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COQA Presentation – Maxxam Analytics

Heavy Oil, Oil Sands and Crude by Rail Testing

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Presentation Overview

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- Summary
  - Brief Overview of Maxxam Analytics International Corp.
    - Size, scope and general capabilities
  - Heavy Oil and Oil Sands Testing
    - Unique attributes for heavy oil and oil sands testing
    - Impacts on analytical testing
  - Crude By Rail Sampling and Testing
    - Observations

Company Overview

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- 2,500 employees
- >75% possess technical degrees
- 520 Diplomas
- 756 Bachelor Degrees
- 192 Masters Degrees
- 30 PhDs

40 Locations
18 Laboratories
9 Outsourced Laboratories
12 Service Centers
Receiving and Processing:
- **2,300,000+ samples**
- **41,000,000+ results**

CANADA'S 10 MOST ADMIRED CORPORATE CULTURES™
Presented by Waterstone

Maxxam

Serving our core markets

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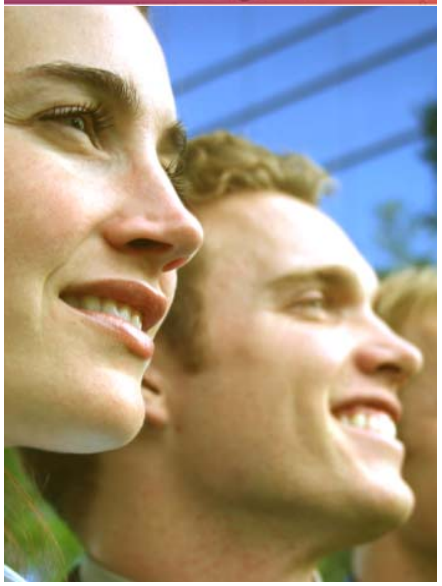
Energy

Environment

Food

Pharma, DNA, & Forensic Drug Testing



Maxxam Operations Locations

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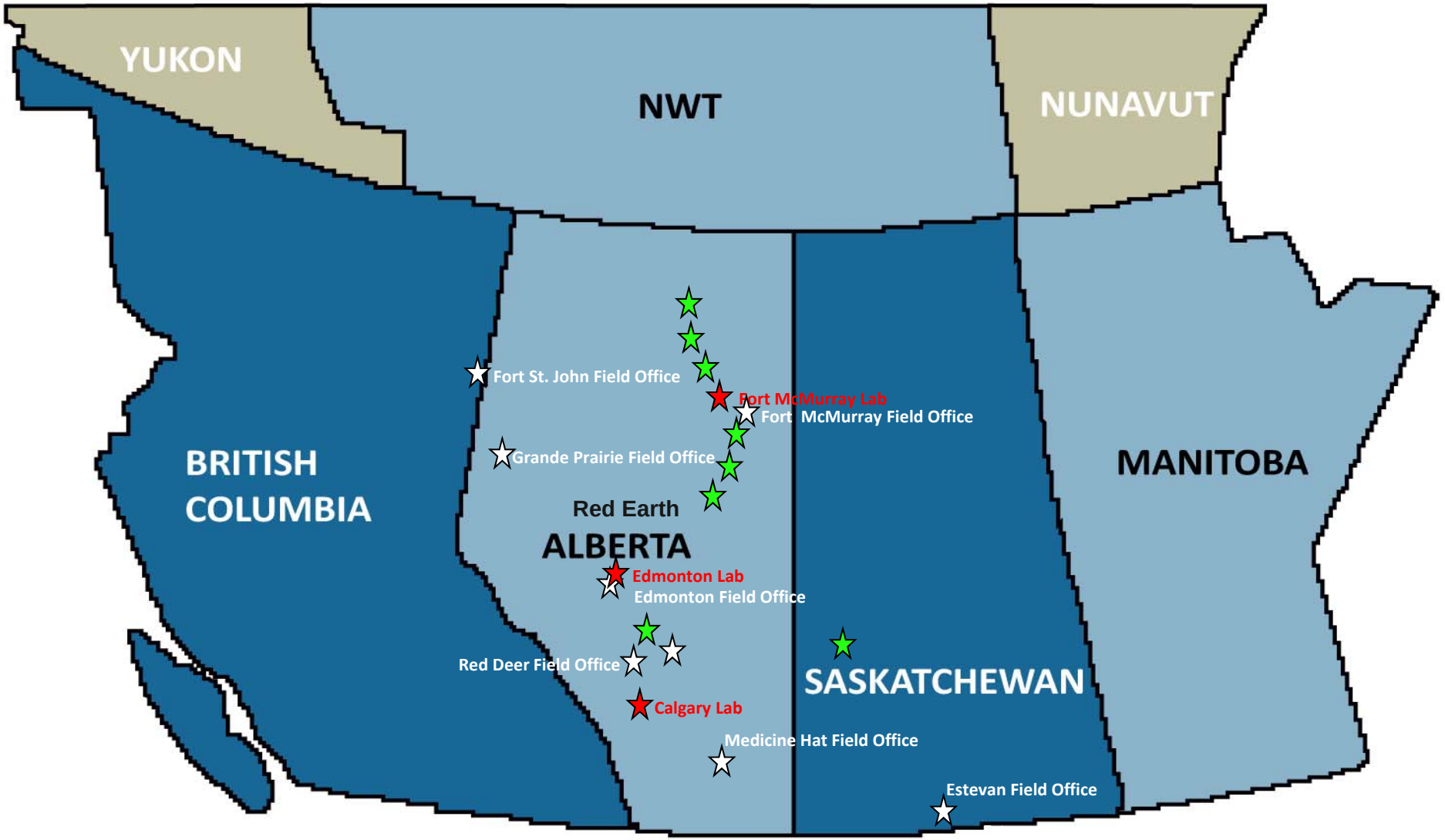

