclude the plural (and vice versa) when the sense allows.*

**(2)** *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the user of the Standard to judge its suitability for his particular purpose.*

**(3)** *CSA Standards are subject to periodic review, and suggestions for their improvement will be referred to the appropriate committee.*

**(4)** *All enquiries regarding this Standard, including requests for interpretation, should be addressed to Canadian Standards Association, Standards Division, 178 Rexdale Boulevard, Rexdale, Ontario M9W 1R3.*

*Requests for interpretation should*
*(a) define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
*(b) provide an explanation of circumstances surrounding the actual field condition; and*
*(c) be phrased where possible to permit a specific "yes" or "no" answer.*

*Interpretations are published in "CSA Information Update". For subscription details and a free sample copy, write to CSA Marketing or telephone (416) 747-2292.*

# B620-1987
# Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods

## 1. Scope

### 1.1

This Standard applies to highway tanks and portable tanks used for the transportation of dangerous goods in bulk by road and for intermodal portable tanks for the transportation of dangerous goods in bulk, other than by air. It covers the design, construction, certification, testing, inspection and retesting, maintenance, and identification of such tanks. Additional design and construction requirements for tanks intended to carry specific products are covered in the following CSA Standards:
B621,
*Selection and Use of Highway Tanks, Portable Tanks, Cargo Compartments and Containers for the Transportation of Dangerous Goods, Classes 3, 4, 5, 6, and 8, in Bulk by Road;*
B622,
*Selection and Use of Highway Tanks, Multi-unit Tank Car Tanks, and Portable Tanks for the Transportation of Dangerous Goods, Class 2, by Road;*
B623,
*Selection, Handling, and Use of Intermodal Portable Tanks for the Transportation of Dangerous Goods, Other Than by Air.*

### 1.2

Notwithstanding the provisions of this Standard, compliance with the provisions of the *Transportation of Dangerous Goods Act* of 1980 and the *Regulations* thereto may call for additional requirements due to particular characteristics or properties of individual dangerous goods. The design, construction, testing or retesting of highway tanks (including those for dangerous wastes), portable tanks, intermodal portable tanks, or reinforced plastic (RP) highway tanks shall be in accordance with the requirements of this Standard and any additional requirements of the *Transportation of Dangerous Goods Regulations.*

### 1.3

This Standard is not intended to be a guide for the design and construction of tanks and as such does not obviate the need for exercising competent engineering judgement, nor does it eliminate the necessity for complete design calculations relating to the intended use of the tank. The values for the various parameters listed are simply the limiting values within which such tanks are restricted for this Standard. It is the responsibility of the tank manufacturer to select adequate values (of safety factor, tensile strength, etc) within these constraints, so that the tank will safely carry out its intended function.

## 2. Reference Publications

### 2.1

This Standard refers to the following publications and where such reference is made it shall be to the edition shown:

**CSA Standards**
B621-1987,
*Selection and Use of Highway Tanks, Portable Tanks, Cargo Compartments and Containers for the Transportation of Dangerous Goods, Classes 3, 4, 5, 6, and 8, in Bulk, by Road;*
B622-1987,
*Selection and Use of Highway Tanks, Multi-unit Tank Car Tanks, and Portable Tanks for the Transportation of Dangerous Goods, Class 2, by Road;*
B623-1987,
*Selection, Handling, and Use of Intermodal Portable Tanks for the Transportation of Dangerous Goods, Other Than by Air;*
CAN3-Z234.1-79,
*Canadian Metric Practice Guide.*
**ASME* Standard**
*Boiler and Pressure Vessel Code, 1986, Section VIII, Division 1.*

**ASTM Standards**
A370-77,
*Mechanical Testing of Steel Products;*

D638-84,
*Test Methods for Tensile Properties of Plastics;*

D651-84,
*Test Method for Tensile Strength of Molded Electrical Insulating Materials;*

D790-84,
*Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials;*

E84-84,
*Test Method for Surface Burning Characteristics of Building Materials.*

**CGA† Pamphlets**
G-4.1-1977,
*Cleaning Equipment for Oxygen Service;*

S-1.2-1980,
*Pressure Relief Device Standards (Part 2),*
*Cargo and Portable Tanks for Compressed Gases;*

TB-2-1975,
*Guidelines for Inspection and Repair of MC 330 and MC 331 Cargo Tanks.*

**ISO‡ Standard**
6892-84,
*Steels—Tensile Testing.*

**Statutes of Canada**
*Safe Containers Convention Act,*
SC 1980-81-82-83 c.9 as amended SC 1980-81-82-83 c.165, s.42 and the Amendment Orders and Regulations, as amended from time to time.

*Transportation of Dangerous Goods Act*, Chapter 36, SC 1980 and the *Regulations* thereto, as amended from time to time.

**US Code of Federal Regulations,**
*Title 49, 1986.*

**The American Society of Mechanical Engineers*
†*Compressed Gas Association*
‡*International Organization for Standardization*

# 3. Definitions, Terminology, and Units of Measurement

## 3.1 Definitions

The definitions, terms, and abbreviations in the *Transportation of Dangerous Goods Act* and *Regulations* thereto shall apply in this Standard.

Where equivalent but different terminology is used in the parts of this Standard reproduced from the *US Code of Federal Regulations, Title 49* (CFR 49), the following shall be considered to be equivalent:

| US CFR, Title 49 | Canadian Code |
|---|---|
| Cargo tank | Highway tank |
| Corrosive materials | Corrosives |
| Hazardous materials | Dangerous goods |
| Department of Transportation or DOT | Department of Transport (Transport Canada) |
| Bureau of Explosives | Transport Dangerous Goods Branch (Transport Canada) |
| Motor vehicle | Road vehicle |
| ASME Code | ASME Boiler and Pressure Vessel Code |

## 3.2 Terminology

### 3.2.1

Highway tanks shall be designated TC 306, TC 307, TC 312, TC 331, TC 338, TC 341, or TC 350. Where the tank specification numbers 306, 307, 312, 331, and 338 are used with the prefix MC or MC DOT in this Standard, they shall mean TC 306, TC 307, TC 312, TC 331, or TC 338 respectively.

### 3.2.2

Portable tanks shall be designated TC 51, TC 56, TC 57, or TC 60. Where the specification numbers 51, 56, 57, and 60 are used in this Standard, they shall mean TC 51, TC 56, TC 57, or TC 60 respectively.

### 3.2.3

Intermodal portable tanks shall be designated TC Type 1, TC Type 2, or TC Type 3.

### 3.2.4

In the certification documents, identification, and nameplates referred to in paragraphs 178.337-17(a), 178.338-18(a)(i), 178.340-10(b), 178.245-6, 178.251-7, and 178.255-14, and Clauses 5.8.12 and 6 of this Standard, the tank designation specifications shall be prefixed by TC.

## 3.3 Units of Measurement

### 3.3.1

The applicable units of measurement used in certification documents, identification, and nameplates shall be in imperial or SI (metric) and shall be clearly identified.

### 3.3.2

To convert from US gallons to Canadian gallons, multiply US gallons by 0.83267.

### 3.3.3

In determining the equivalent SI (metric) units and values, the conversion factors in Table 3.1 shall be used.

**Table 3.1**
**Units and Factors for Converting to SI (Metric)**

| Basic unit | CFR, Title 49 units | SI (Metric) units (see Note 1) |
|---|---|---|
| Temperature | Degree Fahrenheit | Degree Celsius (°C)<br>F temperature = 1.8 (C temperature) + 32 |
| Pressure or stress (force per area) | Pounds per square inch (psi) | Kilopascals (kPa)<br>1 psi = 6.894757 kPa |
| Capacity (volume) | US gallon (see Note 2) | Cubic decimetres or litres ($dm^3$ or L)<br>1 US gallon = 3.785412 $dm^3$ or L |
| Length | Inch | Millimetre (mm)<br>1 inch = 25.4 mm |
| Mass (weight) | Pounds (avoirdupois) | Kilograms (kg)<br>1 pound = 0.45359237 kg |
| Force | Pounds force | Newtons (N)<br>1 pound force = 4.448222 N |
| Acceleration due to gravity (g) | 32.2 feet per second per second ($ft/s^2$) | 9.81 metres per second per second ($m/s^2$) |
| Energy | Foot-pound force | joules (J)<br>1 foot-pound force = 1.355818 J |
| | BTU (International) | Kilo-joules (kJ)<br>1 BTU = 1.055055 (kJ) |

**Notes:**
**(1)** *Specified in CSA Standard CAN3-Z234.1.*
**(2)** *For purposes of this Standard, the imperial and the Canadian gallon are the same.*

# 4. General

## 4.1 Highway Tanks

Highway tanks and associated equipment shall conform to the following:

(a) **TC 306, TC 307, and TC 312**

Clause 5.1, Clause 5.2 (if applicable), and the applicable tank specification in the *US Code of Federal Regulations, Title 49,* reproduced verbatim in Clauses 5.5, 5.6, 5.7, and 5.8, but amended as indicated in Clause 4.4;

(b) **TC 331 and TC 338**

Clause 5.1, Clause 5.2 (if applicable), and the applicable tank specifications in the *US Code of Federal Regulations, Title 49,* reproduced verbatim in Clauses 5.3 and 5.4 but amended as indicated in Clause 4.4;

(c) **TC 341**

Clauses 5.1 and 5.9; or

(d) **TC 350**

Clauses 5.1, 5.5, and 5.10.

## 4.2 Portable Tanks

Portable tanks shall conform to Clause 6.1 and the applicable requirements in the *US Code of Federal Regulations, Title 49,* reproduced verbatim in Clauses 6.2 to 6.6 inclusive, but amended as indicated in Clause 4.4.

## 4.3 Intermodal Portable Tanks

Intermodal portable tanks and associated equipment shall conform to the applicable requirements in Clause 7.

## 4.4 Amendments to Requirements Reproduced from US CFR, Title 49

The portions of the *US Code of Federal Regulations, Title 49,* reproduced in this Standard have been amended as follows:

**General**

Wherever the word "gallons" is used, it shall mean "US Gallons".

**§178.337-1(a)(1) to (4) (page 25)**

This paragraph has been amended to permit only the use of steel in the construction of tanks.

**§178.337-1(b) (page 25)**

Reference is made to CSA Standard B622 instead of §173.315(a)(1).

**§178.337-1(e) (page 25)**

Reference is made to CSA Standard B622 instead of US CFR, Title 49 paragraphs.

**§178.337-2(a)(3) (page 25)**

The words "and made available to duly identified representatives of the Department of Transportation" have been deleted.

**§178.337-3(a) (page 25)**

The second sentence has been deleted (the corrosion allowance requirement is covered in CSA Standard B622.)

**§178.337-3(b) (page 26)**

The words "1962 edition" have been deleted at the end of this paragraph.

**§178.337-4(b) (page 26)**

The words "and must be made available to duly identified representatives of the Department" have been deleted.

**§178.337-10(d) (page 27)**

Reference is made to Clause 5.1.3 instead of §393.86.

**§178.337-16(b)(1) (page 28)**

The reference to the ASME Code has been updated to the 1980 edition by changing "paragraphs UA-70 through UA-72" to "paragraphs 6-1 through 6-4".

**§178.337-17(a), (page 29)**

"Maximum product load" has been added to the information required on the identification plate. The marking requirement "Water capacity in pounds (see Note 1)" has been replaced with "Water capacity (mass)" and a note has been added referring to Clause 3.3.

**§178.337-17(b) (page 29)**

This requirement has been completely rewritten.

**§178.338-1(a)(2) (page 29)**

"(see 173.318(a)(1) and (f) of this subchapter)" has been replaced with "(see CSA Standard B622)".

**§178.338-1(c)(2) (page 29)**

"(see 178.318(a)(1) and (f) of this subchapter)" has been replaced with "(see CSA Standard B622)".

**§178.338-1(e) (page 30)**

Reference is made to CSA Standard B622 instead of §173.318(a)(3).

**§178.338-2(f) (page 30)**

The words "and made available, upon request, to any duly identified representative of the Department" have been deleted.

**§178.338-4(b) (page 31)**

The words "and must be made available, upon request, to any duly identified representative of the Department or the owners of the cargo tank" have been deleted.

**§178.338-8(b)(1) (page 31)**
Reference to §173.33(f) has been deleted.

**§178.338-9(c)(1) (page 32)**
"173.33(d)(1)(ii) and 178.804(b) of this subchapter" has been replaced with "CSA Standard B622".

**§178.338-10(c) (page 33)**
Reference is made to Clause 5.1.3 instead of §393.86.

**§178.338-16 (page 35)**
This paragraph has been amended to clarify the hydrostatic test pressure and to specify the test pressure for the pneumatic test.

**§178.338-18 (page 36)**
The marking "lbs" has been deleted in (b)(8) and a note has been added referring to Clause 3.3.

**§173.318(b)(1)(i) (page 36)**
The second and third sentences have been deleted.

**§173.318(b)(2)(v) (page 36)**
The words "110% of" have been deleted.

**§178.340 and 178.340-1 (page 37)**
TC 350 tanks have been added to the titles and in paragraph (a).

**§178.340-2 (page 38)**
A new paragraph (e) has been added to cover tanks constructed of reinforced plastics.

**§178.340-3 (page 39)**
A reference to Clause 5.10 has been added in the last sentence of paragraph (a)(1).

A new paragraph (c) has been added to cover reinforced plastics.

**§178.340-4 (page 39)**
A new paragraph (c) has been added to cover reinforced plastic tanks.

**§178.340-5 (page 40)**
A new paragraph (e) has been added to cover reinforced plastic tanks.

**§178.340-7 (pages 40 and 41)**
A note has been added to paragraph (c) to clarify the application of this requirement to reinforced plastic tanks.

A new paragraph (e) has been added to cover circumferential reinforcement of reinforced plastic tanks.

**§178.340-8(b) (page 42)**
Reference is made to Clause 5.1.3 instead of §393.86.

**§178.340-10(a) (page 43)**
Clause 5.10 has been added to the list of referenced paragraphs.

**§178.340-10(b)(1) (pages 43 and 44)**
Manufacturer's serial number has been added to the information required.

TC 350 has been added to the information required concerning tank specification numbers.

Minimum thicknesses for material used in heads and shells has been added to the information required.

A note has been added referring to Clause 3.3.

**§178.340-10(b)(2)(i) (page 44)**
The colour black has been added for TC 350.

In the last paragraph, MC Specification has been changed to MC/TC Specification.

**§178.341-2 (page 44)**
A new paragraph (b) has been added to cover reinforced plastic tanks.

**§178.342-2 (page 51)**
A new paragraph (c) has been added to cover reinforced plastic tanks.

**§178.343-2 (page 55)**
A new paragraph (d) has been added to cover reinforced plastic tanks.

**§178.245-1(a)(1) (page 73)**
The words "and made available to duly identified representatives of the Department of Transportation or the owner of the tank" have been deleted.

**§178.245-1(c) (page 73)**
Reference to §173.300 has been deleted.

**§178.245-3(a) (page 73)**
Reference is made to CSA Standard B622 instead of "Part 173". The second sentence has been deleted (the corrosion allowance requirement is covered in CSA Standard B622).

Note 1 has been amended to read the same as Note 1 in §178.337-1(b).

**§178.245-4(b) (page 73)**
The words "and on the report required by §178.245-7(a)" have been deleted because there is no such paragraph.

**§178.245-6(a) (page 74)**
"Gross weight" has been added to the information required on the nameplate.

A note has been added referring to Clause 3.3.

**§178.251-7 (page 77)**
A note has been added referring to Clause 3.3.

**§178.255-8 (page 80)**
This paragraph has been amended to make reference to Clause 5.2.3.

**§178.255-14(a) (page 81)**
The following have been added to the marking requirements:
Owner's serial number;
Gross weight;
Original test date;
Lining material.
A note has been added referring to Clause 3.3.

# 5. Specifications for Highway Tanks

## 5.1 Requirements for All Highway Tanks

### 5.1.1 Means of Containment

Highway tanks used for the shipment of dangerous goods by road shall, unless otherwise specified, meet all of the following design and construction criteria:
(a) Welding and brazing shall be performed in a workmanlike manner using suitable and appropriate techniques, materials, and equipment.
(b) Materials of construction and tank contents shall be such that there will be no significant chemical or galvanic reaction among any of the materials in the package.
(c) Closures shall be adequate to prevent inadvertent leakage of the contents under normal conditions incident to transportation.
(d) Gasketed closures shall be fitted with gaskets of efficient material that will not be deteriorated by the contents of the container.

### 5.1.2 Marking

A tank marked with the name or identification number of a dangerous good may not be used to transport any other material unless the marking is removed or changed to identify the dangerous good in the tank, whichever is appropriate.

### 5.1.3 Rear End Protection

#### 5.1.3.1

Every highway tank that is so constructed that the body has a clearance at the rear end of more than 760 mm (30 in) from the ground when empty shall be provided with bumpers or devices serving similar purposes that are so constructed and located that
(a) the clearance between the effective bottom of the bumpers or devices and the ground shall not exceed 760 mm (30 in) with the vehicle empty;
(b) the maximum distance between the closest points between bumpers, or devices, if more than one is used, shall not exceed 590 mm (24 in);
(c) the maximum transverse distance from the widest part of the vehicle at the rear to the bumper or device shall not exceed 460 mm (18 in);
(d) the bumpers or devices shall be located not more than 590 mm (24 in) forward of the extreme rear of the vehicle; and
(e) the bumpers or devices shall be substantially constructed and firmly attached.

#### 5.1.3.2

Highway tanks constructed and maintained so that the body, chassis, or other parts of the vehicle afford the rear end protection contemplated shall be deemed to be in compliance with Clause 5.1.3.1.

## 5.2 Highway Tanks for the Transportation of Liquefied Compressed Gases

### 5.2.1 Piping, Valves, and Fittings

#### 5.2.1.1

Highway tanks designed to transport a compressed gas shall conform to the following:
(a) The bursting pressure of all piping, pipe fittings, hose, and other pressure parts, except pump seals and safety relief devices, shall be at least 4 times the design pressure of the tank. In addition, the bursting pressure shall not be less than 4 times any higher pressure to which each pipe, pipe fitting, hose, and other pressure part may be subjected in service by the action of a pump or other device.
(b) Welded pipe joints shall be used wherever possible. Where copper tubing is permitted, joints shall be brazed or be of equally strong metal union type. The melting point of brazing material shall be no lower than 535°C (1000°F). The method of joining tubing shall not decrease its strength, such as by the cutting of threads. Screwed fittings shall be at least extra-heavy. Nonmalleable metals shall not be used in the construction of any valve or fitting.
(c) Each hose coupling shall be designed for a pressure at least 20% in excess of the hose design pressure and so that there will be no leakage when connected.
(d) Provision shall be made to prevent damage to piping due to thermal expansion and contraction, jarring, and vibration. Slip joints shall not be used for this purpose.
(e) Piping and fittings shall be grouped in the smallest practicable space and be protected from damage as required by the specification.
(f) All piping, valves, and fittings on every tank shall be proved free from leaks at not less than the

design pressure for the tank. This condition will be considered to have been met when such piping, valves, and fittings have been tested for leakage with gas or air after installation and proved tight at not less than the design pressure marked on the tank with which they are used. In the event of replacement, all such piping, valves, or fittings so replaced shall be tested in accordance with the requirements of this Clause before the tank is returned to transportation service. These requirements shall apply to all hose used on such tanks, except that such hose may be so tested either before or after installation on the tank.

(g) Liquid pumps or gas compressors, wherever used, shall be of suitable design, adequately protected against breakage by collisions, and kept in good condition. They may be driven by road vehicle power takeoff or other mechanical, electrical, or hydraulic means. Unless they are of the centrifugal type, they shall be equipped with suitable pressure-actuated bypass valves permitting flow from discharge to suction or to the tank.

### 5.2.1.2

Highway tanks, other than Specification TC 338 and TC 341 tanks designed to transport liquefied compressed gases, except carbon dioxide, shall conform to the following:

(a) Each tank outlet shall be provided with an approved suitable automatic excess-flow valve or shall be fitted with an approved automatic quick-closing internal valve. These valves shall be located inside the tank or at a point outside the tank where the line enters or leaves the tank. The valve seat shall be located inside the tank or shall be located within a welded flange or its companion flange, or within a nozzle, or within a coupling. The installation shall be made in such a manner as to reasonably assure that any undue strain which causes failure requiring functioning of the valve shall cause failure in such a manner that it will not impair the operation of the valve. Any liquid level gauging device which is constructed so that the outward flow of tank contents does not exceed that passed by a 1.5 mm (0.060 in) diameter opening, or any safety device connection, is not required to be equipped with an excess-flow valve.

(b) Each excess-flow valve shall close automatically at the rated flow of gas or liquid as specified by the valve manufacturer. The flow rating of the piping, fittings, valves, and hose on each side of the excess-flow valve shall be greater than that of the excess-flow valve. If branching or any other restriction is incorporated in the system so that the flow rating is less than that of the excess-flow valve at the tank, additional excess-flow valves shall be located where the flow rates are reduced.

(c) An excess-flow valve may be designed with a bypass, not to exceed 1.0 mm (0.040 in) diameter opening, to allow equalization of pressures.

(d) Each filling and discharge line shall be provided with a manual shut-off valve located as close to the tank as practicable. However, when an internal shut-off valve that closes automatically is used, a manual shut-off valve shall be located in the line ahead of the hose connection. The use of a so-called "stop-check" or excess-flow valve to satisfy this requirement with one valve is prohibited except as provided in §178.337-11(c).

## 5.2.2 Gauging Devices

### 5.2.2.1

Highway tanks for the transport of compressed gases, except those filled by weight, shall be equipped with one or more gauging devices which indicate accurately the maximum permitted liquid level. Additional gauging devices may be installed but may not be used as primary controls for filling of highway tanks. Gauge glasses are not permitted on highway tanks.

### 5.2.2.2

If the primary gauging device is adjustable, it shall be capable of adjustment so that the end of the tube will be in the location specified in Clause 5.2.2.3 for at least one of the ladings to be transported, at the filling level corresponding to an average loading temperature. Exterior means shall be provided to indicate this adjustment. The gauging device shall be legibly and permanently marked in increments not exceeding 11°C (20°F) (or not exceeding 112 kPa (25 psig) on tanks for carbon dioxide or nitrous oxide), to indicate the maximum levels to which the tank may be filled with liquid at temperatures above −8°C (20°F). However, if it is not practicable to so mark the gauging device, this information shall be legibly and permanently marked on a plate affixed to the tank adjacent to the gauging device.

### 5.2.2.3

A dip tube gauging device shall consist of a pipe or tube with a valve at its outer end with its intake limited by an orifice not larger than 1.5 mm (0.060 in) in diameter. If a fixed-length dip tube is used, the intake shall be located midway of the tank both

longitudinally and laterally and at maximum permitted filling level. In tanks for liquefied petroleum gases, the intake shall be located at the level reached by the lading when the tank is loaded to maximum filling density at 5°C (40°F).

### 5.2.2.4

Each valve shall be arranged to discharge upward or sideways and unobstructed to the outside of the protective housing to prevent any impingement of escaping gas upon the tank.

## 5.2.3 Safety Relief Devices

### 5.2.3.1

Each tank shall be provided with one or more safety relief devices which, unless otherwise specified, shall be safety relief valves of the spring-loaded type. Each valve shall be arranged to discharge upward or sideways and unobstructed to the outside of the protective housing to prevent any impingement of escaping gas upon the tank.

### 5.2.3.2

Safety relief valves on each tank shall have a total relieving capacity as determined by the flow formulas contained in CGA Pamphlet S-1.2. Safety relief valves shall have a total relieving capacity sufficient to prevent a maximum pressure in the tank of more than 120% of the design pressure. For an insulated tank the required relieving capacity of the relief valves shall be the same as for an uninsulated tank, unless the insulation will remain in place and will be effective under fire conditions. In this case, each insulated tank shall be covered by a sheet metal jacket of not less than 1.6 mm (16 gauge) thickness.

### 5.2.3.3

Each safety relief valve shall be arranged to minimize the possibility of tampering. If the pressure setting or adjustment is external to the valve, the safety relief valve shall be provided with means for sealing the adjustment and it shall be sealed.

### 5.2.3.4

Each safety relief valve on a tank shall be set to start to discharge at a pressure no higher than the tank design pressure and no lower than the design pressure specified in CSA Standard B622 for the gas transported.

### 5.2.3.5

Each safety relief valve shall be plainly and permanently marked with the pressure in kPa (psig) at which it is set to discharge, with the actual rate of discharge of the device in $m^3$ ($ft^3$)/min of the gas or of air at 15°C (60°F) and 100 kPa (14.7 psia), and with the manufacturer's name or trade name and catalogue number. The start-to-discharge value shall be visible after the valve is installed. The rated discharge capacity of the device shall be determined at a pressure of 120% of the design pressure of the tank.

### 5.2.3.6

Each safety relief valve shall have direct communication with the vapor space in the tank.

### 5.2.3.7

Each connection to a safety relief valve shall be of sufficient size to provide the required rate of discharge through the safety relief valve.

### 5.2.3.8

No shut-off valve may be installed between a safety relief valve and the tank except in cases where two or more safety relief valves are installed on the same tank, and one or more safety shut-off valves are arranged to always provide the required relief capacity through at least one of the safety relief valves.

### 5.2.3.9

Each safety relief valve outlet shall be provided with a protective device to prevent the entrance and accumulation of dirt and water. This device shall not impede flow through the valve.

### 5.2.3.10

Each portion of connected liquid piping or hose than can be closed at both ends shall be provided with a safety relief valve without an intervening shut-off valve to prevent excessive hydrostatic pressure that could burst the piping or hose.

## 5.3 Specification TC 331 Highway Tanks

(Reproduced from CFR, Title 49 (see Clause 4.4).)

**§178.337 Specification MC 331: cargo tanks constructed of steel, primarily for transportation of compressed gases as defined in the Compressed Gas Section.**

**§178.337-1 General requirements.**

(a) *ASME Code construction.* Tanks must be seamless or welded steel construction or a combination of both and must be designed and constructed in accordance with and fulfill the requirements of the ASME Code. Each tank must also meet the following additional requirements.

(b) *Design pressure.* The design pressure of a tank authorized under this specification shall be not less than the vapor pressure of the commodity contained therein at 115°F or as prescribed for a particular commodity in CSA Standard B622, except that in no case shall the design pressure of any tank be less than 100 psig nor more than 500 psig.

NOTE 1: *The term "design pressure" as used in this specification, is identical to the term "maximum allowable working pressure" as used in the ASME Code.*

(c) *Openings.* (1) Excess pressure relief valves shall be located in the top of the tank or heads.

(d) *Reflective design.* Every uninsulated tank permanently attached to a motor vehicle shall, unless it be covered with a jacket made of aluminum, stainless steel, or other bright nontarnishing metal, be painted a white, aluminum or similar reflecting color on the upper two-thirds of area of the tank.

(e) *Insulation.* See CSA Standard B622.

(f) *Postweld heat treatment.* Postweld heat treatment must be as prescribed in the ASME Code except that each tank constructed in accordance with Part UHT of the ASME Code must be postweld heat treated. Each chlorine tank must be fully radiographed and postweld heat treated in accordance with the provisions of the ASME Code under which it is constructed. Where postweld heat treatment is required, the tank must be treated as a unit after completion of all the welds in and/or to the shells and heads. The method must be as prescribed in the ASME Code. Welded attachments to pads may be made after postweld heat treatment. A tank used for anhydrous ammonia must be postweld heat treated. The postweld heat treatment must be as prescribed in the ASME Code, but in no event at less than 1050°F tank metal temperature.

**§178.337-2 Material.**

(a) *General.* (1) All material used for construction of the tank and appurtenances must be suitable for use with the commodities to be transported therein and must comply with the requirements of the ASME Code and/or requirements of the American Society for Testing and Materials in all respects.

(2) Impact tests are required on steel used in fabrication of each tank constructed in accordance with Part UHT of the ASME Code. The tests must be made on a lot basis. A lot is defined as 100 tons or less of the same heat treatment processing lot having a thickness variation no greater than plus or minus 25 percent. The minimum impact required for full size specimens must be 20 foot-pounds in the longitudinal direction at −30°F, Charpy V-Notch and 15 foot-pounds in the transverse direction at −30°F, Charpy V-Notch. The required values for subsize specimens must be reduced in direct proportion to the cross-sectional area of the specimen beneath the notch. If a lot does not meet this requirement, individual plates may be accepted if they individually meet this requirement.

(3) The fabricator shall record the heat, and slab numbers, and the certified Charpy impact values, where required, of each plate used in each tank on a sketch showing the location of each plate in the shell and heads of the tank. Copies of each sketch shall be provided to the owner and retained for at least five years by the fabricator.

(4) The direction of final rolling of the shell material shall be the circumferential orientation of the tank shell.

**§178.337-3 Thickness of tank metal.**

(a) Tank metal thickness must be as required by the ASME Code and paragraph (b) of this section, except that metal of thickness less than three-sixteenths inch may not be used for the shell or heads.

(b) The minimum thickness of metal in the tank shell must be such that at no point therein will the stress on a plane normal to the cylindrical axis exceed 25 percent of the minimum specified tensile strength of the metal. For purposes of this requirement, calculation must be made by the formula:

$$S = (T/2) + [(T^2/4) + S_s^2]^{0.5}$$

where, at any given point under consideration and for the worst combination of loadings:

S = Effective stress as limited by this requirement:

T = The sum of the longitudinal tensile stresses due to internal pressure and other causes, including direct tensile stress due to a

rearward accelerative force equal to twice the static weight, tensile stress due to the bending moment of a rearward accelerative force equal to twice the static weight, applied at the road surface, and tensile flexure stress due to three times the static weight in vertical loading; and

$S_s$ = The vectorial sum of the shear stresses in the plane in question, including direct vertical shear due to three times the static vertical loading, direct lateral shear due to a lateral accelerative force of twice the static weight, and torsional shear due to a lateral accelerative force equal to twice the static weight, applied at the road surface. Maximum concentrated stresses which might be created at pads and cradles due to shear, bending, and torsion shall also be calculated in accordance with appendix G of the ASME Code.

NOTE 1: *The forces, loads, and stresses concerned in the foregoing requirement relate to the weight of the tank itself, its contents, and articles supported by the tank, not including the weight of structures supporting the tank in normal operating condition. The stresses involved are not all uniform through the length of the tank shell.*

(c) Where any tank support is attached to any part of a tank head, the stresses imposed upon the head must be as required in paragraph (b) of this section with respect to maximum concentrated stresses at pads and cradles.

**§178.337-4 Joints.**

(a) Joints shall be as required by the ASME Code, with all undercutting in shell and head material repaired as specified therein.

(b) Welding procedure and welder performance tests must be made annually in accordance with Section IX of the ASME Code. In addition to the essential variables named therein, the following must be considered as essential variables: Number of passes; thickness of plate; heat input per pass; and manufacturer's identification of rod and flux. When fabrication is done in accordance with Part UHT of the ASME Code, filler material containing more than 0.08 percent vanadium must not be used. The number of passes, thickness of plate, and heat input per pass may not vary more than 25 percent from the procedure or welder qualifications. Records of the qualifications must be retained for at least 5 years by the tank manufacturer.

(c) All longitudinal shell welds shall be located in the upper half of the tank.

(d) Edge preparation of shell and head components may be by machine heat processes, provided such surfaces are remelted in the subsequent welding process. Where there will be no subsequent remelting of the prepared surface as in a tapered section, the final 0.050 inch of material shall be removed by mechanical means.

(e) The maximum tolerance for misalignment and butting up shall be in accordance with the ASME Code.

(f) Substructures shall be properly fitted before attachment, and the welding sequence shall be such as to minimize stresses due to shrinkage of welds.

**§178.337-5 Bulkheads, baffles and ring stiffeners.**

(a) Not a specification requirement.

**§178.337-6 Closure for manhole.**

(a) Each tank constructed in accordance with Part UHT of the ASME Code and other tanks above 3,500 gallons water capacity must be provided with a manhole conforming to paragraph UG-46(g)(1) and other requirements of the ASME Code.

(b) The manhole assembly of cargo tanks constructed after June 30, 1979, may not be located on the front head of the tank.

**§178.337-7 Overturn protection.**

(a) See §178.337-10.

**§178.337-8 Outlets.**

(a) *Outlets generally.* (1) An opening shall be provided on each tank used for the transportation of liquefied materials to afford complete drainage.

(2) With the exception of gauging devices, thermometer wells, and safety relief valves, every opening in every tank used for the transportation of compressed gases other than carbon dioxide shall be (i) closed with a plug, cap, bolted flange, or plate or (ii) protected with an excess flow valve or back flow check valve (see §178.337-11(a)) or (iii) be fitted with a remote control valve as specified in §178.337-11(c).

**§178.337-9 Safety relief devices, valves and connections.**

(a) *Safety relief valves.*

(3) Each valve must be designed, constructed, and marked for a rated pressure not less than the tank design pressure at the temperature expected to be encountered.

(c) *Marking inlets and outlets.* All tank inlets and outlets, except safety relief valves, shall be marked to designate whether they communicate with vapor or liquid when the tank is filled to the maximum permitted filling density.

(d) *Refrigeration and heating coils.* (1) Refrigeration and heating coils, when installed in any tank, shall be securely anchored with provision for thermal expansion. They shall be tested externally to at least the tank test pressure, and internally to at least the tank test pressure or at least twice the working pressure of the heating or refrigeration system, if higher, and the tank shall not be placed in or returned to transportation service if any leakage or other evidence of damage is found in these tests. The refrigerant or heating medium to be circulated through the coils must be such as to cause no adverse chemical reaction with the tank or tank contents in case of leakage.

(2) Where any liquid susceptible to freezing, or the vapor of any such liquid, is used for heating or refrigeration, the heating or refrigeration system shall be arranged to permit complete drainage.

**§178.337-10 Protection of fittings.**

(a) All valves, fittings, safety relief devices, and other accessories to the tank proper shall be protected in accordance with paragraph (b) of this section against such damage as could be caused by collision with other vehicles or objects, jackknifing and overturning. In addition, safety relief valves shall be so protected that in the event of overturn of the vehicle onto a hard surface, their opening will not be prevented and their discharge will not be restricted.

(b) The protective devices or housing must be designed to withstand static loading in any direction equal to twice the weight of the tank and attachments when filled with the lading, using a safety factor of not less than four, based on the ultimate strength of the material to be used, without damage to the fittings protected, and must be made of metal at least 3/16 inch thick.

(d) Each cargo tank shall be provided with at least one rear bumper designed to protect the tank and piping in the event of a rear end collision and to minimize the possibility of any part of the colliding vehicle striking the tank. The design shall be such as to transmit the force of a rear end collision in a horizontal line to the chassis of the vehicle. The bumper shall be designed to withstand the impact of the fully loaded vehicle with a deceleration of 2 "g", using a safety factor of four based on the ultimate strength of the bumper material. The bumpers shall conform dimensionally to Clause 5.1.3.

**§178.337-11 Emergency discharge control.**

(a) *Excess flow valves and back flow check valves.* (1) Where used as required in §178.337-8(a) (2) excess flow valves or back flow check valves shall be located inside the tank or inside a welded nozzle which is an integral part of the tank.

(2) Excess flow valves must be in conformance with §173.33(h) of this subchapter.

(c) *Liquid or vapor discharge openings.* Each liquid or vapor discharge opening in a tank intended to be used for a flammable liquid; flammable compressed gas; hydrogen chloride, refrigerated liquid; or anhydrous ammonia, must be equipped with a remotely controlled internal shut-off valve. However, on any liquid or vapor discharge opening of less than 1-1/4 inches NPT, an excess flow valve together with a manually operated external valve may be used in place of a remotely controlled internal shut-off valve. The requirements of this paragraph do not apply to a liquid or vapor discharge opening 1-1/4 inch NPT equipped with an excess flow valve together with a manually operated external valve before October 1, 1984, or to an engine fuel line on a truck-mounted tank of not over 3/4 inch NPT and equipped with a valve having an integral excess flow valve. Each remotely controlled internal valve must comply with the following requirements:

(1) The seat of the valve shall be inside the tank, or in the opening nozzle or flange or in a companion flange bolted to the nozzle or flange.

(2) All parts of the valve inside the tank, nozzle, or companion flange, shall be made of material not subject to corrosion or other deterioration in the presence of the lading.

(3) The arrangement of parts shall be such that damage to parts exterior to the tank will not prevent effective seating of the valve.

(4) The valve may be operated normally by mechanical means, by hydraulic means, or by air, or gas pressure.

(5) On a tank over 3,500 gallons water capacity, each internal shut-off valve must be provided with remote means of automatic closure, both mechanical and thermal, that are installed at the ends of the tank in at least two, diagonally opposite locations. If the discharge connection at the tank is not in the general vicinity of one of the two locations specified

above, one additional fusible element must be installed so that heat from a fire in that area will activate the emergency control system. Fusible elements may not have a melting point exceeding 250°F.

(6) On a tank of 3,500 gallons water capacity or less, each internal shut-off valve must be provided with at least one remote control station, and the actuating means may be mechanical. This station must be at one end of the tank, away from the discharge connection area.

**§178.337-12 Shear section.**

(a) Design or installation of valves specified in §178.337-8(a)(2) shall provide adjacent to and outboard of such valves a section which will break under undue strain.

**§178.337-13 Supporting and anchoring.**

(a) A cargo tank that is not permanently attached to or integral with a vehicle chassis must be secured by turnbuckles or equally efficient securing devices for drawing the tank down tight on the frame. Anchors, stops, or other means must be provided to prevent relative motion between the tank and the vehicle chassis when the vehicle is in operation.

