Classifying and Loading of Crude Oil into Rail Tank Cars

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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 34 [1], *Recommended Methods for the Safe Loading and Unloading of Non-Pressure (General Service) and Pressure Tank Cars*

AAR *Scale Handbook*

ASTM D4057-12 [2], *Standard Practice for Manual Sampling of Petroleum and Petroleum Products*

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[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;

5) marking a package to indicate that it contains a hazardous material;

6) labeling a package to indicate that it contains a hazardous material;

7) preparing a shipping paper;

8) providing and maintaining emergency response information;

9) reviewing a shipping paper to verify compliance with the *HMR* or international equivalents;

10) for each person importing a hazardous material into the United States, providing the shipper with timely and complete information as to the *HMR* requirements that will apply to the transportation of the material within the United States;

11) certifying that a hazardous material is in proper condition for transportation in conformance with the requirements of the *HMR*;

12) loading, blocking, and bracing a hazardous materials package in a freight container or transport vehicle;

13) segregating a hazardous materials package in a freight container or transport vehicle from incompatible cargo;

14) selecting, providing, or affixing placards for a freight container or transport vehicle to indicate that it contains a hazardous material.

4.5 Function-specific Responsibilities

Employees performing activities utilizing transport classifications and proper shipping descriptions shall be trained commensurate to their job responsibilities. The following functions require use of classification information:

1) Identification of transport hazard classes (1-9) per applicable regulatory code. This can include hazardous waste (40 *CFR*) and noting differences in other regulatory agencies such as Transport Canada.

2) Determining primary hazard class (3.11), subsidiary hazards (3.27) (or risks), and the assignment of Packing Group (3.21).

3) Selection of proper shipping name, UN (or NA- North American) number, hazard class (category of risk), subsidiary risks, Packing Group (degree of risk).

4) Creating proper shipping description (PSD) options in EDI (information technology) systems per carrier specifications.

5) Determination of packaging instructions and packaging selection.

6) Preparing and packaging small quantities of hazardous materials, i.e. samples for transport to laboratories.

7) Inspection and placement of marks/labels/placards when offering for transport.

8) Supervision of [rail] tank cars at load, unload, and storage incidental to transport.

9) Securement and proper closure procedures of [rail] tank cars.

10) Transmitting EDI information to carriers (e.g. for waybills, shipping papers, bills of lading [BOLs]).

11) Providing and coordination of emergency response.

12) Certifying shipping papers (via EDI electronic signature).

13) Offering placards.

14) Development of training programs for the above regulated activities.

15) Enforcing, surveying, or inspecting for compliance with applicable regulations.

16) Supervision of new employees performing any of the above activities.

See Annex C for a summary of roles, responsibilities and training requirements of hazmat employees (3.14).

5 Classifying Crude Oil for Transportation by Rail

5.1 Identification of the Physical and Chemical Properties of Crude Oil

5.1.1 General

The identification of the physical and chemical characteristics of crude oil (3.6) is conducted for the purpose of determining the proper hazardous material classification and the assignment of Packing Group (3.21) of the crude oil and subsequent selection of the package to be utilized. See Table 1.

Identifying the physical and chemical properties of crude oil shipped by rail is required by government regulations. Each package used for the shipment of hazardous materials shall be designed, constructed, maintained, filled, its contents so limited, and closed, so that under conditions normally incident to transportation there will be no identifiable (without the use of instruments) release of hazardous materials to the environment, and that the effectiveness of the package will not be substantially reduced.

5.1.2 Reasons for Classification

Classification of a hazardous material (3.12) is the first step in preparing a consignment for transport. Classification is the determination of basic shipping information. Basic information includes:

— UN ID number;

— proper shipping name (technical chemical name);

— primary hazard class;

— subsidiary hazard class/risk(s);

— Packing Group.

Misclassification of a hazardous material could lead to use of an unauthorized rail tank car that may lack the required safety features necessary to safely transport the crude oil, as well as insufficient development of safety and security plans and the communication of inaccurate information to emergency responders.

5.1.3 Determination of Classification

The offeror of crude oil for transportation in commerce shall ensure that the crude oil has been tested and classified in accordance with government regulations prior to being offered into transport by rail.

When determining the hazard class of crude oil, a determination shall be made that the crude oil does not meet the definition of a flammable gas prior to being classified as a Class 3 flammable liquid (3.17). Some crude oils may not be classified as a hazardous material (see 5.1.5).

Within the USA, a flammable gas is defined in 49 *CFR* 173.115 as any material which is a gas at 20 °C (68 °F) or less and 101.3 kPa (14.7 psia) of pressure (a material which has a boiling point of 20 °C (68 °F) or less at 101.3 kPa (14.7 psia)) which:

1) Is ignitable at 101.3 kPa (14.7 psia) when in a mixture of 13 % or less by volume with air; or

2) Has a flammable range at 101.3 kPa (14.7 psia) with air of at least 12 % regardless of the lower limit. Except for aerosols, the limits specified in [these paragraphs] shall be determined at 101.3 kPa (14.7 psia) of pressure and a temperature of 20 °C (68 °F) in accordance with the ASTM E681-85, *Standard Test Method for Concentration Limits of Flammability of Chemicals,* or other equivalent method approved by the [PHMSA] Associate Administrator.

Within Canada, a flammable gas is defined in *TDGR* section 2.13 as a substance that at 50 °C has a vapor pressure greater than 300 kPa or that is completely gaseous at 20 °C at an absolute pressure of 101.3 kPa and that is:

a) compressed (other than in solution) so that when it is packaged under pressure for transport it remains entirely gaseous at 20 °C;

b) liquefied so that when it is packaged for transport it is partially liquid at 20 °C;

c) refrigerated so that when it is packaged for transport it is made partially liquid because of its low temperature;

d) in solution so that when it is packaged for transport it is dissolved in a solvent.

5.1.4 Assignment of Packing Group (PG)

Once crude oil is classified as a flammable liquid (Class 3) (3.17) and prior to being offered for transportation by rail in rail tank cars, the flash point and initial boiling point shall be determined to establish the PG (3.21). See 5.6 for sampling and testing frequency. See Table 1 for the criteria for assignment of PG for a Class 3 flammable liquid.

Table 1—Criteria for Assignment of PG for a Class 3 Flammable Liquid [1]

Packing Group	Flash point (closed-cup)	Initial boiling point (IBP)
I		≤35 °C (95 °F)
II	<23 °C (73 °F)	>35 °C (95 °F)
III	≥23 °C, ≤60 °C (≥73 °F, ≤140 °F)	>35 °C (95 °F)

1) This table is for informational purposes only and does not provide legal advice on compliance with regulations.

5.1.5 Crude Oil Classified as Non-Hazardous

If the material is determined to be non-hazardous per government regulations, e.g. certain Californian crude oils that do not meet the criteria for hazard classes 1-9, periodic sampling and testing (see 5.6) shall be performed to ensure that the non-hazardous classification remains valid.

5.1.6 Potential Effect of Heel on Assignment of Packing Group

The assignment of the PG of the heel (3.14) in rail tank cars shall be the same as the assignment of the last contained product, unless the heel is sampled and tested and found to have a different PG.

A heel can affect the assignment of PG. If multiple crude oils having different packing groups are mixed together, either the PG with the greatest level of potential danger as given in Table 1 shall be assigned, or a sampling and testing program (e.g. see Annex A) shall be in place to determine the effect of the heel on the assignment of PG prior to transport of the crude oil by rail.

5.1.7 Mixing Crude Oils of Differing Packing Groups

When a rail tank car is loaded from sources of different PG, the crude oil shall be assigned the PG with the greatest level of potential danger amongst the sources and as given in Table 1, unless testing dictates otherwise.

5.2 Hydrogen Sulfide (H_2S) Risk and Additional Marking Requirements

Some crude oils contain sulfur compounds which can, through temperature change, agitation, composition etc. evolve hydrogen sulfide (H_2S), a toxic gas. This gas can collect in the vapor space (3.29) of the rail tank car and may present an inhalation hazard to handlers or, in certain circumstances, to emergency responders.