Petroleum Technology & Capabilities

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Petroleum Technology Center – 54,000 ft^2 laboratory space

- Continued and significant investment into science and advanced technology
- Advanced Natural Gas and LPG/NGL GC systems
- Includes Carbon Isotope Analysis (Well abandonments)
- Exclusive Laboratory for Crude Oil Assay & Bitumen Valuation for the Government of Alberta
- Oil sands batch extraction
- Tailings characterization and analysis
- Fuel testing (Diesel, ethanol, aviation, biofuel and coal)
- Crude Oil by Rail testing

Heavy Oil and Oil Sands Derived Bitumen

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- Attributes of Heavy Oil and Oil Sands derived material is significantly different than that of conventional crude oils
  - Density
  - Pour Point
  - Water content
  - Sulphur
  - Acid Number (TAN)
- Unique sample matrices sometimes require the combinations of multiple cleaning techniques, such as centrifuging and distilling to obtain representative “clean” samples
- Unique matrices also demand modifications and alterations to existing standard methods (CCQTA testing method work)

Maxxam Bitumen Preparation Techniques

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Selection of the cleaning method is based on the various industrial processes used in bitumen production

- **Heavy oils produced by cold flow** could be sufficiently cleaned by **high-speed or ultra-speed centrifuging**
- **Oil sand, core samples, mined bitumen froth samples** that contain relatively high solids will require sample **solvent extraction (hot or cold)** for separation of solids and water from the remaining bitumen
- **SAGD bitumen/water emulsion** usually contain very little solid material that has a negligible effect on required tests. Bitumen prepared by removing water through the **distillation process**

Centrifuging – Heavy Oils

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Pros

- No altering of the physical properties of the bitumen
- No solvent addition
- Minimal light ends losses

High-speed and ultra-speed centrifuges

Cons

- Time consuming process
- Sample size limitation
- Does not entirely remove water and sediment
- Possibility for hydrocarbon stratification due to super speeds