(b) A cargo tank designed and constructed so that the cargo tank constitutes in whole or in part the stress member used in place of a frame must have the tank supported by external cradles. A cargo tank mounted on a frame must be supported by external cradles or longitudinal members. The cradles, where used, must subtend at least 120 degrees of the shell circumference. The design calculations for the supports must include beam stress, shear stress, torsion stress, bending moment, and acceleration stress, for the loaded vehicle as a unit, using a factor of safety of 4, based on the ultimate strength of the material and on a 2 "g" longitudinal and lateral loading and 3 times the static weight in vertical loading (see Appendix G of the ASME Code).

(c) Where any tank support is attached to any part of a tank head, the stresses imposed upon the head shall be provided for as required in paragraph (b) of this section.

(d) No tank support or bumper may be welded directly to the tank. All supports and bumpers shall be attached by means of pads of the same material as the tank. The pad thickness shall be no less than 1/4 inch, or the thickness of the shell material if less, and no greater than the shell material. Each pad shall extend at least 4 times its thickness, in each direction, beyond the weld attaching the support or bumper. Each pad shall be preformed to an inside radius no greater than the outside radius of the tank at the place of attachment. Each pad corner shall be rounded to a radius at least one-fourth the width of the pad, and no greater than one-half the width of the pad. Weep holes and telltale holes, if used, shall be drilled or punched before the pads are attached to the tank. Each pad shall be attached to the tank by continuous fillet welding, using filler material having properties conforming to the recommendations of the maker of the shell and head material.

**§178.337-16 Testing.**

(a) *Inspection and tests.* Inspection of materials of construction of the tank and its appurtenances and original test and inspection of the finished tank and its appurtenances must be as required by the ASME Code and as further required by this specification except that for tanks constructed in accordance with Part UHT of the ASME Code the original test pressure must be at least twice the tank design pressure.

(b) *Weld testing and inspection.* (1) Each tank constructed in accordance with Part UHT of the ASME Code must be subjected, after postweld heat treatment and hydrostatic tests, to a wet fluorescent magnetic particle inspection to be made on all welds in or on the tank shell and heads both inside and out. The method of inspection must conform to Appendix 6 of the ASME Code, paragraphs 6-1 through 6-4, except that permanent magnets shall not be used.

(2) On tanks of over 3,500 gallons water capacity other than those described in paragraph (b)(1) of this section unless fully radiographed, a test must be made of all welds in or on the shell and heads both inside and outside by either the wet fluorescent magnetic particle method conforming to Appendix 6 of the ASME Code, liquid dye penetrant method, or ultrasonic testing in accordance with Appendix U of the ASME Code. Permanent magnets must not be used to perform the magnetic particle inspection.

(c) All defects found shall be repaired, the tanks shall then again be postweld heat treated, if such heat treatment was previously performed, and the repaired areas shall again be tested.

**§178.337-17 Marking.**

(a) *Metal identification plate.* Each tank built after July 1, 1985 shall have a corrosion resistant

metal plate permanently affixed by brazing or welding around its perimeter, on the left side (on the right side prior to July 1, 1985) near the front, in a place readily accessible for inspection. It must be maintained in a legible condition. On multitank vehicles plates shall be attached to each tank at the front in a place readily accessible for inspection. Each insulated tank shall have an additional plate, as described, affixed to the jacket in the location specified. Neither the plate itself nor the means of attachment to the tank or jacket may be subject to attack by the tank contents. If the plate is attached directly to the tank by welding it shall be welded thereto before the tank is postweld heat treated. The plate shall be plainly marked by stamping, embossing, or other means of forming letters into the metal of the plate, with the following information in addition to that required by the ASME Code, in characters at least 3/8 inch high:

Vehicle manufacturer.
Vehicle manufacturer's serial number.
D.O.T. specification number MC-331.
Vessel material specification number.
Water capacity (mass).
Original test date.
Maximum product load.

**Note:** *See also Clause 3.3.*

(b) Each specification MC 330, MC 331, or TC 331 tank shall be marked "QT" or "NQT" as applicable to indicate that the tank is constructed of quenched and tempered steel (QT) or other than quenched and tempered steel (NQT). These markings shall be placed near the specification identification plate in letters not less than 50 mm (2 in) in height.

## 5.4 Specification TC 338 Highway Tanks

(Reproduced from CFR, Title 49 (see Clause 4.4).)

### §178.338 Specification MC-338; Insulated Cargo Tank

### §178.338-1 General requirements.

(a) For the purposes of this section—

(1) "*Design pressure*" means the "maximum allowable working pressure" as used in the ASME Code, and is the gauge pressure at the top of the tank.

(2) "*Design service temperature*" means the coldest temperature for which the tank is suitable. (See CSA Standard B622.)

(b) Each cargo tank must consist of a suitably supported welded inner vessel enclosed within an outer shell or jacket, with insulation between the inner vessel and outer shell or jacket, and having piping, valves, supports and other appurtenances as specified in this subchapter. For the purpose of this specification, "tank" means inner vessel and "jacket" means either the outer shell or insulation cover.

(c) Each tank must be designed and constructed to meet the requirements of the ASME Code.

(1) The design pressure of the tank must be at least 25.3 psig but not more than 500 psig. To determine the required thicknesses of the parts of the tank, the static head of the lading shall be added to the design pressure. If the jacket is evacuated, the tank must be designed for a pressure of 14.7 psi, plus the lading static head, higher than its "design pressure". The jacket must be designed in accordance with paragraph (e) or (f) of this section, as appropriate.

(2) The design service temperature of the tank, piping and valves may not be warmer than the liquefaction temperature at one atmosphere of the lading to be transported. (See CSA Standard B622.)

(3) Design and construction details of the tank interior may not allow collection and retention of cleaning materials or contaminants. To preclude the entrapment of foreign material, the design and construction of the tank must allow washing of all interior surfaces by the normal surging of the lading during transportation.

(d) The exterior surface of the tank must be insulated with a material compatible with the lading.

(1) Each cargo tank must have an insulation system that will prevent the tank pressure from exceeding the pressure relief valve set pressure within the specified holding time when the tank is loaded with the specific cryogenic liquid at the design conditions of—

(i) The specified temperature and pressure of the cryogenic liquid, and

(ii) The exposure of the filled highway tank to an average ambient temperature of 85°F.

(2) For a cargo tank used to transport oxygen, the insulation may not sustain combustion in a 99.5% oxygen atmosphere at atmospheric pressure when contacted with a continuously heated glowing platinum wire. The cargo tank must be marked in accordance with §178.338-18(b)(7).

(3) Each vacuum-insulated cargo tank must be provided with a connection for a vacuum gauge to indicate the absolute pressure within the insulation space.

(e) The insulation must be completely covered by a metal jacket. The jacket or the insulation must be so constructed and sealed as to prevent moisture from coming into contact with the insulation (see CSA Standard B622). Minimum metal thicknesses are as follows:

| | Jacket evacuated | | Jacket not evacuated | |
|---|---|---|---|---|
| Type metal | Gauge | Inches | Gauge | Inches |
| Stainless steel | 18 | 0.0428 | 22 | 0.0269 |
| Low carbon mild steel | 12 | 0.0946 | 14 | 0.0677 |
| Aluminum | | 0.1250 | | 0.1000 |

(f) An evacuated jacket must be in compliance with the following requirements:

(1) The jacket must be designed to sustain a minimum critical collapsing pressure of 30 psi.

(2) If the jacket also supports additional loads, such as the weight of the tank and lading, the combined stress, computed according to the formula in §178.338-3(b), may not exceed 25% of the minimum specified tensile strength.

**§178.338-2 Material.**

(a) All material used in the construction of a tank and its appurtenances that may come in contact with the lading must be compatible with the lading to be transported. All material used for tank pressure parts must conform to the requirements of the ASME Code. All material used for evacuated jacket pressure parts must conform to the chemistry and steelmaking practices of one of the material specifications of Section II of the ASME Code or the following ASTM Specifications: A 242, A 441, A 514, A 572, A 588, A 606, A 607, A 633, A 715.

(b) All tie rods, mountings, and other appurtenances within the jacket and all piping, valves and fittings must be of a material suitable for use at the lowest temperature to be encountered.

(c) Impact tests are required on all tank materials, except aluminum, and must be performed using the procedure prescribed in the ASME Code.

(d) The direction of final rolling of the shell material must be the circumferential orientation of the tank shell.

(e) Each tank constructed in accordance with Part UHT of the ASME Code must be postweld heat treated as a unit after completion of all welds to the shell and heads. Other tanks must be postweld heat treated as required by the ASME Code. For all tanks the method must be as prescribed in the ASME Code. Welded attachments to pads may be made after postweld heat treatment.

(f) The fabricator shall record the heat and slab numbers and the certified Charpy impact values of each plate used in the tank on a sketch showing the location of each plate in the shell and heads of the tank. A copy of the sketch must be provided to the owner of the highway tank and a copy must be retained by the fabricator for at least five years.

**§178.338-3 Metal thickness.**

(a) The metal thickness of the tank must be as prescribed in the ASME Code and paragraph (b) of this section. Metal less than 0.187 inch thick may not be used for the shell or heads of a tank unless the tank is enclosed in an evacuated or load-bearing jacket. Metal less than 0.110 inch thick may not be used for the shell or heads of the tank under any circumstances.

(b) The minimum thickness of metal in the shell (cylindrical portion) of the tank must be such that at no point will the stress on a plane normal to the longitudinal axis exceed 25% of the minimum specified tensile strength of the metal. The forces, loads, and stresses considered in this requirement must take into account the weight of the tank itself, its maximum weight of contents, and articles supported by the tank, not including the weight of structures supporting the tank in normal conditions. The stresses involved are not all uniform through the length of the tank. For purposes of this requirement, calculation must be made by the following formula:

$$S = \frac{T}{2} + \left[\frac{T^2}{4} + S_s^2\right]^{0.5}$$

where at any point under consideration and for the worst combination of loadings:

S = Effective stress as limited by this requirement, in psi;

T = The sum of the longitudinal tensile stresses due to external vacuum and internal pressure and other causes, including direct tensile stress due to a rearward acceleration force, tensile stress due to the bending moment of a rearward acceleration force applied at the road surface, and tensile flexure stress using

applicable static loadings specified in paragraphs (b), (e) and (f) of §178.338-13, in psi; and

$S_s$ = The vectorial sum of the shear stresses in the plane in question, including direct vertical shear due to the static vertical loading, direct lateral shear due to a lateral accelerative force, and torsional shear due to a lateral accelerative force, applied at the road surface using applicable static loadings specified in paragraph (b), (e) and (f) of §178.338-13, in psi.

(c) Maximum stress concentrations that may be created at supports due to shear, bending, and torsion must be calculated in accordance with Appendix G of the ASME Code.

(d) Where a tank support is attached to any part of a tank head, the stresses imposed on the head must be in accordance with the requirements in paragraph (c) of this section.

**§178.338-4 Joints.**

(a) All joints in the tank, and in the jacket if evacuated, shall be as prescribed in the ASME Code, except that a butt weld with one plate edge offset is not authorized.

(b) Welding procedure and welder performance tests shall be made in accordance with Section IX of the ASME Code. Records of the qualification shall be retained by the tank manufacturer for at least five years.

(c) All longitudinal welds in tanks and load bearing jackets shall be located so as not to intersect nozzles or supports other than load rings and stiffening rings.

(d) Substructures shall be properly fitted before attachment and the welding sequence shall minimize stresses due to shrinkage of welds.

(e) Filler material containing more than 0.05% vanadium may not be used with quenched and tempered steel.

(f) All tank nozzle-to-shell and nozzle-to-head welds shall be full penetration welds.

**§178.338-5 Stiffening rings.**

(a) A tank is not required to be provided with stiffening rings, except as prescribed in the ASME Code.

(b) If a jacket is evacuated, it must be constructed in compliance with §178.338-1(f). Stiffening rings may be used to meet these requirements.

**§178.338-6 Manholes.**

(a) Each tank in oxygen service shall be provided with a manhole as prescribed in the ASME Code.

(b) Each tank having a manhole shall be provided with a means of entrance and exit through the jacket, or the jacket shall be marked to indicate the manway location on the tank.

(c) A manhole with a bolted closure may not be located on the front head of the tank.

**§178.338-7 Openings.**

(a) The inlet to the liquid product discharge opening of each tank intended for flammable ladings must be at the bottom centerline of the tank.

(b) If the leakage of a single valve, except a pressure relief valve, pressure control valve, full trycock or gas phase manual vent valve, would permit loss of flammable material, an additional closure that is leak tight at the tank design pressure must be provided outboard of such valve.

**§178.338-8 Pressure relief devices, piping, valves, and fittings.**

(a) *Pressure relief devices.* Each tank pressure relief device shall be designed, constructed, and marked in accordance with §173.318(b) of this subchapter.

(b) *Piping, valves, and fittings.*

(1) All piping, valves, and fittings shall be as required by §173.318(b) of this subchapter.

(2) Each valve shall be suitable for the tank design pressure at the tank design service temperature.

(3) All fittings shall be rated for the maximum tank pressure and suitable for the coldest temperature to which they will be subjected in actual service.

(4) All piping, valves and fittings shall be grouped and protected from damage as required by §178.338-10.

(5) When a pressure-building coil is used on a tank designed to handle oxygen or flammable ladings, the vapor connection to that coil shall be provided with a valve or check valve as close to the tank as practicable to prevent the loss of vapor from the tank in case of damage to the coil. The liquid connection to that coil shall also be provided with a valve.

**§178.338-9 Holding time.**

(a) "Holding time" is the time, as determined by testing, that will elapse from loading until the pressure of the contents, under equilibrium conditions, reaches the level of the lowest pressure control valve or pressure relief valve setting.

(b) *Holding time test.*

(1) The test to determine holding time shall be performed by charging the tank with a cryogenic liquid having a boiling point, at a pressure of one atmosphere, absolute, no lower than the design service temperature of the tank. The tank shall be charged to its maximum permitted filling density with that liquid and stabilized to the lowest practical pressure, which shall be equal to or less than the pressure to be used for loading. The cargo tank together with its contents shall then be exposed to ambient temperature.

(2) The tank pressure and ambient temperature shall be recorded at 3-hour intervals until the pressure level of the contents reaches the set-to-discharge pressure of the pressure control valve or pressure relief valve with the lowest setting. This total time lapse in hours represents the measured holding time at the actual average ambient temperature. This measured holding time for the test cryogenic liquid shall be adjusted to an equivalent holding time for each cryogenic liquid that is to be identified on or adjacent to the specification plate, at an average ambient temperature of 85°F. This is the rated holding time (RHT). The marked rated holding time (MRHT) displayed on or adjacent to the specification plate (see §178.338-18(b)(9)) may not exceed this RHT.

(c) *Optional test regimen.*

(1) If more than one cargo tank is made to the same design, only one cargo tank shall be subjected to the full holding time test at the time of manufacture. However, each subsequent cargo tank made to the same design shall be performance tested during its first trip. The holding time determined in this test may not be less than 90% of the marked rated holding time. This test shall be performed in accordance with CSA Standard B622, regardless of the classification of the cryogenic liquid.

(2) *Same design.* The term "same design" as used in this section means cryogenic highway tanks made—

(i) By the same manufacturer;

(ii) To the same engineering drawings, and calculations;

(iii) To the same dimensions of length, diameter, and volume;

(iv) Of the same materials of construction; and

(v) With the same insulation system.

(3) For a cargo tank used in nonflammable cryogenic liquid service, in place of the holding time tests prescribed in paragraph (b) of this section, the marked rated holding time (MRHT) may be determined as follows:

(i) While the cargo tank is stationary, the heat transfer rate must be determined by measuring the normal evaporation rate (NER) of the test cryogenic liquid (preferably the lading, where feasible) maintained at approximately one atmosphere. The calculated heat transfer rate shall be determined from:

$$q = [n(\Delta h)(85 - t_1)]/[t_s\, t_f]$$

Where:

$q$ = calculated heat transfer rate to cargo tank with lading, Btu/hr.

$n$ = normal evaporation rate (NER), which is the rate of evaporation, determined by the test of a test cryogenic liquid in a cargo tank maintained at a pressure of approximately one atmosphere, absolute, lb/hr.

$\Delta h$ = latent heat of vaporization of test fluid at test pressure, Btu/lb.

$t_s$ = average temperature of outer shell during test, °F.

$t_1$ = equilibrium temperature of lading at maximum loading pressure, °F.

$t_f$ = equilibrium temperature of test fluid at one atmosphere, °F.

(ii) The rated holding time (RHT) must be calculated as follows:

$$RHT = [(U_2 - U_1)W]/q \qquad (2.2)$$

Where:

RHT = rated holding time, in hours

$U_1$ and $U_2$ = internal energy for the combined liquid and vapor lading at the pressure offered for transportation, and the set pressure of the applicable pressure control valve or pressure relief valve, respectively, Btu/lb.

$W$ = total weight of the combined liquid and vapor contents in the tank, pounds.

$q$ = calculated heat transfer rate to cargo tank with lading, Btu/hr.

(iii) The MRHT (see §178.338-18(b)(9) of this subchapter) may not exceed the RHT.

**§178.338-10 Collision damage protection.**

(a) All valves, fittings, pressure relief devices and other accessories to the tank proper, which are not isolated from the tank by closed intervening shut-off valves or check valves, shall be installed within the motor vehicle framework or within a suitable collision resistant guard or housing, and appropriate ventilation shall be provided. Each pressure relief device

must be protected so that in the event of the upset of the vehicle onto a hard surface, the device's opening will not be prevented and its discharge will not be restricted.

(b) Each protective device or housing, and its attachment to the vehicle structure, shall be designed to withstand static loading in any direction that it may be loaded as a result of front, rear, side, or sideswipe collision, or the overturn of the vehicle. The static loading shall equal twice the loaded weight of the tank and attachments. A safety factor of four, based on the tensile strength of the material shall be used. The protective device or the housing shall be made of steel at least 3/16 in thick, or other material of equivalent strength.

(c) Each tank motor vehicle shall be provided with at least one rear bumper designed to protect the cargo tank and piping in the event of a rear end collision. The bumper design shall transmit the force of the collision directly to the chassis of the vehicle. The rear bumper and its attachments to the chassis shall be designed to withstand a load equal to twice the weight of the loaded cargo tank and attachments, using a safety factor of four based on the tensile strength of the materials used, with such load being applied horizontally and parallel to the major axis of the cargo tank, or within 30 horizontal degrees thereof. The rear bumper dimensions shall meet the requirements of Clause 5.1.3 and extend vertically to a height adequate to protect all valves and fittings located at the rear of the cargo tank from damage that could result in loss of lading.

(d) Every part of the loaded cargo tank, and any associated valve, pipe, enclosure, or protective device or structure (exclusive of wheel assemblies), shall be at least 14 inches above level ground.

**§178.338-11 Discharge control devices.**

(b) Each liquid filling and liquid discharge line shall be provided with a shut-off valve located as close to the tank as practicable. Unless this valve is manually operable at the valve, the line shall also have a manual shut-off valve.

(c) Each liquid filling and liquid discharge line on a highway tank intended for service transporting a flammable lading shall be provided with a remotely controlled shut-off valve. If pressure from a reservoir or from an engine driven pump or compressor is used to open this valve, the control shall be of fail-safe design, spring-biased to stop the admission of such pressure. If the jacket is not evacuated, the seat of the valve shall be inside the tank, in the opening nozzle or flange, or in a companion flange bolted to the nozzle. If the jacket is evacuated, the remotely controlled valve shall be located as close to the tank as practicable.

(1) On a highway tank with a capacity in excess of 3,500 gallons of water, each remotely controlled shut-off valve shall be provided with remote means of automatic closure, both mechanical and thermal, installed at the ends of the cargo tank in at least two diagonally opposite locations. The thermal means shall consist of fusible elements actuated at a temperature not exceeding 250°F, or equivalent devices. One means may be used to close more than one remotely controlled valve.

(2) On a cargo tank with a capacity of 3,500 gallons of water or less, each remotely controlled shut-off valve shall be provided with at least one remote control station on the end of the cargo tank opposite the main control station. The remote control station shall contain a manual means of closure. In addition, it may contain fusible elements actuated at a temperature not exceeding 250°F, or equivalent devices. One means may be used to close more than one remotely controlled valve.

**§178.338-12 Shear section.**

Unless the valve is located in a rear cabinet forward of and protected by the bumper (see §178.338-10(c)), the design and installation of each valve, damage to which could result in loss of liquid or vapor, shall incorporate a shear section or breakage groove adjacent to, and outboard of, the valve. The shear section or breakage groove shall yield or break under strain without damage to the valve that would allow the loss of liquid or vapor. The protection specified in §178.338-10 is not a substitute for a shear section or breakage groove.

**§178.338-13 Supports and anchoring.**

(a) All attachments of supports and bumpers to tanks and to load-bearing jackets shall be made by means of pads of material similar to that of the tank or jacket, by load rings, or by bosses designed or gusseted to distribute the load. The pad shall be at least 1/4 inch thick, or as thick as the tank or jacket material, if less, but shall in no case be thicker than the tank or jacket material. Each pad shall extend at least four times its thickness, in each direction, beyond the weld attaching the support or bumper. Each pad shall be preformed to an inside radius no greater than the outside radius of the tank or jacket

at the place of attachment. Each pad corner shall be rounded to a radius at least one-fourth the width of the pad and no greater than one-half the width of the pad. If weep holes or telltale holes are used, they shall be drilled or punched before the pads are attached. Each pad shall be attached to the tank or jacket by continuous fillet welding using filler material having properties conforming to the recommendations of the manufacturer of the tank or jacket material. Any fillet weld discontinuity may only be for the purpose of preventing an intersection between the fillet weld and a tank or jacket seam weld.

(b) A tank motor vehicle constructed so that the cargo tank shell constitutes in whole or in part the structural member used in place of a motor vehicle frame must have the tank or the jacket supported by external cradles or by load rings. A cargo tank mounted on a motor vehicle frame shall have the tank or jacket supported by external cradles, load rings, or longitudinal members. If cradles are used, they shall subtend at least 120° of the highway tank circumference. The design calculations for the supports and load bearing tank or jacket, and the support attachments shall include beam stress, shear stress, torsion stress, bending moment, and acceleration stress for the loaded vehicle as a unit, using a safety factor of four, based on the tensile strength of the material, and static loadings that take into consideration the weight of the cargo tank and its attachments when filled to the design weight of the lading (see Appendix G of the ASME Code). The effects of fatigue shall also be considered in the calculations. Minimum static loadings must be as follows:

(1) For a vacuum-insulated highway tank—
(i) Vertically downward of 2;
(ii) Vertically upward of 2;
(iii) Longitudinally of 2; and
(iv) Laterally of 2.
(2) For a nonvacuum-insulated highway tank-
(i) Vertically downward of 3;
(ii) Vertically upward of 2;
(iii) Longitudinally of 2; and
(iv) Laterally of 2.

(c) When a loaded tank is supported within the vacuum jacket by structural members, the design calculations for the tank and its structural members shall be based on a safety factor of four and the tensile strength of the material at ambient temperature. The enhanced tensile strength of the material at actual operating temperature may be substituted for the tensile strength at ambient temperature to the extent recognized in the ASME Code for static loadings. Static loadings shall take into consideration the weight of the tank and the structural members when the tank is filled to the design weight of lading (see Appendix G of the ASME Code). When load rings in the jacket are used for supporting the tank, they shall be designed to carry the fully loaded tank at the specified static loadings, plus external pressure. Minimum static loadings shall be as follows:

(1) Vertically downward of 2;
(2) Vertically upward of 1-1/2;
(3) Longitudinally of 1-1/2; and
(4) Laterally of 1-1/2.

**§178.338-14 Gauging devices.**

(a) *Liquid level gauging devices.*

(1) Unless a cargo tank is intended to be filled by weight, it shall be equipped with one or more gauging devices, which accurately indicate the maximum permitted liquid level at the loading pressure, in order to provide a minimum of 2% outage below the inlet of the pressure control valve or pressure relief valve at the condition of incipient opening of that valve. A fixed-length dip tube, a fixed trycock line, or a differential pressure liquid level gauge shall be used as the primary control for filling. Other gauging devices, except gauge glasses, may be used, but not as the primary control for filling.

(2) The design pressure of each liquid level gauging device shall be at least that of the tank.

(3) If a fixed length dip tube or trycock line gauging device is used, it shall consist of a pipe or tube of small diameter equipped with a valve at or near the jacket and extending into the tank to a specified filling height. The fixed height at which the tube ends in the cargo tank shall be such that the device will function when the liquid reaches the maximum level permitted in loading.

(4) The liquid level gauging device used as a primary control for filling shall be designed and installed to accurately indicate the maximum filling level at the point midway of the tank both longitudinally and laterally.

(b) *Pressure gauges.* Each cargo tank must be provided with a suitable pressure gauge indicating the lading pressure and located on the front of the jacket so it can be read by the driver in the rear view mirror. Each gauge must have a reference mark at the cargo tank design pressure or the set pressure of the pressure relief valve or pressure control valve, whichever is lowest.

(c) *Orifices.* All openings for dip tube gauging devices and pressure gauges in flammable cryogenic liquid service shall be restricted at or inside the jacket by orifices no larger than 0.060 inch diameter. Trycock lines, if provided, may not be greater than 1/2 inch nominal pipe size.

**178.338-15 Cleanliness.**

A highway tank constructed for oxygen service shall be thoroughly cleaned to remove all foreign material in accordance with CGA Pamphlet G-4.1. All loose particles from fabrication, such as weld beads, dirt, grinding wheel debris, and other loose materials, shall be removed prior to the final closure of the manhole of the tank. Chemical or solvent cleaning with a material compatible with the intending lading shall be performed to remove any contaminants likely to react with the lading.

**§178.338-16 Inspection and testing.**

(a) *General.* The material of construction of a tank and its appurtenances shall be checked for conformance to the ASME Code. The tank shall be subjected to either a hydrostatic or pneumatic test.

(b) *Hydrostatic test.* The hydrostatic test pressure shall be one and one-half times the sum of the design pressure, the static head of lading and 101.3 kPa (14.7 psi) if subjected to external vacuum. The hydrostatic test pressure for tanks constructed in accordance with Part UHT of the ASME Boiler and Pressure Vessel Code shall be twice the design pressure of the tank.

(c) *Pneumatic test.* A pneumatic test made at 1.25 times the design pressure may be used in place of the hydrostatic test. Due regard for all personnel should be taken because of the potential hazard involved in a pneumatic test. The pneumatic test pressure in the tank shall be reached by gradually increasing the pressure to one-half of the test pressure. Thereafter, the test pressure shall be increased in steps of approximately one-tenth of the test pressure until the test pressure has been reached. Then the pressure shall be reduced to a value equal to four-fifths of the test pressure and held for a sufficient time to permit inspection of the tank for leaks.

(d) *Weld Inspection.* All tank shell and head welds shall be radiographed in accordance with the ASME Boiler and Pressure Vessel Code. A tank which has been subjected to inspection by the magnetic particle method, the liquid penetrant method, or any method involving a material deposit on the interior tank surface shall be cleaned by scrubbing, or equally effective means, and all such residue and cleaning solution shall be removed from the tank prior to final closure of the tank.

(e) *Defect repair.* All cracks and other defects shall be repaired as prescribed by the ASME Boiler and Pressure Vessel Code. The welder and the welding procedure shall be qualified in accordance with the ASME Boiler and Pressure Vessel Code. After repair, the tank shall again be postweld heat-treated if required by the ASME Boiler and Pressure Vessel Code or, if such heat treatment was previously performed and the tank must be retested.

(f) Verification shall be made of the interior cleanliness of a tank constructed for oxygen service by means that will assure that all contaminants that are likely to react with the lading have been removed as required by §178.338-15.

**§178.338-18 Marking.**

(a) *Nameplate.* Each tank built after July 1, 1985 shall have a corrosion resistant metal plate permanently affixed by brazing or welding around its perimeter, on the left side (on the right side prior to July 1, 1985) near the front. If the plate is attached by welding, it must be welded before the tank is postweld heat-treated. The nameplate shall be plainly marked by stamping, embossing, or other means of forming letters into the metal of the plate, in characters at least 3/8 inch high. The following information, in addition to that required by the ASME Code, shall be included (parenthetical abbreviations may be used):

(1) DOT Specification number MC-338 (DOT MC 338);

(2) Material specification number (Mat. Spec. No.);

(3) Maximum density of lading for which the tank is designed (Max. Dens. of Lading);

(4) Water capacity, in pounds net at 60°F, with the tank at its coldest operating temperature, after deduction for the volume above the inlet to the pressure relief device or pressure control valve, structural members, baffles, piping, and other appurtenances inside the tank (W. Cap.); and

(5) Original test date (Orig. Test Date);

(b) *Specification plate.* Each tank built after July 1, 1985 shall have an additional plate, in the form specified in paragraph (a) of this section. It must be welded, brazed, or riveted to the jacket on the left side (on the right side prior to July 1, 1985) near the front, or at the control station, in a position

readily legible to operating personnel. It must be marked with the information specified in paragraph (a) of this section and in addition, in characters at least 3/8 inch high, the following (parenthetical abbreviations may be used):

(1) Vehicle Manufacturer (Veh. Mfr.);

(2) Manufacturer's vehicle serial number (Veh. No.);

(3) Lining material, if any (Lining);

(4) Date of manufacture (Date of Mfr.);

(5) Certificate date (Cert. Date);

(6) Design service temperature (Design Serv. Temp.);

(7) "Insulation for Oxygen Service" or "Not Authorized for Oxygen Service," as appropriate;

(8) Maximum weight of lading for which the cargo tank is designed, (Max. Net Wt ___);

(9) Marked rated holding time for at least one cryogenic liquid, in hours, and the name of that cryogenic liquid (MRHT ____hrs, name of cryogenic liquid). MRHT markings for additional cryogenic liquids may be displayed on adjacent to the specification plate.

(c) The design weight of lading used in determining the loading in §178.338-3(b), §178.338-10 (b) and (c), and §178.338-13(b) and (c) shall be shown as the maximum weight of lading marking required by paragraph (b) of this section.

**Note:** *See also Clause 3.3.*

### §173.318 Cryogenic Liquids in Cargo Tanks

(b) *Pressure relief devices and pressure control valves.*

(1) General requirements.

(i) Except as otherwise provided in this paragraph, each tank shall be protected by a primary system of one or more pressure relief valves and a secondary system of one or more frangible disks or pressure relief valves. The discharge from any pressure relief system shall be directed upward and unobstructed to the outside of the protective housing in such a manner as to prevent impingement of gas upon the jacket or any structural part of the vehicle. Pressure relief valves shall be of a type that automatically open and close at a predetermined pressure.

(ii) Each pressure relief device shall be designed and constructed for a pressure equal to or exceeding the tank's design pressure at the coldest temperature reasonably expected to be encountered.

(iii) The rated relieving capacity for each pressure relief valve, pressure control valve when used as a pressure relief valve, and frangible disk shall be as determined by the flow formulas contained in paragraph (b)(2)(i) of this section.

(iv) Each pressure relief valve shall be designed and located to minimize the possibility of tampering. If the pressure setting or adjustment is external to the valve, the valve adjustment shall be sealed.

(v) Each pressure relief device shall have direct communication with the vapour space of the tank at the midpoint of the top centerline.

(vi) Each connection to a pressure relief device shall be of sufficient size to allow the required rate of discharge through the pressure relief device.

(vii) No shut-off valve may be installed between a pressure relief device and the tank except when two or more pressure relief valves or two or more frangible disks are installed on the same tank. In that case, one or more shut-off valves may be so installed if the installation is arranged to allow the required relief capacity through at least one pressure relief valve and at least one frangible disk.

(viii) Each pressure relief valve shall be arranged or protected to prevent the accumulation of foreign material between the relief valve and the atmospheric discharge opening in any relief piping. The arrangement or protection shall not impede the flow through the device.

(ix) Each pressure relief device shall be installed and located so that the cooling effects of the contents during venting will not prevent the effective operation of the device.

(2) *Capacity and performance.*

(i) *Capacity of pressure relief systems.*

(A) *Tanks in oxygen or flammable cryogenic liquid service.* The primary system of pressure relief valves and the secondary system of pressure relief devices shall each have a flow capacity equal to or greater than that calculated by the applicable paragraph 5.3.2 or paragraph 5.3.3 of CGA Pamphlet S-1.2.

(B) *Tanks in atmospheric gas (except oxygen) and helium, cryogenic liquid service.* The pressure relief system shall have a flow capacity equal to or greater than that calculated by the applicable formula in paragraph 5.3.2 or 5.3.3 of CGA Pamphlet S-1.2.

(ii) The primary system of pressure relief valves shall have the minimum total capacity specified in paragraph (b)(2)(i) of this section, at a pressure not exceeding 150% of the tank design pressure.

(iv) The primary system of pressure relief valves have a liquid flow capacity rated at a pressure not exceeding 120% of the tank design pressure, that

is equal to or exceeding the maximum rate at which the tank will be filled. However, a rating pressure not exceeding 150% of the tank design pressure is authorized on a tank used in atmospheric gas (except oxygen) and helium, cryogenic liquid service when equipped with the alternate pressure relief system.

(v) Each primary pressure relief valve shall have a set pressure no higher than the tank design pressure.

(vi) The secondary system of pressure relief devices shall be designed to commence functioning at a pressure no lower than 130% and no higher than 150% of the tank design pressure.

(3) *Pressure relief devices for piping, hose and vacuum-insulated jackets.*

(i) Each portion of connected liquid piping or hose that can be closed at both ends shall be provided with either a hydrostatic pressure relief valve without an intervening shut-off valve, or a check valve permitting flow from the pipe or hose into the tank. If used, the relief valve shall be located so as to prevent its discharge from impinging on the tank, piping or operating personnel.

(ii) On a vacuum-insulated highway tank the jacket shall be protected by a suitable relief device to release internal pressure. The discharge area of this device shall be at least 0.00024 $in^2$/lb of water capacity of the tank. The relief device must function at a pressure not exceeding the internal design pressure of the jacket, calculated in accordance with the ASME Code, or 25 psig, whichever is less.

(4) *Optional pressure relief devices and pressure control valves.*

(i) In addition to the required pressure relief devices, a cargo tank may be equipped with one or more pressure control valves if they meet the applicable requirements in this part.

(ii) In addition to the required pressure relief devices, a cargo tank may be equipped with one or more frangible disks set to function at a pressure not less than one and one-half times or more than two times the tank design pressure.

(5) *Tank inlet, outlet, pressure relief device, and pressure control valve markings.*

(i) Each tank inlet and outlet, except pressure relief devices and pressure control valves, shall be marked to indicate whether it communicates with "vapour" or "liquid" when the tank is filled to the maximum filling density.

(ii) Each pressure relief valve shall be plainly and permanently marked with the pressure, in psig, at which it is set to discharge, the discharge rate of the device in SCF per minute (SCFM) of free air, and the manufacturer's name and catalogue number. The marked set-to-discharge pressure value shall be visible with the valve in its installed position. The rated discharge capacity of the device shall be determined at a pressure of 120% of the design pressure of the tank.

(iii) Each pressure control valve shall be plainly and permanently marked with the pressure in psig, at which it is set-to-discharge.

## 5.5 General Requirements for Specifications TC 306, TC 307, TC 312, and TC 350 Highway Tanks

(Reproduced from US CFR Title 49 (see Clause 4.4).)

**§178.340 General design and construction requirements applicable to specifications MC 306 (§178.341), MC 307 (§178.342), MC 312 (§178.343), and TC 350 (Clause 5.10) cargo tanks.**

**§178.340-1 Specification requirements for MC 306, MC 307, MC 312 and TC 350 cargo tanks.**

(a) Specifications MC 306, MC 307, MC 312, and TC 350 cargo tanks constructed on or after December 1, 1967, for the bulk transportation of hazardous materials or TC 350 highway tanks for dangerous wastes must meet the requirements contained in this section in addition to the requirements of each applicable specification as contained in §178.341 (MC 306), §178.342 (MC 307), §178.343 (MC 312) and Clause 5.10 (TC 350).

(b) All of these specification requirements are minimum requirements.

**§178.340-2 General requirements.**

(a) Every cargo tank and vessel shall be designed and constructed in accordance with the best known and available practices in addition to the other applicable cargo tank specification requirements.

(c) Where applicable the additional requirements prescribed in Part 173 of this chapter to accommodate specific commodities are considered an integral part of these specifications.

(d) Multipurpose cargo tank:

(1) A single cargo tank may be divided into compartments of different specification construction. Each such compartment shall conform to specification requirements concerned.

(2) A single cargo tank may be physically altered to comply with another cargo tank specification in the regulations in this part; or altered to accommodate a commodity not requiring a DOT specification tank.

(e) Electrical grounding and fire resistance requirements for MC 306 and MC 307 tanks constructed of reinforced plastics shall conform to the following:

(1) *Electrical Grounding.* To prevent a build-up of electrical charges, each tank compartment shall be equipped with an area of metal of not less than 2 square feet per 1000 U.S. gallons of compartment capacity, which shall be in contact with the product and be electrically connected to a grounding knob. Furthermore, no part of the product shall be more than 78 inches from this metal ground.