Petroleum crude oils transported in bulk that have a potential to evolve lethal levels of H_2S in head space vapors, and rail tank cars shall include a marking, label, tag, or sign to warn of the toxic inhalation hazard.

5.3 Corrosivity Risk

Under this document, petroleum crude oil is not considered a Class 8 (Corrosive) material. However, certain components found in crude oil (e.g. H_2S) in combination with water can form acids which can result in corrosive action in rail tank cars. Continuing rail tank car qualification is mandated by government regulation.

5.4 Selection of Proper Shipping Name (PSN) and Associated UN ID Number

The PSN shall be selected using the following hierarchy:

1) specific technical name, e.g. ethanol;

2) generic use name, e.g. gasoline, resin solution, petroleum crude oil;

3) generic chemical family name, e.g. alcohols not otherwise specified (n.o.s.) or petroleum distillates n.o.s., petroleum products;

4) general hazard class name, e.g. flammable liquid n.o.s., flammable liquid toxic n.o.s.

Following the above PSN hierarchy, petroleum crude oil offered for rail transportation should be given the proper shipping name, Petroleum Crude Oil, with the associated UN ID Number 1267.

If bitumen is blended or processed with a diluent and is to be used as a refinery feedstock, the UN ID Number can be 1993, otherwise it can be assigned UN ID Number 1267.

5.5 Documentation of Transportation Requirements

5.5.1 General Information on Shipping Paper/Document

Shipping paper means a shipping order, bill of lading (3.1), manifest or other shipping document serving a similar purpose and prepared in accordance with government regulations. For rail, the shipping paper information can be electronically transmitted between the offeror and the rail carrier. The shipping paper also requires an offeror's certification signature which may also be electronic.

The in-bound waybill (3.30) should be reviewed to determine the Packing Group (3.21) of the last known product. If the product to be loaded is less dangerous (a higher Packing Group or non-hazardous) then a determination should be made as to the impact on the PG of the material to be loaded. For additional guidance see 5.1.6.

Further information on the shipping paper can be found in Annex D.

Users should consult the regulations in their applicable jurisdiction regarding additional information that may be required on the shipping paper.

5.5.2 EDI (Electronic Data Interchange): Shipping Paper and Waybill Information

Persons offering hazardous materials (3.12) for transportation in rail tank cars shall describe their consignments as prescribed by the *HMR*. Individual rail carriers (3.3) can have specific procedures and protocols for acceptance and carriage of hazardous materials. The EDI provides all the information needed to produce shipping papers, bill of ladings (BOL) (3.1), and waybills (3.30) to carriers and emergency responders. The shipping paper is a regulated document. The shipping paper shall be provided in printed format when requested of the offeror/consignor and/or carrier (3.3).

NOTE The rail carrier maintains a printed copy of the shipping paper until the delivery of the crude oil is complete.

Shipping papers shall be legible, not include any unauthorized codes or abbreviations, and shall not contain any information inconsistent with the description of the hazardous material. Additional information shall be placed after the basic shipping description.

5.6 Sampling and Testing

5.6.1 General

Petroleum crude oils shall be analyzed to determine the physical and chemical characteristics of a particular composition prior to it being offered as a product for transport by rail. Evaluation of the physical and chemical properties with particular consideration being given to known hazardous constituents is critical to proper classification. Once the classification category is established, the appropriate package for loading and transportation is determined. It may be necessary to perform additional, or more frequent, testing to obtain representative test results to determine the physical and chemical characteristics of the crude oil in order to verify the assignment of PG.

NOTE SDS (3.24) transport information is not required, and as such may not provide sufficient information to be used as the sole source of information for the assignment of Packing Group.

5.6.2 Sampling and Testing Program

A documented sampling and testing program shall be implemented and maintained. See Annex A for an example of a sampling and testing program.

5.6.3 Initial Testing for Assignment of Packing Group

5.6.3.1 General

Prior to being offered and transported by rail tank car, the offeror shall obtain in accordance with API *MPMS* Ch. 8.1 or API *MPMS* Ch. 8.2 samples of the petroleum crude oil to be offered, and shall test for flash point and initial boiling point for the assignment of PG. Test methods listed in Table 2 are provided for the purpose of determining flash point, and those listed in Table 3 are provided for determining initial boiling point. Comments are given to offer guidance in the areas of test method applicability, practicability and sample(s) size. It should not be inferred by its placement in the tables that one test is preferred over another.

Table 2—Flash Point Test Methods for the Assignment of PG

Test Method	Applicable Range2	Result Type	Units	Comments
ASTM D56 1 [6]	<93 °C (200 °F)	Numeric	°C or °F	For PG assignment purposes using 23 °C (73 °F), a pass/fail using D56 can be applied. Applicable to homogeneous, single-phase liquids having a viscosity less than 5.5 cSt @ 40 °C (104 °F) that do not form a film while under test. A large sample size is utilized in this test method.
ASTM D3278 1 [10]	0 °C (32 °F) to 110 °C (230 °F)	Numeric	°C or °F	For PG assignment purposes, pass/fail at 23 °C (73 °F) suffices. Applicable to homogeneous, single-phase liquids having a viscosity less 5.5 cSt @ 40 °C (104 °F) that do not form a film while under test. This test method is more conducive to laboratory safety due to the small sample size.
ASTM D3828 1 [11]	−30 °C to 300 °C	Pass/Fail, Numeric	°C	For PG assignment purposes, pass/fail at 23 °C (73 °F) suffices. Applicable to homogeneous, single-phase liquids having a viscosity less 5.5 cSt @ 40 °C (104 °F) that do not form a film while under test. This test method is more conducive to laboratory safety due to the small sample size.
ASTM D93 [8] (ISO 2719) [25] 1	>40 °C to 70 °C	Numeric	°C or °F	Applicable to distillate fuels, residual fuels, biodiesel and those materials that tend to form a surface film under test conditions where a stirrer is not used. A large sample size is utilized in this test method.
ISO 13736 [32] (IP 170) 1	−30 °C to 75 °C	Numeric	°C	For PG assignment purposes, pass/fail at 23 °C (73 °F) suffices. A large sample size utilized in this test method.
ISO 3680 1 [28]	−30 °C to 300 °C	Pass/Fail	°C	This test method is more conducive to laboratory safety due to the small sample size.
ISO 3679 1 [27]	−30 °C to 300 °C	Numeric	°C	For PG assignment purposes, pass/fail at 23 °C (73 °F) suffices. This test method is more conducive to laboratory safety due to the small sample size.
ISO 1516 1 [22]	−30 °C to 110 °C	Pass/Fail	°C	A large sample size is utilized in this test method.
ISO 1523 1 [23]	−30 °C to 110 °C	Numeric	°C	For PG assignment purposes, pass/fail at 23 °C (73 °F) suffices. A large sample size is utilized in this test method.

1) Test Methods listed in the *HMR* and the *TDGR*. This table is for informational purposes only and does not provide legal advice on compliance with regulations.

NOTE The use of alternative test methods to those listed in the *HMR* can be approved by U.S. DOT.

2) Applicable temperature ranges are as of the date of publication of this document.

Table 3—Initial Boiling Point Test Methods for the Assignment of PG

Test Method	Applicable Range[2]	Result Type	Units	Comments
ASTM D86 [1] [7]	0 °C to >250 °C	Numeric	°C	For purposes of PG assignment using 35 °C (95 °F), a pass/fail using D86 can be applied. However, this test method may not be the most appropriate test method in measuring the IBP for crude oil with light components (i.e. methane to butanes).
ASTM D1078 [1] [9]	30 °C to 300 °C	Numeric	°C	Applicable for PG assignment purposes. This test method is not commonly used for wide boiling material, more for narrow range chemicals.
ISO 3405 [1] [26]	IBP=0 °C, FBP <400 °C	Numeric	°C	For purposes of PG assignment using 35 °C (95 °F), a pass/fail using ISO 3405 can be applied. However, this test method may not be the most accurate test method in measuring the IBP for crude oil with light components (i.e. methane to butanes).
ISO 3924 [1] [29]	>55 °C (131 °F)	Numeric	°C	Not applicable for IBP of less than 55 °C (131 °F).
ISO 4626 [1] [30]	−30 °C to 100 °C	Numeric	°C	Applicable for PG assignment purposes. This test method is not commonly used for wide boiling material, more for narrow range chemicals.

