GPAC Testing and Classification Working Group Submission and Recommendations:

# Strengthening the Testing and Classification Framework for Crude Oil by Rail

January 31, 2014

## Contents

# Introduction

In response to recent tragic events, the transportation of dangerous goods (TDG) has received increased attention at the most senior levels of Government. At the TDG-General Policy Advisory Council in November 2013, the Minister of Transport initiated a process to strengthen Canada's TDG framework as it relates to the transportation of crude oil on rail, and has established three working groups in the areas of testing and classification, emergency response and means of containment to inform this work.

This report presents the analysis and recommendations of the testing and classification working group, which was tasked to deliver recommendations for strengthening the TDG framework as it pertains to the testing and classification of crude oil by rail to Transport Canada by January 31, 2014

The working group is chaired by the Canadian Association of Petroleum Producers (CAPP). Other working group members include representatives from Transport Canada, the Teamsters Union of Canada, The Federation of Canadian Municipalities, the Canadian Association of Fire Chiefs, the Chemistry Industry Association of Canada, the Canadian Fuels Association, the Canadian Crude Quality Technical Association, the Railway Association of Canada, the Petroleum Services Association of Canada, and representatives from the energy and rail industries. Participants contributed varying perspectives and degrees of expertise in the development of this report. A full list of participants is included in Appendix B.

The Working Group convened five times between December 2013 and January 2014 to discuss issues, explore options and consider recommendations for change. To inform this work, CAPP distributed a questionnaire to the members of its testing and classification shadow committee, which accounts for approximately 22 per cent of total Canadian oil production. CAPP also hosted a number of discussion sessions with its shadow committee members and other experts such as the Canadian Crude Quality Technical Association (CCQTA) and Transport Canada to better understand challenges pertaining to testing and classification of crude oil for transport by rail and identify solutions to strengthen the regulatory framework.

The scope of this submission is to review the existing classification regulatory framework and propose recommendations to ensure the properties of crude oil for transport by rail are sufficiently and accurately characterized and classified to ensure that appropriate means of containment are selected for transport, and accurate information is available for handling and response in the event of an incident. A glossary of relevant scientific terms is included in Appendix A of this report.

The enclosed submission was developed and informed by the findings of the questionnaire and ongoing discussions in working group and shadow committee sessions, as well as a review of relevant research and existing and recommended practices supported by the industry and third party organizations such as the CCQTA. This submission seeks to address issues related to characteristics and criteria for crude classification for TDG; limitations of existing testing procedures; vapour properties of crude and implications for rail transport; a proposed true vapour pressure testing procedure; sampling and testing frequency and protocol; issues relating to toxicity and corrosivity; best practice and other considerations; and short and long term recommendations for change.

# 1 Characteristics and Criteria for TDG Crude Classification

Under Part 2 of the *Transportation of Dangerous Goods Act* Regulations, liquid substances are considered class 3 flammable liquids if they have a flashpoint less than or equal to 60 degrees Celsius (closed cup) or are expected to be at a temperature that is greater than or equal to their flash point at any time while the substance is in transport. Flammable liquids are assigned to packing groups for transportation based on the following initial boiling point (IBP) and flashpoint thresholds:

| Table 1: PG Classification Thresholds | | |
|---|---|---|
| Packing Group | Criteria | |
| | Initial Boiling Point | Flashpoint |
| I | <=35C @ 101.3 kPaa | -- |
| II | >35C @ 101.3 kPaa | <23C |
| III | >35C | >=23C, <=60C |

These criteria have historically been applied to Class 3 crude oil and petroleum products and, generally, result in their assignment into packing groups I or II for UN 1267. In addition to the TDG criteria, current MSDS requirements and testing procedures for the transportation of UN 1267 Petroleum Crude Oil are included in Table below:

| **Table 2: MSDS Parameters and Tests for Crude Oil** | | | |
|---|---|---|---|
| **Parameter for UN 1267** | **Procedure** | **TDG** | **MSDS** |
| Initial Boiling Point* | D86 | Required | MSDS |
| Flashpoint | D93M/D56* | Required | Required |
| Viscosity | ASTM D1200 and ISO 2431 | Required*** | Recommended |
| Physical State | Visual | | Required |
| Appearance/Odor | Visual | | Required |
| Simulated Distillation** | D7169 | | Required |
| Light Ends | C10- by GC | | Required |
| Density | D5002 | | Required |
| True Vapor Pressure | D6377 | | Required |
| H2S (liquid phase) | D5623 | **** | Required |
| Pour Point | D5853 | | Recommended |

*4 ASTM methods are permitted, including the two listed.