**Note:** *The metal ground may take the form of*

*(i) a metal foot valve, pipe outlet, or plate situated in the base of the tank; or*

*(ii) a metallic grill of wire thickness not less than 0.040 inch in diameter and apertures greater than 0.64 square inches, provided that the necessary areas and distances are complied with.*

*In addition, the laminate shall be made conductive such that it has either*

*(i) a surface resistance of less than $10^9$ ohm; or*

*(ii) a bulk resistivity of less than $10^7$ ohm-metres.*

*All of the above shall be electrically interconnected using stranded copper cables or a continuous metal frame, or both, so that every grounding knob acts as a common ground for all compartments.*

(2) *Fire resistance.* Fire retardant resins meeting the requirements of Class 2 of ASTM Standard E84 shall be used to give a fire resistant exterior surface layer of at least a 0.045 inch thickness. This layer will be considered an integral part of the tank wall in so far as the determination of minimum thickness and minimum physical properties of the material are concerned.

**§178.340-3 Material.**

(a) All sheet and plate material for shell, heads, bulkheads and baffles for cargo tanks which are not required to be constructed in accordance with the American Society of Mechanical Engineers' Boiler and Pressure Vessel Code shall meet the following minimum applicable requirements:

(1) *Aluminum Alloys (AL).* Only aluminum alloy material suitable for fusion welding and in compliance with one of the following ASTM specifications shall be used:

ASTM B-209 Alloy 5052.
ASTM B-209 Alloy 5086.
ASTM B-209 Alloy 5154.
ASTM B-209 Alloy 5254.
ASTM B-209 Alloy 5454.
ASTM B-209 Alloy 5652.

All heads, bulkheads, baffles, and ring stiffeners may use 0 temper (annealed) or stronger tempers. All shells shall be made of materials with properties equivalent to H32 or H34 tempers, except that lower ultimate strength tempers may be used if the minimum shell thicknesses in Table II in §178.341-2, §178.342-2, §178.343-2, or Clause 5.10 are increased in inverse proportion to the lesser ultimate strength.

(2) *Steel.*

| | Mild steel (MS) | High strength low alloy steel (HSLA) | Austenitic stainless steel (SS) |
|---|---|---|---|
| Yield point, psi | 25,000 | 45,000 | 25,000 |
| Ultimate strength, psi | 45,000 | 60,000 | 70,000 |
| Elongation, 2-inch samples, percent | 20 | 25 | 30 |

(c) *Reinforced plastics.*

(1) Reinforced plastics used for the construction of shells, heads, bulkheads, and baffles for highway tanks, which are not required to be constructed in accordance with ASME Boiler and Pressure Vessel Code, shall meet the following minimum applicable requirements:

Minimum ultimate tensile stress, psi - 18,000
Minimum tensile modulus, psi - 1,200,000
Minimum flexural strength, psi - 22,000
Minimum flexural modulus, psi - 1,000,000
Percentage fibre reinforcement content by weight -minimum 25%, maximum 75%
Minimum Barcol hardness - 90% of the manufacturer's value for the fully cured, pure resin.

(2) The above physical properties shall be determined at least every 6 months from samples taken from the tanks or from representative samples

fabricated using identical construction procedures and materials. The ASTM standard test methods to be used are as follows:

(1) Tensile strength - D638/D651
(2) Tensile modulus - D638
(3) Flexural strength - D790
(4) Flexural modulus - D790

All other physical properties necessary for the design calculations shall also be determined using the relevant ASTM standard test procedures.

(3) *Corrosion barrier.* All reinforced plastic tanks shall have an internal, resin rich corrosion barrier suitable for the service intended with a minimum thickness of 0.010 inch. This layer shall not be considered part of the tank wall in so far as the minimum required thicknesses, the physical properties of the reinforced plastic, and the design calculations are concerned.

(4) The exterior of the tank shall be coated with a paint or pigmented layer suitable as a protection against atmospheric degradation and corrosion caused by product spills.

**Note:** *Where this specification uses the word "welded", it shall be taken as meaning physically bonded where reinforced plastics are concerned.*

**§178.340-4 Structural integrity.**

(a) *Maximum stress values.* The maximum calculated stress value must not exceed 20 percent of the minimum ultimate strength of the material as authorized in §178.340-3, except when ASME Code pressure vessel design requirements apply.

(b) *Loadings.* Cargo tanks shall be provided with additional structural elements as necessary to prevent resulting stresses in excess of those permitted in paragraph (a) of this section. Consideration shall be given to forces imposed by each of the following loads individually, and where applicable a vector, summation of any combination thereof:

(1) Dynamic loading under all product load configurations.

(2) Internal pressure.

(3) Superimposed loads such as operating equipment, insulation, linings, hose tubes, cabinets, and piping.

(4) Reactions of supporting lugs and saddles or other supports.

(5) Effect of temperature gradients resulting from product and ambient temperature extremes. Thermal coefficients of dissimilar materials where used should be accommodated.

(c) *Reinforced plastic tanks.* Reinforced plastic tanks shall be designed so that the maximum calculated stress value does not exceed 14.3 per cent of the minimum ultimate strength of the material as authorized in §178.340-3 except when ASME Code pressure vessel design requirements apply and the vessel shall be hydrostatically tested to the greater of 3 psi or 1-1/2 times its design working pressure.

Alternatively, reinforced plastic tanks may be designed so that the maximum stress values are in accordance with §178.340-4(a) on condition that the tank is subject to a hydrostatic qualification test of the greater of 10 psi or 2 times its design working pressure.

**§178.340-5 Joints.**

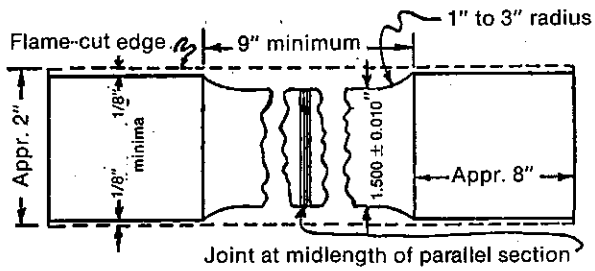
(a) *Method of joining.* All joints between tank shells, heads, baffles (or baffle attaching rings), and bulkheads shall be welded in accordance with the requirements contained in this section.

(b) *Strength of joints (Aluminum Alloy (AL)).* All welded aluminum alloy joints shall be made in accordance with recognized good practice, and the efficiency of a joint shall be not less than 85 percent of the properties of the adjacent material. Aluminum alloys shall be joined by an inert gas arc welding process using aluminum-magnesium type of filler metals which are consistent with the material suppliers recommendations.

(c) *Strength of joints (Mild Steel (MS), High Strength Low Alloy (HSLA), Austenitic Stainless Steel (SS)).* Joints shall be welded in accordance with recognized good practice and the efficiency of any joint shall be not less than 85 percent of the mechanical metal in the tank.

(1) Combinations of mild steel (MS), high strength low alloy (HSLA) and/or austenitic stainless steel (SS), may be used in the construction of a single tank, provided that each material, where used, shall comply with the minimum requirements specified in §178.340-3(a) for the material used in the construction of that section of the tank. Whenever stainless steel sheets are used in combination with sheets or other types of steel, joints made by welding shall be formed by the use of stainless steel electrodes or filler rods and the stainless steel electrodes or filler rods used in the welding shall be suitable for use with the grade of stainless steel concerned, according to the recommendations of the manufacturer of the stainless steel electrodes or filler rods.

(d) *Compliance test.* Compliance with the requirements contained in paragraph (b) or (c) of this section for the welded joints indicated in paragraph (a) of this section shall be determined by preparing from materials representative of those to be used in tanks subject to this specification and by the same technique of fabrication, two test specimens conforming to figure as shown below and testing them to failure in tension. One pair of test specimens may represent all the tanks to be made of the same combination of materials by the same technique of fabrication, and in the same shop, within 6 months after the tests on such samples have been completed. The butt welded specimens tested shall be considered qualifying other types or combinations of types of weld using the same filler material and welding process as long as parent metals are of the same types of material.

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(e) *Strength of joints (reinforced plastic tanks).* The following requirements apply:

(1) The tank shall be designed so as to minimize the number of joints.

(2) The strength of a joint shall not be less than that part of the strongest section adjacent of the joint.

**§178.340-6 Supports and anchoring.**

(a) Cargo tanks with frames not made integral with the tanks as by welding, shall be provided with restraining devices to eliminate any relative motion between the tank and frame which may result from the stopping, starting or turning of the vehicle. Such restraining devices shall be readily accessible for inspection and maintenance; except that insulation and jacketing are permitted to cover the restraining devices.

(b) Any cargo tank designed and constructed so that it constitutes in whole or in part the structural member used in lieu of a frame, shall be supported in such a manner that the resulting stress levels in the cargo tank do not exceed those specified in §178.340-4(a). The design calculations of the support elements shall include loadings imposed by stopping, starting and turning in addition to those imposed as indicated in §178.340-4(b) using 20 percent of the minimum ultimate strength of the support material.

**§178.340-7 Circumferential reinforcements.**

(a) Tanks with shell thicknesses less than three-eighths of an inch shall in addition to the tank heads be circumferentially reinforced with either bulkheads, baffles, or ring stiffeners. It is permissible to use any combination of the aforementioned reinforcements in a single cargo tank.

(1) *Location.* Such reinforcement shall be located in such a manner that the maximum unreinforced portion of the shell be as specified in Table II of the applicable specification and in no case more than 60 inches. Additionally such circumferential reinforcement shall be located within 1 inch of points where discontinuity in longitudinal shell sheet alignment exceeds 10 degrees unless otherwise reinforced with structural members capable of maintaining shell sheet stress levels permitted in §178.340-4(a).

(b) *Baffles.* Baffles or baffle attaching rings if used as reinforcement members shall be circumferentially welded to the tank shell. The welding must not be less than 50 percent of the total circumference of the vessel and the maximum unwelded space on this joint shall not exceed 40 times the shell thickness.

(c) *Double bulkheads:* Tanks designed to transport different commodities which if combined during transit will cause a dangerous condition or evolution of heat or gas shall be provided with compartments separated by an air space. This air space shall be vented and be equipped with drainage facilities which shall be kept operative at all times.

**Note:** *For reinforced plastic tanks the above paragraph covers both immediate and subsequent dangers. However, for the transport of petroleum distillates a "sandwich" construction bulkhead shall be considered as meeting the above requirement on condition that there is a vent and a drain from the core material to the outside of the tank.*

(d) *Ring stiffeners:* Ring stiffeners when used to comply with this section shall be continuous around the circumference of the tank shell and shall have a section modulus about the neutral axis of the ring section parallel to the shell at least equal to that

determined by the following formula:

I/C (Min) = 0.00027 WL (MS, HSLA, and SS) Steel
I/C (Min) = 0.000467 WL (AL) Aluminum Alloy

where:

I/C = Section modulus (inches$^3$).
W = Tank width or diameter (inches).
L = Ring spacing (inches); ie, the maximum distance from the midpoint of the unsupported shell on one side of the ring stiffener to the midpoint of the unsupported shell on the opposite side of the ring stiffener.

(1) If a ring stiffener is welded to the tank shell (with each circumferential weld not less than 50 percent of the total maximum unwelded space on this joint not exceeding 40 times the shell thickness) a portion of the shell may be considered as part of the ring section for purposes of computing the ring section modulus. The maximum portion of the shell to be used in these calculations is as follows:

| Circumferential ring stiffener to tank shell welds | Distance between parallel circumferential ring stiffener to shell welds | Shell section credit |
|---|---|---|
| 1 | — | 20t |
| 2 | Less than 20t | 20t + W |
| 2 | 20t or more | 40t |

where:

t = Shell thickness.
W = Distance between parallel circumferential ring stiffener to shell welds.

(2) If configuration of an internal or external ring stiffener encloses an air space, this air space shall be arranged for venting and be equipped with drainage facilities which shall be kept operative at all times.

(e) *Circumferential reinforcement of reinforced plastic tanks.* Where the section modulus of the tank's shell does not exceed that given by the equation

$$\frac{I}{C}(\text{min}) = \frac{1.479\ WL}{E^{0.5}}$$

Where E is the Youngs (tensile) modulus of the reinforced plastic, then circumferential reinforcement in the form of bulkheads, baffles, or ring stiffeners shall be added to achieve compliance. Such additional reinforcement shall be designed and located so that the maximum distance between each reinforcement shall not exceed 60 inches.

**§178.340-8 Accident damage protection.**

(a) *Appurtenances:* The term "appurtenance" means any cargo tank accessory attachment that has no liquid product retention or other liquid containment function, and provides no structural support to the tank.

(1) The design, construction, and installation of any appurtenance to the shell or head of the cargo tank must be such as to minimize the possibility of appurtenance damage or failure adversely affecting the product retention integrity of the tank.

(2) Structural members, such as the suspension subframe, overturn protection and external rings, when practicable, should be utilized as sites for attachment of appurtenances and any other accessories to a cargo tank.

(3) Except as prescribed in paragraph (a)(5) of this section, the welding of any appurtenance to a shell or head must be made by attachment of a mounting pad. The thickness of a mounting pad must not be less than that of the shell or head to which it is attached. A pad must extend at least 2 inches in each direction from any point of attachment of an appurtenance. Pads must have rounded corners or otherwise be shaped in a manner to preclude stress concentrations on the shell or head. The mounting pad must be attached by a continuous weld around the pad.

(4) The appurtenance must be attached to the mounting pad so there will be no adverse affect upon the product-retention integrity of the tank if any force is applied to the appurtenance, in any direction, except normal to the tank, or within 45° of normal.

(5) Skirting structures, conduit clips, brakeline clips, and similar light-weight attachments, which are of a metal thickness, construction, or material, appreciably less strong but not more than 72 percent of the thickness of the tank shell or head to which such a device is attached, may be secured directly to the tank shell or head if each device is so designed and installed that damage to it will not affect the product retention integrity of the tank. These lightweight attachments must be secured to the tank shell by continuous weld or in such manner as to preclude formation of pockets, which may become sites for incipient corrosion.

(b) *Rear bumpers:* Every cargo tank shall be provided with a rear bumper to protect the tank and piping in the event of a rear end collision and minimize the possibility of any part of the colliding vehicle striking the tank. The bumper shall be located at least 6 inches to the rear of any vehicle component which is used for loading or unloading purposes or may at any time contain lading while in transit. Dimensionally, the bumper shall conform to Clause 5.1.3. Structurally, the bumper shall be designed to successfully absorb (no damage which will cause leakage of product) the impact of the vehicle with rated pay-load, with a deceleration of 2 "g" using a factor of safety of two based on the ultimate strength of the bumper material. For purposes of the regulations in this part such impact shall be considered uniformly distributed and applied horizontally (parallel to the ground) from any direction at an angle not exceeding 30° to the longitudinal axis of the vehicle.

(c) *Overturn protection:* All closures for filling, manhole, or inspection openings shall be protected from damage which will result in leakage of lading in the event of overturning of the vehicle by being enclosed within the body of the tank or dome attached to the tank or by guards.

(1) When guards are required, they shall be designed and installed to withstand a vertical load of twice the weight of the loaded tank and a horizontal load in any direction equivalent to one-half the weight of the loaded tank. These design loads may be considered independently. Ultimate strength of the material shall be used as a calculation base. If more than one guard is used each shall carry its proportionate share of the load. If protection other than guards are considered the same design load criteria is applicable.

(2) Except for pressure actuated vents no overturn protection is required for nonoperating nozzles or fittings less than 5 inches in diameter (which do not contain product while in transit) that project a distance less than the inside diameter of the fitting. This projected distance may be measured either from the shell or the top of an adjacent ring stiffener provided such stiffener is within 30 inches of the center of the nozzle or fitting.

(3) If the overturn protection is so constructed as to permit accumulation of liquid on the top of the tank, it shall be provided with drainage facilities directed to a safe point of discharge.

(d) *Piping:* (1) Product discharge piping shall be provided with protection in such a manner as to reasonably assure against the accidental escape of contents. Such protection may be provided by:

(i) A shear section located outboard of each emergency valve seat and within 4 inches of the vessel which will break under strain and leave the emergency valve seat and its attachment to the vessel and the valve head intact and capable of retaining product. The shear section shall be machined in such a manner as to abruptly reduce the wall thickness of the adjacent piping (or valve) material by at least 20 percent; or

(ii) By suitable guards capable of successfully absorbing a concentrated horizontal force of at least 8,000 pounds applied from any horizontal direction, without damage to the discharge piping which will adversely affect the product retention integrity of the discharge valve.

(2) Minimum road clearance: The minimum allowable road clearance of any cargo tank component or protection device located between any two adjacent axles on a vehicle or vehicle combination shall be at least one-half inch for each foot separating such axles and in no case less than 12 inches.

(3) Strength of piping, fittings, hose and hose couplings: Hose, piping, and fittings for tanks to be unloaded by pressure shall be designed for a bursting pressure of at least 100 p.s.i.g. and not less than four times the pressure to which, in any instance, it may be subjected in service by the action, of any vehicle mounted pump or other device (not including safety relief valves), the action of which may be to subject certain portions of the tank piping and hose to pressures greater than the design pressure of the tank. Any coupling used on hose to make connections shall be designed for a working pressure not less than 20 percent in excess of the design pressure of the hose and shall be so designed that there will be no leakage when connected.

(4) Provision for expansion and vibration: Suitable provisions shall be made in every case to allow for and prevent damage due to expansion, contraction, jarring, and vibration of all pipe. Slip joints shall not be used for this purpose.

(5) Heater coils: Heater coils, when installed, shall be so constructed that the breaking off of their external connections will not cause leakage of contents of tank.

(6) Gauging, loading, and air-inlet devices: Gauging, loading, and air-inlet devices, including their valves, shall be provided with adequate means

for their secure closure, and means shall also be provided for the closing of pipe connections of valves.

**§178.340-9 Pumps.**

(a) Loading or unloading pumps mounted on tractor or trailer, if used, shall be provided with automatic means to prevent the pressure from exceeding the design pressure of the tank mounted equipment.

**§178.340-10 Certification.**

(a) Certification as required in paragraphs (b) and (c) of this section shall indicate that such cargo tank has been designed, constructed, and tested in accordance with the applicable specification MC 306, MC 307, or MC 312, or TC 350 (§178.341, §178.342 or §178.343, Clause 5.10).

(1) *Multipurpose tanks.* If a cargo tank is divided into compartments and each compartment is constructed in accordance with the requirements of a different MC specification, there shall be a metal plate required in paragraph (b) of this section, located on the right side, near the front of each compartment, in a place readily accessible for inspection. Details pertaining to the multipurpose configuration shall also be clearly indicated on the manufacturer's certificate required in paragraph (c) of this section.

(i) If a cargo tank is constructed in accordance with the requirements of one specification and may be physically altered to meet another cargo tank specification in this part; or physically altered to accommodate a commodity not requiring a specification tank, such alterations shall be clearly indicated on the manufacturer's certificate required in paragraph (c) of this section and the tank mounted multi-purpose plate required in paragraph (b)(2) of this section.

(2) *Specification shortages.* If, a cargo tank is manufactured which does not meet all of the applicable specification requirements, thereby requiring subsequent manufacturing involving the installation of additional components, parts, appurtenances or accessories, it is permissible for the original manufacturer to affix the metal certification plate required in paragraph (b) of this section. The specification requirements not complied with shall be indicated on the manufacturer's certificate required in paragraph (c) of this section. When the cargo tank is finally brought into complete compliance, the date such compliance is accomplished shall be stamped on the metal certification plate. The certificate shall indicate the pertinent details, date and concern (manufacturer or carrier) accomplishing complete compliance.

(b) *Metal certification plate.* After July 1, 1985, each cargo tank, or tank compartment if constructed to a different specification, must have a metal certification plate attached to its shell or to an integral supporting structure. The certification plate shall not be subject to corrosion, and must be located on the left side (on the right side prior to July 1, 1985) near the front in a place readily accessible for inspection. Each plate shall be permanently affixed by means of brazing, welding, soldering, riveting, or other equally suitable means. The plate must be marked in characters at least 3/16 inch high by stamping, embossing, or other means of forming letters into or on the metal of the plate itself at least the information prescribed in paragraphs (b)(1) and (b)(2) of this section. The plate may not be painted as to obscure the marking thereon. A combination ASME/DOT certification plate is authorized.

(1) If a cargo tank is to be physically altered to meet another specification (or to accommodate a commodity not requiring a specification tank) such combinations shall be indicated beside specification identification. Additionally the metal multipurpose plates required in subparagraph (2) of this section are required.

Vehicle manufacturer _____
Manufacturer's serial number _____
Specification identification[1,2] DOT MC 306; or
MC 307; or MC 312; or TC 350 _____
Date of manufacture _____
Original test date _____
Certification date _____
Design pressure _____ p.s.i.g.
Test pressure _____ p.s.i.g.
Head material[2] _____
Head thickness, min. required thickness _____
Shell material[2] _____
Shell thickness, min. required thickness _____
Weld material _____
Lining material _____
Nominal tank capacity by compartment
(front to rear) _____ gal.
Maximum product load _____ lbs.
Loading limits _____ g.p.m. and/or p.s.i.g.
Unloading limits _____ g.p.m. and/or p.s.i.g.

[1] The following material designations (or combinations thereof) must be added: Aluminum Alloy (AL); Mild Steel (MS); High Strength Low Alloy (HSLA); Austenitic Stainless Steel (SS). For example "DOT MC 306 AL" for cargo tanks made of aluminum. A multi-purpose cargo tank example would be "Combination MC 306SS — 307SS".

[2] RP (reinforced plastic) highway tanks shall be identified thus: TC 306 RP and "Head Material" and "Shell Material" shall identify the resin(s) used.
**Note:** *See also Clause 3.3.*

(2) *Metal multipurpose plate:* If a cargo tank is to be physically altered, metal multipurpose plates shall be mounted adjacent to the metal certification plate readily accessible for inspection. The mounting of the plates shall be such that only the plate identifying the applicable specification is legible at all times the cargo tank is in complete compliance with such specifications. The mounting of the plates (or plate assembly) shall be secured in such a manner as to be capable of retaining the plate when subjected to normal operating conditions. The same marking size and method used on the certification plate shall be used. The plate shall contain at least the information contained below:

SPECIFICATION IDENTIFICATION MC

EQUIPMENT NECESSARY

| VENTS: | Quantity[1] |
|---|---|
| Pressure actuated ..... | |
| Fusible ..... | |
| Frangible ..... | |
| Product discharge: | |
| Top ..... | |
| Bottom ..... | |
| Pressure unloading fitting ..... | |
| Covers: | |
| Manhole ..... | |
| Fill openings ..... | |

[1] The number required to meet applicable specification. If no physical change is required the letters NC shall follow the number required. If cargo tank is not so equipped the word "NONE" shall be inserted.

(i) *Color coding.* Those parts which must be changed or added to meet the applicable specification requirements and the appropriate multipurpose plate shall be identified using the following colors:

| | |
|---|---|
| MC 306 ..... | RED |
| MC 307 ..... | GREEN |
| MC 312 ..... | YELLOW |
| Nonspecification ..... | BLUE |
| TC 350 ..... | BLACK |

Additionally those parts to be changed or added shall be stamped with the appropriate MC/TC Specification No. ....

## 5.6 Specification TC 306 Highway Tanks

(Reproduced from US CFR, Title 49 (see Clause 4.4).)

**§178.341 Specification MC 306: cargo tanks.**

**§178.341-1 General requirements.**

(a) Specification MC 306 cargo tanks must comply with the general design and construction requirements in §178.340 in addition to the specific requirements contained in this section.

(b) Design pressure: The design pressure of each cargo tank shall be not less than that pressure exerted by the static head of the fully loaded tank in the upright position.

**§178.341-2 Thickness of shells, heads, bulkheads, and baffles.**

(a) *Material thickness.* The minimum thicknesses of tank material authorized in §178.340-3 shall be predicated on not exceeding the maximum allowable stress level (§178.340-4(a)) but in no case less than those indicated in Tables I and II below:

(1) *Product density.* The material thicknesses contained in Tables I and II are minimums based on a maximum 7.2 pounds per gallon product weight. If the tank is designed to haul products weighing more than 7.2 pounds per gallon, the gallon per inch value used to determine the minimum thickness of heads, bulkheads, baffles or shell sheets shall be the actual section capacity required in gallons per inch multiplied by the actual product density in pounds per gallon divided by 7.2.

(b) *Minimum material thickness for reinforced plastic tanks.*

(1) The thickness of tank material authorized in §178.340-3 shall be such that the maximum allowable stress level in §178.340-4 is not exceeded and in no case shall the thickness be less than twice the minimum thickness specified for aluminum in Tables I and II.

(2) In the case of "sandwich" construction the thickness may be determined as the aggregate of all

reinforced plastic layers which form an integral part of the load bearing wall as long as no layer is less than half the minimum thickness specified.

(3) In the case of separate, independent tank cells surrounded by rigid foam within an outer skin, the inner cell wall shall not be less than half the minimum thickness specified in paragraph (1) above. In addition, for such a style of construction, the outer skin shall not be less than the minimum thickness specified in (1) above.

**§178.341-3 Closures for fill openings and manholes.**

(a) Each compartment in excess of 2,500 gallons capacity shall be accessible through a manhole of at least 11 × 15 inches. Manhole and/or fill opening covers shall be designed to provide secure closure of the openings. They shall have structural capability of withstanding internal fluid pressures of 9 p.s.i.g. without permanent deformation. Safety devices to prevent the manhole and/or fill cover from opening fully when internal pressure is present shall be provided.

**TABLE I—MINIMUM THICKNESS OF HEADS, BULKHEADS AND BAFFLES, MILD STEEL (MS), HIGH STRENGTH LOW ALLOY STEEL (HSLA), AUSTENITIC STAINLESS STEEL (SS), IN U.S. STANDARD GAUGE; ALUMINUM ALLOY (AL)—EXPRESSED IN DECIMALS OF AN INCH**

| Volume capacity in gallons per inch | 10 or less | | | Over 10 to 14 | | | 14 to 18 | | | 18 and over | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type of steel | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL |
| Thickness | 14 | 15 | .096 | 13 | 14 | .109 | 12 | 13 | .130 | 11 | 12 | .151 |

## TABLE II—MINIMUM THICKNESS OF SHELL SHEETS, MILD STEEL (MS), HIGH STRENGTH LOW ALLOY STEEL (HSLA), AUSTENITIC STAINLESS STEEL (SS), IN U.S. STANDARD GAUGE, ALUMINUM ALLOY (AL)—EXPRESSED IN DECIMALS OF AN INCH

| Volume capacity in gallons per inch | | 10 or less | | | Over 10 to 14 | | | 14 to 18 | | | 18 and over | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Maximum shell radius** | **Distance between bulkheads, baffles, and ring stiffeners** | **MS** | **HSLA, SS** | **AL** | **MS** | **HSLA, SS** | **AL** | **MS** | **HSLA, SS** | **AL** | **MS** | **HSLA, SS** | **AL** |
| Less than 70 inches | 36 inches or less | 14 | 16 | .087 | 14 | 16 | .087 | 14 | 15 | .096 | 13 | 14 | .109 |
| | Over 36 inches to 54 inches | 14 | 16 | .087 | 14 | 15 | .096 | 13 | 14 | .109 | 12 | 13 | .130 |
| | 54 inches through 60 inches | 14 | 15 | .096 | 13 | 14 | .109 | 12 | 13 | .130 | 11 | 12 | .151 |
| 70 inches or more, less than 90 inches | 36 inches or less | 14 | 16 | .087 | 14 | 15 | .096 | 13 | 14 | .109 | 12 | 13 | .130 |
| | Over 36 inches to 54 inches | 14 | 15 | .096 | 13 | 14 | .109 | 12 | 13 | .130 | 11 | 12 | .151 |
| | 54 inches through 60 inches | 13 | 14 | .109 | 12 | 13 | .130 | 11 | 12 | .151 | 10 | 11 | .173 |
| 90 inches or more, less than 125 inches | 36 inches or less | 14 | 15 | .096 | 13 | 14 | .109 | 12 | 13 | .130 | 11 | 12 | .151 |
| | Over 36 inches to 54 inches | 13 | 14 | .109 | 12 | 13 | .130 | 11 | 12 | .151 | 10 | 11 | .173 |
| | 54 inches through 60 inches | 12 | 13 | .130 | 11 | 12 | .151 | 10 | 11 | .173 | 9 | 10 | .194 |
| 125 inches or more | 36 inches or less | 13 | 14 | .109 | 12 | 13 | .130 | 11 | 12 | .151 | 10 | 11 | .173 |
| | Over 36 inches to 54 inches | 12 | 13 | .130 | 11 | 12 | .151 | 10 | 11 | .173 | 9 | 10 | .194 |
| | 54 inches through 60 inches | 11 | 12 | .151 | 10 | 11 | .173 | 9 | 10 | .194 | 8 | 9 | .216 |

**§178.341-4 Vents.**

(a) Each cargo tank compartment shall be provided with safety relief devices in accordance with the requirements contained in this paragraph. All of such devices shall communicate with the vapor space. Shutoff valves shall not be installed between the tank opening and any safety device. Safety relief devices shall be so mounted, shielded, or drained as to eliminate the accumulation of water, the freezing of which could impair the operation or discharge capability of the device.

(b) *Normal venting:* Each cargo tank compartment shall be provided with pressure and vacuum vents having a minimum through area of 0.44 square inch. All pressure vents shall be set to open at no more than 1 p.s.i.g. and all vacuum vents at no more than 6 ounces. Pressure and vacuum vents shall be designed to prevent loss of liquid through the vent in case of vehicle overturn.

(c) *Loading and unloading venting protection:* If the tank is designed to be loaded or unloaded with the dome cover closed, the vent or vents as described in paragraph (b) of this section or additional vents shall limit the vacuum to 1 p.s.i. and the tank pressure to 3 p.s.i.g. based on maximum product transfer rate to be included on the metal certification plate §178.340-10(b). Unless effective protection against overfilling is made, the pressure vent shall also have sufficient liquid capacity to prevent the pressure from exceeding 3 p.s.i.g. in case of accidental overfilling. This pressure vent may be pressure operated or interlocked with the tank loading device, and shall be designed to prevent loss of liquid through the vent under any condition of vehicle rollover attitude.

(d) *Emergency venting for fire exposure—(1) Total capacity.* The total emergency venting capacity (cu. ft./hr.) of each cargo tank compartment shall be not less than that determined from Table III.

(2) *Pressure-actuated venting.* Each cargo tank compartment shall be equipped with pressure-actuated vent or vents set to open at not less than 3 p.s.i.g. and close when pressure drops to 3 p.s.i.g. or below. The minimum venting capacity for pressure-actuated vents shall be 6,000 cubic feet of free air per hour (14.7 p.s.i.a. and 60°F.) from a tank pressure of 5 p.s.i.g. Pressure-actuated devices shall be designed so as to prevent leakage of liquid past the device in case of surge or vehicle upset, except that they shall function in case of pressure rise under any condition of vehicle rollover attitude.

(3) *Fusible venting.* If the pressure-actuated venting required by paragraph (2) of this paragraph (d) does not provide the total venting capacity required by paragraph (d)(1) of this section additional capacity shall be provided by adding fusible venting devices each having a minimum area of 1.25 square inches; such fusible elements shall be so located as to not be in contact with the tank lading under normal operating conditions. The fusible vent or vents shall be actuated by elements which operate at a temperature not exceeding 250°F. The venting capacity of these devices shall be rated at not more than 5 p.s.i.g.

(e) Flow testing and marking of vents: Each type and size of venting devices shall be flow tested in the ranges specified in the applicable preceding paragraphs. The actual rated flow capacity of the vent in cubic feet of free air per hour at the pressure in p.s.i.g. at which the flow capacity is determined shall be stamped on the device. The fusible vent or vents shall have their flow rating determined at 5 p.s.i.g. differential.

(1) These flow tests may be conducted by the manufacturer or may be delegated to a certified outside agency.

**TABLE III—MINIMUM EMERGENCY VENT CAPACITY IN CUBIC FEET FREE AIR/HOUR (14.7 P.S.I.A. AND 60° F.)**

| Exposed area square feet | Cubic feet free air per hour | Exposed area square feet | Cubic feet free air per hour |
|---|---|---|---|
| 20 | 15,800 | 275 | 214,300 |
| 30 | 23,700 | 300 | 225,100 |
| 40 | 31,600 | 350 | 245,700 |
| 50 | 39,500 | 400 | 265,000 |
| 60 | 47,400 | 450 | 283,200 |
| 70 | 55,300 | 500 | 300,600 |
| 80 | 63,300 | 550 | 317,300 |
| 90 | 71,200 | 600 | 333,300 |
| 100 | 79,100 | 650 | 348,800 |
| 120 | 94,900 | 700 | 363,700 |
| 140 | 110,700 | 750 | 378,200 |
| 160 | 126,500 | 800 | 392,200 |
| 180 | 142,300 | 850 | 405,900 |
| 200 | 158,100 | 900 | 419,300 |
| 225 | 191,300 | 950 | 432,300 |
| 250 | 203,000 | 1000 | 445,000 |

**Note 1:** *Interpolate for intermediate sizes.*

**§178.341-5 Emergency flow control.**

(a) Each product discharge opening shall be equipped with a self-closing shut-off valve, designed, installed, and protected in accordance with §178.340-8(d) and operated so as to assure against the accidental escape of contents. These valves shall be located inside the tank or at a point outside the tank where the line enters or leaves the tank. The valve seat shall be located inside the tank or within the welded flange, its companion flange, nozzle, or coupling. Such product discharge valves (outflow) shall, in addition to normal means, be closed by (1) an automatic heat actuated means which will become effective at a temperature not over 250°F., (2) a secondary closing means, remote from tank filling or discharge openings, for operation in event of fire or other accident.

**§178.341-6 Gauging devices.**

(a) No applicable provisions.

**§178.341-7 Method of test.**

(a) *Test for leaks.* Every cargo tank shall be tested by a minimum air or hydrostatic pressure of 3 p.s.i.g. or at least equal to the tank design pressure of §178.341-1(b), whichever is greater, applied to the whole tank and dome if it be noncompartmented. If compartmented each individual compartment shall be similarly tested with adjacent compartments empty and at atmospheric pressure. Air pressure, if used, shall be held for a period of at least 5 minutes during which the entire surface of all joints under pressure shall be coated with a solution of soap and water, heavy oil, or other material suitable for the purpose, foaming or bubbling of which indicates the presence of leaks. Hydrostatic pressure, if used, shall be done by using water or other liquid having a similar viscosity, the temperature of which shall not exceed 100°F, during the test, and applying pressure as prescribed above, gauged at the top of the tank, at which time all joints under pressure shall be inspected for the issuance of liquid to indicate leaks. All closures shall be in place while test by either method is made. During these tests, operative relief devices shall be clamped, plugged, or otherwise rendered inoperative; such clamps, plugs, and similar devices shall be removed immediately after the test is finished. Any leakage discovered by either of the methods above described, or by any other method, shall be deemed evidence of failure to meet the requirements of this specification. Tanks failing to pass this test shall be suitably repaired, and the above described tests shall be continued until no leaks are discovered, before any cargo tank is put into service.

(b) *Test for distortion or failure.* Every cargo tank shall be tested by pressures prescribed in paragraph (a) of this section and shall withstand such pressure without undue distortion, evidence of impending failure, or failure. Failure to meet this requirement shall be deemed as sufficient cause for rejection under this specification. If there is undue distortion, or if failure impends or occurs, the cargo tank shall not be placed in or returned to service unless an adequate repair is made. The adequacy of the repair shall be determined by the same method of test.

## 5.7 Specification TC 307 Highway Tanks

(Reproduced from US CFR, Title 49 (see Clause 4.4).)

**§178.342 Specification MC 307; cargo tanks.**

**§178.342-1 General requirements.**

(a) Specification MC 307 cargo tanks must comply with the general design and construction requirements in §178.340, in addition to the specific design requirements contained in this section.

(b) The design pressure (maximum allowable working pressure) of each cargo tank shall be not less than 25 p.s.i.g. For working pressures in excess of 50 p.s.i.g. the tank must be designed in accordance with the requirements of the ASME Code.

(c) Tanks shall be of circular cross-section.

**§178.342-2 Thickness of shell, heads, bulkheads, and baffles.**

(a) *Material thickness.* The minimum thicknesses of tank material authorized in §178.340-3 shall be not less than those obtained by applying the following formulas nor less than those specified in Tables I and II below:

Thickness of shell = $T_s = PD/2SE_s$

Thickness of heads = $T_h = 0.885PL^*/SE_h$

*For pressure on concave side only.

Where:

$T_s$ = Minimum thickness of shell material, exclusive of allowance for corrosion or other loadings;

$T_h$ = Minimum thickness of head material, after forming, exclusive of allowance for corrosion and other loadings;
P = Design pressure, pounds per square inch;
D = Inside diameter of shell, inches;
L = Inside crown radius of head, inches;
S = Maximum allowable stress value, pounds per square inch, equals one-fourth of specified minimum ultimate tensile strength. (One-fourth of aluminum alloy's annealed minimum ultimate strength.);
$E_s$ = Lowest efficiency of any longitudinal joint in shell (85% max.);
$E_h$ = Lowest efficiency of any joint in head (85% max.).

