

Classifying and Loading of Crude Oil into Rail Tank Cars

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Classifying and Loading of Crude Oil into Rail Tank Cars

1 Scope

This document provides guidance on the material characterization, transport classification, and quantity measurement for overfill prevention of petroleum crude oil (crude oil) for the loading of rail tank cars. Guidance on the documentation of measurement results is also provided. The criteria for determining the frequency of sampling and testing of petroleum crude oil are identified for transport classification. This document applies only to petroleum crude oil classified as Hazard Class 3—Flammable Liquid under the U.S. *Code of Federal Regulations (CFR)* at the time of publication.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Manual of Petroleum Measurement Standards (MPMS)

MPMS Chapter 3.1A, Manual Gauging of Petroleum and Petroleum Products

MPMS Chapter 3.1B, Level Measurement of Liquid Hydrocarbons in Stationary Tanks by Automatic Tank Gauging

MPMS Chapter 3.2, Standard Practice for Gauging Petroleum and Petroleum Products in Tank Cars

MPMS Chapter 5 (all parts), Metering

MPMS Chapter 7, Temperature Measurement

MPMS Chapter 8.1-2013, Standard Practice for Manual Sampling of Petroleum and Petroleum Products

MPMS Chapter 8.2, Standard Practice for Automatic Sampling of Liquid Petroleum and Petroleum Products

MPMS Chapter 9.1, Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

MPMS Chapter 9.3, Standard Test Method for Density, Relative Density, and API Gravity of Crude Petroleum and Liquid Petroleum Products by Thermohydrometer Method

MPMS Chapter 11.1-2004 (including Addendum 1-2007), Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils

MPMS Chapter 11.5 (all parts), Density/Weight/Volume Intraconversion

MPMS Chapter 12.1.1, Calculation of Static Petroleum Quantities—Upright Cylindrical Tanks and Marine Vessels

AAR Pamphlet 34¹, Recommended Methods for the Safe Loading and Unloading of Non-Pressure (General Service) and Pressure Tank Cars

AAR Scale Handbook

ASTM D4057-12², Standard Practice for Manual Sampling of Petroleum and Petroleum Products

¹ Association of American Railroads, 425 3rd Street, SW, Washington, DC 20024, USA, www.aar.org.

² ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, USA, www.astm.org.

ASTM D6377, *Standard Test Method for Determination of Vapor Pressure of Crude Oil: VPCRx (Expansion Method)*

ASTM D7900, *Standard Test Method for Determination of Light Hydrocarbons in Stabilized Crude Oils by Gas Chromatography*

GPA 2103 ³, *Method for the Analysis of Natural Gas Condensate Mixtures Containing Nitrogen and Carbon Dioxide by Gas Chromatography*

NIST Handbook 44 ⁴, *Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices*

49 CFR Subchapter C ⁵, *Hazardous Materials Regulations (HMR)*

Part 171, *General Information, Regulations, and Definitions*

Part 172, *Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans*

Part 173, *Shippers—General Requirements for Shipments and Packagings*

Part 174, *Carriage by Rail*

Canadian *Transportation of Dangerous Goods Regulations (TDGR)* ⁶

SOR/2012-245 (Amendment 11)

3 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1

bill of lading

BOL

A document between the offeror of a particular good and the carrier detailing the type, quantity and destination of the good being carried. The BOL also serves as a receipt of shipment when the good is delivered to the predetermined destination. If the BOL serves as the shipping paper, it has to accompany the shipped goods, no matter the form of transportation, and has to be signed by an authorized representative from the carrier, offeror or consignee.

Note to entry: The rail tank car BOL is typically an electronic file (electronic data interface—EDI).

3.2

capacity table

tank car capacity table

calibration table

[gauge table]

Table showing the capacities or volumes in a tank for various liquid levels measured from the rail tank car's reference gauge point.