**Represents an either-or test

***Required only to downgrade a substance to PG III that meets PG I requirements

****Potential requirement for proposed UN3494 as per section 7 of this submission

## 2 Limitations of Existing TDG Crude Testing Procedures

While the parameters listed in section 1 provide sufficient characterization of crude oil properties for transport, sampling and lab tests can provide varying results depending on the sampling method and testing procedures applied.

Generally accepted and applied test methods widely in use today tend to be geared towards stable and refined substances such as gasoline and, as such, may not be accurately measuring the actual IBP and flashpoints of crude oils, which are multi-component substances comprised of any combination of carbon chain molecules and other substances.

In particular, crudes with a significant amount of C4 minus molecules (also known as light ends), are the most at risk of being mischaracterized in standard testing procedures for IBP and flash point. This is because the light ends tend to be gaseous at normal temperatures (including the UN recommended ASTM D86 IBP standard test temperature), leading to higher reported IBPs than are actually characteristic of the substance, and a potentially inaccurate packing group assignment.

The standard flashpoint tests also potentially compromise the light end integrity of the sample, leading to higher flash point results than are actually in the substance. The open cup method (ASTM D56) will result in inaccurate test results due to the methane, ethane and propane molecules evaporating during the sample transferring process. The closed cup method (ASTM D93M) is also potentially inaccurate if the sampling procedure compromises the integrity of the vapour components, or if significant impurities exist in the sample (resulting in a flash point range rather than a single value). Strong adherence to sampling procedures such as ASTM D1265 or D3700 is key to preserving sample integrity.

## 3 True Vapour Pressure Test, Criteria and Thresholds

The most promising testing procedure for addressing the shortfalls of existing TDG test methods and accurately characterizing and classifying crude oil for transport by rail is the true vapour pressure (TVP) test method, which measures the vapor pressure of a mixture including any dissolved gases that may be present.

> True Vapour Pressure indicates how the crude oil will perform during handling, highlights conditions under which bubbles are likely to build and shows where pressure build-ups of escaping light ends could happen… Three factors have an influence on the bubble point: pressure, volume and temperature. A more accurate definition takes different temperatures and V/L [vapour to liquid] ratios into account when determining the bubble point: in a multi-component mixture, the bubble point is the temperature at which the first bubbles appear at a fixed V/L ratio.[1]

[1] Hannes Pichler and Klaus Hense. 2012. Vapour pressure testing is an important safety check in the transport, storage and blending of crude oil. Petroleum Technology Quarterly. Q1 2012

TVP differs from Reid Vapour Pressure (RVP) in that RVP was designed to be deliberately insensitive to the contribution of dissolved air,[2] whereas TVP specifically seeks to capture the liquid as well as the dissolved gases. The D6377 standard is the most robust TVP testing method currently available due to D6377 mandating sample capture via a D3700 approved piston cylinder, as well as eliminating atmospheric subjection before sample testing.

The CCQTA has developed preliminary findings regarding TVP benchmarks and thresholds for TDG applications,[3] which suggest that the D6377 TVP test could be applied to existing class 3 TDG thresholds to improve the accuracy of crude oil characteristic identification for packing group assignment. The D6377 method and the TVP metric are gaining increased recognition as a legitimate means to test for and classify the properties of hydrocarbons, and were recently adopted by the U.S. Environmental Protection Agency for managing greenhouse gas emissions.[4] However the application of the TVP method for TDG packing group assignment for crude oil continues to be in the developmental stages. While the preliminary results of the D6377 method hold promise for applicability to crude oil for rail transport, insufficient data exists to reliably define thresholds for appropriate packing group assignment of crude oil to a satisfactory degree of consistency. Additionally, the TVP method is based on a 3 point expansion series that needs to be reconciled with existing TDG PG classification thresholds.