1) Test Methods listed in the *HMR* and the *TDGR*. This table is for informational purposes only and does not provide legal advice on compliance with the regulations.

NOTE The use of alternative test methods to those listed in the *HMR* can be approved by U.S. DOT.

2) Applicable temperature ranges are as of the date of publication of this document.

5.6.3.2 Alternate Best Practice for Determining IBP

While methods listed in Table 3 can be utilized for packing group assignment, to ensure minimal loss of light ends it is recommended crude oil samples be obtained in accordance with 5.6.4.1.2, and tested using ASTM D7900 to determine the boiling range distribution through n-nonane with application of the following qualifiers:

a) The initial boiling point (IBP) (as defined in ASTM D7169 [15]) is the temperature at which 0.5 weight percent is eluted when determining the boiling range distribution.

b) To determine vapor pressure (at 100 °F and a V/L ratio of 4:1), crude oil samples shall be tested using ASTM D6377.

c) If the vapor pressure, as determined in accordance with ASTM D6377 (at 100 °F and a V/L ratio of 4:1), of the crude oil is outside of the scope of ASTM D7900, i.e. is greater than 82.7 kPa (12 psi), one of the following techniques may be used:

   i. GPA 2103 with a weight percent conversion. GPA 2103 is intended for component quantification from methane to hexane using GPA 2177 [21] modified to incorporate a heated high pressure introduction system. A 0.5 weight percent recovery point or IBP can be calculated as prescribed in ASTM D7169.

   ii. Modifications of ASTM D7900 to include sample introduction techniques utilizing GPA 2103 and experimental or theoretical response factors in the manner of an external standard method.

In either configuration of c) i or c) ii, the precision and bias statements of ASTM D7900 and GPA 2103 do not apply. See Table 4 for information on ASTM D7900 and GPA 2103.

Table 4—Initial Boiling Point Alternative Test Methods for the Assignment of PG

Test Method	Applicable Range[1]	Result Type	Units	Comments
ASTM D7900	Methane to n-nonane	Numeric	°C or °F	
GPA 2103	Methane to hexane	Numeric	Volume %	Currently GPA 2103 reports volume percent which should be converted to weight percent for IBP calculation.

1) Applicable temperature ranges are as of the date of publication of this document.

NOTE The use of alternative test methods to those listed in the *HMR* can be approved by U.S. DOT.

5.6.4 Ongoing Sampling Program for Packing Group Determination

5.6.4.1 Representative Sampling Considerations

5.6.4.1.1 General

The objective of choosing the sample source/location and method is to ensure that the sample obtained is representative of the crude oil being loaded into rail tank cars (guidance provided in Annex A).

Refer to API *MPMS* Ch. 8.1 for guidance on static sampling methods, and API *MPMS* Ch. 8.2 for dynamic sampling methods. Procedures should be in place to ensure no additional or different crude oil type that could affect the package selection be introduced downstream of the sample point. Representative samples should be obtained as close as practical to the rail tank car loading point.

5.6.4.1.2 Sample Container for PG Assignment

For crude oil Packing Group assignment for rail transportation purposes, to minimize loss of volatile low molecular weight components, crude oil samples shall be obtained using the closed container (pressurized cylinder) method as specified in API *MPMS* Ch. 8.1-2013/ASTM D4057-12, unless the party responsible for assigning the PG demonstrates that a closed container is not necessary (e.g. a history of test data that demonstrates that the concentration range of volatile low molecular components found does not alter the PG assignment).

5.6.5 Frequency of Ongoing Sampling and Testing for Assignment of Packing Group

Samples shall be obtained and tests shall be performed with sufficient frequency to ensure the assignment of the PG has not changed. The criteria for determining the tests to be used and the frequency of sampling and testing in the sampling and testing program should be determined by the offeror. The frequency of sampling and testing should consider the following factors:

— historical consistency of the physical and chemical characteristics of the petroleum crude oil to be loaded;

— stability of the petroleum crude oil to be loaded;

— single source vs. multiple source(s);

— pipeline specifications changes (tariff rules and regulations);

— type of rail tank car loading facility (i.e. transload);

— new crude oil production or changes in crude oil production characteristics;

— variability of truck or pipeline receipts.

6 Determining the Loading Target Quantity (LTQ)

6.1 General

The loading target quantity (LTQ) is a quantity established by the loading terminal personnel, prior to commencement of loading of rail tank cars. The LTQ is determined by a series of calculations (see Annex B for an example) intended to ensure compliance with regulatory quantity requirements for weight and outage (3.20).

Personnel involved in the process of determining and implementing the LTQ shall be trained in the use of measurement equipment, systems and calculations used for the determination of loaded quantities. Since there are many measurement processes and scenarios unique to each facility, facility procedures shall be documented and utilized.

6.2 Volumetric or Weight Loading Target Quantity (LTQ)

6.2.1 Volumetric Limitation

The total volume calculated, based on the reference temperature given in Table 5, to be loaded into the rail tank car shall not exceed a volume equivalent to an outage (3.20) of 1 % at the relevant reference temperature of the rail tank car shell full capacity.

Liquids shall not completely fill a rail tank car at a temperature of 55 °C (131 °F) or above. Hazardous materials may not be loaded into the dome of a rail tank car. Also see 6.3.3.

Table 5—Reference Temperature Requirement Table [1]

Type of Rail Tank Car Insulation/Coating	Reference Temperature
Non-insulated tank	46 °C (115 °F)
Insulated tank	41 °C (105 °F)
Thermal protection system, incorporating a metal jacket that provides an overall thermal conductance at 15.5 °C (60 °F) of no more than 10.22 kilojoules per hour per square meter per degree Celsius (0.5 Btu per hour/per square foot/per degree F) temperature differential.	43 °C (110 °F)

1) This table does not provide advice on legal compliance with regulations. The current regulations in the local jurisdiction of users of this document shall take precedence and be followed.

6.2.2 Weight Limitation

The maximum weight of crude oil contained in the rail tank car after loading shall not exceed the load limit (3.18) of the rail tank car, or as required by the railroad on the intended rail route to the off-load facility. The load limit shall be obtained from the manufacturers' rail tank car capacity table (3.2), also known as a gauge table. The load limit on the manufacturer's rail tank car capacity table should match the load limit (LD LMT) stenciled on the rail tank car.

6.2.3 Determining if Volume or Weight is to be used for the LTQ

Prior to loading, the offering facility shall perform the necessary calculations to determine if volume or weight will be used in establishing the LTQ. For example, colder temperatures may result in achieving maximum allowable weight during loading regardless of outage. Conversely, warmer temperatures may result in achieving maximum volume with a target minimum outage and not achieving maximum allowable weight. The more restrictive, lower quantity shall be used to establish the LTQ.

6.3 Calculating the Loading Target Quantity (LTQ)

6.3.1 Rail Tank Car Shell Capacity Table (Gauge Table)

The offering facility shall obtain the rail tank car capacity table (3.2) applicable to the unique rail tank car number and record the shell-full capacity. Either the innage (3.15) or outage (3.20) capacity table may be used, but care should be taken to make sure the correct capacity table is used for determining the LTQ. Use of the incorrect capacity table is a common cause of calculation error. Load limit (3.18) and light weight (3.16) are stenciled on the side of the rail tank car, and may be available from an electronic equipment database.

6.3.2 Rail Tank Car Heel (Onboard Quantity (OBQ) Before Loading and Remaining Onboard (ROB) After Off-Loading)

6.3.2.1 General

The purpose of determining the heel (3.14) is to obtain a quantity that will be used as one of the inputs in calculating the LTQ. Depending upon the quantity determination method used, the LTQ could be miscalculated or misstated if the heel were not properly accounted for. In order to avoid overfill conditions, the actual heel quantity or potential uncertainty in the heel quantity should be considered in the weight and volume safety factors incorporated in calculating the LTQ (see Annex B, Segment 1 example).