**TABLE I—MINIMUM THICKNESS OF HEADS, BULKHEADS, AND BAFFLES MILD STEEL (MS), HIGH STRENGTH LOW ALLOY (HSLA) AND AUSTENITIC STAINLESS STEEL (SS) EXPRESSED IN U.S. GAUGE; ALUMINUM ALLOY (AL) IN DECIMALS OF AN INCH**

| | Volume Capacity of Tank in Gallons Per Inch | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 or less | | | Over 10 to 14 | | | 14 to 18 | | | 18 to 22 | | | 22 to 26 | | | 26 to 30 | | | 30 and over | | |
| | MS | HSLA SS | AL | MS | HSLA SS | AL | MS | HSLA SS | AL | MS | HSLA SS | AL | MS | HSLA SS | AL | MS | HSLA SS | AL | MS | HSLA SS | AL |
| Thickness | 14 | 15 | .109 | 13 | 14 | .130 | 12 | 13 | .151 | 11 | 12 | .173 | 10 | 11 | .194 | 9 | 10 | .216 | 8 | 9 | .237 |

**TABLE II—MINIMUM THICKNESS OF SHELL SHEETS MILD STEEL (MS), HIGH STRENGTH LOW ALLOY (HSLA) AND AUSTENITIC STAINLESS STEEL (SS) EXPRESSED IN U.S. GAUGE; ALUMINUM ALLOY (AL) IN DECIMALS OF AN INCH**

| Distance between bulkheads, baffles or other shell stiffeners | Volume Capacity of Tank in Gallons Per Inch | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 or less | | | Over 10 to 14 | | | 14 to 18 | | | 18 to 22 | | | 22 to 26 | | | 26 to 30 | | | 30 and over | | |
| | MS | HSLA SS | AL | MS | HSLA SS | AL | MS | HSLA SS | AL | MS | HSLA SS | AL | MS | HSLA SS | AL | MS | HSLA SS | AL | MS | HSLA SS | AL |
| 36 in or less | 14 | 16 | .109 | 14 | 16 | .109 | 14 | 15 | .109 | 13 | 14 | .130 | 12 | 13 | .151 | 11 | 12 | .173 | 10 | 11 | .194 |
| Over 36 in to 54 in | 14 | 16 | .109 | 14 | 15 | .109 | 13 | 14 | .130 | 12 | 13 | .151 | 11 | 12 | .173 | 10 | 11 | .194 | 9 | 10 | .216 |
| 54 in through 60 in | 14 | 15 | .109 | 13 | 14 | .130 | 12 | 13 | .151 | 11 | 12 | .173 | 10 | 11 | .194 | 9 | 10 | .216 | 8 | 9 | .237 |

(1) The knuckle radius of the head shall not be less than three times the material thickness. The straight flange shall not be less than three times the material thickness for butt-welded heads.

(2) For heads with pressure on the convex side, the material thickness as obtained by the above formula shall be increased by 67 percent unless such heads are adequately braced to prevent excessive distortion.

(b) *Corrosion allowance.* Vessels or part of vessels subject to thinning by corrosion, erosion, or mechanical abrasion, shall have provision made to withstand the intended life and service by a suitable increase in the thickness of the material over that determined by the design formulas, or by using some other suitable method of protection. Material added for these purposes need not be of the same thickness for all parts of the vessel if different rates of attack are expected for the various parts.

(c) *Minimum material thickness for reinforced plastic tanks.*

(1) The thickness of tank material authorized in §178.340-3 shall be such that the maximum allowable stress level in §178.340-4 is not exceeded and in no case shall the thickness be less than twice the minimum thickness specified for aluminum in Tables I and II.

(2) In the case of "sandwich" construction the thickness may be determined as the aggregate of all reinforced plastic layers which form an integral part of the load bearing wall as long as no layer is less than half the minimum thickness specified.

(3) In the case of separate, independent tank cells surrounded by rigid foam within an outer skin, the inner cell wall shall not be less than half the minimum thickness specified in paragraph (1) above. In addition, for such a style of construction, the outer skin shall not be less than the minimum thickness specified in (1) above.

**§178.342-3 Closures for manholes.**

(a) Each compartment shall be accessible through a 15-inch minimum inside diameter manhole. The manhole cover shall be designed to provide a secure closure of the manhole. All joints between manhole covers and their seats shall be made tight against leakage of vapor and liquid. Gaskets, if used, shall be of suitable material not subject to attack by lading.

(1) Closures shall have structural capability of withstanding internal fluid pressures of 40 p.s.i.g. or 1.5 times the design pressure of the tank whichever is greater without permanent deformation. Safety devices to prevent the manhole and/or fill cover from opening fully when internal pressure is present shall be provided.

**§178.342-4 Vents.**

(a) Each cargo tank compartment shall be provided with safety relief devices in accordance with the requirements contained in this paragraph. All of such devices shall communicate with the vapor space. Shutoff valves shall not be installed between the tank opening and any safety device. Safety relief devices shall be so mounted, shielded, or drained as to eliminate the accumulation of water, the freezing of which could impair the operation or discharge capability of the device.

(b) *Total capacity:* Every cargo tank compartment shall be provided with one or more devices with sufficient capacity to limit the tank internal pressure to a maximum of 130 percent of the tank design pressure. This total venting capacity shall be not less than that determined from Table III, using the external surface of the cargo tank or tank compartment as the exposed area.

(c) *Pressure-actuated venting (spring loaded):* Every cargo tank compartment shall be equipped with pressure-actuated vent or vents set to open at not less than the tank design pressure. The minimum venting capacity for pressure-actuated vents shall be 12,000 cubic feet of free air per hour (14.7 p.s.i.a. and 60°F.) per compartment or 12,000 cubic feet of free air per hour (14.7 p.s.i.a. and 60°F.) for each 350 square feet of exposed tank area, whichever is greater. This minimum capacity shall be measured at a pressure of 130 percent of the tank design pressure. Pressure-actuated devices shall be designed to function in case of pressure rise when in any condition of roll over attitude. If pressure (maximum limits to be included on the metal certification plate §178.340-10(b)) unloading devices are provided, the relief valve shall have sufficient capacity to limit the tank internal pressure to 130 percent of design pressure.

(d) *Fusible and frangible venting:* If the pressure-actuated venting required by paragraph (c) of this section does not provide the total venting capacity required by paragraph (b) of this section, additional capacity shall be provided by adding fusible and/or frangible venting devices. Each fusible device shall have a minimum area of 1.25 square inches and shall be actuated by elements which operate at a temperature not exceeding

250°F. when the tank pressure is between the tank design pressure and 130 percent of the tank design pressure. Such fusible elements shall be so located as to not be in contact with the lading under normal operating conditions. The bursting pressure of frangible devices shall be not less than 130 percent nor more than 150 percent of the tank design pressure.

**TABLE III—MINIMUM EMERGENCY VENT CAPACITY IN CUBIC FEET; FREE AIR/HOUR (14.7 P.S.I.A. AND 60°F.)**

| Exposed area square feet | Cubic feet free air per hour | Exposed area square feet | Cubic feet free air per hour |
|---|---|---|---|
| 20 | 15,800 | 275 | 214,300 |
| 30 | 23,700 | 300 | 225,100 |
| 40 | 31,600 | 350 | 245,700 |
| 50 | 39,500 | 400 | 265,000 |
| 60 | 47,400 | 450 | 283,200 |
| 70 | 55,300 | 500 | 300,600 |
| 80 | 63,300 | 550 | 317,300 |
| 90 | 71,200 | 600 | 333,300 |
| 100 | 79,100 | 650 | 348,800 |
| 120 | 94,900 | 700 | 363,700 |
| 140 | 110,700 | 750 | 378,200 |
| 160 | 126,500 | 800 | 392,200 |
| 180 | 142,300 | 850 | 405,900 |
| 200 | 158,100 | 900 | 419,300 |
| 225 | 191,300 | 950 | 432,300 |
| 250 | 203,100 | 1,000 | 445,000 |

*Note 1: Interpolate for intermediate sizes.*

(e) *Flow testing and marking of vents:* Each type and size of venting devices shall be flow tested in the ranges specified in the applicable preceding paragraphs. The actual rated flow capacity of the vent in cubic feet of free air per hour at the pressure in p.s.i.g. at which the flow capacity is determined shall be stamped on the device.

(1) These flow tests may be conducted by the manufacturer or may be delegated to a certified agency.

**§178.342-5 Outlets.**

(a) Each product discharge opening shall be equipped with a self-closing shut-off valve, designed, installed, and protected in accordance with §178.340-8(d) and operated so as to assure against the accidental escape of contents. These valves shall be located inside the tank or within the welded flange, its companion flange, nozzle, or coupling. Such product discharge valves (outflow) shall, in addition to normal means, be closed by (1) an automatic heat actuated means which will become effective at a temperature not over 250°F., (2) a secondary closing means, remote from tank filling or discharge openings, for operation in event of fire or other accident.

(b) Vapor return lines, if used, may be equipped with an excess flow valve at the tank connection if a positive shutoff valve is provided between the excess-flow valve and the hose connection.

**§178.342-6 Gauging devices.**

(a) *Gauge device design.* Every tank compartment except tanks filled by weight, shall be equipped with one or more gauging devices which shall indicate accurately the maximum permitted liquid level in each compartment. Additional gauging devices may be installed but may not be used as primary controls for filling of cargo tanks at pressures above atmospheric. Acceptable gauging devices for use at pressures above atmospheric are the rotary tube, the adjustable slip tube and the fixed length dip tube. Gauge glasses are not permitted to be installed on any cargo tank.

(b) *Fixed level indicators.* All liquid level gauging devices, except those on tanks provided with fixed maximum level indicators, shall be legibly and permanently marked in increments of not more than 20°F to indicate the maximum levels to which the tank may be filled with liquid at temperatures above 20°F. In the event that it is impracticable to put these markings on the gauging device, this information shall be marked on a suitable plate affixed to the tank in a location adjacent to the gauging device.

(c) *Dip tubes.* A fixed length dip tube gauging device when used shall consist of a dip pipe of small diameter equipped with a valve at the outer end, and extending into the tank to a specified fixed length. On horizontally mounted cylindrical tanks, the fixed length to which the tube extends into the tank shall be such that the device will function to indicate when the liquid reaches the maximum level permitted by the regulations in this part.

**§178.342-7 Method of test.**

(a) *Test pressure.* The standard test pressure for each required test shall be 40 p.s.i.g. or a minimum of 1.5 times design pressure whichever is greater.

(b) *Method of test.* Every cargo tank shall be tested by complete filling (including domes if any)

with water or other liquid having a similar viscosity and applying a pressure of not less than the standard test pressure specified in paragraph (a) of this section. The pressure shall be gauged at the top of the tank. The tank shall hold the prescribed pressure for at least 10 minutes. All tank accessories shall be leakage tested after installation and proved tight at not less than the design pressure of the tank, except that hose used on such tanks may be tested either before or after installation. Failure to successfully meet the test criteria shall be deemed evidence of failure to meet the requirements of this specification. Tanks failing to pass this test shall be suitably repaired. The suitability of the repair shall be determined by the same method of test.

(1) *When divided into compartments.* When the interior of the tank is divided into compartments, each compartment shall be tested as a separate tank with adjacent compartments empty and at atmospheric pressure.

## 5.8 Specification TC 312 Highway Tanks

(Reproduced from US CFR, Title 49 (see Clause 4.4))

**§178.343 Specification MC 312: cargo tanks.**

**§178.343-1 General requirements.**

(a) Specification MC 312 cargo tanks must comply with the general design and construction requirements in §178.340 in addition to the specific requirements contained in this section.

(b) *Tank design:* Cargo tanks built under this specification that are unloaded by pressure in excess of 15 p.s.i.g. must be designed and constructed in accordance with and fulfill all requirements of the ASME Code. No tank shall have head, bulkhead, and baffle or shell thicknesses less than that specified in §178.343-2, Tables I and II, nor shall the spacing of bulkheads, baffles, or shell stiffeners exceed that specified in §178.340-7.

(c) Design pressure shall be not less than pressure used for unloading.

**§178.343-2 Thickness of shell, heads, bulkheads, and baffles of non-ASME Code tanks.**

(a) *Material thickness.* The minimum thicknesses of tank material authorized in §178.340-3 shall be predicated on not exceeding the maximum allowable stress level in §178.340-4(a) but in no case less than those indicated in Tables I and II listed below, or the accompanying aluminum alloy formula:

(1) Aluminum alloy formula.

$$\text{Thickness of aluminum alloy materials} = \text{Steel Thickness from Tables I \& II I \& II} \times \left(\frac{3 \times 10^7}{E}\right)\frac{1}{3}$$

Where E = Modulus of Elasticity of the material to be used.

**TABLE I—MINIMUM THICKNESS OF HEADS, BULKHEADS, AND BAFFLES, MILD STEEL (MS), HIGH STRENGTH LOW ALLOY STEEL (HSLA), AUSTENITIC STAINLESS STEEL (SS), IN U.S. STANDARD GAUGE—UNLESS OTHERWISE EXPRESSED IN FRACTIONS OF AN INCH**

| | Volume capacity in gallons per inch | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 or less | | | Over 10 to 14 | | | 14 to 18 | | | 18 and over | | |
| | Product weight in pounds per gallon at 60°F | | | | | | | | | | | |
| | 10 lbs. and less | Over 10 to 13 lbs. | 13 to 16 lbs. | 10 lbs. and less | Over 10 to 13 lbs. | 13 to 16 lbs. | 10 lbs. and less | Over 10 to 13 lbs. | 13 to 16 lbs. | 10 lbs. and less | Over 10 to 13 lbs. | 13 to 16 lbs. |
| Thickness | 12 | 10 | 8 | 10 | 8 | 3/16 | 9 | 3/16 | 1/4 | 8 | 1/4 | 1/4 |

**TABLE II—MINIMUM THICKNESS OF SHELL SHEETS, MILD STEEL (MS), HIGH STRENGTH LOW ALLOY STEEL (HSLA), AUSTENITIC STAINLESS STEEL (SS) IN U.S. STANDARD GAUGE—UNLESS OTHERWISE EXPRESSED IN FRACTIONS OF AN INCH**

| Maximum shell radius | Distance between bulkheads, baffles, or ring stiffeners | Volume capacity in gallons per inch | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 10 or less | | | Over 10 to 14 | | | 14 to 18 | | | 18 and over | | |
| | | Product weight in pounds per gallon at 60°F | | | | | | | | | | | |
| | | 10 lbs. and less | Over 10 to 13 lbs. | 13 to 16 lbs. | 10 lbs. and less | Over 10 to 13 lbs. | 13 to 16 lbs. | 10 lbs. and less | Over 10 to 13 lbs. | 13 to 16 lbs. | 10 lbs. and less | Over 10 to 13 lbs. | 13 to 16 lbs. |
| Less than 70 inches | 36 inches or less | 12 | 10 | 8 | 12 | 10 | 8 | 12 | 10 | 8 | 10 | 8 | 3/16 |
| | Over 36 inches to 54 inches | 12 | 10 | 8 | 12 | 10 | 8 | 10 | 8 | 3/16 | 9 | 3/16 | 1/4 |
| | 54 inches through 60 inches | 12 | 10 | 8 | 10 | 8 | | 9 | 3/16 | 1/4 | 8 | 1/4 | 1/4 |
| 70 inches or more, less than 90 inches | 36 inches or less | 12 | 10 | 8 | 12 | 10 | 8 | 10 | 8 | 3/16 | 9 | 3/16 | 1/4 |
| | 36 inches to 54 inches | 12 | 10 | 8 | 10 | 8 | 3/16 | 9 | 5/16 | 1/4 | 8 | 1/4 | 1/4 |
| | 54 inches through 60 inches | 10 | 8 | 3/16 | 9 | 3/16 | 1/4 | 8 | 1/4 | 1/4 | 3/16 | 1/4 | 5/16 |
| 90 inches or more, less than 125 inches | 36 inches or less | 12 | 10 | 8 | 10 | 8 | 3/16 | 9 | 3/16 | 1/4 | 1/4 | 8 | 1/4 |
| | 36 inches to 54 inches | 10 | 8 | 3/16 | 9 | 3/16 | 1/4 | 8 | 1/4 | 1/4 | 3/16 | 1/4 | 5/16 |
| | 54 inches through 60 inches | 9 | 3/16 | 1/4 | 8 | 1/4 | 1/4 | 3/16 | 1/4 | 5/16 | 3/16 | 1/4 | 5/16 |
| 125 inches or more | 36 inches or less | 10 | 8 | 3/16 | 9 | 3/16 | 1/4 | 8 | 1/4 | 1/4 | 3/16 | 1/4 | 5/16 |
| | 36 inches to 54 inches | 9 | 3/16 | 1/4 | 8 | 1/4 | 1/4 | 3/16 | 1/4 | 5/16 | 3/16 | 1/4 | 5/16 |
| | 54 inches through 60 inches | 8 | 1/4 | 1/4 | 3/16 | 1/4 | 3/16 | 5/16 | 1/4 | 5/16 | 1/4 | 5/16 | 3/8 |

(b) *Lining.* Except as provided in paragraph (c) of this section, cargo tanks shall be lined and the material used for lining each cargo tank subject to this specification shall be homogenous, nonporous, imperforate when applied, not less elastic than the metal of the tank proper, and substantially immune to attack by the commodities to be transported therein. It shall be directly bonded or attached by other equally satisfactory means. Joints and seams in the lining shall be made by fusing the material together, or by other equally satisfactory means.

(c) *Conditions under which tanks need not be lined.* Tanks need not be lined as provided in paragraph (b) of this section, if:

(1) The material of the tank is substantially immune to attack by the materials to be transported therein; or,

(2) The material of the tank is thick enough to withstand 10 years normal service without being reduced at any point to less thickness than that specified in paragraph (a) of this section corresponding to its type; or,

(3) The chemical reaction between the material of the tank and the commodity to be transported therein is such as to allow the tank to be properly passivated or neutralized and if the tank is not frequently cleaned and not used in the transportation of other commodities.

(d) *Minimum material thickness for reinforced plastic tanks.*

(1) The thickness of tank material authorized in §178.340-3 shall be such that the maximum allowable stress level in §178.340-4 is not exceeded and in no case shall the thickness be less than twice the minimum thickness specified for aluminum in Tables I and II.

(2) In the case of "sandwich" construction the thickness may be determined as the aggregate of all reinforced plastic layers which form an integral part of the load bearing wall as long as no layer is less than half the minimum thickness specified.

(3) In the case of separate, independent tank cells surrounded by rigid foam within an outer skin, the inner cell wall shall not be less than half the minimum thickness specified in paragraph (1) above. In addition, for such a style of construction, the outer skin shall not be less than the minimum thickness specified in (1) above.

**§178.343-3 Closure for manholes.**

(a) Each compartment shall be accessible through a manhole conforming to paragraph UG-46(g)(1) of the ASME Code. The manhole cover shall be designed to provide a secure closure of the manhole. All joints between manhole covers and their seats shall be tight against leakage of vapor and liquid. Gaskets, if used, shall be of suitable material not subject to attack by lading.

(1) The manhole cover shall have structural capability of withstanding internal fluid pressures equal to 1.5 times the design pressure of the tank and in no case less than 15 p.s.i.g. without permanent deformation. Safety devices to prevent the manhole and/or fill cover from opening fully when internal pressure is present shall be provided.

**§178.343-4 Vents.**

(a) *Safety vent.* Every cargo tank compartment shall be equipped with suitable pressure relief devices as required by the ASME Code, or shall be fitted with suitable rupture discs in lieu of mechanical pressure relief valves. Such discs shall be designed to rupture at not to exceed 1.5 times the design pressure of the tank. If air inlet devices are provided a relief valve shall have adequate capacity to limit tank pressure to 130 percent of design pressure at maximum inlet flow rate. Such maximum limits to be included on the metal certification plate §178.340-10(b). Air inlet lines if permanently connected to an air source shall be equipped with a check valve. Shutoff valves between the tank and relief valve or rupture disc are prohibited.

**§178.343-5 Outlets.**

(a) Each outlet at or near the top of a tank, used for discharge of lading, must be equipped with a shutoff valve located as close as practical to the point of outlet from the tank. Each such outlet having its discharge end below the top liquid level in the tank must be equipped with an additional shutoff valve, blank flange, or sealing cap at the discharge end of the outlet.

(b) Except as provided in paragraphs (c) and (d), of this section; each bottom outlet must be equipped with a shutoff valve designed, installed, and protected as follows:

(1) Product piping must be protected in such a manner as to reasonably assure against the accidental escape of contents. Such protection must be provided by:

(i) A shear section located out-board of each valve seat and within 4 inches of the vessel which will break under strain and leave the valve seat and its attachment to the vessel and the valve head intact and capable of retaining product. The shear section shall be machined in such a manner as to abruptly reduce the wall thickness of the adjacent piping (or valve) material by at least 20 percent; or

(ii) By suitable guards capable of absorbing a concentrated horizontal force of at least 8,000 pounds applied from any horizontal direction, without damage to the discharge piping which will adversely affect the product retention integrity of the discharge valve.

(2) Each bottom outlet valve must be located inside the tank or immediately adjacent at the outlet point outside the tank.

(i) The valve seat must be located inside the tank or within the welded flange, its companion flange, nozzle, or coupling at the point of outlet from the tank.

(ii) Each bottom discharge valve must be equipped with a remote means to activate a valve closure manually from a point no less than 10 feet away.

(3) In addition, a blank flange, sealing cap, or shutoff valve is required at the discharge end of the outlet.

(c) A bottom opening for purposes other than lading discharge may be closed by a bolted blank flange at the tank shell. If any piping extends from such an opening, it must be fitted with a shutoff valve designed, installed, and protected as described in papagraph (b)(1) of this section. In addition a supplemental closure is required at the discharge end of this piping.

(d) Bottom outlet valves need not meet paragraph (b)(1)(ii) of this section when the cargo tank is transporting a corrosive liquid containing solids in suspension in sufficient quantity that settling may form a layer of solid material that may interfere with sealing of the valve seat.

**§178.343-6 Gauging devices.**

(a) No applicable requirement.

**§178.343-7 Method of test.**

(a) *Test for leaks.* Every cargo tank shall be tested by completely filling the tank and dome with water or other liquid having a similar viscosity, the temperature of which shall not exceed 100°F during the test, and applying a pressure of 1.5 times the design pressure but not less than 3 p.s.i.g. The pressure shall be gauged at the top of the tank. The tank shall hold the prescribed pressure for at least 10 minutes without failure, undue distortion, leakage or evidence of impending failure. All closures shall be in place while test is made. During these tests, operative relief devices shall be clamped, plugged or otherwise rendered inoperative; such clamps, plugs, and similar devices shall be removed immediately after the test is finished.

(b) *Test for distortion or failure.* Every cargo tank shall be tested by the pressures prescribed in paragraph (a) of this section and shall withstand such pressures without undue distortion or other indication of impending failure. If there is undue distortion, or if failure impends or occurs, the cargo tank shall not be placed in or returned to service unless an adequate repair is made. The adequacy of the repair shall be determined by the same method of test.

(c) *Test of heating system.* After an interior heating system consisting of coil piping is installed, and before the tanks to which they are fitted are placed in service, the heating system shall be tested. Systems employing media such as steam or hot water under pressure for heating the contents of cargo tanks shall be tested with hydrostatic pressure and proved to be tight at 200 p.s.i.g.

(d) *When divided into compartments.* When the interior of the tank is divided into compartments, each compartment shall be tested as a separate tank.

## 5.9 Specification TC 341 Highway Tanks for the Transportation of Nonflammable Atmospheric Gases as Refrigerated Liquids

### 5.9.1 Definitions

The following definitions shall apply in this Clause:

**Design pressure** means the maximum allowable working pressure as used in the *ASME Boiler and Pressure Vessel Code,* and is the maximum gauge pressure at the top of the liquid container in its operating position and shall not be less than 174.3 kPa (25.3 psig).

**Design service temperature** means the minimum allowable temperature for which the liquid container is suitable as defined in Section UG-116 of the *ASME Boiler and Pressure Vessel Code.* The temperature shall be −196°C (−320°F). For helium, refrigerated liquid, the design service temperature shall be −269°C (−452°F).

**Design weight of lading** means the mass of the lading used in the design calculations for the liquid container, inner support system, outer shell, anchorage, etc. As a minimum it shall equal the actual mass of lading to be put in the highway tank, but it may exceed this so that the highway tank would be suitable for heavier ladings.

**Insulation** means a material of low thermal conductivity, surrounding the liquid container, which reduces the flow of heat to the liquid container. The associated insulation space may or may not be evacuated.

**Lading** means the refrigerated liquid being transported in the liquid container.

**Liquid container** means the inner tank (pressure vessel) which contains the lading.

**Outer shell** means the outer metal housing around the insulation. This housing protects the insulation from moisture. It is often the primary structural member that serves as the frame of the highway tank or is anchored to the frame of a truck.

**Pressure relief device** means a device intended to prevent rupture of a container, such as a liquid container or outer shell under certain conditions of exposure.

## 5.9.2 General

### 5.9.2.1 Liquid Container

#### 5.9.2.1.1

For design of the liquid container, the static head of the lading shall be added to the design pressure. If vacuum insulation is used, the liquid container shall be designed for a pressure of 101.3 kPa (14.7 psia) more than the design pressure plus the static head of the lading.

#### 5.9.2.1.2

The liquid (pressure) container shall be welded construction and be designed, constructed, inspected, tested, and stamped in accordance with and fulfill the requirements of the *ASME Boiler and Pressure Vessel Code.* The design shall include minimum static loadings defined in Clause 5.9.2.2.1 and shall be based on the use of maximum allowable stresses specified in the *ASME Boiler and Pressure Vessel Code* at room temperature 38°C (100°F) when pressurized without lading and at the design service temperature when fully loaded. The combination of the static loadings which could occur during transport shall be considered for different locations on the container.

#### 5.9.2.1.3

Local stresses in the shell at the inner support system shall be determined in accordance with Section UG-54 of the *ASME Boiler and Pressure Vessel Code,* Section VIII, Division 1, using the design pressure and loadings specified in Clause 5.9.2.2.1. The mass of the liquid container itself, the design mass of the lading, and articles supported by the liquid container shall be considered using the forces given in Clause 5.9.2.2.1. The allowable stress value for the combined membrane stresses shall not exceed the lower of 1.25 times the maximum allowable stress value as prescribed by the *ASME Boiler and Pressure Vessel Code,* Section VIII, Division 1, at a temperature of 38°C (100°F) or the maximum allowable stress value as prescribed by the *ASME Boiler and Pressure Vessel Code,* Section VIII, Division 1, at the design service temperature of the warmest refrigerated liquid for which the container is designed. If the combined stresses cannot be determined accurately, adequate factors of safety shall be applied.

#### 5.9.2.1.4

Metal less than 4.5 mm (0.177 in) thick may not be used for the shell or heads of a liquid container unless the container is enclosed in an evacuated or load bearing outer shell. Metal less than 2.5 mm (0.098 in) thick may not be used under any circumstances.

#### 5.9.2.1.5

Design details that permit the collection and retention of cleaning materials or contaminants shall be avoided. Designs that permit the flushing of all surfaces by the normal sloshing of the liquid are preferred.

### 5.9.2.2 Inner Support System

#### 5.9.2.2.1

The liquid container shall be supported within the outer shell by members designed to withstand static loadings, as a minimum, of

(a) vertical downward of 2
(b) vertical upward of 1.5
(c) longitudinal of 1.5
(d) lateral of 1.5

times the weight of the liquid container and attachments when filled to the design weight of lading using a safety factor of not less than 4 based on the room temperature minimum tensile strength of the material used.

#### 5.9.2.2.2

The design mass of lading used in determining the loadings in Clause 5.9.2.1 and Clause 5.9.2.2 shall be shown on the markings required by Clause 5.9.11.1(e) and on the certification documents required by Clause 5.9.12.

### 5.9.2.3 Insulation

The surface of the liquid container shall be insulated. Insulating material shall not be subject to corrosive attack by the expected contents of the tank. Insulating material for highway tanks for oxygen service shall not sustain combustion when contacted with a glowing platinum wire in a 99.5% oxygen atmosphere at atmospheric pressure. Containers so insulated shall be marked INSULATION FOR OXYGEN and all others marked with INSULATION NOT FOR OXYGEN in accordance with Clause 5.9.11.1(i).

### 5.9.2.4 Outer Shell

#### 5.9.2.4.1

The insulation shall be completely covered with a metal shell constructed and sealed so that moisture cannot come in contact with the insulation. Minimum metal thicknesses shall be as follows:

| Metal | Gauge | Evacuated | Not evacuated |
|---|---|---|---|
| Carbon steel | 12 | 2.40 mm (0.0946 in) | 1.72 mm (0.0677 in) |
| Stainless steel | 18 | 1.09 mm (0.0428 in) | 0.68 mm (0.0269 in) |
| Aluminum | | 3.18 mm (0.125 in) | 2.54 mm (0.100 in) |

#### 5.9.2.4.2

If a vacuum is maintained in the insulation space, the outer shell shall be designed for a minimum collapsing pressure of 206.8 kPa (30 psi) differential [103.4 kPa (15 psi) differential with a safety factor of 2]. All joint welds shall be made by welders certified by the Canadian Welding Bureau or equivalent.

#### 5.9.2.4.3

The following requirements shall apply:

(a) The cylindrical portion of the outer shell between stiffening rings shall have a critical collapsing pressure of at least 206.8 kPa (30 psi) as determined by the following equation:

$$P_c = [2.6E\ (t/D)^{2.5}]/[(L/D)-0.45(t/D)^{0.5}]$$

where

$P_c$ = critical collapsing pressure, kPa (psi)
E = modulus of elasticity of outer shell material, kPa (psi)
t = thickness of outer shell material, mm (in)
D = outside diameter of outer shell, mm (in)
L = distance between stiffening ring centers, mm (in)

**Note:** *The heads are considered as stiffening rings located one-third the head depth from the head tangent line.*

(b) If stiffening rings are used in designing the cylindrical portion of the outer shell for external pressure, each ring shall be attached to the outer shell by fillet welds. Outside stiffening ring attachment welds shall be continuous. Inside ring attachment welds may be intermittent. Where intermittent welds are used, the total length of welds on each side of the ring shall be at least one-third of the outer shell circumference or, if welded on one side, two-thirds of the outer shell circumference. The maximum spacing between intermittent welds attaching internal rings shall not exceed eight times the thickness of the shell to which they are attached. A portion of the outer shell may be included when calculating the moment of inertia of the ring. The effective width of outer shell plate, W, in mm (in) on each side of the attachment to the ring is given by the following equation:

$$W = 0.78\ (Rt)^{0.5}$$

where

R = outside radius of the outer shell, mm (in)
t = thickness of the outer shell material, mm (in)

(c) Where a stiffening ring consists of a closed section having two webs attached to the outer shell, the outer shell plate between the webs may be included up to the limit of twice the value of W as defined above. The flange of the section, if not a standard structural shape, shall be subject to the same limitation, with W based on R and t of the flange. Where two separate members, such as two angles, are located less than 2W apart they may be treated as a single stiffening ring (the maximum width of outer shell plate which may be considered effective is 4W). The closed section between an external ring and the outer shell shall be provided with a drain opening.

(d) Each stiffening ring shall have a minimum moment of inertia as determined by one of the following equations:

$I = 7.24D^3L/E$ (metric units)
$I = 1.05D^3L/E$ (conventional units)
$I' = 9.51D^3L/E$ (metric units)
$I' = 1.38D^3L/E$ (conventional units)

where

I = required moment of inertia of the stiffener itself about a centroidal axis parallel to the outer shell axis, $mm^4$ ($in^4$)

I' = required moment of inertia of the combined section of stiffener and effective width of outer shell plate about a centroidal axis parallel to the outer shell axis, $mm^4$ ($in^4$)

D = outside diameter of the outer shell, mm (in)

L = one-half the distance from the centerline of the stiffening ring to the next line of support on one side, plus one-half the distance from the centerline of the stiffening ring to the next line of support on the other side of the stiffening ring, both measured parallel to the axis of the outer shell (a line of support is either a stiffening ring meeting the requirements of this paragraph or a circumferential line on a head at one-third the depth of the head from the tangent line), mm (in)

E = modulus of elasticity of the stiffener material, kPa (psi)

(e) The outer shell heads on vacuum-insulated highway tanks shall be sufficiently thick to sustain a critical collapsing pressure of at least 206.8 kPa (30 psi) as determined by the following equation:

$P_c = 0.25E(t/R)^2$

where

$P_c$ = critical collapsing pressure, kPa (psi) (200 kPa min) (30 psi min.)

E = modulus of elasticity of head material, kPa (psi)

t = thickness of head material after forming, mm (in)

R = inside dish radius of head, mm (in). For ellipsoidal heads, $R = K_1Do$, where $K_1$ is established from Table UG-37 in the *ASME Boiler and Pressure Vessel Code*, and Do is the outside diameter of head.

### 5.9.2.4.4

A non-evacuated outer shell shall have circumferential reinforcement prescribed as follows:

(a) Ring stiffeners, heads, and bulkheads shall be located in such a manner that the maximum unreinforced portion of the outer shell is not more than 1524 mm (60 in).

(b) Ring stiffeners, when used to comply with this Clause, shall be continuous around the circumference of the outer shell and shall have a section modulus about the neutral axis of the ring section parallel to the shell at least equal to that determined by the following equations:

$\frac{I}{C}$ (min) = 0.00686 DL for steel (metric units)

$\frac{I}{C}$ (min) = 0.00027 DL for steel (conventional units)

$\frac{I}{C}$ (min) = 0.001186 DL for aluminum (metric units)

$\frac{I}{C}$ (min) = 0.000467 DL for aluminum (conventional units)

where

$\frac{I}{C}$ = section modulus, $mm^3$ ($in^3$)

D = outer shell diameter, mm (in)

L = ring spacing, ie, the maximum distance from the midpoint of the unsupported outer shell on one side of the ring stiffener to the midpoint of the unsupported outer shell on the opposite side of the ring stiffener, mm (in)

### 5.9.2.4.5

If a ring stiffener is welded to the outer shell (with each circumferential weld not less than 50% of the total circumference of the vessel and the maximum

unwelded space on this joint not exceeding 40 times the shell thickness), a portion of the outer shell may be considered as part of the ring section for purposes of computing the ring section modulus. The maximum portion of the shell to be used in these calculations shall be as follows:

| Circumferential ring stiffener to outer shell welds (number of sides) | Distance between parallel circumferential ring stiffener to outer shell welds | Outer shell section credit |
|---|---|---|
| 1 | | 20t |
| 2 | less than 20t | 20t + $L_1$ |
| 2 | 20t or more | 40t |

where

t = outer shell thickness, mm (in)

$L_1$ = distance between parallel circumferential ring stiffener to outer shell welds, mm (in)

### 5.9.2.4.6

If the configuration of the internal or external ring stiffener encloses an air space, this air space shall be arranged for venting and be equipped with drainage facilities which shall be kept operative at all times.

### 5.9.2.4.7

When load rings in the outer shell are used for supporting the liquid container, they shall be designed to carry the combination of the static loadings specified in Clause 5.9.2.2.1 which could occur during transport. Where loads are applied to the outer shell stiffening rings from the support system used to support the inner container within the outer shell, 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. Loads applied directly to the outer shell or outer head shall be analyzed in accordance with Appendix G of the *ASME Boiler and Pressure Vessel Code.*

### 5.9.2.4.8

If the outer shell constitutes in whole or in part a structural member used in lieu of the frame of the vehicle, it shall conform to Clause 5.9.7.2.

## 5.9.3 Materials

### 5.9.3.1 Liquid Container

All materials used for the construction of the liquid container and its appurtenances that may come in contact with the lading shall be suitable for use with the lading to be transported. All materials used for the liquid container pressure parts shall conform to the *ASME Boiler and Pressure Vessel Code* in all respects.

### 5.9.3.2 Others

All tie rods, mountings, and other appurtenances within the outer shell and all piping, fittings, and valves shall be of materials suitable for use at the lowest temperature to be encountered. For highway tanks to be used in oxygen service the outer shell shall be of steel.

### 5.9.3.3 Cleaning

Surfaces of the liquid container, associated valves, pumps, piping, etc, that will contact the lading to be transported shall be suitably cleaned of contaminants for the service intended. Tanks constructed for oxygen service shall be cleaned and inspected for cleanliness employing appropriate methods described in CGA Pamphlet G-4.1.

## 5.9.4 Joints

### 5.9.4.1 General

All joints for the liquid container shall be as required by the *ASME Boiler and Pressure Vessel Code.*

### 5.9.4.2 Welding

Welding procedure specifications, procedure qualification records, and welder qualification tests including qualification renewals shall be in accordance with Section IX of the *ASME Boiler and Pressure Vessel Code.*

### 5.9.4.3 Location

All longitudinal welds in liquid containers and a load-bearing outer shell shall be so located as not to intersect supports other than load rings and stiffening rings.

### 5.9.4.4 Attachments

The substructure shall be properly fitted before attachment, and the welding sequence shall be such as to minimize stresses due to the shrinkage of the weld.

### 5.9.5 Piping and Controls

#### 5.9.5.1 Manholes

Any tank to be used in oxygen service shall be provided with a manhole as prescribed in paragraph §178.338-6 in Specification TC 338.

#### 5.9.5.2 Outlets

With the exception of gauging devices, pressure relief devices, manual vents, and pressure control valves or devices, each opening in the liquid container shall be closed with a plug, cap, bolted flange or plate, or provided with a valve conforming to Clause 5.9.5.5.

#### 5.9.5.3 Discharge Control (Shut-Off Valves)

Each liquid filling and liquid discharge line shall be provided with a manually operable shut-off valve located as close to the tank as is practicable.

#### 5.9.5.4 Pressure Relief Devices

#### 5.9.5.4.1 Liquid Container

Pressure relief devices shall be provided for the liquid container in accordance with CGA Pamphlet S-1.2, Part 2. In addition, the following requirements shall apply:

(a) Each liquid container shall be protected by a pressure relief system comprising a primary system of one or more pressure relief valves and a secondary system of one or more pressure relief valves or frangible discs.