Further data collection, testing, results validation, method reconciliation and ongoing monitoring is required before the test could be reasonably applied in regulatory practice. Fortunately, the CCQTA, in partnership with CAPP, is aptly positioned to lead this research in the short term and could generate recommendations for regulatory thresholds within 3 to 9 months.

In the interim, Protective Direction 31 should sufficiently address the risk of improper Packing Group assignment associated with inaccurate sampling and testing methods, by requiring all crude to be shipped as PG I unless recent and accurate tests prove otherwise.

# 4 Vapour Properties of Crude and Implications for Rail Transport[5]

Despite Protective Direction 31, the presence of significant C4 minus molecules in crude oil transported by rail and the potential for these molecules to gasify in transport have raised concerns by Transport Canada about the vapour composition of crude and the upper risk threshold for crude oil shipped by rail in PG I containers.

While all liquid products (including water) exist in a gaseous state to some extent at equilibrium conditions, crude oils with a high proportion of C4 minus components may exhibit higher vapourization rates (and, correspondingly, higher true vapour pressures) at ambient pressures and temperatures compared to other crude oils. This may lead to higher than anticipated gaseous pressure in rail cars

[2] Faulkiner, Bob. CCQTA / ASTM Update. TVP and V/L of High Vapour Pressure Crude Oil. December 2013.
[3] CCQTA. CCQTA Update On TVP/RVP of Crude Oil For Contractual Purposes – July 11, 2013. Available at: http://www.ccqta.com/files/CCQTA%20TVP%20RVP%20Update%202013%20Jul%2011.pdf
[4] United States Environmental Protection Agency. May 2013. Available at: http://epa.gov/ttn/emc/approalt/ALT101.pdf
[5] Reference to the glossary of terms in Appendix A may be helpful for this section

resulting in greater risk in the event of an incident. The key is to understand the nature of this risk and take appropriate measures.

Railcars of Class 3 flammable liquids are purposely loaded to retain a vapour space to enable liquid and vapour compressibility and thermal expansion throughout transport (usually at 5 per cent vapour space for rail cars). This approach avoids the risk of an immediate liquid release in a thermal presence, and slows the timing of a high energy release in the event of an incident.[6]

In terms of vapour pressure, a car is normally loaded at 0-5 psig. Once closed, if a car liquid temperature climbs from ambient (nominally 15C) to 60C, vapour pressure in the car can triple[7] raising the pressure to approximately 10-15psig.

DOT 111 tank cars have a testing pressure of 100psig (689kPaa) and a bursting pressure of 500psig (3,447kPaa),[8] and standard car relief valve settings range anywhere from 60 to 75psig (414-517kPag)[9] - more than four times the highest pressure likely observed with crude in the car. Consequently, industry operating and handling pressures for crude oil tend to be well within the thresholds established for the DOT 111 tank cars under normal transport

The current method for characterizing crude for transport from a risk perspective is Reid Vapour Pressure (RVP). At a temperature of 38C and a vapour to liquid ratio of 4 to 1 (Reid Vapour Pressure (RVP) conditions), marketed Canadian crude oils tend to exhibit RVP's up to 12 psia (82kPaa)[10]. However, these crudes have often been blended or comingled so that they may be offered for transport via pipeline, which generally has an industry standard RVP limit near 15 psia (103kPaa).[11] [12]

North American native crude oils (i.e. oil directly from the well that is not diluted or mixed) can have RVP levels as high as 17psia (117kPaa). Taking into consideration issues such as availability of data, variability of sampling, seasonality, and stratification of oil products, values of 20psia are likely observable in current operations (which continue to be within the 0-5 psig loading range noted above). In the unlikely event that excessively high vapour levels in crude oils for rail transport do materialize in the course of transport, setting an upper limit on the RVP for crude commodities for transport by rail would be a prudent approach.

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[6] It is worth noting that railcar pressure decrease is also a risk factor in crude transport, and railcars have vacuum relief valves to allow atmospheric air to enter the tank car and protect against collapse when there is a vacuum in the car (say during a cooling during transport). Existing tanks are designed to recognize these types of properties for class 3 flammable liquids such as crude oil.