Note to entry: The same capacity table may be assigned to many similar, but not identical, rail tank cars. The table may be based on either innage or outage gauges and may indicate either liquid or vapor space gallons. These are

³ Gas Processors Association, 6526 E. 60th Street, Tulsa, Oklahoma 74145, USA, www.gasprocessors.com.

⁴ National Institute of Standards and Technology, 100 Bureau Drive, Stop 3460, Gaithersburg, Maryland 20899, USA, www.nist.gov.

⁵ The U.S. *Code of Federal Regulations* is available from the U.S. Government Printing Office, Washington, DC 20402, USA, www.gpo.gov.

⁶ Transport Canada, 330 Sparks Street, Ottawa, ON K1A 0N5, Canada, <http://www.tc.gc.ca>.

referred to as outage/liquid, outage/vapor, innage/liquid or innage/vapor tables. Rail tank car manufacturers have traditionally located the reference gauge point at the top inside of the car's shell at the shell-full point; the top of the manway closest to the center point of the car as specified by API *MPMS* Ch. 3.2.

[Source: API *MPMS* Ch. 12.1.2 ^[4]]

3.3

carrier

A person who transports property in commerce by rail [tank] car.

[Source: 49 *CFR* 171.8 modified]

3.4

combustible liquid

Classification for a crude oil which has a flash point greater than 60 °C (140 °F) and below 93 °C (200 °F), and is offered for transportation in bulk.

[Source: 49 *CFR* 173.120 modified]

3.5

consignee

The person or place shown on a shipping document, package marking, or other media as the location to which a carrier is directed to transport a hazardous material.

[Source: 49 *CFR* 171.8]

3.6

crude oil

Hydrocarbons that exist in liquid phase in natural underground reservoirs and remain liquid at atmospheric pressure.

[Source: 16 *CFR* 317.2 and EIA Energy Glossary modified]

3.7

dead crude oil

stabilized crude oil

A term usually employed for crude oils that, when exposed to normal atmospheric pressure at room temperature, will not result in actual boiling of the sample.

[Source: ASTM D6377-10]

Note to entry: For the purposes of this document the terms "stabilized" and "dead" are synonymous, and the terms "non-stabilized", "un-stabilized", and "live" are synonymous.

3.8

division

Subset of a hazard class [(under the U.S. *HMR*) indicating a particular kind of hazard within that class].

[Source: 49 *CFR* 171.8 modified]

Note to entry: For example, Class 2 has three divisions: 2.1 flammable gas; 2.2 compressed gas; and 2.3 toxic gas.

3.9

gauge

The measure of the liquid level in a tank, vertically from the [rail] tank car's reference gauge point.

[Source: API *MPMS* Ch. 12.1.2 ^[4] modified]

3.10**gauging**

A process of measuring the height of a liquid in a container.

[Source: API *MPMS* Ch.12.1.2]

3.11**hazard class**

The category of hazard assigned to a hazardous material under the definitional criteria of part 173 of the *HMR* and the provisions of the 49 *CFR* hazmat table.

Note to entry: A material may meet the defining criteria for more than one hazard class but is assigned to only one hazard class.

[Source: 49 *CFR* 171.8]

3.12**hazardous material(s)****HM****dangerous goods****DG**

Materials determined by the U.S. Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce.

[Source: 49 *CFR* 171.8 modified]

Note to entry: The U.S. refers to these materials as “hazardous materials” while other United Nations (UN) members refer to them as “dangerous goods”.

3.13**hazmat employee**

1) An individual who:

- (i) is employed on a full time, part time, or temporary basis by a hazmat employer; or
- (ii) is self-employed (including an owner-operator of a motor vehicle, vessel, or aircraft) transporting hazardous materials in commerce; and
- (iii) who during the course of such full time, part time, or temporary employment, or such self employment, directly affects hazardous materials transportation safety as [defined] by regulation; and

2) includes an individual, employed on a full time, part time, or temporary basis by a hazmat employer, or self employed, who during the course of employment:

- (i) loads, unloads, or handles hazardous materials;
- (ii) designs, manufactures, fabricates, inspects, marks, maintains, reconditions, repairs, or tests a package, container or packaging component that is represented, marked, certified, or sold as qualified for use in transporting hazardous material in commerce;
- (iii) prepares hazardous materials for transportation;
- (iv) is responsible for safety of transporting hazardous materials;
- (v) operates a vehicle used to transport hazardous materials, certified, or sold as qualified for use in transporting hazardous material in commerce.