Dehydration of Bitumen by Distillation

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Pros

- Light ends lost in the process are mostly recoverable and could be remixed with bitumen
- No solvent addition (bitumen stays native)

Cons

- Partially lost light ends
- Risk of bumping during process
- Sediment and salt will be concentrated in bitumen
- Expensive and time consuming cleaning process

Vacuum distillation unit

Bitumen Dehydration by Rotovap

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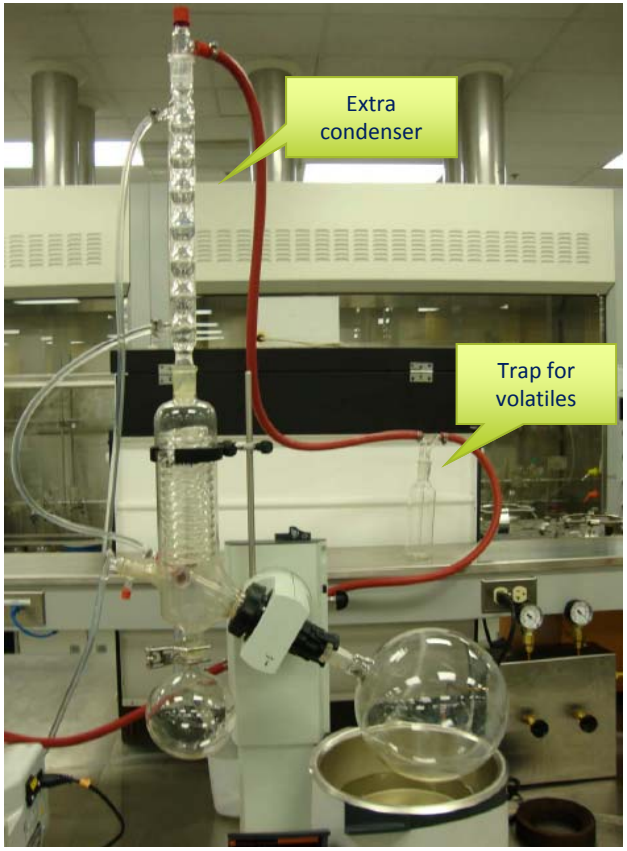
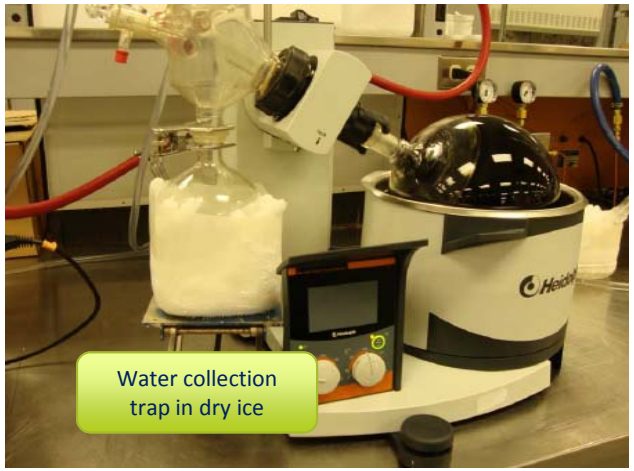


- Rotovaps used instead of vacuum distillation
- Modification implemented for the best performance