[7] Segato, Randy. Bakken Lights Ends Brief. November 2013. p 11

[8] U.S. Code of Federal Regulations. Specifications for Tank Cars. Part 179.201-1 Available at: http://www.gpo.gov/fdsys/pkg/CFR-2011-title49-vol3/xml/CFR-2011-title49-vol3-part179.xml 179.201-1

[9] GPAC Means of Containment Working Group Recommendations. Appendix 1: Railway Supply Institute. Comments on the railway supply institute committee on tank cars. P 10 of report.

[10] Crude Oil Monitor. Canadian Crude Quick Reference Guide. Available at: http://www.crudemonitor.ca/tools/Quick_Reference_Guide.pdf

[11] Segato, Randy. Bakken Lights Ends Brief. November 2013. p 11

[12] Enbridge Pipelines. Crude Oil Characteristics. 2013. Available at: http://www.enbridge.com/DeliveringEnergy/Shippers/CrudeOilCharacteristics.aspx

As an interim strategy, and building upon the intent of Protective Direction 31, Transport Canada could move to immediately establish a RVP upper limit for crudes transported by rail, which should be set at 20psia (138kPaa) (based on a 4:1 V/L ratio at 38C). This threshold is consistent with normal RVP values observed in North American native crudes, yet sets an upper limit to control for unreasonable and unusual industry operating practices that may create higher than normal pressures in tank cars. This threshold is well within existing tank car specifications and adds much needed certainty regarding the "upper risk threshold" for crude classified as Packing Group I.

In the short term, and building upon recommendation 1, further study should be conducted regarding crude oil properties in rail car transit at various temperatures and pressures, to better understand the risk of crude behaviours as they pertain to classification, car design and containment, and hazard communication and response requirements in the event of a spill or fire incident. Such work would need to be undertaken jointly between the classification and testing working group, the means of containment working group, and Transport Canada. The results of this research would then inform changes and adjustments to the interim threshold discussed above.

# 5 Sampling and Testing Location and Frequency

Appropriate sampling and testing frequency is critical to ensuring accurate characterization and classification of crude for transportation on an ongoing basis. However, the *Transportation of Dangerous Goods Act* and Regulations do not stipulate or provide any guidance as to testing frequency or location in order for consignors to classify the dangerous goods prior to offering for transport.

CAPP members recognize the importance of frequent and accurate sampling in the classification of crude for transport by rail. Generally speaking, companies will undertake testing activities for the following reasons:

- Product characterization for MSDS. This is done initially for new products, for the addition of new formations, for liquid volatility changes, and is renewed every three years.
- Routine product testing to meet safe facility operation and transport specifications (e.g. truck, pipeline, rail). This is done multiple times during the year, usually annually, semi-annually or more frequently until stability is observed in the sample and/or sufficient data is accrued. Once stability is achieved, companies will generally test annually or semi-annually at various points (such as wells and battery stations), in a manner consistent with Alberta Energy Regulator requirements under Directive 17, Chapter 8. Directive 17 requirements "vary, depending on a number of factors, such as production rate, potential for the composition to change over time, and the end use of the fluid." [13]
- Fulfill client request for contract negotiations. This is done on an as needed basis.
- Test at lease automatic custody transfer points (LACT). This ensures accurate classification at point of custody transfer such as at rail-loading facilities.

[13] Alberta Energy Regulator. Directive 017: Measurement Requirements for Oil and Gas Operations. 8-1. May 2013

While no specific test point and frequency requirements are in place for rail specific transportation, a promising approach would be to require routine testing at point of custody transfers and at rail loading facilities based on variables and frequencies similar to those specified in Section 8 of Alberta Directive 17.[14] Under this approach, known product would be routinely tested at load facilities annually or semi-annually, re-tested in the event of a known change in the product composition (e.g. addition of a new formation or supply, blending, seasonality and weathering), and frequently re-tested (e.g. monthly) in the event of a known volatility and/or until stability is achieved.

# 6 True Vapour Pressure Field Test for Crude by Rail

One further potential development in the sampling and testing of crude by rail is the prospect of a TVP field test instrument for crude on rail. Such an affordable field testing instrument could serve as a validation of the TDG aspects of the MSDS parameters and lab tests, and result in real time auditing of railcar TVP with minimal training requirements and the potential to blend down live crude at the facility prior to transport. This, however, is an ongoing solution that must be coordinated with railcar design changes to incorporate facilities that would allow convenient sampling of the contents, and is something that should be addressed by the GPAC means of containment concurrent working group.