(b) For liquid containers in oxygen service the primary and secondary relief systems shall each have at least a flow capacity as calculated from the applicable formula in Clause 5.3 of CGA Pamphlet S-1.2.

(c) For liquid containers in other than oxygen service the pressure relief system shall have at least a flow capacity as calculated from the applicable formula in Section 5.3 of CGA pamphlet S-1.2.

(d) The primary relief system shall have a set pressure not higher than the design pressure. The secondary relief system shall commence to function between 130% and 150% of design pressure.

(e) Pressure relief devices shall be installed so as to have direct communication with the vapor space of the liquid container near the mid-point of the top centerline and so installed and located that the cooling effect of the contents will not prevent effective operation of the device.

(f) Connections to pressure relief devices including entrance and exit piping shall be of sufficient size to provide the required rate of discharge through the pressure relief devices.

(g) The liquid container may be equipped with pressure control valves conforming to the above.

#### 5.9.5.4.2 Outer Shell

The outer shell shall be protected by a suitable pressure relief device to release internal pressure. The discharge area of this device shall be at least 0.34 $mm^2/kg$ (0.00024 $in^2/lb$) of the water capacity of the liquid container. This relief device shall function at a pressure not exceeding the internal design pressure of the outer shell, calculated in accordance with the *ASME Boiler and Pressure Vessel Code,* or 172 kPa (25 psig), whichever is less.

#### 5.9.5.5 Piping, Valves, and Fittings

#### 5.9.5.5.1

Welded pipe joints shall be used wherever possible. Where copper tubing is permitted, joints shall be brazed or made with equally strong metal unions. Metal unions shall not decrease the strength of the tubing, eg, by cutting threads or grooves. The melting point of brazing material shall be no lower than 538°C (1000°F). The materials used in valves and fittings shall be suitable for use at the temperature of the lading.

#### 5.9.5.5.2

The bursting strength of all pipe, fittings, and hose shall be at least four times the design pressure of the liquid container and not less than four times the pressure to which it may be subjected in service by the action of a pump or other device, the action of which may subject portions of the piping to pressures greater than the tank's design pressure.

#### 5.9.5.5.3

Each valve shall be designed and constructed for a rated pressure not less than the tank's design pressure at the coldest temperature expected to be encountered.

#### 5.9.5.5.4

Valve parts or fitting parts made of aluminum that are subject to internal rubbing or abrasion in normal service shall not be used with oxygen.

#### 5.9.5.5.5

An aluminum valve, pipe, or fitting, external to the jacket that retains lading during transportation, shall not be installed on any highway tank used to transport oxygen.

#### 5.9.5.5.6

Suitable provisions shall be made to prevent damage to piping due to thermal expansion and contraction, jarring, and vibration.

#### 5.9.5.5.7

All pipe, valves, fittings, and hose on every tank shall be proved free from leaks at not less than the design pressure of the tank.

#### 5.9.5.5.8

Piping shall be grouped and protected from damage as required by Clause 5.9.6.

#### 5.9.5.5.9

Each portion of liquid piping or hose which can be closed at both ends shall be provided with a pressure relief valve without an intervening shut-off valve.

#### 5.9.5.5.10

Wherever a pressure building coil is used on a highway tank, the vapour connection to the coil shall be provided with a valve or check valve. The liquid connection to the coil shall be provided with a shut-off valve. All such valves shall be as close to the tank as practicable to prevent loss of lading in case of damage during transportation.

### 5.9.6 Protection of Piping, Valves, and Fittings

#### 5.9.6.1 General

All pressure relief devices and their inlet piping and all valves, fittings, and other accessories which are in communication with the liquid container without intervening shut-off valves or check valves shall be installed within the road vehicle framework or within a suitable protective device or housing, and appropriate ventilation shall be provided. Pressure relief devices shall be protected so that in the event of the upset of the vehicle onto a hard surface, their opening will not be prevented and their discharge will not be restricted. Every part of the loaded highway tank and any associated valve or pipe, enclosure, or protective device or structure (exclusive of the wheel assemblies) shall be at least 360 mm (14 in) above level ground.

#### 5.9.6.2 Mid-tank Piping

Piping and valves subject to liquid container pressure during transportation that are not located at the rear of the tank and within the projection of the highway tank's circumference and the vehicle frame, or that do not have intervening shut-off valves or check valves located within the motor vehicle framework, shall be protected by a protective device or housing. Unless the valve is located in a rear cabinet forward of and protected by the rear bumper, paragraph §178.338-12 of Specification TC 338 shall apply.

#### 5.9.6.3 Protective Housing

The protective devices or housing and their attachments to the vehicle structure shall be designed to withstand static loading in any direction in which they may be loaded as a result of a front, rear, side or sideswipe collision, or the overturn of the vehicle. The static loading shall be equal to twice the mass of the tank and attachments when the tank is filled with the lading. The strength of this device or housing and its attachment to the vehicle structure shall be based on 25% of the ultimate strength of the material.

#### 5.9.6.4 Rear Bumper

Each highway tank shall be provided with at least one rear bumper complying with paragraph §178.338.10(c) in Specification TC 338.

### 5.9.7 Supports and Anchoring

#### 5.9.7.1 Highway Tank with Frame

Each highway tank supported by a frame not made integral with the outer shell as by welding, shall be provided with positive restraining devices for drawing the highway tank down tight on the frame without introducing undue concentration of stresses. In addition, suitable stops or anchors shall be attached either to the frame or to the outer shell to prevent relative motion between them which may result from the starting, stopping, and turning of the vehicle. The stops and anchors shall be so installed as to be readily accessible for inspection and maintenance. The stops and anchors and their attachments to the frame and outer shell shall be capable of withstanding the combination of static loadings required by Clause 5.9.7.2 which could occur during transport.

### 5.9.7.2 Frameless Highway Tank

#### 5.9.7.2.1

A highway tank constructed so that the outer shell constitutes, in whole or in part, the structural member used in place of a structural frame of a vehicle shall have the highway tank supported by external cradles or other suitable supporting devices such as load rings. Design for supports, load-bearing outer shell and liquid container support attachments to the outer shell head shall take into account the beam stresses, shear stresses, torsion stresses, bending moments, and acceleration stresses for the loaded vehicle as a whole and shall include the combination of the static loadings in Clause 5.9.2.2.1 which could occur during transport. Cradles used without other stiffening means shall subtend at least 120° of the circumference to which they are attached.

#### 5.9.7.2.2

Attachments of the outer shell to the suspension system shall be designed to withstand the combination of the following static loadings which could occur during transport:

(a) vertical downward of 2
(b) vertical upward of 2
(c) longitudinal of 2
(d) lateral of 2

times the mass of the highway tank and its attachments when filled to the design mass of lading. The combined stresses, including thermal stresses induced into the supports, their attachments, and the outer shell shall not exceed 25% of the minimum tensile strength at room temperature of the material used. The effects of fatigue shall be considered in the calculation. All attachments of supports to inner vessels and to load-bearing outer shells shall be by means of pads of material similar to that of the inner vessel or outer shell respectively, by load rings, or by bosses so designed or gussetted as to distribute the load. The pad arrangement shall be as required in paragraph §178.338-13(a) of Specification TC 338.

### 5.9.8 Gauging Devices

### 5.9.8.1 Level Gauging Devices

#### 5.9.8.1.1

Each highway tank, except highway tanks filled by mass, shall be equipped with one or more gauging devices to indicate the maximum permitted liquid level. Gauging devices may be a fixed-length dip tube or differential pressure liquid level gauge.

#### 5.9.8.1.2

The volume setting of a fixed-length dip tube shall be indicated in a visible location at or adjacent to the valve.

#### 5.9.8.1.3

The design pressure of each liquid level gauging device shall be no lower than that of the liquid container.

#### 5.9.8.1.4

A liquid level gauging device used as a primary control for filling shall be designed and installed to indicate the maximum allowed filling level with the highway tank parked on a level surface.

### 5.9.8.2 Pressure Gauges

All highway tanks shall be provided with a pressure gauge located in the operating compartment. A shut-off valve shall be installed between the gauge and the highway tank.

### 5.9.8.3 Vacuum Gauges

Each vacuum-insulated highway tank shall be provided with a connection for a vacuum gauge to the insulation space.

### 5.9.9 Pumps

Liquid pumps, if used, shall be of suitable design and protected in accordance with Clause 5.9.6. Parts made of aluminum which are subject to internal rubbing or abrasion in normal service shall not be used with liquid oxygen ladings. They may be driven by road vehicle power take-off or other mechanical, electrical, or hydraulic means. The downstream piping shall be protected from over pressure.

### 5.9.10 Inspection and Testing

### 5.9.10.1 General

Inspection of materials of construction of the liquid container and its appurtenances, excluding the outer shell, shall be as required by the *ASME Boiler and Pressure Vessel Code*. The liquid container shall be subjected to either a hydrostatic or a pneumatic test in accordance with the *ASME Boiler and Pressure Vessel Code*.

### 5.9.10.2 Piping and Appurtenances

Piping and appurtenances shall be tested to at least line operating pressure.

### 5.9.11 Marking of Tanks

#### 5.9.11.1

A code plate with the markings required by the *ASME Boiler and Pressure Vessel Code* under which the liquid container was constructed, and a corrosion resistant metal name plate shall be permanently affixed by brazing, welding, or riveting to the outer shell in a readily visible location. The name plate shall be plainly marked by stamping, embossing, or other means of forming characters not less than 5 mm (3/16 in) into the metal of the plate. The plate shall be marked with the following information (parenthetical abbreviations may be used):

(a) TC specification number (TC-341);
(b) tank manufacturer (Tank Mfr);
(c) manufacturer's serial number (S/N);
(d) date of manufacture (Date of Mfr);
(e) design mass of lading _____ kg (design weight of lading _____ lb);
(f) water capacity (W. Cap _____ kg (lb)) which shall be based on the density of water [(0.9980 kg/L) (8.32828 lb/US gallon)] with the liquid container at its design service temperature after deduction for the volume above the inlet of the pressure relief or pressure control valve;
(g) design service temperature (Design Service Temp.) _____ °C (°F);
(h) original test date (Orig. Test Date);
(i) insulation for oxygen or insulation not for oxygen;
(j) the Canadian Registration Number (CRN) of the pressure vessel design as provided by the province of principal use and others with whom the design is registered;
(k) the Vehicle Identification Number (VIN).

#### 5.9.11.2

Highway tanks for use in Canada shall be marked in SI (metric) units.

### 5.9.12 Certification

#### 5.9.12.1 General

For each highway tank, the highway tank vehicle manufacturer shall supply and the owner shall obtain the following:

(a) The affidavit of manufacture or other document required under the Pressure Vessels Act of the Province of principal use. Where a highway tank is to operate interprovincially, the affidavit shall be for the province of principal use but the Canadian Registration Number (CRN) shall show design approval by all provinces in which the highway tank will operate.

(b) A certificate stating that the highway tank is in compliance with the specification and the applicable Codes. The certificate shall be signed by a responsible person for the highway tank vehicle manufacturer. The certificate shall state whether it includes certification that all valves, piping, and protective device comply with the specification. In the case of a highway tank manufactured in two or more stages, each manufacturer who performs a manufacturing operation on the incomplete vehicle, or portion thereof, shall furnish to the succeeding manufacturer, at or before the time of delivery, a certificate covering the particular operation performed by that manufacturer. The certificates shall include sufficient information such as sketches, drawings, or other clear descriptions of the particular work performed by that manufacturer. Each certificate shall be signed by an official of the manufacturing firm responsible for the portion of the completed highway tank vehicle represented thereby, such as basic highway tank fabrication, insulation, jacket, or piping.

(c) A photograph, pencil rub, or other facsimile of the plates required in Clause 5.9.11.

#### 5.9.12.2 Retention

The owner shall retain a copy of the documents referred to in Clause 5.9.12.1 and related papers in his file throughout his ownership of the highway tank and for at least 1 year thereafter. In the event of change in ownership, retention by the prior owner of non-fading, photographically reproduced copies will be deemed to satisfy this requirement. Each motor carrier using the highway tank, if not the owner thereof, shall obtain a copy of the documents referred to in Clause 5.9.12.1 and retain them in his files during the period he uses the highway tank and for at least 1 year thereafter.

## 5.10 Specification TC 350 Highway Tanks for the Transportation of Dangerous Wastes

**Note:** *Specification TC 350 tanks are intended for the transportation of dangerous wastes where the use of TC 306, TC 307, or TC 312 tanks is impractical or inappropriate.*

### 5.10.1 General

#### 5.10.1.1

Specification TC 350 highway tanks shall comply with the general design and construction requirements in Clauses 5.1 and 5.5 in addition to the specific requirements contained in this Clause.

### 5.10.1.2

Highway tanks built to this specification shall be designed to operate both with an internal pressure (design pressure) of not less than 100 kPa (14.5 psig) and a full 100 kPa (14.5 psi) vacuum. In addition
(a) for design pressures exceeding 100 kPa (14.5 psig), the tank shall be designed and constructed in accordance with and shall fulfill the requirements of the *ASME Boiler and Pressure Vessel Code;*
(b) no tank shall have head, bulkhead, and baffle or shell thicknesses less than those specified in Clause 5.10.2.1.1, Tables 5.1 and 5.2; and
(c) the spacing of bulkheads, baffles, or shell stiffeners shall not exceed the requirements specified in paragraph §178.340-7.

### 5.10.1.3

The design pressure shall be not less than pressure used for unloading.

### 5.10.1.4

Tanks shall be of circular cross-section.

**Note:** *A non-ASME Code tank is permitted only if it has a design pressure (maximum allowable working pressure) of exactly* 100 kPa *(14.5 psig).*

## 5.10.2 Thickness of Shell, Heads, Bulkheads, and Baffles of the Non-ASME Code Tanks

### 5.10.2.1 Material Thickness

### 5.10.2.1.1

Minimum material thicknesses for highway tanks constructed of Mild Steel (MS), High Strength Low Alloy Steel (HSLA), Austenitic Stainless Steel (SS), and Aluminum Alloy 5454-H32 (AL) shall be in accordance with Tables 5.1 and 5.2.

### 5.10.2.1.2

Both the minimum design thicknesses of heads and shells and the actual thicknesses shall be marked on the certification plate for the tank.

### 5.10.2.2 Lining

Except as permitted in Clause 5.10.2.3, highway tanks shall be lined and the material used for lining each highway tank shall be homogeneous, nonporous, imperforate when applied, not less elastic than the metal of the tank proper, and substantially immune to attack by the commodities to be transported therein. It shall be directly bonded or attached by other equally satisfactory means. Joints and seams in the lining shall be made by fusing the material together, or by other equally satisfactory means.

### 5.10.2.3 Conditions Under Which Tanks Need Not be Lined

Tanks need not be lined as provided in Clause 5.10.2.2 where
(a) the material of the tank is substantially immune to attack by the materials to be transported therein; or
(b) the material of the tank is thick enough to withstand 10 years of normal service without being reduced at any point to less thickness than that specified in Clause 5.10.2.1; and
(c) the chemical reaction between the material of the tank and the commodity to be transported therein is such as to allow the tank to be properly passivated or neutralized, and if the tank is not frequently cleaned and not used in the transportation of other commodities.

## 5.10.3 Closure for Manholes

### 5.10.3.1

Each compartment shall be accessible through a 380 mm (15 in) minimum inside diameter manhole. The manhole cover shall be designed to provide a secure closure of the manhole. All joints between manhole covers and their seats shall be made tight against leakage of vapor and liquid at 1.5 times the design working pressure. Gaskets, if used, shall be of suitable material not subject to attack by the lading.

### 5.10.3.2

Manhole covers shall have structural capability of withstanding internal fluid pressures equal to 1.5 times the design pressure of the tank and in no case less than 152 kPa (22 psig) without permanent deformation. Safety devices shall be provided to prevent the manhole and/or fill cover from opening fully when internal pressure is present.

### 5.10.3.3

Full opening heads are permitted and shall have the structural capability of withstanding 1.5 times the design working pressure without permanent deformation or leakage.

## Table 5.1
## Minimum Thickness of Heads and Bulkheads
## Mild Steel (MS), High Strength Low Alloy Steel (HSLA), Austenitic Stainless Steel (SS), and Aluminum Alloy 5454-H32 (AL) in US Standard Gauge unless otherwise expressed in mm (fractions of an inch)

| **Volume capacity of tank in litres per 6.7 mm of length** | **255 mm or less** | | | **Over 255 to 355 mm** | | | **355 to 455 mm** | | | **455 to 560 mm** | | | **560 to 660 mm** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type of steel | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL |
| Thickness in mm when crown radius ≤ tank OD and knuckle radius ≥6% of tank OD | 10 | 12 | 4.37 | 8 | 11 | 4.76 | 7 | 10 | 4.76 | 4.76 | 10 | 6.35 | 6.35 | 8 | 6.35 |
| Thickness in mm when crown radius > tank OD and/or knuckle radius <6% of tank OD | 8 | 11 | 4.76 | 6.35 | 8 | 6.35 | 6.35 | 4.76 | 6.35 | 6.35 | 4.76 | 7.94 | 7.94 | 6.35 | 7.94 |

| **Volume capacity of tank in US gallons per inch of length** | **10 or less** | | | **Over 10 to 14** | | | **14 to 18** | | | **18 to 22** | | | **22 to 26** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type of steel | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL |
| Thickness in inches when crown radius ≤ tank OD and knuckle radius ≥6% of tank OD | 10 | 12 | 11/64 | 8 | 11 | 3/16 | 7 | 10 | 3/16 | 3/16 | 10 | 1/4 | 1/4 | 8 | 1/4 |
| Thickness in inches when crown radius > tank OD and/or knuckle radius <6% of tank OD | 8 | 11 | 3/16 | 1/4 | 8 | 1/4 | 1/4 | 3/16 | 1/4 | 1/4 | 3/16 | 5/16 | 5/16 | 1/4 | 5/16 |

**Note:** *Heads with a depth less than 10% of tank OD are not permitted.*

## Table 5.2
## Minimum Thickness of Shell Sheets
## Mild Steel (MS), High Strength Low Alloy Steel (HSLA), Austenitic Stainless Steel (SS), and Aluminum Alloy 5454-H32 (AL) in US Standard Gauge unless otherwise expressed in mm (fractions of an inch)

| **Volume capacity of tank in litres per 6.7 mm of length** | | **255 mm or less** | | | **Over 255 to 355 mm** | | | **355 to 455 mm** | | | **455 to 560 mm** | | | **560 to 660 mm** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type of steel | | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL |
| Distance between bulkheads, baffles or ring stiffeners | 915 mm or less | 8 | 8 | 6.35 | 8 | 8 | 6.35 | 7 | 7 | 7.94 | 4.76 | 4.76 | 7.94 | 6.35 | 6.35 | 7.94 |
| | Over 915 to 1220 mm | 7 | 8 | 6.35 | 4.76 | 4.76 | 7.94 | 6.35 | 6.35 | 7.94 | 6.35 | 6.35 | 9.53 | 6.35 | 6.35 | 9.53 |
| | Over 1220 mm through 1525 mm | 7 | 7 | 7.94 | 6.35 | 6.35 | 7.94 | 6.35 | 6.35 | 9.53 | 6.35 | 6.35 | 9.53 | 6.35 | 6.35 | 9.53 |

| **Volume capacity of tank in US gallons per inch of length** | | **10 or less** | | | **Over 10 to 14** | | | **14 to 18** | | | **18 to 22** | | | **22 to 26** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type of steel | | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL | MS | HSLA, SS | AL |
| Distance between bulkhead, baffles or ring stiffeners | 36 in or less | 8 | 8 | 1/4 | 8 | 8 | 1/4 | 7 | 7 | 5/16 | 3/16 | 3/16 | 5/16 | 1/4 | 1/4 | 5/16 |
| | Over 36 to 48 in | 7 | 8 | 1/4 | 3/16 | 3/16 | 5/16 | 1/4 | 1/4 | 5/16 | 1/4 | 1/4 | 3/8 | 1/4 | 1/4 | 3/8 |
| | Over 48 through 60 in | 7 | 7 | 5/16 | 1/4 | 1/4 | 5/16 | 1/4 | 1/4 | 3/8 | 1/4 | 1/4 | 3/8 | 1/4 | 1/4 | 3/8 |

### 5.10.4 Vents

#### 5.10.4.1 Safety Relief Devices

Each highway tank compartment shall be provided with safety relief devices. All such devices shall communicate with the vapor space. Shut-off valves shall not be installed between the tank opening and any safety device. Safety relief devices shall be so mounted, shielded, or drained as to eliminate the accumulation of water, if freezing of the devices could impair the operation or discharge capability of the device.

#### 5.10.4.2 Total Capacity

Every highway tank compartment shall be provided with one or more devices with sufficient capacity to limit the tank's internal pressure to a maximum of 130% of the tank design pressure. This total venting capacity shall be not less than that determined from Table 5.3, using the external surface of the highway tank or tank compartment as the exposed area.

#### 5.10.4.3 Pressure-Actuated Venting (Spring Loaded)

Every highway tank compartment shall be equipped with pressure-actuated vent or vents set to open at not less than the tank design pressure. The minimum venting capacity for pressure-actuated vents shall be 340 $m^3$ (12 000 $ft^3$) free air/h at 100 kPa and 15°C (14.7 psia and 60°F) per compartment or 340 $m^3$ (12 000 $ft^3$) free air/h at 100 kPa and 15°C (14.7 psia and 60°F) for each 33 $m^2$ (350 $ft^2$) of exposed tank area, whichever is greater. This minimum capacity shall be measured at a pressure of 130% of the tank design pressure. Pressure-actuated devices shall be designed to function in case of pressure rise when in any condition of roll over attitude. If pressure (maximum limits to be included on the metal certification plate stipulated in §178.340-10(b)) unloading devices are provided, the relief valve shall have sufficient capacity to limit the tank internal pressure to 130% of design pressure.

#### 5.10.4.4 Frangible Venting

If the pressure-actuated venting required by Clause 5.10.4.3 does not provide the total venting capacity required by Clause 5.10.4.2, additional capacity shall be provided by adding frangible venting devices. The bursting pressure of frangible devices shall be not less than 130% nor more than 150% of the tank design pressure.

#### 5.10.4.5 Flow Testing and Marking of Vents

Each type and size of venting device shall be flow tested in the ranges specified in the applicable preceding clauses. The actual rated flow capacity of the vent in $m^3$ ($ft^3$) of free air per hour at the pressure in kPa (psig) at which the flow capacity is determined shall be stamped on the device. These flow tests may be conducted by the manufacturer or may be delegated to a certified agency.

### 5.10.5 Outlets

#### 5.10.5.1

All outlets (excluding full opening heads and manholes) shall be equipped with a shut-off valve located as close as possible to the tank with a minimum of piping between the tank and the valve.

#### 5.10.5.2

All such valves shall be protected by

(a) a shear section located out-board of each valve seat and within 100 mm (4 in) of the vessel, which shall break under strain and leave the valve seat and its attachment to the vessel and the valve head intact and capable of retaining product (the shear section shall be machined in such a manner as to abruptly reduce the wall thickness of the adjacent piping (or valve) material by at least 20%); or

(b) by suitable guards capable of absorbing a concentrated horizontal force of at least 200 kN (45 000 lbf) applied from any horizontal direction, without damage to the discharge piping that will adversely affect the product retention integrity of the discharge valve.

#### 5.10.5.3

In addition, a blank flange, sealing cap, or shut-off valve shall be provided at the discharge end of the outlet.

#### 5.10.5.4

A bottom opening for purposes other than lading discharge may be closed by a bolted blank flange at the tank shell. If any piping extends from such an opening, it shall be fitted with a shut-off valve designed, installed, and protected as described in Clause 5.10.5.2. In addition, a supplemental closure shall be provided at the discharge end of this piping.

## Table 5.3
## Minimum Emergency Vent Capacity in $m^3$ Free Air/Hour (100 kPa and 15°C)

| Exposed area, $m^2$ | $m^3$ free air per hour | Exposed area, $m^2$ | $m^3$ free air per hour |
|---|---|---|---|
| 1 | 240 | 19 | 4 570 |
| 2 | 480 | 20 | 4 810 |
| 3 | 720 | 25 | 5 900 |
| 4 | 960 | 30 | 6 630 |
| 5 | 1 200 | 35 | 7 700 |
| 6 | 1 440 | 40 | 7 800 |
| 7 | 1 680 | 45 | 8 430 |
| 8 | 1 920 | 50 | 8 830 |
| 9 | 2 160 | 55 | 9 280 |
| 10 | 2 400 | 60 | 9 780 |
| 11 | 2 640 | 65 | 10 300 |
| 12 | 2 880 | 70 | 10 660 |
| 13 | 3 130 | 75 | 11 200 |
| 14 | 3 370 | 80 | 11 580 |
| 15 | 3 610 | 85 | 11 910 |
| 16 | 3 850 | 90 | 12 340 |
| 17 | 4 090 | 95 | 12 880 |
| 18 | 4 330 | 100 | 13 400 |

## Minimum Emergency Vent Capacity in $ft^3$ Free Air/Hour (14.7 psia and 60°F)

| Exposed area, $ft^2$ | $ft^3$ free air per hour | Exposed area, $ft^2$ | $ft^3$ free air per hour |
|---|---|---|---|
| 20 | 15 800 | 275 | 214 300 |
| 30 | 23 700 | 300 | 225 100 |
| 40 | 31 600 | 350 | 245 700 |
| 50 | 39 500 | 400 | 265 000 |
| 60 | 47 400 | 450 | 283 200 |
| 70 | 55 300 | 500 | 300 600 |
| 80 | 63 300 | 550 | 317 300 |
| 90 | 71 200 | 600 | 333 300 |
| 100 | 79 100 | 650 | 348 800 |
| 120 | 94 900 | 700 | 363 700 |
| 140 | 110 700 | 750 | 378 200 |
| 160 | 125 500 | 800 | 392 200 |
| 180 | 142 300 | 850 | 405 900 |
| 200 | 158 100 | 900 | 419 300 |
| 225 | 191 300 | 950 | 432 300 |
| 250 | 203 100 | 1 000 | 445 000 |

**Note:** *Interpolate for intermediate sizes.*

### 5.10.6 Gauging Devices

Where gauge glasses are necessary, they shall be of the porthole type and shall be protected by a safety cap when not in use.

### 5.10.7 Method of Test

#### 5.10.7.1 Test for Leaks

Every highway tank shall be tested (and retested) by completely filling the tank and dome with water or other liquid having a similar viscosity, the temperature of which shall not exceed 38°C (100°F) during the test, and applying a pressure of 1.5 times the design pressure but not less than 155 kPa (22.5 psig). The pressure shall be gauged at the top of the tank. The tank shall hold the prescribed pressure for at least 10 min without failure, undue distortion, leakage, or evidence of impending failure. All closures shall be in place while the test is made. During these tests, operative relief devices shall be clamped, plugged, or otherwise rendered inoperative. Such clamps, plugs, and similar devices shall be removed immediately after the test is finished.

#### 5.10.7.2 Test for Distortion or Failure

Every highway tank shall be tested to the pressures prescribed in Clause 5.10.7.1 and shall withstand such pressures without undue distortion or other indication of impending failure. If there is undue distortion or if failure impends or occurs, the tank shall not be placed in or returned to service unless an adequate repair is made. The adequacy of the repair shall be determined by the same method of test.

#### 5.10.7.3 Test of Heating System

After an interior heating system consisting of coil piping is installed, and before the tanks to which they are fitted are placed in service, the heating system shall be tested. Systems employing media such as steam or hot water under pressure for heating the contents of highway tanks shall be tested with hydrostatic pressure and proved to be tight at 1380 kPa (200 psig).

#### 5.10.7.4 When Divided into Compartments

When the interior of the tank is divided into compartments, each compartment shall be tested as a separate tank.

### 5.10.8 Inspection, Retesting, and Maintenance

Tanks shall be inspected and maintained in accordance with Clause 8, except that the hydrostatic or pneumatic retest shall be carried out at intervals not exceeding 2 years.

## 6. Specifications for Steel Portable Tanks

### 6.1 Requirements for All Steel Portable Tanks

#### 6.1.1 Means of Containment

Portable tanks used for the shipment of dangerous goods by road shall, unless otherwise specified, meet all of the following design and construction criteria:

(a) Welding and brazing shall be performed in a workmanlike manner using suitable and appropriate techniques, materials, and equipment.

(b) Materials of construction and tank contents shall be such that there will be no significant chemical or galvanic reaction, among any of the materials in the package.

(c) Closures shall be adequate to prevent inadvertent leakage of the contents under normal conditions incident to transportation.

(d) Gasketed closures shall be fitted with gaskets of efficient material that will not be deteriorated by the contents of the container.

#### 6.1.2 Piping, Valves, and Fittings

##### 6.1.2.1

The bursting strength of any piping or fitting shall be not less than four times the design pressure of the tank, and not less than four times that pressure to which, in any instance, it may be subjected in service, by the action of a pump or other device (not including safety relief valves) the action of which may be to subject certain portions of the tank piping to pressures greater than the design pressure of the tank.

##### 6.1.2.2

Welded pipe joints shall be used wherever possible. Joints in copper tubing where permitted shall be of the brazed type or of any equally strong metal union type. The melting point of brazing material must be not less than 535°C (1000°F). Such joints shall

in any event be of such a character as not to decrease the strength of the tubing, as by the cutting of threads.

### 6.1.2.3

Fittings shall be extra heavy. Non-malleable metals shall not be employed in the construction of valves or fittings.

### 6.1.2.4

Suitable provision shall be made to allow for expansion, contraction, jarring, and vibration of all pipe. Slip joints shall not be used for this purpose.

### 6.1.2.5

Piping and fittings shall be grouped in the smallest practicable space and shall be protected from damage as required by the specification.

### 6.1.2.6

All piping, valves, and fittings on every tank shall be leakage tested with gas or air after installation and proved tight at not less than the design pressure of the tank on which they are used. In the event of replacement, all such piping, valves, or fittings so replaced shall be tested in accordance with this requirement before the tank is returned to transportation service. This requirement shall apply to all hose used on such tanks, except that such hose may be so tested either before or after installation on the tank.

## 6.1.3 Steel Portable Tanks for the Transport of Compressed Gases

### 6.1.3.1

Portable tanks, except those filled by weight, shall be equipped with one or more gauging devices which indicate accurately the maximum permitted liquid level. Additional gauging devices may be installed but may not be used as primary controls for filling of portable tanks. Gauge glasses are not permitted on portable tanks.

### 6.1.3.2

If the primary gauging device is adjustable, it shall be capable of adjustment so that the end of the tube will be in the location specified in Clause 6.1.3.3 for at least one of the ladings to be transported, at the filling level corresponding to an average loading temperature. Exterior means shall be provided to indicate this adjustment. The gauging device shall be legibly and permanently marked in increments not exceeding 11°C (26°F) (or not exceeding 112 kPa (25 psig) on tanks for carbon dioxide or nitrous oxide), to indicate the maximum levels to which the tank may be filled with liquid at temperatures above −8°C (20°F). However, if it is not practicable to so mark the gauging device, this information shall be legibly and permanently marked on a plate affixed to the tank adjacent to the gauging device.

### 6.1.3.3

A dip tube gauging device shall consist of a pipe or tube with a valve at its outer end with its intake limited by an orifice not larger than 1.5 mm (0.060 in) in diameter. If a fixed-length dip tube is used, the intake shall be located midway of the tank both longitudinally and laterally and at maximum permitted filling level. In tanks for liquefied petroleum gases, the intake shall be located at the level reached by the lading when the tank is loaded to maximum filling density at 5°C (40°F).

### 6.1.3.4

Each opening for a pressure gauge, except on a tank used exclusively for the transportation of carbon dioxide or nitrous oxide, shall be restricted at or inside the tank by an orifice no larger than 1.5 mm (0.060 in) in diameter.

### 6.1.3.5

Each tank shall be provided with one or more safety relief devices which, unless otherwise specified, shall be safety relief valves of the spring-loaded type. Each valve shall be arranged to discharge upward or sideways and unobstructed to the outside of the protective housing to prevent any impingement of escaping gas upon the tank.

### 6.1.3.6

Safety relief valves on each tank shall have a total relieving capacity as determined by the flow formulas contained in CGA Pamphlet S-1.2. Safety relief valves shall have a total relieving capacity sufficient to prevent a maximum pressure in the tank of more than 120% of the design pressure. For an insulated tank the required relieving capacity of the relief valves shall be the same as for an uninsulated tank, unless the insulation will remain in place and will be effective under fire conditions. In this case, each insulated tank shall be covered by a sheet metal jacket of not less than 1.6 mm (16 gauge) thickness.

### 6.1.3.7

Each safety relief valve shall be arranged to minimize the possibility of tampering. If the pressure setting or adjustment is external to the valve, the safety relief valve shall be provided with means for sealing the adjustment and it shall be sealed.

### 6.1.3.8

Each safety relief valve on a tank shall be set to start to discharge at a pressure no higher than the tank design pressure and no lower than the design pressure specified in CSA Standard B622 for the gas transported.

### 6.1.3.9

Each safety relief valve shall be plainly and permanently marked with the pressure in kPa (psig) at which it is set to discharge, with the actual rate of discharge of the device in cubic metres (cubic feet) per minute of the gas or air at 15°C (60°F) and 100 kPa (14.5 psia), and with the manufacturer's name or trade name and catalogue number. The start-to-discharge value shall be visible after the valve is installed. The rated discharge capacity of the device shall be determined at a pressure of 120% of the design pressure of the tank.

### 6.1.3.10

Each safety relief valve shall have direct communication with the vapor space in the tank.

### 6.1.3.11

Each connection to a safety relief valve shall be of sufficient size to provide the required rate of discharge through the safety relief valve.

### 6.1.3.12

No shut-off valve may be installed between a safety relief valve and the tank except in cases where two or more safety relief valves are installed on the same tank, and one or more safety shut-off valves are arranged to always provide the required relief capacity through at least one of the safety relief valves.

### 6.1.3.13

Each safety relief valve outlet shall be provided with a protective device to prevent the entrance and accumulation of dirt and water. This device shall not impede flow through the valve.

### 6.1.3.14

Each portion of connected liquid piping or hose than can be closed at both ends shall be provided with a safety relief valve without an intervening shut-off valve to prevent excessive hydrostatic pressure that could burst the piping or hose.

### 6.1.3.15

Steel portable tanks designed to transport liquefied compressed gases, except carbon dioxide, shall comply with the following:

(a) Each tank shall be provided with a suitable automatic excess-flow valve. These valves shall be located inside the tank or at a point outside the tank where the line enters or leaves the tank. The valve seat shall be located inside the tank or shall be located within a welded flange or its companion flange, or within a nozzle, or within a coupling. The installation shall be made in such a manner as to reasonably assure that any undue strain which causes failure requiring functioning of the valve shall cause failure in such a manner that it will not impair the operation of the valve. Safety device connections and liquid level gauging devices which are so constructed that the outward flow of tank contents does not exceed that passed by a No. 54 drill size opening, are not required to be equipped with excess-flow valves.

(b) Excess-flow valves shall close automatically at the rated flows of gas or liquid as specified by the valve manufacturer. The connections or lines on each side of the excess-flow valve, including valves, fittings, etc, shall have a greater capacity than the rated flow of the excess-flow valve.

(c) Excess-flow valves may be designed with a by-pass, not to exceed a No. 60 drill size opening, to allow equalization of pressures.

(d) Filling and discharge lines shall be provided with manually operated shut-off valves located as close to the tank as it practicable. The use of so-called "stop-check" valves to satisfy this requirement and the requirement in Item (a) with one valve is not permitted.

## 6.2 Specification TC 51 Steel Portable Tanks

(Reproduced from US CFR, Title 49 (see Clause 4.4).)

**§178.245 Specification 51: steel portable tanks**

**§178.245-1 Requirements for design and construction.**

(a) Tanks must be of seamless or welded steel construction or combination of both and must have in excess of 1,000 pounds water capacity. Fusion welded tanks must be postweld heat treated and radiographed to provide the highest joint efficiency provided by the ASME Code. Tanks must be designed and constructed in accordance with and fulfill the requirements of the ASME Code. Tanks constructed in accordance with the requirements of Part UHT of the ASME Code must comply with the following additional requirements:

(1) Welding procedure and welder performance tests must be made annually in accordance with section IX of the ASME Code. In addition to the essential variables named therein the following must be considered to be essential variables: Number of passes, thickness of plate, heat input per pass, and manufacturer's identification of rod and flux. The number of passes, thickness of plate and heat input per pass may not vary more than 25 percent from the procedure qualification. Records of the qualification must be retained for at least 5 years by the tank manufacturer.

(2) Impact tests must be made on a lot basis. A lot is defined as 100 tons or less of the same heat and having a thickness variation no greater than plus or minus 25 percent. The minimum impact required for full-sized specimens shall be 20 foot-pounds (or 10 foot-pounds for half-sized specimens) at 0°F Charpy V-notch in both the longitudinal and transverse direction. If the lot test does not pass this requirement, individual plates may be accepted if they individually meet this impact requirement.

(b) Except as noted below, all openings in the tank shall be grouped in one location, either at the top of the tank or at one end of the tank.

*Exceptions:* (1) The openings for liquid level gauging devices, or for safety devices, may be installed separately at the other location or in the side of the shell; (2) one plugged opening of 2-inch National Pipe Thread or less provided for maintenance purposes may be located elsewhere; (3) an opening of 3-inch National Pipe Size or less may be provided at another location, when necessary, to facilitate installation of condensing coils.

(c) Each uninsulated tank used for the transportation of compressed gas must have an exterior surface finish that is significantly reflective such as a light reflecting color if painted, or a bright reflective metal or other material if unpainted.