Bitumen Density Measurement Challenges

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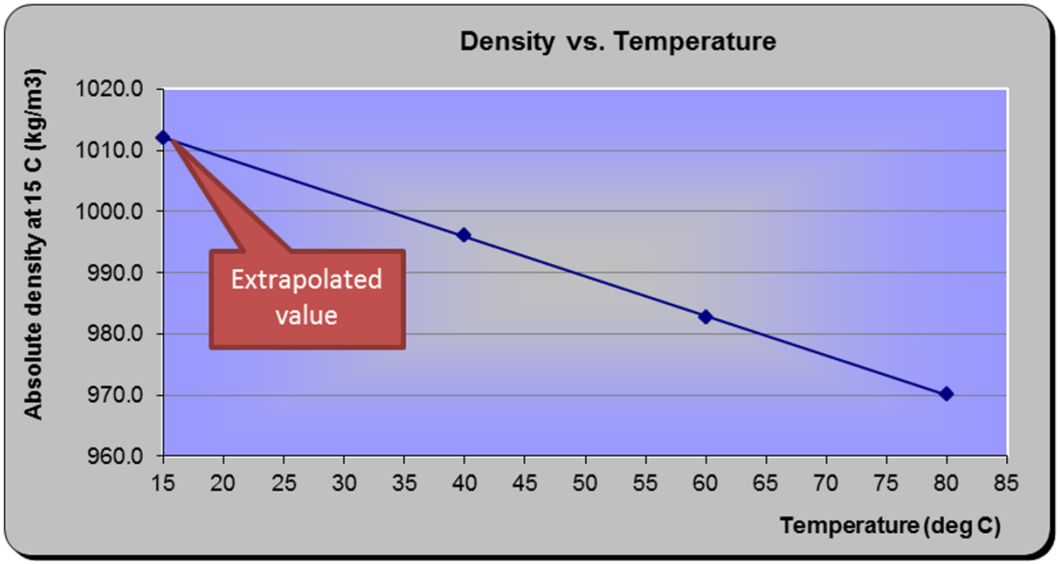
- Need for more accurate density measurement of bitumen
- The samples are too viscous to be injected in the instrument at 15°C
- API density conversion tables are not applicable for bitumen matrix
- Density measurements at elevated temperatures (40, 60 and 80°C) and extrapolation to 15°C provide reliable results
- This method is in use by industry and is in the process to be adopted as industry standard