# 7 Toxicity

Toxicity has been raised as a potential concern for the transportation of crude oil by rail, particularly as it relates to the H2S content, and producers take this hazard very seriously. All crude oils have some level of H2S present in the liquid phase, which creates a potential inhalation hazard in the event it evaporates into vapour phase. Companies routinely test for sulfur levels and ensure the hazard is appropriately recorded on the MSDS as well as noted on tank car placards for crude transported with high sulfur content. Various other regulatory bodies also monitor and regulate the handling and reporting of this hazard, including Occupational Health and Safety (WHMIS Products) and Federal & Provincial Hazardous Products Acts.

From a classification perspective, crude oil does not meet the classification criteria for TDG Class 6 based on the current TDG test criteria for Class 6 Toxic and Infectious Substances, LD50 (oral or dermal) and LC50 (inhalation) endpoints. According to the Government of Alberta:

> The maximum concentration of H2S in crude oil is about 14.6% without keeping the mixture under pressure. Under normal conditions of transport there would not be sufficient H2S in the crude oil to reclassify the crude as a toxic liquid. Therefore, the crude oil should continue to be shipped as UN 1267.[15]

[14] Requiring testing at points of custody transfer would add much needed clarity and certainty regarding responsibility and liability in the event of an incident.

[15] Government of Alberta. Transportation of Sour Water and Sour Crude Oil. 2012 p. 3. Available at: http://www.transportation.alberta.ca/Content/docType272/Production/sourwater.pdf

However, Crude Oil sour at the UN level is assigned UN 3494, Class 3 and Class 6.1, and the US Department of Transportation (DOT) has adopted this UN number for Crude Oil sour. In Canada, UN3494 is not listed in Schedule 1 of the Transportation of Dangerous Goods (TDG) regulations, but its use is permitted in Canada based on TDG Section 1.10:

> *TDG Section 1.10 Use of Classification in the ICAO Technical Instructions, the IMDG Code or the UN Recommendations*
>
> A person may use the appropriate classification set out in the ICAO Technical Instructions, the IMDG Code or the UN Recommendations to transport dangerous goods within Canada by a road vehicle, a railway vehicle or a ship on a domestic voyage if these Regulations or the document from which the classification is taken does not forbid their transport.

That said, no criteria for defining H2S toxicity in crude have been published by the UN, DOT, or Transport Canada, and UN 3494 remains an optional UN number adopted only by a few producers. Indeed, according to the U.S. Department of Transportation:

> [Pipeline and Hazardous Materials Administration] PHMSA does not establish a concentration level for hydrogen sulfide in petroleum sour crude oil in order to determine if the vapors are an inhalation hazard. To determine whether petroleum sour crude oil presents an inhalation hazard, it must be tested to determine if the material meets division 2.3 (gas poisonous by inhalation) as defined in § 173.115(c) of the HMR. If the vapors in the petroleum sour crude oil meet the definition of a division 2.3 material, you must follow the marking and labeling requirements of § 172.327.[16]

This issue needs to be further investigated and criteria established for the creation of UN 3494 classification in Canada.

# 8 Corrosivity

Crude corrosivity has also been raised as a potential concern, but not as a corrosive substance under the TDG act and regulations. This is because crude oil does not meet the current test criteria for TDG TC/UN TDG Class 8 Corrosives (i.e. the material is not corrosive to human skin nor does it exhibit a corrosion rate that exceeds 6.25 mm per year at a test temperature of 55°C, as determined in accordance with the ASTM Corrosion Test).[17]

[16] U.S. Department of transportation. Regulatory Review and Reinvention Branch. Correspondence dated October 31, 2012.