6.3.2.2 Heel Determination

A heel quantity shall be determined, or a visual inspection carried out to establish that there is no measurable heel.

Open manway cover (3.19): A physical gauge (3.9) measurement should be obtained from the rail tank car reference gauge point. For more information see API *MPMS* Ch. 3.2.

Closed manway cover (3.19): One of the following options should be used to measure and record the heel quantity:

1) Rail tank car weigh scales.

2) For rail tank cars not equipped with closed or restricted gauging connections and a gauging device installed on a location other than the rail tank car reference gauge point, a measurement of the heel can be made through the manual vent line or vent valve, using a PEGD (3.22), manual gauge tape or graduated gauge rod. The offering facility shall take into account the deviation between observed reference height and the reference gauge height; the difference shall be assumed to be the heel.

3) For rail tank cars equipped with closed or restricted gauging connections installed on the rail tank car reference gauge point, utilize a portable electronic gauging device (PEGD) (3.22).

4) For rail tank cars equipped with closed or restricted gauging connections not installed on the rail tank car reference gauge point, utilize a PEGD (3.22). The offering facility shall take into account the deviation between observed reference height and the reference gauge height; the difference shall be assumed to be the heel. For example, if the PEGD touchpoint is 1 in. short of reference gauge height, the heel will be deemed to be a minimum of 1 in.

6.3.2.3 Heel Density and Temperature for LTQ

If the heel exceeds 1,100 gallons, or 8,000 lbs. (approximately 12 in. depth at the reference gauge point) [7], the heel density should be used in the calculation of LTQ. Otherwise, the density of the heel may be presumed to be the same

[7] 12 in. corresponds to less than 0.5 % of a variance in the LTQ.

as the density of either the crude oil to be loaded or the last offload (if known), or given a conservative value such as the relative density (specific gravity) of water (1.000).

The temperature of the heel can be presumed to be ambient unless the heel volume exceeds 7 % of the rail tank car capacity.[8] When the heel volume is 7 % or less, use of presumed ambient heel temperatures will result in less than a 0.25 % variance in the LTQ. When heel volume exceeds 7 %, the offering facility should utilize a measured temperature in calculating the LTQ.

If state or federal regulations prohibit the venting of vapors and therefore do not permit opening the manway (3.19) cover or using the vent stack for measurement and sampling, rail tank car weigh scales or closed sampling and gauging equipment should be used. Otherwise, the rail tank cars may require a fitting for closed system gauging equipment to be used.

6.3.2.4 Clingage and Residue

Many crude oils have high viscosities and high paraffin content which can result in crude oil adhering to the sidewalls or ends of the rail tank car (clingage). An estimate of clingage quantity and the uncertainty in estimating clingage quantity should be considered in the weight and volume safety factors incorporated in the LTQ calculation (see Annex B, Segment 1 example). It is recommended that a process be considered to minimize an excessive residual buildup of clingage. Weigh scales, by design, will provide quantities that are inclusive of clingage that are otherwise not capable of being measured through manual gauging (3.10).

6.3.2.5 ROB Heel

The unloading facility should ensure that the rail tank car has been emptied to the maximum extent practicable.

If regulations allow, the unloading facility should verify that the rail tank car is empty by conducting a physical check (e.g. a visual check) or physical gauge (3.9) measurement or by weighing each offloaded rail tank car using a weigh scale.

6.3.3 Temperature

Crude oil expands and contracts based on changes in temperature. For example, the volume can change by 0.4 % to 0.6 % per 10 °F change depending upon the density. Volume corrections shall be carried out in accordance with API *MPMS* Ch. 11.1-2004 or API *MPMS* Ch. 11.5, as appropriate.

Because the temperature of the crude oil at time of loading, and the possible temperature increase during transit, are essential in understanding the potential for a rail tank car overfill, accurate and representative temperature measurement and related calculations are essential to establishing the LTQ.

For initial LTQ purposes, the temperature of the crude oil prior to loading shall be estimated from either the temperature of the storage tank, truck(s), or pipeline from which the crude oil is supplied. When loading, the temperature value used in the initial LTQ should be verified within the first few minutes of loading when the temperature has stabilized and any adjustment made to the final LTQ.

There are cases where the planned maximum unloading temperature is above the reference temperature (see Table 5). In these cases the consignee (3.5) should notify the loading facility to use the planned maximum unloading temperature for calculating the LTQ.

[8] The value of 7 % is obtained from the Residue Test as defined in 19 U.S.C. 1321.

6.3.4 Sampling and LTQ Density

6.3.4.1 Sampling Points Based on Loading Scenarios

As all possible scenarios cannot be anticipated, common loading scenarios are outlined below.

a) Single Source

All the crude oil loaded into a rail tank car comes from one source, such as a storage tank or pipeline, with capacity equal to or greater volume than the capacity of the rail tank car. A composite sample shall be obtained in accordance with API *MPMS* Ch. 8.1 or API *MPMS* Ch. 8.2.

NOTE Alternatively, an on-line densitometer can be used in place of sampling and testing to obtain the density for the LTQ calculation.

b) Multiple Sources

In instances where crude oil is loaded into a rail tank car from more than one source such as multiple trucks and/or storage tanks, representative samples from each source should be utilized to determine the densities for the LTQ calculation. If densities are obtained from truck run tickets, periodic verification shall be performed.

See also 5.6.4.1.1.

6.3.4.2 Density

The LTQ calculation system or process will require density as an input variable. The density shall be determined based on representative samples or an on-line densitometer. Representative sampling is described in API *MPMS* Ch. 8.1 and API *MPMS* Ch. 8.2. Ensure that the obtained density has been converted to standard reference conditions (3.25) in accordance with API *MPMS* Ch. 9.1 or API *MPMS* Ch. 9.3.

If a truck run ticket density is used for LTQ calculation, the offering facility should have a process in place to periodically verify the density. The verification may take the form of testing samples from loading lines or trucks.

Regardless of where the sample used for density is obtained, no additional product should be introduced downstream of the location where samples are obtained as this could alter the density for LTQ calculations.

6.3.4.3 Testing

Multiple test methods exist for measuring density. Methods for determining density include API *MPMS* Ch. 9.1, API *MPMS* Ch. 9.3 or ASTM D5002 [13]. Application of the test method for density requires a dead crude oil (3.7) or field stabilization of the crude oil prior to sampling and testing. Indications of un-stabilized crude oil are visible bubbling, foaming, and/or boiling. The lack of hydrometer stabilization, if performed using API *MPMS* Ch. 9.1, can be another indication of sample instability.

NOTE Use of density test methods on un-stabilized/live crude oils can yield erroneous results due to loss of light components.

6.3.4.4 LTQ Calculation Example

See Annex B for an example of calculating LTQ.

6.4 Measurement Equipment and Processes

6.4.1 General

Measurement systems used during the loading of rail tank cars should be consistent with API *MPMS* standards or other applicable standards.

Measurement equipment or processes exhibit measurement uncertainty. These measurement uncertainties include rail tank car capacity tables (3.2), gauging equipment, temperature and density measuring equipment, metering and proving equipment and processes, and weigh scales.

6.4.2 Metering Systems

Metering systems can be used to determine the total quantity (volume, weight, or both) being loaded. Metering systems generally include a flow meter (either volumetric or mass), appropriate temperature and pressure instruments for compensation to standard reference conditions (3.25), and a flow computer to collect the instrument signals, perform the necessary calculations, and produce a final run ticket or quantity report. The meters and accessory equipment require periodic proving, calibration, or verification to ensure they are in good working order. The frequency and tolerances are set by the manufacturer, equipment owner or contract terms. Specific guidance for tolerances is also provided within the applicable API standard. Refer to API *MPMS* Ch. 5 and API *MPMS* Ch. 7.