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Crude by Rail
General Observations

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- Lots of activity within Western Canada
  - Relative inexperience and knowledge gap at many levels
- Undefined quality requirements
  - What to test for and how often?
- Under appreciated safety requirements
- No rail transloading facility design is the same
  - Presents unique sampling challenges and unique sampling techniques

Typical Specification

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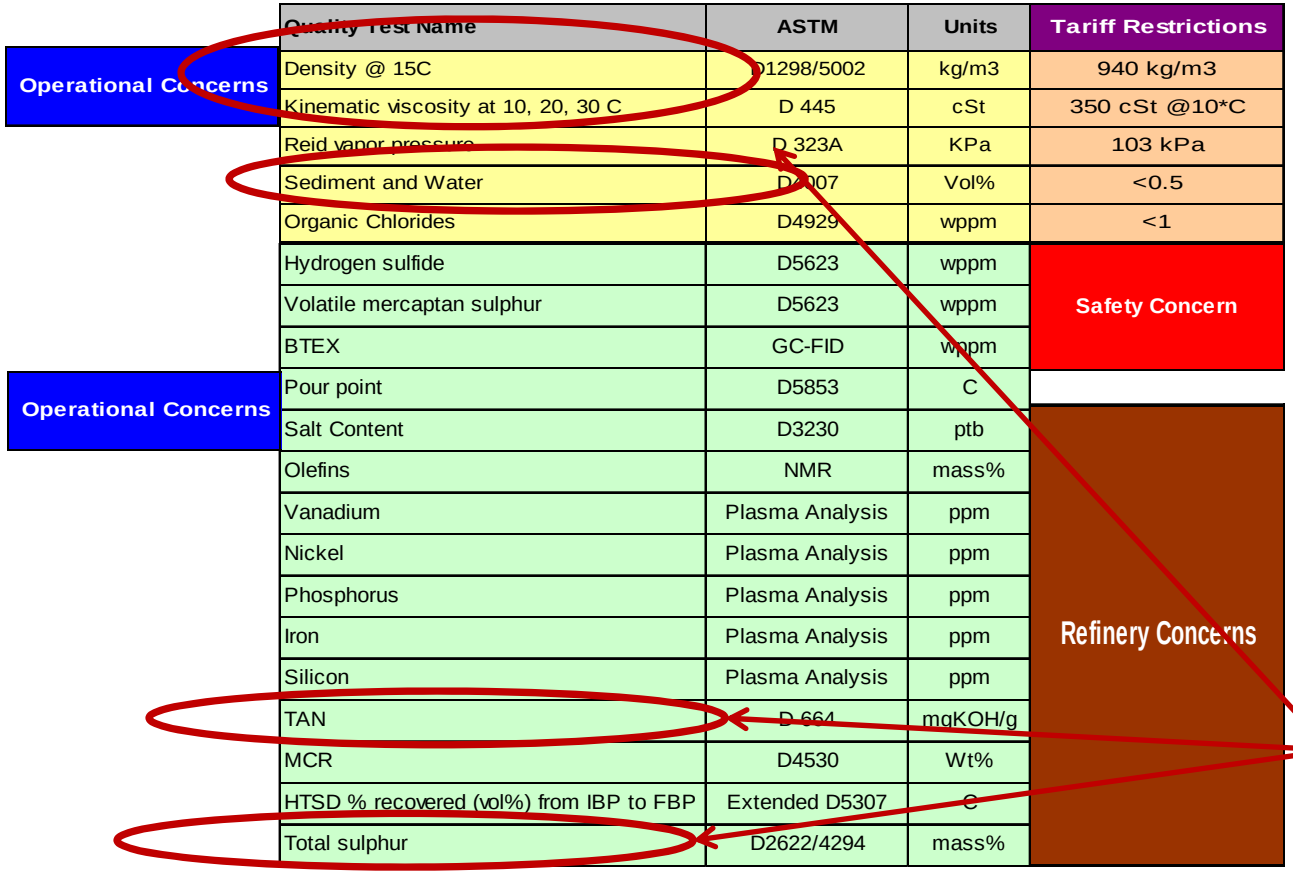