[Source: 49 *CFR* 171.8 modified]

Note to entry: This is a U.S. term. Different terms may be used outside of the USA.

3.14**heel****onboard quantity****OBQ****remaining (quantity) onboard****ROB**

The material remaining in a rail tank car, prior to loading or after the crude oil is unloaded.

Note to entry: ROB and OBQ may include any combination of water, oil, oil residue, oil/water emulsions, and sediment.

[Source: API *MPMS* Ch. 17.1 modified]

3.15**innage**

Level of liquid in a tank measured from the datum plate or tank bottom to the surface of the liquid.

[Source: API *MPMS* Ch. 3.1A]

3.16**light weight****[tare]****LT WT**

The number on the sides of a [rail] tank car near its ends indicating the empty weight of the car.

[Source: API *MPMS* Ch. 12.1.2 modified]

3.17**[flammable] liquid**

a liquid having a flash point of not more than 60 °C (140 °F), or any material in a liquid phase with a flash point at or above 37.8 °C (100 °F) that is intentionally heated and offered for transportation or transported at or above its flash point in a bulk packaging, with the following exceptions.

- 1) Any liquid meeting one of the definitions [of a flammable gas].
- 2) Any mixture having one or more components with a flash point of 60 °C (140 °F) or higher, that make up at least 99 % of the total volume of the mixture, if the mixture is not offered for transportation or transported at or above its flash point.
- 3) Any liquid with a flash point greater than 35 °C (95 °F) that does not sustain combustion according to ASTM D4206^[12] or the procedure in appendix H to Part 173 of the *HMR*.
- 4) Any liquid with a flash point greater than 35 °C (95 °F) and with a fire point greater than 100 °C (212 °F) according to ISO 2592^[24].
- 5) Any liquid with a flash point greater than 35 °C (95 °F) which is in a water-miscible solution with a water content of more than 90 % by mass.

[Source: 49 *CFR* 173.120]

Note to entry: Liquid in this context refers to flammable liquid Class 3 as defined in the *HMR*.

3.18**[weight] load limit****LD LMT**

The number on the sides of a rail tank car near its ends indicating the maximum legal weight of its contents.

Note to entry: The maximum gross loaded weight of the rail tank car is the sum of the load limit and light weight (tare).

[Source: API *MPMS* Ch. 12.1.2 modified]

3.19**manway**

A cylindrical opening on the top of a [rail] tank car, with a manway cover, for [personnel] access to the interior of the car.

[Source: API *MPMS* Ch. 12.1.2 modified]

3.20**[crude oil] outage****ullage**

The amount by which a packaging falls short of being liquid full, usually expressed in percent by volume.

[Source: 49 *CFR* 171.8]

3.21**Packing Group****PG**

A grouping according to the degree of danger presented by [some] hazardous materials [dangerous goods].

Note to entry: PG I indicates great danger; PG II, medium danger; PG III, minor danger.

[Source: 49 *CFR* 171.8]

3.22**portable electronic gauging device****PEGD**

An electronic sensing device suspended on a measuring tape, and a housing with readouts.

[Source: API *MPMS* Ch. 3.1A]

3.23**relative density****specific gravity**

The ratio of the mass of a given volume of liquid at a specific temperature to the mass of an equal volume of pure water at the same or different temperature. Both reference temperatures shall be explicitly stated.