**§178.245-2 Material.**

(a) All material used for the construction of the tank and appurtenances shall be suitable for use with the commodity to be transported therein.

(b) A material of thickness less than 3/16 inch shall not be used for the shells and heads.

**§178.245-3 Design pressure.**

(a) The design pressure of a tank authorized under this specification shall be not less than the vapor pressure of the commodity contained therein at 115°F, or as prescribed for a particular commodity in CSA Standard B622, except that in no case shall the design pressure of any container be less than 100 psig or more than 500 psig.

NOTE 1: *The term "design pressure" as used in this specification is identical to the term "maximum allowable working pressure" as used in the ASME Code.*

**§178.245-4 Tank mountings.**

(a) Tanks shall be designed and fabricated with mountings to provide a secure base in transit. "Skids" or similar devices shall be deemed to comply with this requirement.

(b) All tank mountings such as skids, fastenings, brackets, cradles, lifting lugs, etc., intended to carry loadings shall be permanently secured to tanks in accordance with the requirements of the Code under which the tanks were fabricated and shall be designed to withstand static loadings in any direction equal to twice the weight of the tank and attachments when filled with the lading using a safety factor of not less than four, based on the ultimate strength of the material to be used. The specific gravity used in determining the static loadings shall be shown on the marking required by §178.245-6(a).

(c) Lifting lugs or hold-down lugs may be added to either the tank or tank mountings. If lifting lugs and hold-down lugs are added directly to the tank, they shall be secured to doubling plates welded to the tank and located at points of support, except that

lifting lugs or hold-down lugs with integral bases serving as doubling plates may be welded directly to the tank. Each lifting lug and hold-down lug shall be designed to withstand static loadings in any direction equal to twice the weight of the tank and attachments when filled with the lading using a safety factor of not less than four, based on the ultimate strength of the material to be used.

(d) All tank mountings shall be designed so as to prevent the concentration of excessive loads on the tank shell.

**§178.245-5 Protection of valves and accessories.**

(a) All valves, fittings, accessories, safety devices, gaging devices, and the like shall be adequately protected against mechanical damage.

(b) The protective device or housing shall comply with the requirements under which the tanks are fabricated with respect to design and construction, and shall be designed to withstand static loadings in any direction equal to twice the weight of the tank and attachments when filled with the lading using a safety factor of not less than four, based on the ultimate strength of the material to be used.

**§178.245-6 Name plate.**

(a) In addition to the markings required by the Code (see §178.245-1(a)) under which tanks were constructed, they shall have permanently affixed, on one of the heads of the tank, a metal plate. This plate shall be permanently affixed by means of soldering, brazing, or welding around its complete perimeter. Neither the plate itself nor the means of attachment to the tank shall be subject to destructive attack by the contents of tank. Upon such plate shall be plainly marked by stamping, embossing, or other means of forming letters into or onto the metal plate itself the following information in characters at least 1/8 inch high:

Manufacturer's name _____

Serial No. _____ Owner's serial No. _____

D.O.T. Specification No. _____

Water capacity (pounds) _____

Tare weight (pounds) _____

Design pressure (psig) _____

Design specific gravity _____

Gross weight (lbs) _____

Original test date _____

Tank retested at _____ (psig) on _____

**Note:** *See also Clause 3.3.*

(b) All tank outlets and inlets, except safety relief valves, shall be marked to designate whether they communicate with vapor or liquid when the tank is filled to the maximum permitted filling density.

## 6.3 General Requirements for TC 56 and TC 57 Steel Portable Tanks

(Reproduced from US CFR, Title 49 (see Clause 4.4).)

**§178.251 General design and construction requirements applicable to specifications 56 (§178.252) and 57 portable tanks (§178.253).**

**§178.251-1 General requirements.**

(a) These specifications apply to tanks of any shape (cylindrical, conical, cubical, or other).

(b) The rated gross weight of the tank must not exceed the values used during the design qualification vibration and drop tests.

**§178.251-2 Materials of construction.**

(a) Except for gaskets, pressure relief devices, valve seats, liners, and linings, all construction material must be metal.

(b) Hardware for handling and securing, fitting protection, outlet piping, valves, relief devices, and closures must be made of material that is electrolytically compatible with, or suitably protected from electrolytic action when joined to the product retention components of the tank.

(c) Any material used must not be susceptible to stress corrosion cracking.

(d) Material specification: All sheet, plate, and extruded material for shell, heads, bulkheads, and baffles for portable tanks must meet the following minimum requirements:

(1) *Aluminum alloys.* Aluminum alloys must be suitable for fusion welding and must meet the following requirements:

Minimum yield strength ..... 24,000 p.s.i.
Minimum ultimate strength ..... 30,000 p.s.i.
Minimum elongation of standard 2 inch gage length ..... 8 percent

(2) *Steel.* Steel must meet the following requirements:

| | Mild steel | Low alloy low carbon | Stainless |
|---|---|---|---|
| Minimum yield strength, p.s.i. | 25,000 | 45,000 | 25,000 |
| Minimum ultimate strength, p.s.i. | 45,000 | 60,000 | 70,000 |
| Minimum elongation of standard 2 inch gage length (percent) | 20 | 25 | 30 |

(3) *Magnesium alloys.* Magnesium alloy must conform to ASTM B-90-69, Grade ZE-10A.

**§178.251-3 General construction requirements.**

(a) *Method of joining.* All joints between tank shells, heads, baffles (or baffle attaching rings), and bulkheads must be welded in accordance with the requirements of this section.

(b) *Strength of joints (Aluminum Alloy (AL), Magnesium Alloy (MG)).* All welded joints must be made in accordance with recognized good practice. The efficiency of a joint must not be less than 85 percent of the mechanical properties of the adjacent material. Each alloy must be joined by an inert gas arc welding process using filler metals which are consistent with material suppliers' recommendations.

(c) *Strength of joints (Mild Steel (MS), High Strength Low Alloy (HSLA), Austenitic Stainless Steel (SS)).* Joints must be welded in accordance with recognized good practice. The efficiency of any joint must not be less than 85 percent of the mechanical properties of the adjacent material.

(d) *Compliance test.* Compliance with the requirements contained in paragraph (b) or (c) of this section for the welded joints must be determined by preparing two test specimens from materials and fabrication techniques representative of those to be used in each tank. Each specimen must be tested to failure under tension. Each test specimen must be prepared and tested in accordance with ASTM Standard E8-81 for metallic materials and ASTM Standard B557-81 for aluminum and magnesium-alloy products. As a minimum, one pair of representative test specimens, consisting of the minimum and maximum thickness for each type of material used, may represent all the related tanks manufactured in the same shop within 12 months after the tests on the samples have been successfully completed. The butt welded specimens tested may be considered as qualifying other types or combinations of types of welds using the same filler material and welding process as long as parent metals are the same.

**§178.251-4 Stacking, mounting, and tie-down provisions.**

(a) *Load support devices.* Each tank designed to be stacked in storage must be provided with load support devices. There may be no significant permanent deformation of the load support devices or the tank under either of the following stress conditions:

(1) Tanks loaded to their maximum authorized gross weight and stacked at least 18 feet high.

(2) A load on the support devices at least three times the maximum authorized gross weight of the tank.

(b) *Base mounting.* Each tank must be constructed with mountings to provide a secure base during transportation. The mounting may be in the form of a skid or similar structure.

(c) *Tie-down system.* If there are tie-down devices that are a structural part of the tank, the tie-down system must be capable of withstanding the following static loading without significant deformation to the tank. The static loading applied must have, with respect to the center of gravity of the tank, a vertical component of at least two times the maximum authorized gross weight of the tank.

(1) If the design of the tank necessitates specific front and side orientation when loaded on a transportation vehicle, the static loading applied must have two horizontal components at right angles to each other, one direction at a time as follows:

(i) A longitudinal component at least seven times the maximum authorized gross weight of the tank in the direction of travel of the vehicle, and

(ii) A component of five times the maximum authorized gross weight of the tank in the transverse direction, or

(2) If the design of the tank does not necessitate specific front and side orientation when loaded on a transportation vehicle, the static loading applied must have two horizontal components at right angles

to each other, one direction at a time, of at least seven times the maximum authorized gross weight of the tank.

(d) If there is a structural part of the tank that could be used to tie the tank down and which is not in compliance with paragraph (c) of this section, it must be securely covered or locked during transportation to prevent its use as a tie-down.

**§178.251-5 Testing.**

(a) *Design qualification testing.* Design qualification tests prescribed in this paragraph must be made on at least one of each design and size tank, except that a set of tests, when made on a tank of one size, may serve to qualify smaller tanks made of the same kind and thickness of materials, by the same fabrication technique, and with identical supports, and equivalent closures, and other appurtenances. Tests must be performed sequentially on a single tank in the order listed in this section. Additional tests must be made if there is any increase in design size of the tank, any reduction in thickness of material, or any change in material, or in fabrication technique. Test samples must be retained for 1 year.

(1) *Vibration and drop tests.* See applicable specification, §178.252-3(a) or §178.253-5(a).

(2) *Structural integrity tests*—(i) *Lifting devices.* If there is a system of lifting devices that is a structural part of the tank or is permanently attached thereto or to the support structure, the system must be capable of supporting at least three times the maximum gross weight of the tank, and each individual lifting device must be capable of supporting at least the maximum gross weight of the tank, without significant permanent deformation in either the lifting device system or in any part of the tank.

(ii) *Shipment support structure.* If the tank supports are a structural part of the tank, the supports must be capable of absorbing a force equal to the maximum gross weight of the tank or breaking without significant permanent deformation to the product retention component of the tank. The force must be applied to the supports at ground level from at least two horizontal directions at right angles to each other, one direction at a time.

(iii) *Stacking support devices.* If stacking support devices are a structural part of the tank, there must be no significant permanent deformation of any device or the tank under either of the following stress conditions:

(a) Tanks loaded to their maximum authorized gross weight and stacked at least 18 feet high.

(b) A load on the stacking support devices of at least three times the maximum authorized gross weight of the tank.

(iv) *Fittings and protective devices.* Each fitting (or its protective device) subject to this test requirement must be capable of withstanding a force at least two times the maximum authorized gross weight of the tank without resultant damage to the fitting. The force must be applied to the fitting or its protective device in at least two horizontal directions at right angles to each other, one direction at a time, and in alignment with the fitting.

(b) *Production quality control, testing and inspection.* See applicable specification, §178.252-3(b) or §178.253-5(b).

**§178.251-6 Rejected tanks.**

No tank which fails to pass any of the prescribed tests may be placed in service until suitable repairs have been made and satisfactory re-test results have been obtained.

**§178.251-7 Identification and marking.**

(a) A metal certification plate must be permanently affixed to each tank and must be readily accessible for inspection. The plate must be marked in letters and numerals at least 1/8-inch high by stamping, embossing, or other means of forming letters into or on the metal plate itself. The marking must contain at least the following information:

*Tank manufacturer* _____

*Specification identification: Spec. 56 or Spec. 57* __

Design pressure (*for specification 57 only*) __p.s.i.g.

Test pressure (*for specification 56 only*) ___ p.s.i.g.

Serial number _____

Original test date _____

Tare weight _____ lbs.

Rated gross weight[1] _____ lbs.

Volumetric capacity _____ US gal. (or cu. ft.)

Materials of construction[2] _____

*[1]The rated (permitted) gross weight may not exceed that weight used during the design qualification tests involving vibration and drop.*

*[2]E.g., AL for aluminum, MG for magnesium alloy, MS for mild steel, HSLA for high strength low alloy, SS for austenitic stainless steel, including ASTM or ASME reference.*
**Note:** *See also Clause 3.3.*

(b) Unless the tank has been designed for stacking and meets the appropriate stacking integrity requirements of this specification, it must also be marked in letters at least 2 inches high in contrasting colors "Do Not Stack" and "Do Not Place Other Freight On Top Of This Tank", on at least two sides of the tank. These instructions must also appear on the certification plate. Plate markings are required to meet the requirements of paragraph (a) of this section and need not be in contrasting color.

## 6.4 Specification TC 56 Steel Portable Tanks

(Reproduced from US CFR, Title 49, (see Clause 4.4).)

**§178.252 Specification 56; metal portable tank.**

**§178.252-1 General requirements.**

(a) Each tank must be in compliance with the general design and construction requirements in §178.251 in addition to the specific requirements of this section.

(b) Each tank may not exceed a rated gross weight of 7,700 pounds.

**§178.252-2 Openings.**

(a) Each fill and discharge opening must be equipped with a closure and locking device.

(b) A drum-type locking ring closure is authorized for openings not exceeding 23 inches in diameter. A drum-type locking ring closure must be at least a 12-gage bolted ring with forged lugs having at least a 5/8-inch steel bolt tapped into one of the lugs. The locking ring must be equipped with a lock nut or equivalent device.

(c) For a tank that incorporates a hopper-type product discharge opening, the closure device must be constructed to retain product under the test conditions outlined in §178.251-5 and §178.252-3(a). Closures for those openings must be designed with positive mechanical locking and sealing devices to prevent leakage during normal conditions incident to transportation.

**§178.252-3 Testing.**

(a) *Design qualification testing.* In addition to the testing prescribed in §178.251-5(a), a vibration and a drop test are also required on each design. For these tests, the tank must be filled with a fine, dry powdered material having a density that results in the tank having a gross weight not less than the rated gross weight of the tank.

(1) *Vibration test.* This test must be performed for 1 hour using a minimum double amplitude of 1 inch at a frequency that causes the test tank to be raised from the floor of the testing table so a piece of flat steel strap may be passed between the tank and the table. The tank must be restrained so that all horizontal motion is restricted and only vertical motion is permitted.

(2) *Drop test.* The tank must be capable of withstanding without leakage of contents of 2-foot free drop onto a flat unyielding horizontal surface, striking the target surface in the position and attitude from which maximum damage to the tank (including closures) is expected.

(b) *Production quality control, testing, and inspection*—(1) *Leakage test.* Each tank must be tested by a minimum air or hydrostatic pressure of at least 2 pounds per square inch gage applied to the entire tank. If the air pressure is used, the entire surface of all joints under pressure must be coated with, or immersed in, a solution of soap and water, or other material suitable for the purpose of detecting leaks. If the hydrostatic pressure test is used it must be carried out by using water or other liquid having a similar viscosity, the temperature of which may not exceed 100°F. and all joints under pressure must be inspected for leaks. For either test, the pressure must be held for a period of time sufficiently long to assure detection of leaks. All closures must be in place during the test. Any tank that has detectable leakage or significant permanent deformation does not meet the requirements of this specification.

## 6.5 Specification TC 57 Steel Portable Tanks

(Reproduced from US CFR, Title 49, (see Clause 4.4).)

**§178.253 Specification 57; metal portable tank.**

**§178.253-1 General requirements.**

(a) Each tank must be in compliance with the general design and construction requirements in §178.251 in addition to the specific requirements of this section.

(b) Each tank must have a capacity of at least 110 gallons but not more than 660 gallons.

**§178.253-2 Openings.**

(a) Each fill and discharge opening must be equipped with a closure device that meets the following requirements:

(1) Any closure for a fill opening in excess of 20 square inches must be equipped with a device to prevent the closure from fully opening without first relieving internal pressure.

(2) Any product discharge valve, if used, must be provided with a leak tight device, such as a cap or plug.

(3) Each closure must be vapor tight.

(b) A drum-type locking ring closure is authorized for any opening less than 23 inches in diameter. A drum-type locking ring closure must be at least a 12-gage bolted ring with forged lugs having at least a 5/8-inch steel bolt tapped into one of the lugs. The locking ring must be equipped with a lock nut or equivalent device.

**§178.253-3 Protection of fittings.**

Each fitting which could be damaged sufficiently to result in leakage of tank contents must be protected by suitable guards or protective housings. The term "fitting" includes valves, closure devices, safety relief devices, and other accessories through which contents could leak from the tank. Each fitting or fitting protection device must be capable of withstanding the fitting protection test specified in §178.251-5.

**§178.253-4 Vents.**

(a) Each tank must be equipped with at least one pressure relief device such as a spring-loaded valve, frangible disc or fusible plug.

(b) Each pressure relief device must communicate with the vapor space of the tank when the tank is in a normal transportation attitude. Shutoff valves must not be installed between the tank opening and any pressure relief device. Pressure relief devices must be mounted, shielded, or drained to prevent the accumulation of any material that could impair the operation or discharge capability of the device.

(c) The total emergency venting capacity (cu. ft./hr.) of each portable tank must be at least that determined from the following table.

| Total surface area square feet[1, 2] | Cubic feet free air per hour |
|---|---|
| 20 | 15,800 |
| 30 | 23,700 |
| 40 | 31,600 |
| 50 | 39,500 |
| 60 | 47,400 |
| 70 | 55,300 |
| 80 | 63,300 |
| 90 | 71,200 |
| 100 | 79,100 |
| 120 | 94,900 |
| 140 | 110,700 |
| 160 | 126,500 |

[1]Interpolate for intermediate sizes.
[2]Surface area excludes area of legs.

(1) The pressure operated relief device must open at not less than 3 pounds per square inch gage and at not over the design test pressure of the tank. The minimum venting capacity for pressure activated vents must be 6,000 cubic feet of free air per hour (measured at 14.7 p.s.i.a. and 60°F.) at not more than 5 pounds per square inch gage.

(2) If a frangible device is used for relieving pressure, the device must have a minimum area of 1.25 square inches and must be rated at less than the design test pressure of the tank.

(3) If a fusible device is used for relieving pressure, the device must have a minimum area of 1.25 square inches. The device must function at a temperature between 220°F. and 300°F. and at a pressure less than the design test pressure of the tank, unless this latter function is accomplished by a separate device.

(d) No relief device may be used which would release flammable vapors under normal conditions of transportation (temperature up to and including 130°F.).

**§178.253-5 Testing.**

(a) *Design qualification testing.* In addition to the testing prescribed in §178.251-5, a vibration test, a drop test, and a pressure test are also required on each design. For the vibration and drop tests, the tank must be filled with a liquid to not less than the rated gross weight.

(1) *Vibration test.* This test must be performed for 1 hour using a minimum double amplitude of 1 inch at a frequency that causes the test tank to be raised from the floor of the testing table so a piece of flat steel strap may be passed between the tank and the table. The tank must be restrained so that all horizontal motion is restricted and only vertical motion is permitted.

(2) *Drop test.* The tank must be capable of withstanding without leakage of contents a 2-foot free drop onto a flat unyielding horizontal surface, striking the target surface in the position and attitude from which maximum damage to the tank (including piping and fittings) is expected.

(3) *Pressure test.* The tank must be capable of maintaining, under hydrostatic test for at least 5 minutes, at least one and one-half times the design pressure prescribed in this paragraph, without detectable leakage or significant permanent deformation. The pressure must be measured at the top of the tank. Each closure must be in place and blocked if necessary as for shipment. Each closure must be standard, except that tapping for pressurizing and gaging is permitted. Design pressure must be determined as follows:

$P = (hd/115) + 3$

Where:

P = Design pressure in p.s.i.g.;
h = Inside height of tank in inches;
d = Maximum allowable density in pounds per gallon;
115 = Number of cubic inches in 1 gallon (231) divided by a safety factor of two.

(b) *Production quality control, testing and inspection*—(1) *Leakage test.* Each tank must be leak tested by a minimum sustained air pressure of at least three pounds per square inch gage applied to the entire tank. The entire surface of all joints under pressure must be coated with or immersed in a solution of soap and water or other material suitable for the purpose of detecting leaks. The pressure must be held for a period of time sufficiently long to assure detection of leaks. All closures must be in place during the test, but safety relief devices may be removed and such openings plugged. Any tank that has detectable leakage or significant permanent deformation does not meet the requirements of this specification.

## 6.6 Specification TC 60 Steel Portable Tanks

(Reproduced from US CFR, Title 49, (see Clause 4.4).)

**§178.255 Specification 60; steel portable tanks.**

**§178.255-1 General requirements.**

(a) Tanks must be of fusion welded construction, cylindrical in shape with seamless heads concave to the pressure. Tank shells may be of seamless construction.

(b) Tanks must be designed and constructed in accordance with and fulfill all the requirements of the ASME Code.

(c) Tanks including all permanent attachments must be postweld heat treated as a unit.

**§178.255-2 Material.**

(a) Material used in the tank must be steel of good weldable quality and conform with the requirements of the ASME Code.

(b) The minimum thickness of metal, exclusive of lining material, for shell and heads of tanks shall be as follows:

| Tank capacity: | Minimum thickness (inch) |
|---|---|
| Not more than 1,200 gallons | 1/4 |
| Over 1,200 to 1,800 gallons | 5/16 |
| Over 1,800 gallons | 3/8 |

**§178.255-3 Expansion domes.**

(a) Expansion domes, if applied, must have a minimum capacity of one percent of the combined capacity of the tank and dome.

**§178.255-4 Closures for manholes and domes.**

(a) The manhole cover shall be designed to provide a secure closure of the manhole. All covers, not hinged to the tanks, shall be attached to the outside of the dome by at least 1/8 inch chain or

its equivalent. Closures shall be made tight against leakage of vapor and liquid by use of gaskets of suitable material.

**§178.255-5 Bottom discharge outlets.**

(a) Bottom discharge outlets prohibited, except on tanks used for shipments of sludge acid and alkaline corrosive liquids.

(b) If installed, bottom outlets or bottom washout chambers shall be of metal not subject to rapid deterioration by the lading, and each shall be provided with a valve or plug at its upper end and liquid-tight closure at its lower end. Every such valve or plug shall be designed to insure against unseating due to stresses or shocks incident to transportation. Bottom outlets shall be adequately protected against handling damage and outlet equipment must not extend to within less than one inch of the bottom bearing surface of the skids or tank mounting.

**§178.255-6 Loading and unloading accessories.**

(a) When installed, gauging, loading and air inlet devices, including their valves, shall be provided with adequate means for their secure closure; and means shall also be provided for the closing of pipe connections of valves.

(b) Interior heater coils, if installed, must be of extra heavy pipe and so constructed that breaking off of exterior connections will not cause leakage of tanks.

**§178.255-7 Protection of valves and accessories.**

(a) All valves, fittings, accessories, safety devices, gauging devices, and the like shall be adequately protected against mechanical damage by a housing closed with a cover plate.

(b) Protective housing shall comply with the requirements under which the tanks are fabricated with respect to design and construction, and shall be designed with a minimum factor of safety of four to withstand loadings in any direction equal to two times the weight of the tank and attachments when filled with water.

**§178.255-8 Safety devices.**

(a) See Clause 5.2.3.

**§178.255-9 Compartments.**

(a) When the interior of the tank is divided into compartments, each compartment shall be designed, constructed and tested as a separate tank. Thickness of shell and compartment heads shall be determined on the basis of total tank capacity.

**§178.255-10 Lining.**

(a) If a lining is required, the material used for lining the tank shall be homogeneous, nonporous, imperforate when applied, not less elastic than the metal of the tank proper. It shall be of substantially uniform thickness, not less than 1/32 inch thick if metallic, and not less than 1/16 inch if nonmetallic, and shall be directly bonded or attached by other equally satisfactory means. Rubber lining shall be not less than 3/16 inch thick. Joints and seams in the lining shall be made by fusing the material together or by other equally satisfactory means. The interior of the tank shall be free from scale, oxidation, moisture and all foreign matter during the lining operation.

**§178.255-11 Tank mountings.**

(a) Tanks shall be designed and fabricated with mountings to provide a secure base in transit. "Skids" or similar devices shall be deemed to comply with this requirement.

(b) All tank mountings such as skids, fastenings, brackets, cradles, lifting lugs, etc., intended to carry loadings shall be permanently secured to tanks in accordance with the requirements under which the tanks are fabricated, and shall be designed with a factor of safety of four, and built to withstand loadings in any direction equal to two times the weight of the tanks and attachments when filled to the maximum permissible loaded weight.

(c) Lifting lugs or side hold-down lugs shall be provided on the tank mountings in a manner suitable for attaching lifting gear and hold-down devices. Lifting lugs and hold-down lugs welded directly to the tank shall be of the pad-eye type. Doubling plates welded to the tank and located at the points of support shall be deemed to comply with this requirement.

(d) All tank mountings shall be so designed as to prevent the concentration of excessive loads on the tank shell.

**§178.255-12 Pressure test.**

(a) Each completed portable tank prior to application of lining shall be tested before being put into transportation service by completely filling the tank with water or other liquid having a similar viscosity, the temperature of which shall not exceed 100°F. during the test, and applying a pressure of 60 pounds per square inch gauge. The tank shall be capable of holding the prescribed pressure for at least 10 minutes without leakage, evidence of impending failure, or failure. All closures shall be in place while the test is made and the pressure shall be gauged at the top of the tank. Safety devices and/or vents shall be plugged during this test.

**§178.255-13 Repair of tanks.**

(a) Tanks failing to meet the test may be repaired and retested, provided that repairs are made in complete compliance with the requirements of this specification.

**§178.255-14 Marking.**

(a) In addition to marking required by the American Society of Mechanical Engineers Code, every tank shall bear permanent marks at least 1/8 inch high stamped into the metal near the center of one of the tank heads or stamped into a plate permanently attached to the tank by means of brazing or welding or other suitable means as follows:

Manufacturer's name _____ Serial No. _____

DOT specification _____

Nominal capacity _____ (gallons)

Tare weight _____ (pounds)

Date of manufacture _____

Owner's serial number _____

Gross weight (pounds) _____

Original test date _____

Lining material (when applicable) _____

**Note:** *See also Clause 3.3.*

# 7. Steel Intermodal Portable Tanks

## 7.1 General

### 7.1.1

This Clause covers steel intermodal portable tanks of diameters no greater than 2438 mm (96 in) that are designed to carry liquids having a vapour pressure of less than 297 kPa (43 psi) absolute at a temperature of 50°C (122°F).

### 7.1.2

Intermodal portable tanks shall be designated as follows:

(a) Tanks with a maximum allowable working pressure (MAWP) equal to or greater than 175 kPa (25 psi) and less than 680 kPa (100 psi) gauge shall be designated TC Type 1, and shall be for transport by road and marine only.

(b) Tanks with a MAWP equal to or greater than 100 kPa (14.5 psi) and less than 175 kPa (25 psi) gauge shall be designated TC Type 2, and shall be for transport by road and marine only.

(c) Tanks with a MAWP equal to or greater than 245 kPa (35 psi) and less than 680 kPa (100 psi) gauge shall be designated TC Type 3, and shall be for transport by road, marine, and rail.

### 7.1.3

Each tank, including attachments and service and structural equipment, shall be designed to withstand, without loss of contents, the maximum internal pressure that can be anticipated to result from the contents and the static and dynamic stresses incurred in normal handling and transportation.

### 7.1.4

For the purposes of this Clause, maximum allowable working pressure (MAWP) means the higher of the following two pressures measured at the top of the tank while in the operating position:

(a) the highest gauge pressure allowed in the shell during filling or discharge; or

(b) the maximum gauge pressure to which tanks for liquids shall be designed, which is the sum of the following partial pressures minus 100 kPa (14.5 psi):

(i) the absolute vapour pressure in kPa (psi) at 65°C (149°F);

(ii) the partial pressure in kPa (psi) of air or gases, or both, in the outage space, being determined by an outage temperature of not more than 65°C (149°F) and a liquid expansion due to the increase of the bulk mean temperature of tr-tf (tf = filling temperature, usually 15°C (59°F), tr = 50°C (122°F) maximum bulk temperature); and

(iii) a dynamic pressure of not less than 35 kPa (5 psi) gauge.

### 7.1.5

Each tank shall have a cross-sectional design that is capable of being stress analyzed either mathematically or experimentally in accordance with the method in Section UG-101 of the *ASME Boiler and Pressure Vessel Code*, or by any other equally precise method.

### 7.1.6

Each tank shall be designed so that the center of gravity of the filled tank is approximately centered within the points of attachment for lifting devices.

### 7.1.7

Where credit is taken for insulation to reduce the required emergency venting capacity of safety relief devices, the insulation shall be jacketed or otherwise protected from accumulation of moisture or foreign matter that would decrease its efficiency or corrode the tank.

### 7.1.8

Each lined tank shall have a lining material that meets the following requirements:

(a) The material used to line the tank shall be

(i) substantially immune to attack by the lading transported;

(ii) homogeneous;

(iii) non-porous;

(iv) imperforate;

(v) at least as elastic as the material of the tank shell; and

(vi) compatible with the thermal expansion characteristics of the tank shell.

(b) The lining of the tank, tank fittings, and piping shall be

(i) attached by bonding or other satisfactory means;

(ii) continuous; and

(iii) extended around the face of any flange.

(c) Joints and seams in the lining shall be made by fusing the material together or by other equally effective means.

### 7.1.9

Means of containment used for the shipment of dangerous goods by road by intermodal portable tanks shall, unless otherwise specified, meet all of the following design and construction criteria:

(a) welding and brazing shall be performed in a workmanlike manner using suitable and appropriate techniques, materials, and equipment;

(b) materials of construction and tank contents shall be such that there will be no significant chemical or galvanic reaction among any of the materials in the package;

(c) closures shall be adequate to prevent inadvertent leakage of the contents under normal conditions incident to transportation;

(d) gasketed closures shall be fitted with gaskets of efficient material which will not be deteriorated by the contents of the container.

## 7.2 Materials of Construction

### 7.2.1

Each tank shall be constructed of carbon or alloy steel. Materials included in Part UHT of the *ASME Boiler and Pressure Vessel Code* or equivalent materials are not permitted. Any materials used in the tank shell shall conform to a national code recognized by a competent Canadian authority and shall be suitable for the external environments in which the tank will be carried. The minimum elongation for any material shall be at least 20%, as determined in accordance with ASTM Standard A370.

### 7.2.2

The specified minimum tensile stength and the specified minimum yield strength shall be

(a) the specified values for the material in Section VIII, Division 1 of the *ASME Boiler and Pressure Vessel Code*; or

(b) the specified values in the national code to which the material is manufactured.

### 7.2.3

When a minimum yield strength, a minimum tensile strength, or an elongation is not specified in the applicable national code, tensile tests and analysis of results shall be in accordance with ISO Standard 6892. The yield strength in tension shall be the stress corresponding to a permanent strain of 0.2% of the gauge length, except that for austenitic steels the yield strength shall be the stress corresponding to a permanent strain of 0.2 or 1.0% of the gauge length as appropriate.

### 7.2.4

Tensile strength, yield strength, and elongation shall be determined using a specimen having a gauge length calculated by using the following equation:

$$L_o = 5.65\ (S_o)^{1/2}$$

where

$L_o$ = the gauge length of the specimen, mm (in)
$S_o$ = the cross-sectional area of the specimen, $mm^2$ ($in^2$)

## 7.3 Structural Integrity

The maximum calculated stress value in a tank at the test pressure as defined in Clause 7.11.1 shall not exceed

(a) 1.5 times the specified maximum allowable stress values in tension for the material in Section VIII, Division 1 of the *ASME Boiler and Pressure Vessel Code;*

(b) for austenitic steels, the lower of

(i) 93.75% of the specified minimum yield strength referred to in Clause 7.2.2(b), where the yield strength is derived using the 0.2% offset; or

(ii) 75% of the specified minimum yield strength referred to in Clause 7.2.2(b), where the yield strength is derived using the 1.0% offset; or

(c) for carbon and low alloy steels, the lower of 93.75% of the specified minimum yield strength, derived using the 0.2% offset, or 37.5% of the specified minimum tensile strength, both referred to in Clause 7.2.2(b).

## 7.4 Tank Supports, Frameworks, and Lifting Attachments

### 7.4.1

Each tank shall be constructed with a permanent support structure that provides a secure base in transport. Skids, frameworks, cradles, or similar devices capable of withstanding the forces specified in Clause 7.13.1 or 7.14.1, as applicable, are acceptable.

### 7.4.2

The calculated stress in tank supports, frameworks, and lifting attachments shall not exceed 80% of the specified minimum yield strength of the material of construction under the applicable lading conditions specified in Clause 7.13.1 or 7.14.1 as applicable.

### 7.4.3

A tank that meets the definition of a "tank container" in accordance with the *Transportation of Dangerous Goods Regulations* shall also meet the requirements of the *Safe Containers Convention Act*, in addition to the requirements of this Standard.

## 7.5 Joints in Tank Shells

### 7.5.1

Joints in tank shells shall be made by fusion welding. Such joints and their efficiencies shall be as required by the *ASME Boiler and Pressure Vessel Code.*

### 7.5.2

Weld procedures and welder performance shall be *ASME Boiler and Pressure Vessel Code* qualified or shall be qualified by the certification agency in accordance with the procedures in the *ASME Boiler and Pressure Vessel Code,* Section IX, "Welding and Brazing Qualifications".

### 7.5.3

A record of each qualification shall be retained by the manufacturer for the period prescribed in the *ASME Boiler and Pressure Vessel Code,* Section VIII, "Pressure Vessels", and shall be made available to any duly identified representative of Transport Canada or the owner of the tank.

## 7.6 Protection of Valves and Accessories

Each valve, fitting, accessory, safety device, gauging device, and other appurtenance shall be adequately protected against mechanical damage.

## 7.7 Inspection Openings

### 7.7.1

Each tank or independent compartment of a tank shall be fitted with a manhole or other inspection opening sited above the maximum liquid level to allow for complete internal inspection and adequate access for maintenance and repair of the interior.

### 7.7.2

Each tank or independent compartment of a tank with a capacity of more than 1900 L (500 US gal) shall be fitted with an elliptical or obround manhole with inside dimensions at least 280 × 380 mm (11 × 15 in) or 255 × 405 mm (10 × 16 in), or with a circular manhole with an inside diameter of at least 380 mm (15 in).

### 7.7.3
Any inspection opening and closure shall be designed and reinforced as required by the *ASME Boiler and Pressure Vessel Code.*

## 7.8 External Design Pressure

### 7.8.1
Tanks not fitted with vacuum relief devices shall be designed to withstand a positive external pressure differential of at least 40 kPa (6 psi).

### 7.8.2
Tanks fitted with vacuum relief devices shall be designed to withstand a positive external pressure differential not less than the set pressure of the vacuum relief device and in any case at least 21 kPa (3 psi).

## 7.9 Pressure and Vacuum Relief Devices

### 7.9.1 Devices Required
Each tank, or each independent compartment of the tank, shall be fitted with pressure relief devices in accordance with the following:

(a) Each tank, or each independent compartment of the tank, with a capacity of more than 1900 L (500 US gal), shall be provided with a primary pressure relief device consisting of a spring-loaded pressure relief valve and, in addition, may have one or more emergency pressure relief devices that may be a spring-loaded pressure relief valve, a frangible disc, or fusible element in parallel with the primary pressure relief device.

**Note:** *The choice of the emergency pressure relief device may be restricted by the requirements of CSA Standard B623.*

(b) Each tank, or each independent compartment of the tank, with a capacity of 1900 L (500 US gal) or less, shall be fitted with a primary pressure relief device that may be either a frangible disc or a spring-loaded pressure relief valve.

(c) If a frangible disc is inserted in series with the required pressure relief valve, the frangible disc shall precede the pressure relief valve and the space between them shall be provided with a suitable tell-tale indicator to permit detection, prior to and during shipment, of disc rupture, pinholing, or leakage that could cause a malfunction of the pressure relief system.

### 7.9.2 Location and Construction of Relief Devices

#### 7.9.2.1
Pressure relief devices shall be spring-loaded valves, frangible discs, or fusible elements. Vacuum relief devices shall be capable of reclosing in any attitude. Each pressure relief device inlet shall be situated in the vapour space of the tank. The discharge from any device shall be unrestricted and directed to prevent impingement upon the tank shell or structural framework. Protective devices which deflect the flow of vapor are permissible provided the required venting capacity is maintained.

#### 7.9.2.2
Pressure and vacuum relief devices, including their inlets, shall be sited on the top of the tank in a position as near as possible to the longitudinal and transverse center of the tank with the following limitation:

(i) longitudinally on the tank within 1100 mm (42 in) or 1/6 the tank length, whichever is less, from the top center of the tank or tank compartment, as applicable; and

(ii) transversally within 12° of the tank top.

#### 7.9.2.3
Except for a relief device installed in a piping system, each relief device shall provide unrestricted venting under all conditions. Each pressure relief system, including any piping, shall provide a venting capacity at least equal to the venting capacity specified in Clause 7.9.4 for the tank on which the system is installed.

#### 7.9.2.4
Fusible elements, when installed, shall not be protected from direct communication with external heat sources.

#### 7.9.2.5
Spring-loaded pressure relief valves shall be constructed in a manner to prevent unauthorized adjustments of the relief setting.

### 7.9.3 Pressure Settings of Relief Devices

#### 7.9.3.1 Primary Pressure Relief Devices
The primary pressure relief device required by Clause 7.9.1 shall be set to function in a range of no less than 100% and no greater than 125% of the maximum allowable working pressure (MAWP) for

tanks having a MAWP below 300 kPa (44 psi) gauge. For tanks having a MAWP of 300 kPa (44 psi) gauge or greater, the primary pressure relief device shall be set to function in a range of no less than 100% of the MAWP and no more than 110% of the MAWP. Spring-loaded pressure relief valves shall close after discharge at a pressure not less than 90% of the start-to-discharge pressure and remain closed at all lesser pressures.

### 7.9.3.2 Special Configuration Relief Devices

Where a spring-loaded relief valve is preceded by a frangible disc, the bursting pressure of the frangible disc shall be more than 110% of the start-to-discharge pressure of the relief valve and both settings shall fall within the range specified in Clause 7.9.3.1 or Clause 7.9.3.3, as applicable.