It is recommended that flow meters be located as near as practical to the rail tank car being loaded to avoid a potential concern regarding line fullness or line integrity.

Line fullness refers to the concept that pipelines could contain air or vapor, when assumed to be filled with liquid, and the metered quantity might not represent the loaded quantity. If the meter cannot be located in close proximity, it is recommended the loading facility implement procedures for determining or confirming the line fill condition of the pipeline or other equipment used for loading of crude oil into rail tank cars.

Line integrity is related to the possibility that common manifold valves or relief devices could be leaking. Therefore, line integrity will ensure the product reaches its intended destination.

6.4.3 Storage Tank Gauging

Storage tank gauging is another method for determining total quantity (volume, weight, or both) being loaded into rail tank cars. Tank gauging shall be carried out in accordance with API *MPMS* Ch. 3.1A or Ch. 3.1B.

Gauging systems for a storage tank can be manual or automatic, and will include a tank capacity table, level gauge, temperature measurement, and calculation of quantity per API *MPMS* Ch. 12.1.1. The measurement equipment will require periodic calibration or verification to ensure they are in good working order.

API *MPMS* Ch. 3.1A and API *MPMS* Ch. 3.1B describe gauging and temperature measurement equipment used in both open and closed measurement systems. Specific instruction is provided for level gauging. General instruction is provided for temperature and sampling.

All valves between the storage tank(s) and the rail tank car(s) shall be closed and verified, except those which have to be open for the loading.

NOTE Leaking or open valves between the tank(s) and rail car(s) will result in a mismeasurement.

6.4.4 Rail Tank Car Gauging

Rail tank car gauging is another method for determining total quantity (volume, weight or both) being loaded. Refer to API *MPMS* Ch. 3.2 as the primary reference that describes the equipment and procedures for the liquid level method of measurement for rail tank cars.

Gauging systems for a rail tank car can be manual or automatic, and will include a rail tank car capacity table (3.2), level gauge, temperature measurement, and calculation of quantity. The measurement equipment requires periodic calibration or verification to ensure they are in good working order.

API *MPMS* Ch. 3.2 describes gauging and temperature measurement equipment used in both open and closed measurement systems. Specific instruction is provided for rail tank car gauging. General instruction is provided for temperature and sampling.

6.4.5 Weigh Scales

Static (stationary) or weigh-in-motion (dynamic) weigh scales (railway track scales) are acceptable methods for quantity determination of crude oil. If an operator considers weigh scales as an option, they shall refer to the latest editions of AAR *Scale Handbook*, NIST *Handbook 44*, or an equivalent standards body, for certification, calibration, specification of location, maintenance, operation, and testing requirements.

If transloading from trucks, the net weight of the individual trucks, as measured by truck scales, may be used to determine total rail tank car weight (see NIST *Handbook 44*).

6.5 Other Operational Considerations

6.5.1 Process Safety Factors

The LTQ methodology calculates the quantity by volume and weight to meet regulatory requirements. Actual loading processes can introduce variability into the inputs used in the LTQ calculation. Therefore, it is recommended that the loading facility provide estimated process safety factors for volume and weight into the LTQ calculations (see Annex B, Segment 1 example). The volume safety factor or weight safety factor that is used in the LTQ calculation should be selected using loading facility judgment based on the accuracy and variability of their process for loading of the rail tank car.

6.5.2 Overfill Prevention

An offering facility shall have an overfill prevention system or procedure in place as a secondary safety system. It should not be used as the primary LTQ control. An overfill prevention system can be either automatic or manual.

An automatic system is alarmed, typically visual and audible, for rail tank car loading operations and is activated without operator intervention. When an automatic protective action or alarm condition is received, the loading facility should confirm that the LTQ has not been exceeded.

A manual alarm system requires operator action when an alarm is received, in accordance with terminal operating procedures. The alarm set points should be set to allow sufficient time for operations personnel to react and prevent any potential overfill or release. In determining protection levels to allow human reaction times, the pump rates from truck and tanks and maximum human reaction timeframes should be used.

If an alarm overfill prevention system is not available, an operator should be physically present with an unobstructed view or with a measurement capability to ensure that a rail tank car is not overfilled.

In the event that a rail tank car is overfilled, appropriate personnel should be notified in accordance with terminal operating procedures and steps should be taken to remove excess product from the rail tank car.

6.5.3 Preparing a Rail Tank Car for Loading

AAR Pamphlet 34 provides the recommended best industry practices and can be used when developing operational procedures for preparing a rail tank car for loading. The offering facility shall secure and protect the track, and each rail tank car shall be secured, inspected, and placed in a safe condition prior to the commencement of loading operations. Applicable regulations should be regularly reviewed for updates of operational procedures.

6.5.4 Preparing a Loaded Rail Tank Car for Shipment

Prior to release to the carrier (3.3) for transportation, all tank rail cars shall be inspected and secured according to regulations. As part of this process, a tamper-resistant seal should be installed or affirmed in place on the manway (3.19) cover, top fittings protection lid, and bottom operated valve handle. Additional seals may be affixed in accordance with the terminal operating procedures. Regulatory requirements, and recommendations from AAR Pamphlet 34, should be considered when developing procedures for securing a rail tank car.

See Annex D for information concerning shipping paper.

6.5.5 Verification

The offeror shall periodically review procedures and verify that all requirements as prescribed in Section 6 of this document are implemented.

7 Record Retention

At a minimum, document retention requirements of records, shipping papers, etc. prescribed in 49 *CFR*, or other regulatory rules or standards shall be met.

Any party that provides a shipping paper shall retain a copy of the shipping paper, or an electronic image of the shipping paper. This document shall be accessible at, or through the party's principal place of business. The shipping paper shall be available, upon request, to an authorized official of any Federal, State, or local government agency at reasonable times and locations.

Each shipping paper copy shall include the date of acceptance by the originating carrier (3.3). For crude oil shipped by rail, the date on the bill of lading (3.1) or the shipment waybill (3.30) may be used in place of the date of acceptance by the originating carrier.

For the shipment of crude oil by rail, each offeror shall retain the shipping paper(s) and documentation of quantity and quality, including results of sampling and testing for the classification of crude oil, for a minimum of two years after the crude oil is accepted by the originating carrier.

Each offeror should periodically review and verify adherence to document retention policies and requirements of this document.

Annex A
(informative)

Sampling and Testing Program Example [9]

The crude oil testing program should take into account both initial and ongoing testing. Testing of crude oil should include all tests necessary to ensure the proper characterization for the purpose of determining the proper Packing Group (3.21) and package.

Testing should be conducted prior to offering the crude oil for rail transportation. An ongoing testing program should periodically test parameters when there is reason to believe, or where historical data indicate, the characterization of the crude oil may change the assignment of Packing Group. The program should identify if the Packing Group has changed, and if it has, a re-evaluation of the transportation requirements shall be conducted. Sampling frequency should be adjusted based on the variability of test results.

Sampling should ensure that when a composite sample is obtained, it is representative of the crude oil to be loaded. Samples can either be obtained manually (per API *MPMS* Ch. 8.1) or automatically (per API *MPMS* Ch. 8.2). The preferred method for collecting representative samples of crude oil are those obtained via a flow-proportional auto in-line sampler that conforms to the requirements of API *MPMS* Ch. 8.2.

The number of samples obtained should take into consideration how the crude oil is loaded and the number of rail tank cars to be loaded. The trains may be as large as unit trains (trains containing a single commodity originating at a single origin and terminating at a single destination), or as small as a single manifest rail tank car.

When loading from a single storage tank (assuming that the crude oil is mixed), one sample per unit train may be sufficient as the same product is being loaded into all rail tank cars. This sample could be taken directly from the tank, provided there is no means to introduce a new product into a rail tank car from another source. The same principle applies when loading the volume of smaller tanks into fewer rail tank cars. In summary, if the storage tank volume exceeds the rail tank car volume, then only one sample may be taken.