[Source: API *MPMS* Ch. 9.1]

3.24**safety data sheet****SDS****material safety data sheet****MSDS**

Written or printed material concerning a hazardous chemical that is prepared in accordance with the following:

Chemical manufacturers and importers shall obtain or develop a safety data sheet for each hazardous chemical they produce or import. Employers shall have a safety data sheet in the workplace for each hazardous chemical which they use.

[Source: 29 *CFR* 1910.1200]

3.25**standard reference conditions**

The standard reference conditions of pressure and temperature for use in measurements on crude petroleum and its products is 101.325 kPa (absolute) (14.696 psia or 0 psig) and 15 °C, 20 °C or 60 °F, with the exception of liquid hydrocarbons having a vapor pressure greater than atmospheric at 15 °C, 20 °C or 60 °F, in which case the standard pressure shall be equilibrium vapor pressure at 15 °C, 20 °C or 60 °F.

Note to entry: 101.325 kPa = 1.01325 bar = 1 013.25 mbar = 1 atm.

[Source: ISO 5024:1999 ^[31] modified]

3.26**standard temperature**

The temperature at which a product is traded by volume, normally 60 °F in the U.S., and either 15 °C or 20 °C elsewhere.

[Source: API *MPMS* Ch. 12.1.2]

3.27**subsidiary hazard**

As defined in the transport regulations of the U.S., Canada and the international regulations for air and sea transport, a hazard of a material other than the primary hazard.

[Source: 49 *CFR* 171.8 modified]

3.28**tank car capacity****stenciled capacity****tank car volume**

The number on the ends of a [rail] tank car indicating its shell-full capacity.

Note to entry: This is the amount of water in gallons and liters that the car can contain at 15.56 °C (60 °F).

[Source: API *MPMS* Ch. 12.1.2 modified]

3.29**vapor space**

The volume above the liquid surface.

[Source: API *MPMS* Ch. 12.1.2]

3.30**waybill**

Document issued and used by a carrier providing details and instructions relating to the shipment of a consignment of goods. Typically it will show the names of the consignor and consignee, the point of origin of the consignment, its destination, and route.

Note to entry: A waybill in itself does not contain all the information required by law in a shipping paper.

4 Roles and Responsibilities

4.1 General

For the purposes of this document, it has been chosen to use the term “offeror” as defined below. However, in common usage, the term “offeror” is often used interchangeably with other terms such as “shipper”, “consignor” and “one who offers”. Users of this document should be aware of and comply with all regulatory requirements when offering crude oil for shipment by rail.

4.2 Offeror

An offeror is:

- 1) Any person who does either or both of the following.
 - i. Performs, or is responsible for performing, any pre-transportation function required for the transportation of hazardous material in commerce by rail.
 - ii. Tenders or makes the hazardous material available to a carrier for transportation in commerce by rail.
- 2) A carrier is not an offeror when it performs a pre-transportation function required as a condition of acceptance of a hazardous material for transportation in commerce (e.g., reviewing shipping papers, examining packages to ensure that they are in conformance with the *HMR*, or preparing shipping documentation for its own use) or when it transfers a hazardous material to another carrier for continued transportation in commerce without performing a pre-transportation function.

4.3 Consignor

In Canada, the consignor is defined as a person who:

- a) is named in a shipping document as the consignor;
- b) imports or who will import dangerous goods into Canada; or
- c) if paragraphs (a) and (b) do not apply, has possession of dangerous goods immediately before they are in transport. (expéditeur)

NOTE A person may be both a consignor and a carrier of the same consignment, for example, a manufacturer who also transports the dangerous goods he or she produces.

4.4 Pre-transportation Functions

Offerors perform pre-transportation functions. Pre-transportation functions assure the safe transportation of a hazardous material in commerce. These include, but are not limited to:

- 1) determining the hazard class (3.11) of a hazardous material (3.12);
- 2) selecting a hazardous materials packaging;
- 3) filling a hazardous materials packaging, including a bulk packaging;
- 4) securing a closure on a filled or partially filled hazardous materials package or container or on a package or container containing a residue of a hazardous material;