### 7.9.3.3 Emergency Pressure Relief Devices

Each frangible disc, other than those used as, or in conjunction with, a primary relief device in accordance with Items (b) or (c) of Clause 7.9.1, shall be designed to burst at a pressure greater than 125% and no greater than 150% of the MAWP. Each spring-loaded pressure relief valve used as an emergency pressure relief device shall be set to operate at no less than 125% of the MAWP and be fully open at 150% of the MAWP.

### 7.9.3.4 Fusible Elements

Fusible elements shall have a nominal yield temperature greater than the highest tank operating temperature and less than or equal to 121°C (250°F). The pressure developed in the tank at the fusible element yield temperature shall be below the test pressure of the tank.

### 7.9.3.5 Vacuum Relief Devices

Vacuum relief devices, when used, shall be designed to provide total containment of the product under normal and accident conditions and shall be set to open at a nominal external over-pressure of not less than 21 kPa (3 psi) but not greater than the external pressure for which the tank is designed. Each vacuum relief device shall have a minimum cross-sectional flow area of 2.84 $cm^2$ (0.44 $in^2$).

## 7.9.4 Venting Capacity of Pressure Relief Devices

### 7.9.4.1

Each pressure relief valve shall have a minimum venting capacity of 170 standard cubic meters per hour (SCMH) (6000 standard cubic feet per hour (SCFH)). The minimum total pressure relief valve venting capacity for each tank shall be 340 SCMH (12 000 SCFH) per 32.5 $m^2$ (350 $ft^2$) of exposed tank area, but in any case at least 340 SCMH (12 000 SCFH). Spring-loaded relief valves shall have a minimum inside diameter of 31.75 mm (1.25 in).

### 7.9.4.2

The total venting capacity of all pressure relief devices installed on each tank shall be sufficient with all devices operating to limit the pressure in the tank to less than or equal to the test pressure. Except as provided in Clause 7.9.4.3 or 7.9.4.4, the total venting capacity shall be at least equal to that shown in Table 7.1 or 7.2.

## Table 7.1
## Minimum Total Venting Capacity
## Cubic Metres per Hour at Atmospheric Pressure and 15°C

| Exposed area $m^2$ | $m^3$ free air per hour | Exposed area $m^2$ | $m^3$ free air per hour |
|---|---|---|---|
| 2 | 841 | 37.5 | 9 306 |
| 3 | 1 172 | 40 | 9 810 |
| 4 | 1 485 | 42.5 | 10 308 |
| 5 | 1 783 | 45 | 10 806 |
| 6 | 2 069 | 47.5 | 11 392 |
| 7 | 2 348 | 50 | 11 778 |
| 8 | 2 621 | 52.5 | 12 258 |
| 9 | 2 821 | 55 | 12 732 |
| 10 | 3 146 | 57.5 | 13 206 |
| 12 | 3 655 | 60 | 13 674 |
| 14 | 4 146 | 62.5 | 14 142 |
| 16 | 4 625 | 65 | 14 604 |
| 18 | 5 092 | 67.5 | 15 066 |
| 20 | 5 556 | 70 | 15 516 |
| 22.5 | 6 120 | 75 | 16 422 |
| 25 | 6 672 | 80 | 17 316 |
| 27.5 | 7 212 | 85 | 18 198 |
| 30 | 7 746 | 90 | 19 074 |
| 32.5 | 8 268 | 95 | 19 938 |
| 35 | 8 790 | 100 | 20 790 |

## Table 7.2
## Minimum Total Venting Capacity
## Cubic Feet per Hour at Atmospheric Pressure and 59°F

| Exposed area $ft^2$ | $ft^3$ free air per hour | Exposed area, $ft^2$ | $ft^3$ free air per hour |
|---|---|---|---|
| 20 | 27 600 | 275 | 237 000 |
| 30 | 38 500 | 300 | 256 000 |
| 40 | 48 600 | 350 | 289 500 |
| 50 | 58 600 | 400 | 322 100 |
| 60 | 67 700 | 450 | 355 900 |
| 70 | 77 000 | 500 | 391 000 |
| 80 | 85 500 | 550 | 417 500 |
| 90 | 94 800 | 600 | 450 000 |
| 100 | 104 000 | 650 | 479 000 |
| 120 | 121 000 | 700 | 512 000 |
| 140 | 136 200 | 750 | 540 000 |
| 160 | 152 100 | 800 | 569 000 |
| 180 | 168 200 | 850 | 597 000 |
| 200 | 184 000 | 900 | 621 000 |
| 225 | 199 000 | 950 | 656 000 |
| 250 | 219 500 | 1 000 | 686 000 |

### 7.9.4.3

Notwithstanding the minimum total venting capacity shown in Table 7.1 or 7.2, a tank in dedicated service may have a lesser total venting capacity provided the certificate of compliance specifies the dangerous goods for which the tank is suitable. The lesser total venting capacity shall be determined using the following equation:

$Q = 5\ 660\ 000\ A^{0.82}(ZT)^{0.5}/(LC)(M^{0.5})$ (metric units)

$Q = 37\ 980\ 000\ A^{0.82}\ (ZT)^{0.5}/(LC)(M^{0.5})$ (conventional units)

where

Q = the total required venting capacity, $m^3$ ($ft^3$) of air per hour at standard conditions of 15°C (60°F) and 1 atmosphere

T = the absolute temperature of the vapour at the venting condition, Kelvin (°C + 273) (Rankine (°F + 460))

A = the total external surface area of tank shell, $m^2$ ($ft^2$)

L = the latent heat of vapourization of the liquid, calories per gram (Btu/lb)

Z = the compressibility factor for the vapour. If this factor is unknown, let Z = 1.0

M = the molecular mass of vapour

C = a constant derived from (k), the ratio of specific heats of the vapour. If k is unknown, let C = 315.

where

$C = 520[k(2/(k+1))^{[(k+1)/(k-1)]}]^{1/2}$

and where

$k = C_p/C_v$

$C_p$ = the specific heat at constant pressure, cal/g°C (Btu/lb°F)

$C_v$ = the specific heat at constant volume, cal/g°C (Btu/lb°F)

### 7.9.4.4

The required total venting capacity determined by using Table 7.1 or 7.2 or Clause 7.9.4.3 may be reduced for insulated tanks to $Q_t$, by using the following equation:

$Q_t = FQ_1$

where

$Q_t$ = the total required venting capacity of the insulated tank

$Q_1$ = the total venting capacity required for an uninsulated tank according to Table 7.1 or 7.2, or Clause 7.9.4.3

F = a coefficient with a value greater than or equal to 0.25 according to the following equation:

$F = 8U(649-t)/\ 93.5 \times 10^6$ (metric units)

$F = 8U(1200-t)/\ 34\ 500$ (conventional units)

where

U = the thermal conductance of the insulation system taken at 37.8°C (100°F) in g·cal/h·$m^2$ °C (Btu/h·$ft^2$°F)

t = the actual temperature of the substance at loading, in °C (°F). If this temperature is unknown, let t = 15°C (59°F).

### 7.9.4.5

Insulation systems used for the purpose of reducing the venting capacity shall be approved by Transport Canada. In all cases, insulation systems approved for this purpose shall

(i) remain effective at all temperatures up to 650°C (1200°F); and

(ii) be jacketed with a material having a melting point of 650°C (1200°F) or greater.

### 7.9.4.6

The flow capacity rating of any pressure relief device shall be certified by the manufacturer to be in accordance with the applicable provisions of the *ASME Boiler and Pressure Vessel Code*, with the following exceptions:

(i) the ASME Code stamp is not required; and

(ii) the flow capacity certification test for spring-loaded pressure relief valves may be conducted at a pressure not to exceed 120% of the set pressure, provided the stamped flow capacity rating is not greater than 83% of the average capacity of the valves tested.

## 7.9.5 Markings on Pressure and Vacuum Relief Devices

The following information shall be plainly displayed on each pressure relief device:

(a) the pressure or, when appropriate, the temperature at which the device is set to function;

(b) except for vacuum relief devices, the rated flow capacity of air discharged per minute at 15°C (59°F) and atmospheric pressure, at

(i) the set pressure for frangible discs;

(ii) no greater than 20% above the start-to-discharge pressure for spring-loaded relief devices; or

(iii) the fusing temperature for fusible elements.

(c) the manufacturer's name and catalogue number; and

(d) the allowable tolerances at the start-to-discharge pressure and the allowable tolerances at the discharge temperature.

## 7.10 Valves, Nozzles, Piping, and Gauging Devices

### 7.10.1

All tank nozzles, except for those provided for relief devices, thermometer wells, and inspection openings, shall be fitted with manually operated stop valves located as near the shell as practicable, either internal or external to the shell.

### 7.10.2

A tank nozzle installed for a pressure relief device shall not be provided with a stop valve that restricts the flow from the tank to the pressure relief device (see Clause 7.9.2.3).

### 7.10.3

A tank nozzle installed in the vapour space to provide a filling or cleaning opening, which is closed by a blank flange or other suitable means, need not be provided with a manually operated stop valve.

### 7.10.4

A tank nozzle installed for a thermometer well or inspection opening need not be provided with a manually operated stop valve.

### 7.10.5

Each valve shall be designed and constructed to a rated pressure not less than the maximum allowable working pressure of the tank.

### 7.10.6

Each stop valve with a screwed spindle shall be closed by a clockwise motion of the handwheel.

### 7.10.7

All valves shall be constucted to prevent unintentional opening.

### 7.10.8

Each internal discharge valve shall be self-closing, and shall be located inside the tank, within the welded flange, or within its companion flange.

### 7.10.9

A shear section shall be located outboard of each internal discharge valve seat and within 100 mm (4 in) of the tank wall. The shear section shall break under strain without affecting the product retention capabilities of the tank and any attachments.

### 7.10.10

All piping shall be of suitable material. Welded joints shall be used wherever practicable. The bursting strength of all piping and pipe fittings shall be at least 4 times the MAWP of the tank and at least 4 times the pressure that it may be subjected to by the action of a pump or other device that may subject portions of the piping to pressures greater than the MAWP of the tank. Piping shall be supported in such a manner as to prevent damage due to thermal stresses, jarring, or vibration.

### 7.10.11

All nozzles and tank shell penetrations for nozzles shall be designed and constructed in accordance with the *ASME Boiler and Pressure Vessel Code.*

### 7.10.12

Glass liquid level gauges, or gauges of other easily destructible material, which are in direct communication with the contents of the tank, are prohibited.

### 7.10.13

Each discharge pipe shall be equipped with either a bolted blank flange or a liquid tight screw cap.

## 7.11 Testing

### 7.11.1 Hydrostatic Test

Each tank and all piping, valves, and other attachments that are subject to the pressure of the contents of the tank, except pressure relief devices, shall be hydrostatically tested by completely filling the tank (including domes, if any) with water or other liquid having a similar density and viscosity and applying pressure of at least 150% of the maximum allowable working pressure. The tank shall maintain the full test pressure for at least 10 min after the pressure source has been shut off. While under pressure, the tank shall be inspected for leakage, undue distortion, or other conditions which indicate weakness or which might render the tank unsafe for transportation service. Failure to successfully meet the test criteria shall be deemed evidence of failure to meet the requirements

of this Standard. Tanks failing to pass the test shall be suitably repaired and shall successfully pass the prescribed test prior to use for transporting any dangerous goods.

### 7.11.2 Testing of Internal Coils

Internal coils, if installed, shall be hydrostatically tested to an internal gauge pressure of 1380 kPa (200 psi) or 150% of the rated pressure of the coils, whichever is greater.

### 7.11.3 Tank Container Qualification Test

For each tank design, a prototype tank, using a framework for containerized transport, shall fulfill the requirements for compliance with the requirements of Annex II of the *Safe Containers Convention Act.* In addition, the following tests shall be completed without leakage or deformation that would render the tank unsuitable for use:

(a) **Longitudinal Inertia.** The tank loaded to its maximum gross weight shall be positioned with its longitudinal axis vertical. It shall be held in this position for 5 min by support at the lower end of the base structure providing lateral restraint only.

(b) **Lateral Inertia.** The tank loaded to its maximum gross weight shall be positioned for 5 min with its transverse axis vertical. It shall be held in this position for 5 min by support at the lower side of the base structure providing vertical and lateral restraint and by support at the upper side of the base structure providing lateral restraint only.

(c) **Rail Impact Test.** Tanks for transportation by rail shall be capable of passing the impact test in accordance with the *Canadian Transport Commission Regulations* (see Appendix A of this Standard). Compliance with this requirement shall be demonstrated by a physical test of a representative prototype tank.

### 7.11.4 Approval of Small Tanks of the Same Design

Design approval shall include the prototype testing of at least one tank of each design and each size. However, a set of tests made on a tank of one size may serve for the approval of smaller tanks with equal or lesser diameter and length made of the same material and thickness by the same fabrication technique and with the required identical type of supports and equivalent closures and other appurtenances.

### 7.11.5 Pressure and Vacuum Relief Devices

Each spring-loaded relief device shall be tested for the accuracy of the setting prior to installation on a tank and shall be effectively sealed to maintain the required setting.

## 7.12 Marking of Tanks

### 7.12.1 General

#### 7.12.1.1

Each intermodal portable tank shall bear a corrosion resistant metal identification plate that is permanently attached to the tank and readily accessible for inspection.

#### 7.12.1.2

The information required in Clause 7.12.2.1, and Clause 7.12.2.2 when appropriate, shall be stamped, embossed, or otherwise marked by an equally durable method on the plate in characters at least 3 mm (1/8 in) high. The plate shall not be painted.

### 7.12.2 Required Information

#### 7.12.2.1

At least the following information shall appear on the metal identification plate for each tank:

(a) Transport Canada Specification number;
(b) country of manufacture;
(c) manufacturer's name;
(d) date of manufacture;
(e) manufacturer's serial number;
(f) identification of Transport Canada certification agency and certification mark;
(g) maximum allowable working pressure, kPa or bar (psi) gauge;
(h) test pressure, kPa or bar (psi) gauge;
(i) total measured water capacity of tank or each compartment at 20°C (68°F), L (gal);
(j) maximum allowable gross weight, kg (lb);
(k) equivalent minimum shell thickness of reference mild steel, mm (in);
(l) tank material and specification number;
(m) metallurgical design temperature range, °C (°F) (if greater than 50°C (122°F) and less than −20°C (−4°F);
(n) month, year, and test pressure of the most recent test;
(o) stamp of expert who carried out the most recent test;

(p) as applicable, information on meeting Specification AAR600.

**Note:** *See also Clause 3.3.*

### 7.12.2..2

The following additional information shall appear on the metal identification plate when applicable:

(a) lining material;

(b) heating coil maximum allowable working pressure, kPa or bar (psi) gauge;

(c) corrosion allowance, mm (in).

### 7.12.2.3

In addition to the markings required by Clause 7.12.2.1, the framing of each intermodal portable tank that meets the definition of "tank container" in accordance with the *Transportation of Dangerous Goods Regulations* shall have a Safety Approval Plate containing the information required by the Safe Containers Convention Act.

### 7.12.2.4

Nothing in this Clause shall be deemed to preclude the display of other pertinent information on the required metal identification plate.

## 7.13 Additional Requirements for Types 1 and 2 Intermodal Portable Tanks

### 7.13.1 Tank Shell Loadings

### 7.13.1.1

Tank shells, heads, and their fastenings shall be designed in such a manner as to prevent stresses in excess of two-thirds of those specified in Clause 7.3. The design calculation shall include the forces imposed by the most severe of the following loads where W is the maximum loaded weight of the tank and its attachments:

(a) an internal pressure equal to the maximum allowable working pressure in combination with the simultaneously applied loadings of 3W vertically downward, 2W longitudinally, and 1W laterally acting through the center of the tank, and the requirements of Items (d), (e), and (f);

(b) an internal pressure equal to the maximum allowable working pressure in combination with the simultaneously applied loadings of 1W vertically upward, 2W longitudinally, and 1W laterally acting through the center of the tank, and the requirements of Items (d), (e), and (f);

(c) the load on the tank head resulting from an internal pressure equal to the maximum allowable working pressure in combination with the dynamic pressure resulting from a longitudinal deceleration of 2 *g*, and the requirements of Items (d), (e), and (f);

(d) loads resulting from any discontinuities between tank shell and heads;

(e) superimposed loads such as operating equipment, insulation, linings, and piping; and

(f) reactions of supporting lugs and saddles to other supports.

### 7.13.1.2

The shell thickness used in calculating the resulting stress levels in a tank shall be exclusive of any corrosion allowance.

### 7.13.2 Minimum Thickness of Shell and Heads

### 7.13.2.1

For the purpose of this Clause, reference mild steel is steel with a specified minimum tensile strength of 37 daN/mm$^2$ (53 650 psi) and a minimum elongation of 27%.

### 7.13.2.2

The minimum thickness of the shell and heads of a Type 1 or 2 tank constructed of reference mild steel shall be

(a) 5 mm (0.20 in) where the maximum cross-sectional dimension is 1.8 m (5.9 ft) or less; or

(b) 6 mm (0.25 in) where the maximum cross-sectional dimension is greater than 1.8 m (5.9 ft).

### 7.13.2.3

The minimum thickness of the shell and heads of a tank constructed of a steel other than the reference mild steel shall be determined using the following equation:

$e_1 = (10e_0)/ (Rm_1A_1)^{1/3}$ (metric units)

$e_1 = (112.3e_0)/ (Rm_1A_1)^{1/3}$ (conventional units)

where

$e_0$ = required thickness of the reference mild steel from Clause 7.13.2.1, mm (in)

$e_1$ = equivalent thickness of the steel to be used, mm (in)

$Rm_1$ = specified minimum tensile strength of the steel used in daN/mm$^2$ (psi)

$A_1$ = specified minimum elongation of the steel to be used expressed as a percentage (ie, if 20%, use 20.0)

### 7.13.2.4

Where other than the standard minimum thickness for the reference mild steel is specified for a tank in CSA Standard B623, the specified minimum shell and head thickness for other than the reference mild steel shall be at least equal to the greater of the thicknesses required in Clauses 7.13.2.3 or 7.13.2.5 or as determined by the following equation:

$e_1 = (10e_0d_1)/1.8(Rm_1A_1)^{1/3}$ (metric units)
$e_1 = (112.3e_0d_1)/5.9(Rm_1A_1)^{1/3}$ (conventional units)

where
$e_0$ = the specified minimum shell and head thickness of the reference mild steel specified in CSA Standard B623, mm (in)
$e_1$ = equivalent thickness of the steel to be used, mm (in)
$d_1$ = actual outside diameter of the tank, m (ft)
$Rm_1$ = specified minimum tensile strength of the steel to be used, daN/mm² (psi)
$A_1$ = specified minimum elongation of the steel to be used as a percentage (ie, if 20% use 20.0)

### 7.13.2.5

The minimum thickness of the shell and heads of a Type 1 or 2 tank constructed of material other than reference mild steel shall be
(a) 3 mm (0.11 in) where the maximum cross-sectional dimension is 1.8 m (5.9 ft) or less; or
(b) 4 mm (0.15 in) where the maximum cross-sectional dimension is greater than 1.8 m (5.9 ft).

## 7.14 Additional Requirements for Type 3 Intermodal Portable Tanks

### 7.14.1 Tank Shell Loadings

### 7.14.1.1

Tank shells, heads, and their fastenings shall be designed to prevent stresses in excess of two-thirds of those specified in Clause 7.3. The design calculation shall include the forces imposed by the most severe of the following loads where W is the maximum loaded weight of the tank and its attachments:
(a) an internal pressure equal to the maximum allowable working pressure in combination with the simultaneously applied loadings of 3W vertically downward, 4W longitudinally, and 1.5W laterally acting through the center of the tank, and the requirements of Items (d), (e), and (f);
(b) an internal pressure equal to the maximum allowable working pressure in combination with the simultaneously applied loadings of 2W vertically upward, 4W longitudinally, and 1.5W laterally acting through the center to the tank, and the requirements of Items (d), (e), and (f);
(c) the load on the tank head resulting from an internal pressure equal to the maximum allowable working pressure in combination with the dynamic pressure resulting from a longitudinal deceleration of 4 *g*, and the requirements of Items (d), (e) and (f);
(d) loads resulting from any discontinuities between tank shell and heads;
(e) superimposed loads such as operating equipment, insulation, linings and piping; and
(f) reactions of supporting lugs and saddles to other supports.

### 7.14.1.2

The shell thickness used in calculating the resulting stress levels in a tank shall be exclusive of any corrosion allowance.

### 7.14.2 Minimum Thickness of Shell and Heads

### 7.14.2.1

The minimum thickness of the shell and heads of a tank constructed of reference mild steel shall be 9.52 mm (0.38 in).

### 7.14.2.2

The minimum thickness of the shell and heads of a tank constructed of austenitic stainless steel shall be 4.18 mm (0.17 in).

### 7.14.2.3

Where Table 6.1 of CSA Standard B623 specifies a minimum thickness for the shell and heads, that thickness for Type 3 tanks constructed of austenitic stainless steel may be reduced using the criteria in Clause 7.13.2, but shall not be less than 4.18 mm (0.17 in).

# 8. Inspection, Retesting, and Maintenance of Highway Tanks, Portable Tanks, and Intermodal Portable Tanks

## 8.1 Frequency of Visual Inspection and Retest

### 8.1.1

Highway tanks with design pressures equal to or less than 103 kPa (15 psi) gauge shall be inspected or retested as follows:

(a) A visual inspection shall be performed in accordance with Clause 8.2 at 2 year intervals; and

(b) Where proper internal and external inspections of the tank are precluded by linings, insulation, or other impediments, a hydrostatic or pneumatic retest shall be carried out at 5 year intervals.

(c) In addition to visual inspection subject to Item (a), TC 350 highway tanks shall be hydrostatically and pneumatically tested at 2 year intervals.

### 8.1.2

Highway tanks with design pressures in excess of 103 kPa (15 psi) gauge shall be inspected and retested as follows:

(a) A visual inspection shall be performed within 2 to 3 year intervals in accordance with Clause 8.2; and

(b) A hydrostatic or pneumatic retest shall be carried out at 5 year intervals.

(c) For TC 350 highway tanks, a hydrostatic or pneumatic retest shall be carried out at 2 year intervals.

### 8.1.3

Portable tanks shall be retested and inspected as follows:

(a) Tanks with design pressures equal to or less than 103 kPa (15 psi) gauge shall be subjected to a hydrostatic or pneumatic retest and inspected at 2 year intervals in accordance with Clauses 8.2 and 8.3. Visual inspection shall be carried out while the tank is under test pressure.

(b) Tanks with design pressures in excess of 103 kPa (15 psi) gauge shall be inspected within 2 to 3 year intervals in accordance with Clause 8.2 and hydrostatically retested every 5 years in accordance with Clause 8.3.

(c) Tanks TC 60 and 60 shall be inspected at 2 year intervals in accordance with Clause 8.2 and hydrostatically retested in accordance with Clause 8.3:

(i) 4 years after the original test;

(ii) every 2 years thereafter up to the total of 12 years of service; and

(iii) at least once annually thereafter.

(d) Hydrostatic retesting on rubber lined portable tanks is not required except before each relining.

### 8.1.4

Intermodal portable tanks shall be retested and inspected as follows:

(a) they shall be subjected to a visual inspection at intervals not exceeding 2.5 years in accordance with Clause 8.2;

(b) they shall be subjected to a hydrostatic retest and inspected at intervals not exceeding 5 years in accordance with Clause 8.3;

(c) intermodal portable tanks that also meet the definition of "tank container" in accordance with the *Transportation of Dangerous Goods Regulations* shall have their framework inspected in accordance with the *Safe Convention Containers Act* at intervals not exceeding 2.5 years.

### 8.1.5

Each tank and each safety relief valve of any highway tank used for the transportation of chlorine shall be hydrostatically or penumatically retested and visually inspected at least once every 2 years.

### 8.1.6

Each highway tank and portable tank used for the transportation of anhydrous ammonia, constructed of quenched and tempered steel, or constructed of other than quenched and tempered steel but without postweld heat treatment, shall be internally inspected by the wet fluorescent magnetic particle method, in accordance with Clause 8.4, immediately prior to and in conjunction with the performance of any hydrostatic or pneumatic retest prescribed in this Clause. This requirement does not apply to highway tanks and portable tanks that do not have manholes.

### 8.1.7

When any repairs are made on highway tanks TC 331, MC 330, or MC 331, or portable tanks TC 51 or 51, TC 60 or 60 that require grinding or welding, the tanks shall be inspected by the wet fluorescent magnetic particle method, in accordance with Clause 8.4, after hydrostatic or pneumatic retesting, to assure that all defects have been removed. Repairs shall be carried out in accordance with Clause 8.7.

### 8.1.8

Notwithstanding the periodic retesting or inspection requirements of Clauses 8.1.1 to 8.1.5, hydrostatic or pneumatic retesting and visual inspection is required if

(a) the tank shows evidence at any time of bad dents, corroded areas, leakage, or other conditions that indicate weakness that might render the tank unsafe for transportation; or

(b) the tank has not been used for transporting dangerous goods for 1 year or more; or

(c) the tank has been involved in an accident in which it may have been dented, torn, or otherwise damaged so as to affect its product retention integrity; or

(d) the shell of the product compartment of the tank as originally manufactured has been modified; or

(e) the tank is operating under special permit authorization, in which case it shall be retested in accordance with the requirements of the special permit.

## 8.2 Visual Inspection Procedure

Visual inspection of tanks or compartments shall consist of the following items:

(a) An external inspection of the tank, but where this is precluded, an internal inspection is acceptable. Where both external and internal inspections are precluded, either the external jacketing or the internal liner shall be inspected for indications of vessel defects.

(b) Inspection for corroded areas, bad dents, defects in welds, defects in piping, valves, and gaskets, and other conditions, including leakage, that indicate weakness in the tank that might render it unsafe for transportation.

(c) Ensuring that devices for tightening manhole covers are operative, and the covers are leakproof.

(d) The pneumatic or hydrostatic testing of spring-loaded safety relief valves rated in excess of 48 kPa (7 psi) gauge.

(e) Inspection to assure operability of spring-loaded safety relief devices operating at 48 kPa (7 psi) gauge or less.

(f) Ensuring that all emergency devices and valves are free from corrosion, distortion, or any other damage that would prevent their normal operation.

(g) Ensuring that bolts or nuts on any flanged connection or blank flange are not missing or loose.

(h) Ensuring that required markings on the tank are legible.

## 8.3 Hydrostatic or Pneumatic Retesting Procedures

### 8.3.1 General

#### 8.3.1.1

If a tank is compartmented, each compartment shall be similarly tested with the adjacent compartment empty and at atmospheric presure.

#### 8.3.1.2

If a tank compartment contains a cooling or heating system, it shall be tested with that system at atmospheric pressure.

#### 8.3.1.3

While the retesting is being carried out, all closures shall be in place and all relief devices clamped, plugged, or otherwise rendered inoperative. Relief devices shall be returned to their operative condition immediately after the tests are completed.

#### 8.3.1.4

All tank valves, piping, fittings, hoses, and other accessories in communication with the lading shall be pressure-tested and proven tight at not less than the tank design pressure.

#### 8.3.1.5

All pressure-bearing portions of the heating system of a tank (or compartment), employing such a medium as steam or hot water for heating the lading, shall be retested under hydrostatic testing pressure and proven tight at 1380 kPa (200 psi) gauge. Systems using flues for heating shall be suitably tested to ensure against product leakage into the flues or into the atmosphere.

#### 8.3.1.6

Refrigerating or heating coil or coils, installed in tanks for carbon dioxide and nitrous oxide, shall be tested externally to at least the same pressure as the test pressure of the tank, and internally to at least twice the working pressure of the heating or refrigerating system to be used, but in no case less than the test pressure of the tank.

#### 8.3.1.7

The tank insulation, if any, and its jacket need not be removed from insulated tanks, unless it is found to be impossible to reach test pressure or maintain a condition of pressure equilibrium after the test pressure is reached.

#### 8.3.1.8

A tank or compartment has satisfactorily passed the hydrostatic or pneumatic retest if it has successfully retained the applicable test pressure for at least 10 min, and a visual examination of all external surfaces proves satisfactory.

### 8.3.2 Hydrostatic Retesting

For hydrostatic retesting, the tank including its domes, if any, shall be completely filled with water or a liquid having a viscosity similar to water. Pressure shall be gauged at the top of the tank and applied in accordance with Table 8.1.

### 8.3.3 Pneumatic Retesting

#### 8.3.3.1

Pneumatic retesting may be carried out only in those cases where there is no suspicion of weakness and where subsequent problems may arise due to the presence of water.

#### 8.3.3.2

When a pneumatic retest is performed, it should be in accordance with a detailed written procedure that includes suitable safeguards to protect employees should a failure occur.

#### 8.3.3.3

During the pneumatic retest, the entire surface of all joints under pressure shall be coated with a solution of soap and water, heavy oil, or other materials suitable for the purpose of foaming or bubbling to indicate the presence of leaks. Other equally sensitive methods for determining leaks may be used or the pressure retention time shall be increased to 1 h. Pneumatic pressure shall be applied in accordance with Table 8.1.

## 8.4 Fluorescent Testing Procedure

The wet fluorescent magnetic particle inspection shall be carried out in accordance with Section V of the *ASME Boiler and Pressure Vessel Code* and the CGA Technical Bulletin TB-2, *Guidelines for Inspection and Repair of MC 330 and MC 331 Cargo Tanks.*

## 8.5 Retest and Inspection Reports

### 8.5.1 Retest Reports

Following the required retest, a written report shall be prepared that shall contain the following:

(a) **Requirements for All Tanks**

(i) Owner's name, address, and telephone number.

(ii) The name, organization, and address of the person witnessing or performing the test, and the applicable dates, including test medium, test pressure, and results.

(iii) Complete nameplate data, including specification, manufacturer's serial number and data required by the *ASME Boiler and Pressure Vessel Code.*

(iv) A statement of the nature and severity of defects found, if any, and by what method the damage or defect was discovered. In particular, information shall be furnished to indicate the location of defects detected. If no defect or damage was discovered, that fact shall be reported.

(v) A statement of the disposition of the tank after inspection, such as "tank scrapped" or "tank returned to service".

(b) **Additional Requirements for TC 331, MC 330, MC 331, TC 51, and 51 Tanks**

(i) A statement indicating whether the tank is constructed of a quenched and tempered steel (QT), or other than quenched and tempered steel (NQT).

(ii) A statement indicating whether the tank was stress-relieved after manufacture.

(iii) A statement indicating whether the highway tank has been used for transportation of anhydrous ammonia or liquefied petroleum gas since the previous inspection or test. If the highway tank was used for anhydrous ammonia, a statement indicating whether each shipment of ammonia was certified by its shipper as containing a minimum of 0.2% water by weight.

(iv) A statement indicating the methods employed to make repairs, who made the repairs, and the date they were completed. Also a statement indicating whether the tank was stress-relieved after repairs and, if so, whether complete or local stress-relieving was performed.

### 8.5.2 Visual Inspection Reports

Following the required visual inspection, a written report shall be prepared that will contain:

(a) owner's name, address, and telephone number;

(b) the name, organization, and address of the person performing the inspection, and applicable date;

(c) complete nameplate data, including specification, manufacturer's serial number and data required by the *ASME Boiler and Pressure Vessel Code;*

(d) a record of the condition of the items listed in Clause 8.2.

### 8.5.3 Welding Inspection Reports

When welding inspection is required by Clauses 8.1.6 and 8.1.7, a written welding inspection report shall be prepared and included with the retest or inspection report.

## 8.6 Retest or Inspection Date Marking

The month and year of the last visual inspection or hydrostatic or pneumatic retest shall be durably and legibly marked on the tank in letters not less than 32 mm (1-1/4 in) high on the right side near the front. The type of inspection or test shall be indicated and the following suffix letters shall be used:

V - visual inspection

H - hydrostatic retest

P - pneumatic retest

WF - wet fluorescent test

## 8.7 Repairs of Highway Tanks and Portable Tanks

### 8.7.1

Repair of a tank is authorized provided that such repairs are made in compliance with the specification for its original design and construction. Repairs to the reinforced plastic of a reinforced plastic highway tank shall be carried out under the guidance and supervision of a manufacturer of such tanks.

### 8.7.2

All cracks and other defects found on highway tanks TC 331, MC 330, or MC 331 shall be repaired in accordance with the repair procedures described in CGA Technical Bulletin TB-2, *Guidelines for Inspection and Repair of MC 330 and MC 331 Cargo Tanks,* and Section VIII of the edition of the *ASME Boiler and Pressure Vessel Code* under which the tank was built.

### 8.7.3

Each tank having cracks and defects requiring welded repairs shall meet all of the requirements of this Clause, except that postweld heat treatment, after minor weld repairs, is not required.

### 8.7.4

No field welding shall be allowed, except to non-pressure parts.

### 8.7.5

In addition to any other provisions of the specifications, no tank shall be repaired or remodelled in a way to cause leakage or cracks, or the likelihood of leakage or cracks by areas of stress concentration due to shrinkage of cooling metal in welding operations, sharp fillets, reversal of stresses, or otherwise.

### 8.7.6

Suitability of repairs shall be confirmed by tests and inspections required by the applicable tank specification.

## Table 8.1
## Pressures for Retesting

| Tank specification | Pressure, kPa (psi) |
|---|---|
| TC 306 or MC 300, 301, 302, 303, 305, 306 | 21 (3) |
| TC 307 or MC 304, 307 | 258 (37.5) or 1.5 × design pressure, whichever is greater |
| TC 312 or MC 310, 311, 312 | 21 (3) or 1.5 × design pressure whichever is greater |
| TC 331 or MC 330, 331 | 1.5 × design pressure |
| TC 338 or TC 341 | 1.25 × design pressure, air pressure |
| TC 350 | 1.5 × design pressure or 155 kPa (22.5) |
| TC 51 or 51 | 1.5 × design pressure |
| 52 | 1.5 × design pressure |
| 53 | 14 (2) or 1.5 × design pressure, whichever is greater |
| TC 56 or 56 | 14 (2) or 1.5 × design pressure, whichever is greater |
| TC 57 or 57 | 21 (3), air pressure only |
| TC 60 or 60 | 415 (60) |
| TC Type 1 | 1.5 × MAWP |
| TC Type 2 | 1.5 × MAWP |
| TC Type 3 | 1.5 × MAWP |

# 9. Requirements for Tanks to be Manufactured, Repaired, Tested, Inspected, and Certified by Registered Facilities

## 9.1 Scope

This Clause covers the requirements for tanks complying with this Standard to be manufactured, repaired, tested, retested, inspected, and certified by registered facilities.

**Notes:**

**(1)** *The tank certification requirements of this Standard are not intended to duplicate or supersede the pertinent requirements of provincial pressure vessel acts and/or regulations.*

**(2)** *Compliance with the certification requirements of this Standard does not provide exemption from*

*(a) provincial requirements for the approval and/or registration of pressure parts designs; or*

*(b) required provincial approvals and/or authorizations of facilities which manufacture, inspect, test, repair, or service pressure vessels, pressure relief devices, or pressure piping systems.*

## 9.2 General

### 9.2.1

Manufacturing, repairing, testing, retesting, and inspection in accordance with this Standard shall be performed only by a facility which has been registered with the Director by issuance of a certificate of registration of the type shown in Figure 9.1.

### 9.2.2

The certification plate and/or other plates required by the applicable specifications in this Standard shall be attached to a tank only where the tank has been

(a) manufactured, inspected, and tested in accordance with this Standard by a registered facility; and

(b) certified by a registered facility as meeting the specifications marked on the plate.

### 9.2.3

The markings required by this Standard for visual inspection and with respect to retesting shall be applied to a tank only where the tank has been

(a) inspected and/or tested in accordance with this Standard by a registered facility; and

(b) certified by that registered facility as meeting the applicable requirements of Clause 8.

## 9.3 Registration to Carry Out Visual Inspections

### 9.3.1

Application for registration to perform visual inspections shall be submitted to the Director. Figure 9.2 provides an example of a form that may be used in applying for registration.

### 9.3.2

The application shall include statements that the following resources are available on site, can be obtained from specified sources, or are not required:

(a) a facility for the safe purging of tanks requiring internal inspection. This will include any necessary test equipment to check confined space atmospheres prior to entry and to ensure that entry will be safe;

(b) a facility for the safe external and/or internal cleaning prior to inspection;

(c) equipment to safely test and/or operate safety relief valves;

(d) a facility to produce and maintain the records and certification required by this Standard; and

(e) persons having at least two years experience in the maintenance of the tank involved to carry out visual inspections. At the discretion of the Director, alternate qualifications may be acceptable.

## 9.4 Registration to Carry Out Testing or Retesting, or Both

### 9.4.1

Application for registration to perform tests or retests shall be submitted to the Director. Figure 9.2 provides an example of a form that may be used in applying for registration.

### 9.4.2

The application shall include the information required in Clause 9.3.2 and statements that the following resources are available on site, can be obtained from specified sources, or are not required:

(a) a site conforming to any regulations or by-laws covering pneumatic and/or hydrostatic testing operations. The application shall include a description of the safety precautions to protect personnel in the event of tank failure during test;

(b) pressurizing equipment, hydrostatic or pneumatic, or both, having maximum pressure ratings in excess of those required for the proposed operations;

(c) a manual outlining the procedures of proposed testing and/or retesting activities, which shall include a listing of the qualifications and experience of personnel responsible for these activities; and
(d) persons having at least five years experience in the maintenance and testing of the tank involved to carry out testing and/or retesting. At the discretion of the Director, alternate qualifications may be acceptable.