If a unit train is being filled by more than one tank, then samples from each storage tank should be taken. These samples may be obtained at the tank outlet as long as the crude is mixed and no means are available to introduce a new material. A record for which rail tank car is filled from which storage tank(s) should be created and retained. If the characteristics of the crude oil vary, each rail tank car may be sampled since the rail tank car may be filled by as many as 3 to 4 trucks. In these cases, the crude oil type is generally classified as the same due to being produced from the same geographical/geological field. However, the origin of the crude oil may be from several different independent sources or geographic locations. Therefore, the testing program may include taking samples of either the rail tank car or taking samples from multiple trucks offloading product. If trucks are the basis of testing, the most conservative result should be used for classification and packing group determination.

It does not matter if the loading is conducted from single or multiple sources (storage tanks or trucks) as long as no other petroleum crude oil is introduced downstream of the auto in-line sampler.

Testing at unloading is generally not required. If testing at the rail tank car unloading point is desired, caution should be exercised to ensure the rail tank car has not stratified during transport.

[9] The example given above is merely for illustration purposes only. Each company should develop its own approach. It is not to be considered exclusive or exhaustive in nature. API makes no warranties, express or implied for reliance on or any omissions from the information contained in this document.

Annex B
(informative)

Example for Calculating LTQ

The following example is merely for illustration purposes only. It is not to be considered exclusive or exhaustive in nature. API makes no warranties, express or implied for reliance on or any omissions from the information contained in this document. This example is for non-heated light crude oil, loaded into a non-insulated rail tank car. Some considerations in this example are for other types of rail tank cars, e.g. insulated and heated rail tank cars. This example is included as a guide for developing a tool for operators to use. Individual facilities should determine the input values needed from operations and develop input screens needed for the calculations.

When loading the rail tank car from multiple sources using tank trucks, the calculation shall be restarted with each truck load. This is due to the possibility that different crude oil qualities will change the LTQ.

LTQ for Loading Light Cold Crude Oil into Non-insulated Rail Tank Car

Segment 1—Rail Tank Car Specifics and Process Safety Factors

All of the values in Segment 1 are input values with the exception of the reference temperature for Shell Full Temperature (SFT), Statutory Outage and Regulatory Mandated Values.

Input: Rail Tank Car Name and Number (Reporting Marks): TASX 41093

Source: Rail tank car stenciling and/or nameplate

Volume

Input: CAPY (Tank Volume Capacity): 31,770 gal (756.43 BBL)

Source: Rail tank car capacity data sheet or gauge table information for the shell-full (zero-outage) level

Input: Volume Safety Factor (VSF): 105 gal (2.5 BBL) as an example only

Source: Loading facility judgment based on the accuracy of their process for loading the rail tank car

Weight

Input: Maximum Gross Weight (GWR or Gross Weight on Rail): 286,000 lb.

Source: Rail tank car capability or rail carrier route restriction, whichever is lower

Input: LT WT (Light Weight or Tare Weight): 74,700 lb.

Source: Rail tank car capacity data sheet or gauge table information

Input: LD LMT (Load Limit): GWR – LT WT = 286,000 lb. – 74,700 lb. = 211,300 lb.

Weight Safety Factor (WSF): 500 lb. (226.80 kg) as an example only

Source: Loading facility judgment based on the accuracy of their process for loading the rail tank car

Regulatory

Input: Tank Type: Non-insulated.

Source: User should be able to use a drop-down box or needs to type into the cell the following rail tank car type: insulated, jacketed, or non-insulated

Reference Temperature: 115 °F

Source: Based on Tank Type (insulated 105 °F, jacketed 110 °F, non-insulated 115 °F) (see Table 5)

Regulatory Outage: 1 %

Source: Regulatory requirement, based on the Reference Temperature

Completely Full Temperature (CFT): 131 °F, and may not load into the dome

Source: Regulatory requirement, based on completely filling a rail tank car

Input: Special temperature constraint for terminal heating crude oil before off-loading: 115 °F.

Source: Off-loading terminal (see Section 6.3.3)

Entries (Input) are in Orange:			
Calculations are in Grey:			
LTQ Results are in Green:			
Segment 1 – Rail Tank Car Specifics and Process Safety Factors			
Rail Tank Car Name and Number (Reporting Marks):	TASX 41093		Source: Rail tank car stenciling and/or nameplate.
CAPY (Tank Volume Capacity):	31,770	gal	Source: Rail tank car capacity data sheet or gauge table information for the shell-full (zero-outage) level.
Maximum Gross Weight (GWR or Gross Weight on Rail):	286,000	lb	Source: Rail tank car capability or rail carrier route restriction, whichever is lower.
LT WT (Light Weight or Tare Weight):	74,700	lb	Source: Rail tank car capacity data sheet or gauge table information.
Volume Safety Factor (VSF):	105	gal	Source: Loading facility judgment based on accuracy of process.
Weight Safety Factor (WSF):	500	lb	Source: Loading facility judgment based on accuracy of process.
Regulatory			
Tank Type:	non-insulated		insulated, jacketed, or non-insulated
Statutory Outage:	1%		
Regulatory Mandated: Fixed Value			
Reference Temperature for Statutory Outage:	115	°F	Based on Rail Car Type (insulated 105 °F, jacketed 110 °F, non-insulated 115 °F)
Statutory Reference for Shell Full Temperature (SFT):	131	°F	**Regulatory Mandated Fixed Value: Volume cannot exceed Shell Full at SFT**
Special temperature constraint for terminal heating or during transportation of crude before off-loading:	115	°F	Source: Off-loading terminal

Figure B.1—Segment 1 Example

Segment 2—Heel Volume and Weight

Input: Heel Depth: 4.00 in.

Source: As measured, verified, or potential highest case

Input: Heel Temperature: 15 °F

Source: As measured, or presume equal to ambient temperature

Input: Heel API gravity at 60: 40° API

Source: As measured, from prior load data, from historical verification, or potential heaviest case (such as water at 10° API, 1.000 Specific Gravity, 8.3372 lb./gal, or 999.016 kg/m^3)

References: GPA 2145-09 [20], API *MPMS* Ch. 11.4.1 [3]

Input: Measured Heel Volume (GOV): 108 gal (2.571 BBL) as an example only

Source: Rail tank car capacity data sheet or gauge table information, based on Heel Depth

Input: Clingage Only Volume (COV): 0 gal (0 BBL) as an example only

Source: If possible to verify, estimated from a method such as visual observation or weigh scales

Segment 2 – Heel Volume and Weight				
Heel Depth:	4.00	in.	10.16	cm
	Source: As measured, verified, or potential highest case			
Heel Temperature:	15	°F		
	Source: As measured, or presume equal to ambient temperature			
Heel API gravity at 60:	40	° API		
	Source: As measured, from prior load data, from historical verification, or potential heaviest case (such as water at 10° API, 1.000 Specific Gravity, 8.3372 lb./gal (GPA 2145-09), or 999.016 kg/m3 (API MPMS Ch. 11.4.1)			
Weight in Air:	6.8697	lb/gal, Reference: API MPMS Ch. 11.5	824.261	kg/m^3, Reference: API MPMS Ch. 11.1
Volume Correction Factor for Heel:	1.02243	Reference: API MPMS Ch. 11.1		
Measured Heel Volume (GOV):	108	gal	Source: Rail tank car capacity data sheet or gauge table information, based on Heel Depth	
Additional Clingage Volume:	0	gal	Source: If possible to verify, estimated from a method such as visual observation or weigh scales	
Total Heel Volume (GSV):	110	gal	Measured Heel Volume + Additional Clingage Volume, corrected to Standard Temperature	
Heel Weight: Total Heel Volume × Heel lb/gal =	759	lb		
Equivalent Volume for 1% of Capacity	318	gal		
Initial Volume Load Limit: CAPY - 1% Outage Vol - VSF =	31,347	gal		
Initial Load Limits Reduced by Heel:	31,237	gal		