[17] For a review of corrisivity levels of crude products, see http://www.ai-ees.ca/media/6860/1919_corrosivity_of_dilbit_vs_conventional_crude-nov28-11_rev1.pdf and http://www.pipelineandgasjournal.com/managing-corrosion-pipelines-transport-crude-oils and http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=18381 (National Academy of Science) http://www.nap.edu/catalog.php?record_id=18381&utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+nap%2Fnew+(New+from+the+National+Academies+Press

Rather, it is the water, solids and H2S contaminants in crude that can lead to tank car corrosion, especially during the movement of empty railcars which contain residue of the contaminants in contact with oxygen over long periods of time. Consequently, corrosivity tends to be monitored from an asset management perspective within the industry – whether in the well, at processing and storage facilities, or in company owned trucks and rail tanks. While some companies monitor corrosion on a weekly basis, from a regulatory perspective, the Government of Alberta has established guidelines for managing corrosion in dangerous goods road transport tanks, based on CSA B620,[18] which is also the standard applied in section 5 of the Federal TDG regulations.[19] The equivalent TDG railcar standard is applied in section 5 of the TDG regulations is CAN/CGSB-43.147-2005.[20] If corrosivity remains a concern for Transport Canada, a prudent approach would be to review the existing standards to ensure they are up to date.

# 9 Other Considerations

Throughout the research and consultation process a number of other issues and concerns have arisen

Industry Best Practices

TDG classification, sampling and testing procedures for crude oil by rail is an evolving and complex field, and there is variation in terms of operating practices. Research on crude oil properties and industry leading sampling, testing and reporting practices needs to be developed and distributed to key stakeholders, in concert with information sharing regarding TDG regulatory changes, to strengthen TDG accuracy and safety for the upstream oil and gas sector.

Gazette

Any changes forthcoming from this working group need to be applied to the contents of Canada Gazette Part I released on January 11, 2014, which addresses issues of proof of classification and sampling method document.

Implications for Other Transportation Modes

The proposed regulatory changes contemplated for crude oil by rail will likely have implications for crude transported through other modes of transport. Further research and stakeholder engagement is required to fully understand the impact of the proposed changes on other modes of transportation.

North American Harmonization

There is a continued need to ensure any classification, testing and sampling requirements and tank car specification changes are harmonized and/or consistent with regulations in the United States.

[18] Government of Alberta. Dangerous Goods Transport Tanks. 2012. Ministry of Transportation. Available at http://www.transportation.alberta.ca/Content/docType272/Production/transporttanks.pdf
[19] Transport Canada. CSA-B620. Available at: http://www.tc.gc.ca/eng/tdg/moc-highway-csab620-472.html
[20] Transport Canada. CAN/CGSB-43.147-2005. Available at http://www.tc.gc.ca/eng/tdg/moc-railcar-cgsb43147-294.html#reference

# 10 Recommendations

Based on the analysis, the Testing and Classification Working Group offers the following recommendations for GPAC and Transport Canada consideration.

Vapour Properties of Crude and Implications for Rail Transport

1. As an interim and immediate priority, and building upon the intent of Protective Direction 31, Transport Canada move to immediately establish the 20psia (38C) (138kPaa) RVP (V/L ratio of 4:1) upper limit for all crude offered for transport by rail, adding much needed certainty regarding the "upper risk threshold" for crude classified as Packing Group I. While sufficient from an interim perspective, future work (as outlined in recommendation 2 below) will lead to more accurate refinements/ changes in this threshold based on research on crude oil characteristics for transport by rail.

2. In the immediate term, Transport Canada launch work with the testing and classification and means of containment working groups to research crude oil properties in transit in rail cars at various temperatures and pressures, with the objective of better understanding the risks associated with crude behaviours as they pertain to classification, car design and containment, and hazard communication and response requirements in the event of a spill or fire incident.

Characterization

3. As a short-term priority (3-9 month implementation, including regulatory development and comment period), Transport Canada work with CAPP and CCQTA to gather samples and undertake sufficient testing to develop accurate and reliable thresholds for the application of vapour pressure testing procedures (such as ASTM D6377) for Packing Group assignment for crude oils for transport by rail, in a manner consistent with current Packing Group threshold criteria.

4. As a long-term priority (6-24 month implementation), Transport Canada work with relevant stakeholders to have the TVP test for Packing Group assignment of crude on rail recognized at the UN level.

Sampling and Testing

5. As a short term priority (3-6 month implementation), Transport Canada require routine testing at point of custody transfers and at rail loading facilities based on variables and frequencies similar to those specified in Section 8 of Alberta Directive 17. Specifically, Transport Canada could require that product be routinely "tested at load facilities annually or bi-annually, re-tested in the event of a known change in the product composition (e.g. addition of a new formation or supply, blending, seasonality and weathering), and frequently re-tested (e.g. monthly) in the event of a known volatility and/or until stability is achieved."