Quality Test Name	ASTM	Units	Tariff Restrictions
Density @ 15C	D1298/5002	kg/m3	940 kg/m3
Kinematic viscosity at 10, 20, 30 C	D 445	cSt	350 cSt @10*C
Reid vapor pressure	D 323A	KPa	103 kPa
Sediment and Water	D4007	Vol%	<0.5
Organic Chlorides	D4929	wppm	<1
Hydrogen sulfide	D5623	wppm	
Volatile mercaptan sulphur	D5623	wppm	
BTEX	GC-FID	wppm	
Pour point	D5853	C	
Salt Content	D3230	ptb	
Olefins	NMR	mass%	
Vanadium	Plasma Analysis	ppm	
Nickel	Plasma Analysis	ppm	
Phosphorus	Plasma Analysis	ppm	
Iron	Plasma Analysis	ppm	
Silicon	Plasma Analysis	ppm	
TAN	D 664	mgKOH/g	
MCR	D4530	Wt%	
HTSD % recovered (vol%) from IBP to FBP	Extended D5307	C	
Total sulphur	D2622/4294	mass%	

- Crude by rail objectives should be identical or similar to pipeline objectives
- Crude by rail spec should be more strict than pipeline spec
- What to producers typically test for?

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Sampling – Crude by Rail

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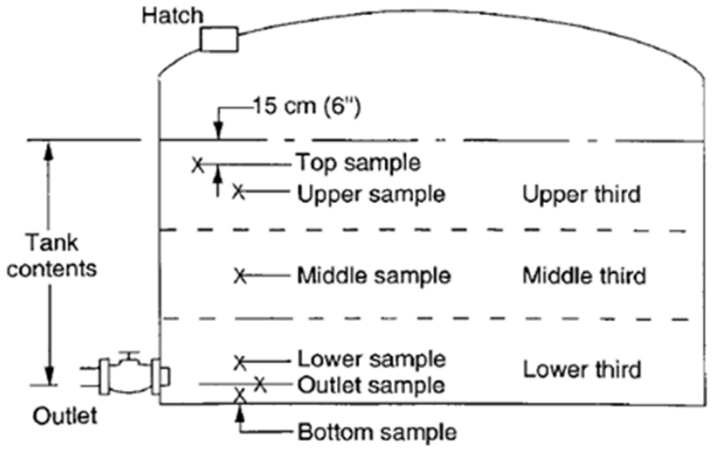
- Sample - a portion extracted from a total volume that may or may not contain the constituents in the same proportions that are present in that total volume
- Sampling - the steps required to obtain a sample for analysis that is representative of the contents of any pipe, tank, or other vessel
- Crude oils are usually nonhomogeneous - concentration of entrained water is higher near the bottom of the vessel (i.e.. Bottom of a truck)
- Automatic sampling is recommended whenever samples of crude oils are required for custody transfer measurements
- Representative sample (% of rail cars loaded) of manifest and unit trains (ex. 1 in 10, 1 in 20)

Sampling Procedures

- Sampling of crude oils from rail cars is not very well defined by ASTM and API
- ASTM D4057 “Standard Practice for Manual Sampling of Petroleum and Petroleum Products”
- ASTM D4177 “Standard Practice for Automatic Sampling of Petroleum and Petroleum Products”
- ASTM D5842 “Standard Practice for Sampling and Handling of Fuels for Volatility Measurement”



Picture source: ASTM

- Consideration: Are there a significant differences in sampling between tank and rail car?

Sample Handling

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- ASTM D5854 “Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products”
- Representative samples of crude oils are required for the determination of parameters used for establishing standard volumes, prices, and compliance with regulatory specifications
- Care and effort are required to maintain compositional integrity of samples from collection to testing
  - Need to minimize light end or component loss for RVP, H2S, light ends, density etc.
- Tank car sampling recommendation - Sample the product after the car is loaded or obtain a mid flow sample

Transport Canada – Protective Direction 31

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- Transport Canada release – October 17, 2013
  - Protective Direction 31 released
- Focus is on Crude Oil transported by Rail
  - The requirement is focused on rail transportation but includes road transport for Transportation of Dangerous Goods (TDG)
- Ambiguous requirements for TDG testing and Safety Data Sheet (MSDS) requirements
  - States Classification 3 Packing Group 1 for all crude oil unless supported by safety data sheet
  - Infers new/updated safety data sheets (MSDS) required for products after July 7, 2013

Crude by Rail Testing

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- Rail car transportation is regulated by the Railway Safety Act, the Transportation of Dangerous Goods Act and MSDS of products

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Liquid	**Odour & Appearance**:	Dark Brown, hydrocarbon-like
Odour Threshold (ppm):	Not Available	**Specific Gravity**:	0.7 – 0.8
Vapour Density (air=1):	2.5 -5.0 (estimated)	**Vapour Pressure (mmHg)**:	280-360 @ 20°C
Evaporation Rate:	Not Available	**Boiling Pt. (°C)**:	-40 to 530
Freezing Pt. (°C):	<-60	**pH**:	Not Available
Coefficient of Water/Oil Distribution:	<0.1	**Percent Volatiles, (v/v)**:	15 - 30 (estimated)

TDG Classification: 3

Flash Point (°C) & Method: <-35 (PMCC)	**Auto-Ignition Temp. (°C)**: 250 (estimated)
Upper Explosive Limit (% v/v): 8 (estimated)	**Lower Explosive Limit (% v/v)**: 0.8 (estimated)

- Rail companies are being required to have more detailed analytical data about the crude oil load
- Increased business of moving crude by rail also increases risk

Conclusion
Crude Oil by Rail

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- Need for consistent and detailed sampling procedure for rail cars that are applicable for all types of crude oil transported by rail
- Staff have to be familiar with crude oil loading practices and proper sampling procedures
- Be in control - test the product that are you hauling
- Based on testing, choose the products and blends that are going to ensure safe transport and problem-free unloading

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