Figure B.2—Segment 2 Example

Segment 3—Crude Oil Density and Temperature

Input: API gravity at 60 (Standard Density for Crude Oil to be Loaded): 40° API

Source: As measured or from inbound shipment data

Input: Pre-fill Temperature (PFT): 30 °F

Source: As measured from source

Segment 3 – Crude Oil to be Loaded - Density and Temperature					
Crude API gravity at 60:	40	° API	Estimate of Loading Temperature:	30	°F
	Source: As measured or otherwise determined		Source: As measured from source tank, pipeline, meter, etc.		
Weight in Air:	6.8697	lb/gal, Reference: API MPMS Ch. 11.5		824.332	kg/m³, Reference: API MPMS Ch. 11.1
	Weighted Averages of Heel and Loaded Crude				
Estimated Loaded Temperature (weighted average of Loading crude and Heel):				29.9	°F
Estimated Loaded Gravity (weighted average of Loading crude and Heel):				40.0	° API
Weight in Air:	6.8697	lb/gal, Reference: API MPMS Ch. 11.5		824.261	kg/m³, Reference: API MPMS Ch. 11.1
Volume Correction Factor for Estimated Load Temperature:		1.01502	Reference: API MPMS Ch. 11.1		

Figure B.3—Segment 3 Example

Segment 4—Volume Limit

Segment 4 – Volume Limit									
Statutory Outage Reference Temperature Check						Values at 60°F			
		Gallons	BBL	lbs	°F	API	kg/m^3	lb/gal	VCF
CAPY (Tank Volume Capacity) at Statutory Reference Temperature:	A	31,770	756.43	212,176	115.0	40.0	824.332	6.8697	0.97218
1% of Capacity at Statutory Reference Temperature:	B=A x 1%	318	7.56	2,122	115.0	40.0	824.332	6.8697	0.97218
Volume Safety Factor (VSF) at Reference Temperature:	C	108	2.57	721	115.0	40.0	824.332	6.8697	0.97218
Total Volume at Statutory Reference Temperature:	D=A-B-C	31,344	746.29	209,333	115.0	40.0	824.332	6.8697	0.97218
Net VCF for Difference Between Reference Temperature and Loaded Temperature:	E								0.95780
Total Volume at Loaded Temperature:	F=D x E	30,021	714.80	209,333	29.9	40.0	824.332	6.8697	1.01502
Existing Heel Volume at Loaded Temperature:	G	109	2.59	759	29.9	40.0	824.332	6.8697	1.01502
LTQ Volume at Loaded Temperature:	H=F-G	29,913	712.21	208,575	29.9	40.0	824.332	6.8697	1.01502
Statutory Reference for Shell Full Temperature (SFT) Check						Values at 60°F			
		Gallons	BBL	lbs	°F	API	kg/m^3	lb/gal	VCF
Volume Load Limit at Statutory Reference Temperature for Shell Full:	I	31,770	756.43	210,394	131.0	40.0	824.332	6.8697	0.96401
Volume Safety Factor (VSF) at Reference Temperature:	J	109	2.59	721	131.0	40.0	824.332	6.8697	0.96401
Existing Heel Volume at Reference Temperature:	K	115	2.73	759	131.0	40.0	824.332	6.8697	0.96401
Total Volume at Statutory Reference Temperature:	L=I-J-K	31,547	751.11	208,914	131.0	40.0	824.332	6.8697	0.96401
Net VCF for Difference Between Reference Temperature and Loaded Temperature:	M								0.94975
LTQ Volume at Loaded Temperature:	N=L x M	29,961	713.36	208,914	29.9	40.0	824.332	6.8697	1.01502

Figure B.4A—Segment 4A Example

Statutory Reference for Shell Full Temperature (SFT) Check						Values at 60°F			
		Gallons	BBL	lbs	°F	API	kg/m³	lb/gal	VCF
Volume Load Limit at Statutory Reference Temperature for Shell	I	31,770	756.43	210,394	131.0	40.0	824.332	6.8697	0.96401
Volume Safety Factor (VSF) at Reference Temperature:	J	109	2.59	721	131.0	40.0	824.332	6.8697	0.96401
Existing Heel Volume at Reference Temperature:	K	115	2.73	759	131.0	40.0	824.332	6.8697	0.96401
Total Volume at Statutory Reference Temperature:	L=I-J-K	31,547	751.11	208,914	131.0	40.0	824.332	6.8697	0.96401
Net VCF for Difference Between Reference Temperature and Loaded Temperature:	M								0.94975
LTQ Volume at Loaded	N=L x M	29,961	713.36	208,914	29.9	40.0	824.332	6.8697	1.01502
Volume only Check When Loading "Hot" Crude						Values at 60°F			
		Gallons	BBL	lbs	°F	API	kg/m³	lb/gal	VCF
Volume Limit at Loaded Temperature for Shell Full:	O	31,770	756.43	221,526	29.9	40.0	824.332	6.8697	1.01502
Volume Safety Factor (VSF) at Loaded Temperature:	P	103	2.46	721	29.9	40.0	824.332	6.8697	1.01502
Existing Heel Volume at Loaded Temperature:	Q	109	2.59	759	29.9	40.0	824.332	6.8697	1.01502
LTQ Volume at Loaded	R=O-P-Q	31,558	751.38	220,046	29.9	40.0	824.332	6.8697	1.01502
Volume or Weight Restriction When Heating Crude Before Offload						Values at 60°F			
		Gallons	BBL	lbs	°F	API	kg/m³	lb/gal	VCF
Volume Limit at Loaded Temperature for Shell Full:	O	31,770	756.43	212,176	115.0	40.0	824.332	6.8697	0.97218
Volume Safety Factor (VSF) at Loaded Temperature:	P	108	2.57	721	115.0	40.0	824.332	6.8697	0.97218
Existing Heel Volume at Loaded Temperature:	Q	114	2.70	759	115.0	40.0	824.332	6.8697	0.97218
LTQ Quantity at Unloaded Temp:	R=O-P-Q	31,548	751.15	210,697	115.0	40.0	824.332	6.8697	0.97218
SUMMARY		Gallons	BBL	lbs					
LTQ Volume at Loaded		29,913	712.21	208,575	Statutory Outage Reference Temperature				
LTQ Volume at Loaded		29,961	713.36	208,914	Statutory Reference for Shell Full Temperature (SFT)				
LTQ Volume at Loaded		31,558	751.38	220,046	Volume only Check When Loading Crude				
LTQ Quantity at Unloaded Temp:		31,548	751.15	210,697	Volume Restriction When Heating Crude Before Offload				
Limiting LTQ for Volume		29,913	712.21	208,575					

Figure B.4B—Segment 4B Example

Segment 5—Weight Limit

Segment 5 – Weight Limit		
	lbs	
Weight Load Limit: GWR - LT WT - WSF - Heel Weight =	210,041	
LTQ Quantity at Unloaded Temp:	210,697	Weight Restriction When Heating Crude Before Offload
Limiting LTQ from Volume Section:	208,575	
Smallest lb value governs:	208,575	Limited by Statutory Volume Outage

Figure B.5—Segment 5 Example

Segment 6—Loading Target Quantity (LTQ)

Segment 6 – Loading Target Quantity (LTQ)								
					Values at 60°F			
	Gallons	BBL	lbs	°F	API	kg/m³	lb/gal	VCF
LTQ at 60°F:	30,362	722.90	208,575	60.0	40.0	824.332	6.8697	1.00000
LTQ Volume at Loaded Temp.:	**29,913**	**712.21**	**208,575**	**29.9**	**40.0**	824.332	6.8697	1.01502
LTQ Volume at Average Loading Temp.:	29,913	712.22	208,575	30.0	40.0	824.332	6.8697	1.01499
Critical Output for Operators								

Figure B.6—Segment 6 Example

Annex C
(informative)

Summary of Roles, Responsibilities and Training Requirements of Hazmat Employees

Table C.1 gives a summary of roles, responsibilities and training requirements of hazmat employees (3.13). This table is for information purposes only and does not provide legal advice on compliance with regulations.