True Vapour Pressure Field Test for Crude by Rail

6. As an ongoing priority with renewed focus, Transport Canada continue to work with CAPP and the CCQTA to develop a true vapour pressure field testing instrument and method to serve as validation of the TDG aspects of the MSDS data sheet parameters and lab tests, and develop railcar specifications (through the concurrent means of containment GPAC working group) to incorporate facilities that would allow convenient sampling of the contents.

Toxicity

7. As a short term priority (3-6 month implementation), Transport Canada work with industry to consider criteria for defining H2S toxicity in crude oil for rail transport under UN 3494, as well as appropriate hazard notification, handling and responder precautions.

Corrosivity

8. As a short term priority (3-6 month implementation), Transport Canada continue to consider issues of corrosivity in the design of railcars pursuant to CAN/CGSB-43.147-2005, and seek to ensure the standard is sufficiently up to date in order to address any ongoing concerns in relation to railcar corrosivity from an asset management perspective.

Industry Best Practices

9. As an immediate priority, CAPP begin to work with partners (e.g. CCQTA, TC, COQA, API, PHMSA, ASTM) to develop and disseminate information and best practices in relation to the characterization, testing, sampling, hazard communication, handling and training for the transportation of crude oil by rail. Specific elements could include hosting training and awareness sessions and developing and distributing support materials relating to ideal tests and sampling practices, communication of scientific information and crude characteristics, test and sample methods for MSDS development, recommended lab tests, practices and procedures, and/or sampling frequencies and locations.

Harmonization

10. As an ongoing priority, Transport Canada coordinate TDG regulatory change for oil by rail classification, testing, sampling and railcar specifications with the U.S. to ensure continued North American harmonization.

## Appendix A: Glossary of Terms

1. Pounds per square inch gauge (psig): Unit of pressure relative to the surrounding atmosphere.
2. Pounds per square inch absolute (psia): Measures pressure relative to a perfect vacuum.
3. Kilopascals gauge (kPag): Unit of pressure relative to the surrounding atmosphere.
4. Kilopascals absolute (kPaa): Measures pressure relative to a perfect vacuum.
5. Vapour Pressure: Pressure exerted by a vapour in equilibrium with its solid or liquid phase.
6. True Vapour Pressure (TVP): Vapour pressure of a mixture including any dissolved gases that may be present at the stated V/L ratio and temperature.
7. Reid Vapour Pressure (RVP): Measure of the absolute vapour pressure by a liquid at 37.8 °C at a vapour to liquid ratio of 4:1. Expressed in pounds per square inch (absolute)
8. Standard Atmosphere Conditions: The standard atmosphere (atm) is an established constant. It is approximately equal to typical air pressure at earth mean sea level and is defined as follows: 15°C @ 101.325Kpaa

## Appendix B: List of Working Group Members

| Association/Company | Name |
|---|---|
| Federation of Canadian Municipalities (FCM) | Daniel Rubinstein |
| | Gil Gelineau |
| Canadian Association of Fire Chiefs (CAFC) | Brian Ladds |
| | John-Paul Cody –Cox |
| Chemistry Industry Association of Canada (CIAC) | Brian Mullen |
| Railway Association of Canada (RAC) | Andy Ash |
| | Scott Christon (CN) |
| | Jean Ouellette (CN) |
| | Darlene Nagy CP) |
| Canadian Fuels Association (CFA) | John Skowronski |
| | Brian Ahearn |
| | Adrian Michielson (Imperial Oil Resources) |
| Canadian Association of Petroleum Producers (CAPP) | David Pryce, |
| | Vicki Balance |
| | Shireen Symonds |
| | Ben Brunnen (Consultant) |
| | |
| | Randy Segato (CCQTA, Suncor Energy Inc.) |
| | Henry Ridders (Talisman Energy Inc.) |
| | Hugh MacLennan (Devon Canada Corporation) |
| Teamsters Union Canada | Phil Benson |
| | Ken Deptuck |
| Petroleum Services Association of Canada (PSAC) | Patrick Delaney |
| Transport Canada | Peter Coyles |
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| | Patrick Juneau |
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