## 9.5 Registration as a Manufacturer of Tanks

### 9.5.1

Applications for registration as a manufacturer of tanks shall be submitted to the Director. Figure 9.2 provides an example of a form that may be used in applying for registration.

### 9.5.2

The application shall include the items required in Clauses 9.3.2 and 9.4.2, and statements that the following resources are available on site, can be obtained from specified sources, or are not required:
(a) a suitably qualified and experienced person to carry out design and engineering of the tank;
(b) a written quality control program, which shall be submitted with the application;
(c) tank fabrication equipment of appropriate type and size.

## 9.6 Certificates of Compliance

### 9.6.1

A certificate of compliance shall be issued to the owner by a representative of each facility at which a tank is completely or partly manufactured. The certificate(s) shall be retained by the owner or the owner's designate for the life of the tank. A copy of the certificate(s) shall be held by the manufacturer for a minimum of ten years from the date of delivery. In the case of resale, the certificate(s) shall be transferred to and retained by the new owner.

### 9.6.2

The certificates shall contain the following:
(a) A statement that the tank, including all fittings, valves, piping, and protective devices, complies with the applicable specification(s) of this Standard.
(b) A statement that, to the extent work was performed, the tank, including all fittings, valves, piping, and protective devices, complies with the applicable specifications of this Standard.
(c) All information required to be shown on the certification or nameplate by the applicable specification of this Standard and in the case of TC 338, on the nameplate and specification plate.
(d) An identification number for the tank.
(e) The name and address of the registered facility.
(f) The signature, name, and address of the person responsible for compliance with this Standard.
(g) For tanks constructed and inspected in compliance with the *ASME Boiler and Pressure Vessel Code*, a copy of the Affidavit of Manufacture or the Manufacturer's Data Report, and the Canadian Registration Number (CRN).
(h) Sufficient information to indicate the location and size of all manholes, nozzles, and other openings.

## 9.7 Design Qualification Test Reports

### 9.7.1

A design qualification test, including the rail impact test, where required by the applicable specification, shall be carried out by the registered facility prior to commercial production of the tanks.

### 9.7.2

The design qualification test reports shall include
(a) the name and address of the registered facility where the tests were carried out;
(b) the signature, name, and address of the person responsible for compliance with this Standard;
(c) detailed engineering drawings and specifications for the design; and
(d) a statement that the prototype(s) passed the qualification tests prescribed in this Standard.

### 9.7.3

One copy of the test report shall be sent to the Director.

## 9.8 Reports of Visual Inspections and Retests

### 9.8.1

Reports of visual inspections shall be completed as required in Clause 8. A copy of the report shall be provided to the owner or owner's designate who shall retain the report until the next visual inspection report has been received. The registered facility performing the inspection shall retain a copy of the report for the interval between inspections required in Clause 8.

### 9.8.2

Reports of retests shall be completed as required in Clause 8. A copy of the report shall be provided to the owner or the owner's designate who shall retain the report until the next retest report has been received. The registered facility performing the retest shall retain a copy of the report for the interval between retests required in Clause 8.

### 9.8.3

In the case of resale it is the responsibility of the new owners to obtain a copy of a current inspection or retest report, or both, and to retain these reports in accordance with Clause 9.8.2.

## Figure 9.1
## Certificate of Registration as a Facility for the Manufacture, Repair, Test, Retest, or Inspection of Highway Tanks and Portable Tanks

In accordance with CSA Standard B620

REGISTRATION NUMBER: _____ COMPANY NAME: _____

COMPANY ADDRESS: _____

_____

CORPORATE OFFICER RESPONSIBLE FOR COMPLIANCE:

NAME: _____ TITLE: _____

The facility located at _____
(Address)

_____

is hereby registered as a recognized facility for the functions indicated below:

| | Visual Inspection | Retest: Hydrostatic | Retest: Pneumatic | Repair | Manufacture |
|---|---|---|---|---|---|
| TC 306 | | | | | |
| TC 307/312/350 | | | | | |
| TC 330/331 | | | | | |
| TC 338 | | | | | |
| TC 341 | | | | | |
| TC 51 | | | | | |
| TC 56/57 | | | | | |
| TC 60 | | | | | |
| TC Type 1 | | | | | |
| TC Type 2 | | | | | |
| TC Type 3 | | | | | |
| Other (specify): | | | | | |

The registration is only applicable to the above facility and only for the function indicated above when carried out on the specification tanks and/or their US equivalents.

Limitations to this certificate: _____

_____

**Expiry Date of Registration**
This registration is valid for 5 years from date of issue. A new application must be submitted where there is any substantive change in the information given on the application form filed with Transport Canada. Application for renewal must be made by registered mail at least 3 months before expiry.

SIGNATURE: _____ TITLE: _____

DATE OF ISSUE: _____

FOR DIRECTOR, REGULATORY REQUIREMENTS
TRANSPORT DANGEROUS GOODS DIRECTORATE

## Figure 9.2
## Application for Registration as a Facility for the Manufacture, Testing, Repair, Retesting, or Visual Inspection of Highway Tanks, Portable Tanks, and Intermodal Portable Tanks Built in Accordance with the Specifications Included in CSA Standard B620

**1. NAME AND ADDRESS OF THE COMPANY REQUESTING REGISTRATION**

Name: _____

Address: _____

**2. FUNCTION FOR WHICH REGISTRATION IS REQUESTED**

Manufacturing _____

Repairing _____

Visual Inspection _____

Hydrostatic/Pneumatic Testing and/or Retest _____

Fluorescent Testing _____

Other (Specify): _____

**3. NAME AND ADDRESS OF CORPORATE OFFICER RESPONSIBLE FOR ENSURING THAT THE FUNCTION(S) IS CARRIED OUT IN ACCORDANCE WITH CSA B620**

Name: _____

Title: _____

Address: _____

_____

**4. TANK SPECIFICATION(S)**

| | Visual Inspection | Retest: Hydrostatic | Retest: Pneumatic | Repair | Manufacture |
|---|---|---|---|---|---|
| (a) Highway Tanks | | | | | |
| TC 306 | _____ | _____ | _____ | _____ | _____ |
| TC 307/312/350 | _____ | _____ | _____ | _____ | _____ |
| TC 330/331 | _____ | _____ | _____ | _____ | _____ |
| TC 338/341 | _____ | _____ | _____ | _____ | _____ |
| Other (specify): | _____ | _____ | _____ | _____ | _____ |

| | Visual Inspection | Retest: Hydrostatic | Retest: Pneumatic | Repair | Manufacture |
|---|---|---|---|---|---|
| (b) Portable Tanks | | | | | |
| TC 51 | _____ | _____ | _____ | _____ | _____ |
| TC 56/57 | _____ | _____ | _____ | _____ | _____ |
| TC 60 | _____ | _____ | _____ | _____ | _____ |
| Other (specify): | _____ | _____ | _____ | _____ | _____ |
| (c) Intermodal Portable Tanks | | | | | |
| TC Type 1 | _____ | _____ | _____ | _____ | _____ |
| TC Type 2 | _____ | _____ | _____ | _____ | _____ |
| TC Type 3 | _____ | _____ | _____ | _____ | _____ |
| Other (specify): | _____ | _____ | _____ | _____ | _____ |

**5. DETAILS OF THE FACILITY**

(a) Workshop area

Owned/leased _____ Obtained, when needed, from: Not necessary _____

| Address | (Name) | Justify |
|---|---|---|
| _____ | _____ | _____ |
| _____ | (Address) _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |

(b) Office space and equipment for the preparation and retention of reports

Owned/leased _____ Obtained, when needed, from: Not necessary _____

| Address | (Name) | Justify |
|---|---|---|
| _____ | _____ | _____ |
| _____ | (Address) _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |

(c) Equipment and services to clean and decontaminate tanks

Owned/leased ____ Obtained, when needed, from: Not necessary ____

Address (Name) Justify

(d) Safety equipment and established working procedures for checking decontamination and for working in confined spaces (attach written working procedures to this application)

Owned/leased ____ Obtained, when needed, from: Not necessary ____

Address (Name) Justify

(e) Tank fabrication equipment
(Attach list indicating size and type of major tank manufacturing machinery)

Owned/leased ____ Obtained, when needed, from: Not necessary ____

Address (Name) Justify

(f) Equipment necessary for retesting/inspecting the tank, accessories, and safety devices

Owned/leased ____ Obtained, when needed, from: Not necessary ____

Address (Name) Justify

(g) Quality Control

Specify how control of the quality of the work carried out is maintained:

(i) written quality control procedures (attached to this application) _____

(ii) other (attach full description to this application) _____

(h) Specify the minimum relevant qualifications and/or experience of the personnel who will carry out, or directly supervise the following functions:

(i) design and engineering _____

(ii) quality control _____

(iii) welding _____

(iv) fitting of piping and appurtenances _____

(v) tank cleaning and decontamination _____

(vi) verification of cleanliness and decontamination _____

(vii) visual inspection _____

(viii) hydrostatic and/or pneumatic testing or retesting _____

(ix) other retesting/inspection procedures _____

(i) Specify the overall dimensions of the largest tank which may be readily accommodated within the workshop area:

Length _____ Width _____ Height _____

Signed _____
(Corporate Officer Named in 3)

# Appendix A
# Rail Impact Tests

**Note:** *This Appendix is not a mandatory part of this Standard and has been included for information only.*

## A1. Scope

This method is to be used for practical field tests of all IMO 1, 2, and 5 portable tanks at any facility authorized by the Director of Operations, Rail Transport Committee, Canadian Transport Commission, except those where written authority from the Director of Operations was secured to test in a different manner.

## A2. Equipment

### A2.1

A flat car is to be used to hold portable tanks. The car should be representative of the type of car intended for use in portable tank transportation and, unless otherwise agreed, is to be equipped with standard draft gear and conventional underframe.

### A2.2

Five empty cars are to be used as buffer cars which will be placed with air and hand brakes applied, and all equipped with standard draft gear. The total mass of the buffer cars is to be approximately 113 500 kg (250 000 lbs).

### A2.3

One car of not less than 62 500 kg (70 tons) minimum capacity loaded to the allowable gross mass with high density material is to be used to provide a low centre of gravity.

### A2.4

One locomotive or ramp is to be used to attain speeds up to 4.5 m/s (10 mph).

### A2.5

A minimum of 90 m (300 ft) length of reasonably level tangent track between the buffer cars and the test cars is required to attain the speed necessary for impact testing.

### A2.6

Speed measurement devices to be used shall be either radar equipment or electric timers.

### A2.7

Whenever possible, impact registers should be used as a performance check. They shall be nailed to the car floor and tapes marked and recorded after each impact.

## A3. Arrangement of Test Equipment

### A3.1

Place buffer cars at the far end of the track and set air and hand brakes.

### A3.2

Locate the flat car with portable tank between the buffer cars and locomotive.

### A3.3

Brief the train crew on the procedure. Delegate one person to advise the appropriate member of the train crew in regard to when moves are to be made. All participants and observers should be instructed to take precaution for their personal safety and observe safety practices of the carrier and or company conducting the tests. If desirable, train crews should have a test run without impacting the test load to establish accuracy of speed.

### A3.4

Place the switch contacts of the electric timer on the track in accordance with manufacturer's instructions.

### A3.5

Position the radar scanner in an appropriate location and follow the manufacturer's instructions.

## A4. Test Procedure

### A4.1

The flat car carrying the portable tank shall be a sufficient distance from the buffer cars. The pulled car should then be pushed toward the buffer cars until the desired speed is obtained and then released and allowed to roll freely into the buffer cars having knuckles positioned for coupling.

### A4.2

There shall be four impacts of the test loads. The first three at 1.8, 2.7, and 3.6 m/s (4, 6, and 8 mph), respectively (track needs of flat car), in the same direction and as described above. The first two impacts shall be approximately 1.8 and 2.7 m/s (4 and 6 mph), respectively, whereas the third and fourth impacts must equal or exceed 3.6 m/s (8 mph). The fourth impact, at 3.6 m/s (8 mph), shall be at the opposite end of the test car from the first three impacts.

### A4.3

After finishing the test described in Clauses A4.1 and A4.2, the flat car carrying the portable tank shall be left on the track with air and hand brakes applied and end-impacted by the car described under Clause A2.3 from each end in such a way that the tank will be subjected to a force equal to four times the weight of the loaded portable tank measured at the corner castings through load cells.

## A5. Acceptable Results of the Test

### A5.1

The portable tank shall be inspected from the outside after each impact. Any visible deformation of the tank and any visible cracks of the tank or frame welds or structure constitutes test failure.

### A5.2

Any deflection in the frame, measured diagonally in both directions on both sides between corner castings, greater than 3 mm (1/8 in) constitutes failure.

### A5.3

Any visible deformation or cracks in the welds or plates of the tank, when inspected from inside the tank, constitutes failure. This internal inspection is mandatory for every tank after finishing the impact test.

Canadian Standards Association

# Order Form

Mail to:
**Sales Group**
**Canadian Standards Association**
**178 Rexdale Blvd.**
**Rexdale (Toronto), Ontario**
**Canada M9W 1R3**
**(416) 747-4044 Telex: 06-989344**
**FAX: 416-747-4149**

*Ship to:*

Name _____

Organization _____

Address _____

City _____ Prov./State _____

Country _____ Postal/Zip code _____

Purchase order No. _____
(North America only)

CSA Customer No. _____

**ALL ORDERS UNDER $175.00 MUST BE PREPAID.**

*Method of payment:*

Charge to credit card indicated:

☐ American Express ☐ Visa ☐ MasterCard

Card No. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Expiration date _____

Card holder's name _____

Signature _____

☐ Payment enclosed $ _____
*Make cheque payable to Canadian Standards Association.*

☐ Charge SM/FACT deposit account No. _____

Date | SM No. | Signature | Telephone ( )

| Quantity | Catalogue No. | Title | List price | 20% discount (Sustaining Members only) | Total |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Notes:**
**(1)** *If billing address is different, please specify.*
**(2) Payment.** *Orders from outside North America must be accompanied by payment. Shipping charges should be included in your payment.*
**(3) Postage and Handling.** *Orders are normally sent Book Rate. If you require First Class Mail or AirPost, please refer to ordering information for charges. Shipments may be designated to any other carrier at the customer's expense.*

**Prices subject to change without notice.**

Sub-total $_____

Postage and Handling
Book Rate: $1.25 Canada
$3.50 U.S. and Foreign $_____

Alternative Delivery
(see shipping note) $_____

**Grand Total** $_____

# *General Instruction No. 2*
## *B620-1987*
## *February 1992*

CSA Preliminary Standard B620-1987, *Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods,* was published in October 1987; it consisted of **106 pages,** each dated **October 1987.**

An amendment to the Contents and the addition of Clause 5.5, paragraph §178.340-10(c) and Appendix B have been formally approved and are incorporated (and identified by a vertical line in the margin) in the attached replacement pages.

CSA Preliminary Standard B620-1987 now consists of the following pages:

**1, 2, 5–42,** and **45–106** dated **October 1987**; and

**3, 4, 43, 44, 44A,** and **107–113** dated **February 1992.**

These replacement pages are to be inserted into your copy of the Standard; the pages replaced should be kept for reference.

# Contents

for their secure closure, and means shall also be provided for the closing of pipe connections of valves.

**§178.340-9 Pumps.**

(a) Loading or unloading pumps mounted on tractor or trailer, if used, shall be provided with automatic means to prevent the pressure from exceeding the design pressure of the tank mounted equipment.

**§178.340-10 Certification.**

(a) Certification as required in paragraphs (b) and (c) of this section shall indicate that such cargo tank has been designed, constructed, and tested in accordance with the applicable specification MC 306, MC 307, or MC 312, or TC 350 (§178.341, §178.342 or §178.343, Clause 5.10).

(1) *Multipurpose tanks.* If a cargo tank is divided into compartments and each compartment is constructed in accordance with the requirements of a different MC specification, there shall be a metal plate required in paragraph (b) of this section, located on the right side, near the front of each compartment, in a place readily accessible for inspection. Details pertaining to the multipurpose configuration shall also be clearly indicated on the manufacturer's certificate required in paragraph (c) of this section.

(i) If a cargo tank is constructed in accordance with the requirements of one specification and may be physically altered to meet another cargo tank specification in this part; or physically altered to accommodate a commodity not requiring a specification tank, such alterations shall be clearly indicated on the manufacturer's certificate required in paragraph (c) of this section and the tank mounted multi-purpose plate required in paragraph (b)(2) of this section.

(2) *Specification shortages.* If a cargo tank is manufactured which does not meet all of the applicable specification requirements, thereby requiring subsequent manufacturing involving the installation of additional components, parts, appurtenances or accessories, it is permissible for the original manufacturer to affix the metal certification plate required in paragraph (b) of this section. The specification requirements not complied with shall be indicated on the manufacturer's certificate required in paragraph (c) of this section. When the cargo tank is finally brought into complete compliance, the date such compliance is accomplished shall be stamped on the metal certification plate. The certificate shall indicate the pertinent details, date and concern (manufacturer or carrier) accomplishing complete compliance.

(b) *Metal certification plate.* After July 1, 1985, each cargo tank, or tank compartment if constructed to a different specification, must have a metal certification plate attached to its shell or to an integral supporting structure. The certification plate shall not be subject to corrosion, and must be located on the left side (on the right side prior to July 1, 1985) near the front in a place readily accessible for inspection. Each plate shall be permanently affixed by means of brazing, welding, soldering, riveting, or other equally suitable means. The plate must be marked in characters at least 3/16 inch high by stamping, embossing, or other means of forming letters into or on the metal of the plate itself at least the information prescribed in paragraphs (b)(1) and (b)(2) of this section. The plate may not be painted as to obscure the marking thereon. A combination ASME/DOT certification plate is authorized.

(1) If a cargo tank is to be physically altered to meet another specification (or to accommodate a commodity not requiring a specification tank) such combinations shall be indicated beside specification identification. Additionally the metal multipurpose plates required in subparagraph (2) of this section are required.

Vehicle manufacturer _____
Manufacturer's serial number _____
Specification identification[1,2] DOT MC 306; or MC 307; or MC 312; or TC 350 _____
Date of manufacture _____
Original test date _____
Certification date _____
Design pressure _____ p.s.i.g.
Test pressure _____ p.s.i.g.
Head material[2] _____
Head thickness, min. required thickness _____
Shell material[2] _____
Shell thickness, min. required thickness _____
Weld material _____
Lining material _____

Nominal tank capacity by compartment
(front to rear) _____ gal.
Maximum product load _____ lbs.
Loading limits _____ g.p.m. and/or p.s.i.g.
Unloading limits _____ g.p.m. and/or p.s.i.g.

[1] The following material designations (or combinations thereof) must be added: Aluminum Alloy (AL); Mild Steel (MS); High Strength Low Alloy (HSLA); Austenitic Stainless Steel (SS). For example "DOT MC 306 AL" for cargo tanks made of aluminum. A multi-purpose cargo tank example would be "Combination MC 306SS — 307SS".

[2] RP (reinforced plastic) highway tanks shall be identified thus: TC 306 RP and "Head Material" and "Shell Material" shall identify the resin(s) used.
**Note:** *See also Clause 3.3.*

(2) *Metal multipurpose plate:* If a cargo tank is to be physically altered, metal multipurpose plates shall be mounted adjacent to the metal certification plate readily accessible for inspection. The mounting of the plates shall be such that only the plate identifying the applicable specification is legible at all times the cargo tank is in complete compliance with such specifications. The mounting of the plates (or plate assembly) shall be secured in such a manner as to be capable of retaining the plate when subjected to normal operating conditions. The same marking size and method used on the certification plate shall be used. The plate shall contain at least the information contained below:

SPECIFICATION IDENTIFICATION MC

EQUIPMENT NECESSARY

| VENTS: | Quantity[1] |
|---|---|
| Pressure actuated | |
| Fusible | |
| Frangible | |
| Product discharge: | |
| Top | |
| Bottom | |
| Pressure unloading fitting | |
| Covers: | |
| Manhole | |
| Fill openings | |

[1] The number required to meet applicable specification. If no physical change is required the letters NC shall follow the number required. If cargo tank is not so equipped the word "NONE" shall be inserted.

(i) *Color coding.* Those parts which must be changed or added to meet the applicable specification requirements and the appropriate multipurpose plate shall be identified using the following colors:

| | |
|---|---|
| MC 306 | RED |
| MC 307 | GREEN |
| MC 312 | YELLOW |
| Nonspecification | BLUE |
| TC 350 | BLACK |

Additionally those parts to be changed or added shall be stamped with the appropriate MC/TC Specification No. ....

(c) *Manufacturer's certificate.* A certificate signed by a responsible official of the manufacturer of the cargo tank, or from a competent testing agency, certifying that each such cargo tank is designed, constructed and tested in accordance and complies with the requirements contained in the applicable specification shall be procured, and such certificate shall be retained in the files of the carrier during the time that such cargo tank is employed by him plus one year. In lieu of this certificate if the motor carrier himself elects to ascertain that any such tank fulfills the requirements of the specification by his own test, he shall similarly retain the test data. (See also Appendix B of this Standard.)

## 5.6 Specification TC 306 Highway Tanks

(Reproduced from US CFR, Title 49 (see Clause 4.4).)

**§178.341 Specification MC 306: cargo tanks.**

**§178.341-1 General requirements.**

(a) Specification MC 306 cargo tanks must comply with the general design and construction requirements in §178.340 in addition to the specific requirements contained in this section.

(b) Design pressure: The design pressure of each cargo tank shall be not less than that pressure exerted by the static head of the fully loaded tank in the upright position.

**§178.341-2 Thickness of shells, heads, bulkheads, and baffles.**

(a) *Material thickness.* The minimum thicknesses of tank material authorized in §178.340-3 shall be predicated on not exceeding the maximum allowable stress level (§178.340-4(a)) but in no case less than those indicated in Tables I and II below:

(1) *Product density.* The material thicknesses contained in Tables I and II are minimums based on a maximum 7.2 pounds per gallon product weight. If the tank is designed to haul products weighing more than 7.2 pounds per gallon, the gallon per inch value used to determine the minimum thickness of heads, bulkheads, baffles or shell sheets shall be the actual section capacity required in gallons per inch multiplied by the actual product density in pounds per gallon divided by 7.2.

(b) *Minimum material thickness for reinforced plastic tanks.*

(1) The thickness of tank material authorized in §178.340-3 shall be such that the maximum allowable stress level in §178.340-4 is not exceeded and in no case shall the thickness be less than twice the minimum thickness specified for aluminum in Tables I and II.

(2) In the case of "sandwich" construction the thickness may be determined as the aggregate of all

# Appendix B
# Requirements for the Certification and Recertification of a Highway Tank by its Owner

**Note:** *This Appendix is not a mandatory part of this Standard but is written in mandatory language to accommodate its adoption by anyone wishing to do so.*

## B1. Scope

### B1.1

The certification and recertification requirements outlined in the clauses of this Appendix apply to a highway tank that does not have a manufacturer's data plate nor a manufacturer's certificate of compliance but meets, or is equivalent to, a TC 306, TC 307, or TC 350 highway tank specification, and for which the service conditions will be such that the tank specification does not require compliance with the requirements of the *ASME Boiler and Pressure Vessel Code.*

### B1.2

Where the service conditions will be such that the tank specification requires compliance with the requirements of the ASME Code, this Appendix may be used if the appropriate provincial regulatory authority has given its written consent for the highway tank to be used as a pressure vessel under those service conditions.

## B2. Purpose

The purpose of this Appendix is to permit the owner of a highway tank to certify or recertify the tank as being in compliance with a construction specification of this Standard when
(a) the original certification and markings are absent; and
(b) it is impossible or impractical for the original manufacturer to certify or recertify compliance with the applicable specification.

**Note:** *The owner may not certify or recertify a highway tank if the original manufacturer refuses to do it on the grounds that he does not believe that the tank is in compliance with the applicable specification for which certification is desired.*

## B3. General

### B3.1

The owner of the highway tank shall specify
(a) the highway tank specification;
(b) the maximum working pressure;
(c) the maximum product density; and
(d) the maximum product temperature
for which he proposes to certify the tank.

### B3.2

The owner of the highway tank shall engage a registered highway tank manufacturing, testing, and inspecting facility to fulfill the requirements outlined in Clause B4.

## B4. Inspection and Testing Requirements

### B4.1 Determination of Cylinder and Head Material Thicknesses

#### B4.1.1

The tank shell shall be visually inspected and the thickness of the shell material determined from the bare metal surface of the interior of the tank. If the tank is lined, the inspection and measurements shall be done from the bare, or painted, metal surface of the exterior of the tank.

#### B4.1.2

The thickness of the shell material shall be determined at the following locations:

(a) at a minimum of four separate locations, equispaced circumferentially, in the knuckle of each head;
(b) at the centre of each head and at a minimum of three other locations on the head equispaced on a circle centred on the head with a diameter equal to the tank radius;
(c) at a minimum of eight locations equispaced on the circumference of the tank section and repeated for every 4 ft of cylinder length;
(d) at any areas showing signs of corrosion, pitting, or staining and at any areas susceptible to corrosion including, but not limited to, sump areas, areas of impingement during loading/unloading, heat-affected zones of welds, areas adjacent to heating devices, areas surrounding inlets, outlets, and manways, and areas adjacent to enclosed spaces on the outer side of the shell; and
(e) at any additional locations necessary to ensure that a minimum of two determinations of material thickness shall have been made for each piece of material used to construct the tank shell.

### B4.2 Visual Inspection of Welds

The welds shall be inspected for pitting, corrosion, undercuts, and other defects. Any suspect areas shall be subject to a dye-penetrant test inspection in accordance with Section V of the ASME Code and CGA Technical Bulletin TB-2. Furthermore welds shall be visually inspected to ensure that they are at least as thick as the adjacent shell material.

### B4.3 Determination of the Material of Construction and its Properties

A sample shall be cut from one of the major shell sheets in a manner that permits an easy repair and avoids altering the physical properties of the sample or the surrounding material. The sample shall be chemically analyzed to identify the alloy and be mechanically tested to determine the ultimate strength, the 0.2% offset yield strength, and elongation.

### B4.4 Structural Integrity Determinations

The maximum stress on the tanker that will be encountered for the maximum product density and maximum working pressure in conjunction with the conditions specified in paragraph §178.340-4(b) shall be calculated. Also the maximum allowable stress for the material of construction identified in Clause B4.3 shall be calculated as specified in paragraph §178.340-4(a).

### B4.5 Visual Inspection of Circumferential Reinforcement and Section Modulus Determination

The circumferential reinforcement shall be visually inspected to ensure that it is in accordance with paragraph §178.340-7. The dimensions of the reinforcing rings, their spacing, and the manner of their attachment to the shell shall be determined. In the case of an insulated tanker only one ring need be inspected on condition that it is near the centre of the tank compartment and that the ring spacing can be determined by inspection of weld heat-affected zones from the inside of the tank. The section modulus of the ring stiffener about the neutral axis of the ring section parallel to the tank axis and the minimum required section modulus, as given by the formula in paragraph §178.340-7(d), shall be calculated.

### B4.6 Visual Inspection of Rollover Protection and Load Capacity Determination

The overturn protection devices shall be visually inspected to ensure that they are in compliance with paragraph §178.340-8(c). Where such protection is achieved by the use of guards, their dimensions shall be determined and a calculation made of the maximum horizontal and vertical loads that they should withstand. Also the required vertical and horizontal load capacities as specified in paragraph §178.340-8(c)(1) shall be calculated.

### B4.7 Visual Inspection of Rear Bumpers and Impact Load Determination

The bumper shall be visually inspected and its dimensions determined to ensure that it is in compliance with Clause 5.1.3 and paragraph §178.340-8(b). A calculation shall be made, using a safety factor of two, to determine the maximum impact the bumper should absorb without suffering damage that would cause a leakage

of product. Also the impact on the bumper that would cause a 2 g deceleration of the loaded vehicle shall be calculated.

### B4.8 Emergency Flow Control and Piping Protection Inspection and Determination

Each product-discharge opening in the bottom of the tank shall be equipped with an emergency flow control valve located as specified in paragraph §178.341-5. Verify that it is equipped with a secondary means of closure at least 10 ft away and determine if it is equipped with an automatic heat-actuated means of closure. Verify by visual inspection that the emergency valve and piping is protected in accordance with paragraph §178.340-8(d). Calculate the maximum force which such guards should be able to absorb successfully when such a force is applied horizontally from any direction.

### B4.9 Inspection of Vents and Capacity Determinations

All venting devices shall be visually inspected to determine their size, operating pressure (or temperature), and rated capacity. Test all spring-operated vents to ensure that they open at the required pressure for the proposed maximum working pressure. Calculate the exposed area of each tank compartment and determine which specification (MC 306/307/312/350) the venting capability meets. Determine the loading and unloading limits in gallons per minute or psig.

### B4.10 Inspection of Manholes and Covers

Manholes and covers shall be inspected to ensure that they are in good condition and that they will withstand the maximum working pressure without deformation or leakage.

### B4.11 Inspection of Attachments to the Tank Shell

The attachments of appurtenances to the tank shell shall be inspected where they are visible and do not require the dismantling of parts. Where such attachments are obscured, the corresponding inside area of the tank shell shall be inspected for signs of damage or corrosion. Where damage, distortion, corrosion, or the manner of attachment may weaken the product-retention capacity of the tank, the attachment shall be repaired using a pad as described in paragraph §178.340-8(a).

### B4.12 Hydrostatic Testing and Inspection

The tank shall be visually inspected and hydrostatically tested to a pressure equal to the greater of

(a) the minimum prescribed test pressure for the proposed specification; or

(b) 1.5 times the proposed maximum working pressure.

Testing and inspection shall be done in accordance with Clause 8. A written report shall be prepared.

### B4.13 Inspection and Testing Report

The results of the inspections and calculations performed in accordance with Clauses B4.1 to B4.11 inclusive shall be recorded on a report form such as the one shown in Figure B1 or equivalent. The report shall be signed by an authorized agent of the registered facility and, together with the testing and inspection reports required by Clause B4.12, sent to the owner of the highway tank. Copies of the report shall be retained by the registered facility.

## B5. Verification of Compliance

### B5.1

On receipt of the inspection and testing reports from the registered facility, the owner of the tank shall verify that, except as provided for in Clause B5.2, the characteristics of the tank, as described in the reports, meet or exceed the prescribed requirements for the proposed specification.

### B5.2

The tank shell material thickness shall be equal to or greater than the minimum required thickness, taking into account mill tolerances, specified in the minimum thickness table for the prescribed specification. However, for MC 312 and TC 350 specifications the minimum material thickness measured may be deemed acceptable if it is no more than 10 one-thousandths of an inch

below the minimum allowable thickness prescribed in the appropriate minimum thickness table.

### B5.3

If the characteristics of the tank meet or exceed the prescribed requirements for the proposed specification, except as provided for in Clause B5.2, and the owner of the tank is prepared to accept the responsibility for attesting that the highway tank meets the proposed specification, then he may certify and affix the plate to the tanker, in accordance with Clause B6, indicating that it meets its specification.

## B6. Certification and Marking

### B6.1 Certificate of Compliance

The owner of the tank shall prepare a certificate as prescribed in paragraph §178.340-10(c) except that it shall indicate that the tank specification has been certified by the owner. This certificate together with the inspection and test reports shall be retained by the tank owner.

### B6.2

The owner of the tank shall have a metal certification plate in accordance with paragraph §178.340-10(b) attached to the tank. Where some of the required information is unknown, the word "UNKNOWN" shall be stamped on the plate. In addition the plate shall include an identification of the vehicle owner and adjacent to the specification identification shall be marked the words "OWNER CERTIFIED".

## Figure B1
## Verification of Highway Tank Design for Owner Certification/Recertification

Vehicle Identification Number _____ Owner's Fleet Number _____ Other I.D. Number _____
Proposed Tank Specification _____ Proposed Maximum Working Pressure _____ Proposed Maximum Product Density _____

| Clause | Inspection/calculation results | | Proposed specification requirement | |
|---|---|---|---|---|
| B4.1 Material thickness | Minimum thickness, cylinder<br>Minimum thickness, heads<br>(Attach report of readings) | _____<br>_____ | Minimum required thickness from minimum thickness table for maximum product density for proposed specification (see Clause B5.2) | Minimum thickness, cylinder _____<br>Minimum thickness, heads _____ |
| B4.2 | Weld thickness is greater than or equal to the thickness of adjacent shell material | Yes / No | The weld thickness must be greater than or equal to the thickness of the adjacent shell material | |
| B4.3 Material alloy and properties | Shell material alloy<br>Yield point, psi<br>Ultimate strength, psi<br>Elongation, 2 in sample, % | _____<br>_____<br>_____<br>_____ | Alloy is acceptable as per §178.340-3<br>Yield point, psi<br>Ultimate strength, psi<br>Elongation, 2 in sample, % | Yes / No<br>_____<br>_____<br>_____ |
| B4.4 Structural integrity | Maximum stress in tank under conditions specified in §178.340-4(b) | _____ | Maximum allowable stress calculated as per §178.340-4(a) | _____ |
| B4.5 Circumferential reinforcement | Maximum distance between circumferential reinforcements<br>Section modulus of ring stiffeners | _____<br>_____ | Maximum allowable distance between circumferential reinforcements<br>Minimum required section modulus of ring stiffener as per §178.340-7(d) | 60 in<br>_____ |
| B4.6 Rollover protection | Calculated maximum vertical load sustainable<br>Calculated maximum horizontal load sustainable<br>All closures for filling, manholes, and inspection openings are protected in accordance with §178.340-8(c) | _____<br>_____<br>Yes / No | Required vertical load capacity<br>Required horizontal load capacity (as per §178.340-8(c)(1))<br>All closures for filling, manholes, and inspection openings must be protected in accordance with §178.340-8(c) | _____<br>_____ |

*(Continued)*

## Figure B1 (Continued)

| Clause | Inspection/calculation results | | Proposed specification requirement | |
|---|---|---|---|---|
| B4.7<br>Rear bumpers | The dimensions of the bumper conform to Clause 5.1.3 | Yes / No | The dimensions of the bumper must conform to Clause 5.1.3 | |
| | The bumper is located at least 6 in to the rear of any vehicle component used for loading/unloading or that contains lading while in transit | Yes / No | The bumper must be located at least 6 in to the rear of any vehicle component used for loading/unloading or that contains lading while in transit | |
| | Calculated maximum horizontal impact sustainable (with safety factor of two) | _____ | Required impact resistance (ie, impact that gives fully loaded vehicle a 2 g deceleration) | _____ |
| B4.8<br>Emergency flow control and piping protection | The emergency valve is installed and protected in accordance with §178.340-8(d)(1) | Yes / No | The emergency valve must be installed and protected in accordance with §178.340-8(d)(1) | |
| | The minimum ground clearance of piping, guards, and components is in accordance with §178.340-8(d)(2) | Yes / No | The minimum ground clearance of piping, guards, and components must be in accordance with §178.340-8(d)(2) | |
| | Calculated maximum sustainable horizontal impact capacity of guards | _____ | Minimum required impact resistance<br>8 000 lbs. (MC 306/307/312)<br>45 000 lbs. (TC 350) | |
| | Emergency flow control meets (Delete those that do not apply) | §178.341-5<br>§178.342-5<br>§178.343-5 | Proposed specification requires compliance with | §178.341-5<br>§178.342-5<br>§178.343-5 |
| B4.9<br>Vents | The vents installed meet the requirements of | §178.341-4<br>§178.342-4<br>§178.343-4<br>Clause 5.10.4 | The proposed specification requires compliance with | §178.341-4<br>§178.342-4<br>§178.343-4<br>Clause 5.10.4 |
| B4.10<br>Closure for manholes | Manhole/fill cover is equipped with a safety catch to prevent it from opening fully when pressurized | Yes / No | The manhole/fill cover must be equipped with a safety catch to prevent it from opening fully when pressurized | |
| | Number and design of manhole cover hold downs are adequate for intended working pressure | Yes / No | The number and design of manhole cover hold downs must be adequate for the intended working pressure. | |

*(Continued)*

## Figure B1 (Concluded)

| Clause | Inspection/calculation results | | Proposed specification requirement |
|---|---|---|---|
| B4.11 | Attachments to tank shell are free from corrosion, distortion, and damage and do not threaten the product-retention integrity of the tank | Yes / No | Attachments to the tank shell must be free from corrosion, distortion, and damage and they must not threaten the product-retention integrity of the tank |
| B4.12 Inspection and testing | The tank has satisfactorily undergone a visual inspection and a hydrostatic retest in accordance with Clause 8 (Attach reports) | Yes / No | The tank must have satisfactorily undergone a visual inspection and a hydrostatic retest in accordance with Clause 8 |
| Other observations | Other defects and/or design characteristics that would disqualify this tanker from meeting the proposed specification were observed. If the above answer is yes, specify the deficiencies observed. | | Yes / No |
| | Signed: _____ Inspector, Registered Facility | | |
| | This document is simply a report of work done and does not constitute a certification or warranty of the suitability of the tank for any service. | | |

# Related CSA Standards

B621
Selection and Use of Highway Tanks, Portable Tanks, Cargo Compartments and Containers for the Transportation of Dangerous Goods, Classes 3, 4, 5, 6, and 8, in Bulk, by Road

B622
Selection and Use of Highway Tanks, Multi-unit Tank Car Tanks, and Portable Tanks for the Transportation of Dangerous Goods, Class 2, by Road

B623
Selection, Handling, and Use of Intermodal Portable Tanks for the Transportation of Dangerous Goods, Other Than by Air

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