Table C.1—Roles, Responsibilities and Training Requirements of Hazmat Employees

Hazardous Material— Rail Tank Car Function	Responsibilities: Training Requirements
Classification: preparing proper shipping descriptions	All Classification requirements: — Identification of hazard classes, precedence of classes, and proper shipping name — Assignment of Packing Group — Structure of the proper shipping description and special notations — Nature of dangerous goods (physical, chemical, toxicological properties) — Hazardous substances — Marine pollutants — Use of the applicable regulatory list of hazardous materials/dangerous goods — Emergency response guidance
Selecting/preparing rail tank cars for offering	Hazard classes — Packaging selection — Type of rail tank car — Required markings — Segregation requirements — Placarding — First aid/safety measures — Safe handling procedures
Marking, labels/placarding	Hazard classes Marking/placarding requirements — Primary and subsidiary risks — Marine pollutants — Test/date stencil marks

Table C.1—Roles, Responsibilities and Training Requirements of Hazmat Employees (Continued)

Hazardous Material— Rail Tank Car Function	Responsibilities: Training Requirements
Unload/load rail tank cars	Thorough working knowledge of the *HMR* shipping papers: — Hazard classes — Marks/labels/placards — Stowage — Segregation — Securement — Emergency response guidance — First aid — Safe handling procedures — Right to know/OSHA/SDS training Knowledge and training in AAR Pamphlet 34
Preparation of EDI for dispatch to carrier (waybill, BOLs)	Documentation requirements — Consignor and consignee address/contact information — Proper shipping description (UN ID, PSN, hazard class(es), PG, special notations as required) — Quantity with units — Container type and count — Certification section with name and title of signatory, time, place — 24/7 emergency contact information with contract number as applicable — International requirements (e.g. emergency response assistance plan [ERAP])
Offering for transport	Thorough working knowledge of the *HMR* (including classification, marks/placards, documentation, securement, etc.)
Accepting for transport	Thorough working knowledge of the *HMR* (including classification, marks/placards, documentation, securement, etc.)
Handling/securing for transport	Thorough working knowledge of the *HMR* — Hazard classes — Marking/placarding requirements — First aid — Safe handling procedures — Right to know/OSHA/SDS training — International regulatory requirements, e.g. ERAP for Transport Canada

Table C.1—Roles, Responsibilities and Training Requirements of Hazmat Employees (Continued)

Hazardous Material— Rail Tank Car Function	Responsibilities: Training Requirements
Carriage (acceptance of rail tank cars for transport)	Thorough working knowledge of the *HMR* — Documentation (EDI, waybills, BOL, shipping papers) — Proper shipping descriptions including hazard classes — Marks/labels/placards — Stowage/segregation requirements — Emergency response — First aid/safety
Enforce, survey, inspect for compliance with applicable rules and regulations	Thorough working knowledge of the *HMR*, operational and safety procedures.

Annex D
(informative)

Shipping Paper

D.1 General

Users should consult the regulations in their applicable jurisdiction regarding additional information that may be required on the shipping paper.

Examples of proper shipping descriptions are shown in Table D.1. They are presented in sets of five codes, representing U.S. DOT and TC (Transport Canada). To simplify, all Packing Groups are represented in the appropriate entry. These are the “codes” selected at consignment by dispatchers to go along with a consignment or unit train of rail tank cars. The codes are pre-loaded into IT shipping systems.

NOTE Selecting the wrong code can put the wrong shipping description on the EDI waybill and/or shipping papers.

Table D.1 is an example for illustration purposes only. It is not to be considered exclusive or exhaustive in nature. API makes no warranties, express or implied for reliance on or any omissions from the information contained in this document.

Table D.1—Example Proper Shipping Descriptions for IT Waybill Systems

U.S. DOT or Transport Canada (TC)	Waybill System Code	Proper Shipping Descriptions
		CLASSIFICATIONS: EXAMPLE PROPER SHIPPING DESCRIPTIONS FOR TYPICAL PETROLEUM CRUDE OILS, ALL PACKING GROUPS
DOT	1028R - DOTM	UN1267, PETROLEUM CRUDE OIL, 3, I, II, OR III; OPTIONAL DISCLOSURE: UN1267, PETROLEUM CRUDE OIL, 3, I, MARINE POLLUTANT
TC	1028R - TCM	UN1267, PETROLEUM CRUDE OIL, 3, PG I, II, OR III, MARINE POLLUTANT (*WHEN TRANSPORTED VIA WATER)*
		PETROLEUM CRUDE OILS: ALL PACKING GROUPS WITH A POTENTIAL TO ACCUMULATE LETHAL LEVELS OF H_2S IN HEAD SPACE VAPORS
DOT	1028P - DOTM	UN1267, PETROLEUM CRUDE OIL, 3, I, II, OR III (POTENTIAL HYDROGEN SULFIDE INHALATION HAZARD); OPTIONAL DISCLOSURE: UN1267, PETROLEUM CRUDE OIL, 3, I, II, OR III, MARINE POLLUTANT (POTENTIAL HYDROGEN SULFIDE INHALATION HAZARD)
TC	1028P - TCM	UN1267, PETROLEUM CRUDE OIL, 3, PG I, II, OR III, MARINE POLLUTANT (*WHEN TRANSPORTED VIA WATER*), (POTENTIAL HYDROGEN SULFIDE INHALATION HAZARD)

Table D.1—Example Proper Shipping Descriptions for IT Waybill Systems (Continued)

U.S. DOT or Transport Canada (TC)	Waybill System Code	Proper Shipping Descriptions
		INTERNATIONAL CLASSIFCATION FOR UN3494: PETROLEUM CRUDE OILS MEETING THE CRITERIA AS A TOXIC DIVISION 6.1 SUBSIDIARY RISK NOTE: ANYTHING MEETING THE CRITERIA OF A 6.1 TOXIC SHOULD NOT BE SHIPPED IN BULK. VARIATIONS OF THESE COULD BE USED FOR SAMPLES (NON-BULK):
DOT	1028T - DOTM	UN3494, PETROLEUM SOUR CRUDE OIL, FLAMMABLE, TOXIC, 3 (6.1), PG I, II, OR III (WARNING - HYDROGEN SULFIDE INHALATION HAZARD) SEE 49 CFR 172.327 AND 172.102, SPECIAL PROVISION 357
TC	1028T - TCM	UN3494, PETROLEUM SOUR CRUDE OIL, FLAMMABLE, TOXIC, 3 (6.1), PG I, II, OR III, MARINE POLLUTANT (WHEN TRANSPORTED VIA WATER) (WARNING - HYDROGEN SULFIDE INHALATION HAZARD)
		TYPICAL FLAMMABLE LIQUID OF PETROLEUM CRUDE OILS, TRANSMIX: ALL PGs:
DOT	1028W - DOTM	UN1993, FLAMMABLE LIQUIDS, N.O.S. (PETROLEUM CRUDE OIL, TRANSMIX), 3, I, II, OR III; OPTIONAL DISCLOSURE: UN1993, FLAMMABLE LIQUIDS, N.O.S. (PETROLEUM CRUDE OIL, TRANSMIX), 3, I, II, OR III, MARINE POLLUTANT (PETROLEUM CRUDE OIL, TRANSMIX)
TC	1028W - TCM	UN1993, FLAMMABLE LIQUIDS, N.O.S. (PETROLEUM CRUDE OIL, TRANSMIX), 3, I, II, OR III, MARINE POLLUTANT (PETROLEUM CRUDE OIL, TRANSMIX) (*WHEN TRANSPORTED VIA WATER*)
		HIGH FLASH PETROLEUM CRUDE OIL (FP PM CC > 60 DEG C) GHS AQTOXIC EHS/MARINE POLLUTANT (ACUTE 1, CHRONIC 1, 2)
DOT	1028X - DOTM	NOT REGULATED FOR TRANSPORTATION UNDER 49 CFR; OPTIONAL DISCLOSURE: UN3082, ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (PETROLEUM CRUDE OIL), 9, III, MARINE POLLUTANT (PETROLEUM CRUDE OIL)
TC	1028X - TCM	UN3082, ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (PETROLEUM CRUDE OIL), 9, III, MARINE POLLUTANT (PETROLEUM CRUDE OIL)

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