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Master of Public Policy
Capstone Project

Evaluation of Emergency Response Protocols for
Crude Oil Transportation: Pipeline vs. Rail

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Executive Summary

This capstone project reviews and evaluates the emergency response protocols for crude oil transportation via pipeline and rail. The growth of the Canada's oil sands and the use of hydraulic fracturing are providing access to what were previously thought to be uneconomic oil and gas deposits. This coupled with our growing use of crude oil is changing the energy landscape in North America. To accommodate this changing environment, increased transportation of crude oil is necessary. The increase in energy production and transport has had a parallel increase in public awareness of energy and dangerous goods transport. Canadian transportation systems operate within a highly regulated environment. However, no activity is without risk, crude oil spills occur and sometimes, major disasters have happened. To minimize the damages caused by accidental spills, we must employ emergency response protocols. This paper describes and compares the emergency response protocols of both pipeline and rail transport of crude oil. We review two large incidents for both modes of transportation of crude oil to determine if the emergency response protocols established forth by the governing bodies were adequate. Based on the comparison of the two protocols, we recommend enhancements for the two protocols and suggest further areas of research to advance current regulatory and emergency response frameworks.

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Introduction

The growth in Canada's oil sands and the use of hydraulic fracturing are both providing access to what were previously thought to be uneconomic oil and gas deposits.[1] This coupled with our growing use of crude oil is changing the energy landscape in North America. In addition, the movement of oil and gas is beginning to have a wider reach especially to the Asia pacific market, which is in turn causing a discussion about our current energy infrastructure.[2] The changing dynamics of the energy market have spurred response in the pipeline and rail industry; specifically new transloading facilities, need for new pipelines, and manufacturing of new tank cars.

To enhance our current transportation network and increase crude oil movement, earning social license is imperative.[3] The increase in energy production and transport has had a parallel increase in public awareness of energy and dangerous goods transport, and the associated health and safety, and environmental issues. This shift in public awareness together with the movement towards more environmental action in Canada has spurred debate about the effectiveness of our regulatory systems. There is now a need to mitigate the risks associated with an increase in energy transport.

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[1] Standing Senate Committee on Energy,the Environment and Natural Resources, *Moving Energy Safely: A Study of the Safe Transport of Hydrocarbons by Pipelines, Tankers and Railcars in Canada* (Ottawa, ON, CAN: Canada. Senate Committee Reports,[2013]). http://site.ebrary.com/lib/ucalgary/docDetail.action?docID=10812883&ppg=1.
[2] Ibid.
[3] Ibid.

Canadian transportation systems operate within a highly regulated environment. There are extensive regulatory frameworks, management systems, standards and practices in place to promote safety. Regulation of hazardous goods transport is necessary to ensure the safe construction and operation of the transportation system. However, no activity is without risk, spills will occur and major disasters have happened.[4] After the tragic spill in Lac-Mégantic, Quebec where a substantial spill of crude oil had catastrophic environmental effects and 47 lives were lost, the regulatory framework surrounding crude oil transportation has been called into question. To reduce the damages from these events, we must employ emergency response protocols. While regulation is necessary to manage the risks associated with transport, we need to be prepared to react in case of a release, incident, spill or major disaster.

This paper describes and compares the emergency response protocols of both pipeline and rail transport of crude oil. By looking at two large incidents involving spills of crude oil from both pipelines and rail, we will attempt to determine if the emergency response protocols established by the regulators were adequate in dealing with the issues associated with major spills. In addition, we consider whether there are enhancements that would better equip emergency response practices.

[4] Ibid.

Modes of Transport: Pipeline vs. Rail

The Canadian transportation system is regarded as very safe. Transport Canada estimates that 99.997% of toxic or flammable goods shipments arrive at their destination with no incident.[5] Tens of millions of shipments containing these hazardous goods are shipped every year. Moreover, 72% of all reportable incidents involving dangerous goods across all modes of transport (rail, pipeline, truck, and vessel) occurred at the facilities where the product was prepared for transport, unloaded, or stored, i.e. at transloading facilities rather than on route. (Transport Canada identified 56% of incidents were due to human error and 34% based on equipment failure. The remaining 10% were due to a mix of reasons.[6])
This means that the actual transport of dangerous goods is in fact quite safe and it is the errors involved in the handling of these substances that leads to the vast majority of incidents.

According to the Canadian Association of Petroleum Producers (CAPP), the Canadian railroad network moved approximately 300,000 barrels of crude oil per day at the end of 2013, a figure projected to increase to 1 million barrels per day by the end of 2015.[7] According to the Canadian Energy Pipeline Association (CEPA), pipelines move about 3 million barrels of oil per day. Generally, crude oil in North

[5] Standing Committee on Transport,Infrastructure and Communities, *Review of the Canadian Transportation Safety Regime: Transportation of Dangerous Goods and Safety Management Systems* (Ottawa, ON, CAN: Canada. Parliament. House of Commons,[2015]). http://site.ebrary.com/lib/ucalgary/docDetail.action?docID=11048507&ppg=1.
[6] Ibid.
[7] Canadian Association of Petroleum Producers, *Transporting Crude Oil by Rail in Canada* (Calgary, AB, CAN: Canadian Association of Petroleum Producers,[2014]). http://site.ebrary.com/lib/ucalgary/docDetail.action?docID=11009400&ppg=1.

America has been transported cross-country by pipelines.[8] In recent years however, pipeline capacity has become strained to major markets because of massive increases in the production of crude oil. Because of this constraint, transporting crude by rail has become a viable option. CAPP estimates that the crude oil industry is currently facing a 3 to 5 year period of constrained pipeline capacity given that major crude oil pipeline expansions are on hold either because of delayed construction or prolonged regulatory processes; including: Keystone XL, the TransMountain Expansion, the Enbridge Northern Gateway, and TransCanada's Energy East.[9]

While crude oil has a wide range of uses, its properties pose risks for people and the environment making its transport risky and a topic of constant debate.[10]
Crude oil can spread rapidly, especially in water, and can be flammable under certain conditions. It can seep into the ground or sink in water, which makes recovery difficult. Specialized equipment is needed to clean up oil spills.

Advantages of Crude Oil Transport by Pipeline

Pipelines have a variety of advantages over rail and studies have shown that they in fact are the safest mode of transport for crude oil.[11] Pipelines are unique in that the

[8] "Economic Benefits of Pipelines," Canadian Energy Pipeline Association, , accessed September 9, 2015, http://www.cepa.com/about-pipelines/economic-benefits-of-pipelines.
[9] Canadian Association of Petroleum Producers, *Transporting Crude Oil by Rail in Canada*
[10] Standing Senate Committee on Energy,the Environment and Natural Resources, *Moving Energy Safely: A Study of the Safe Transport of Hydrocarbons by Pipelines, Tankers and Railcars in Canada*
[11] Diana Furchtgott-Roth and Kenneth P. Green, *Intermodal Safety in the Transport of Oil* (Vancouver, BC, CAN: Fraser Institute,[2013]).
http://site.ebrary.com/lib/ucalgary/docDetail.action?docID=10784936&ppg=1.

container in which the product is shipped, the pipeline itself, is static while the commodity is moving through it, and this container is generally buried underground. Whereas in all other modes of transport, rail specifically, the vessel and the commodity are above ground and both are moving.[12] Pipelines are also more cost-effective than the alternative transportation options, they require significantly less energy to operate than trucks or rail and have a much lower carbon footprint Pipelines provide containment of product and a continuous service unlike other modes of transport.

Disadvantages of Crude Oil Transport by Pipeline

While pipelines are regarded as the safest mode of transport for crude oil transportation, they also pose a number of unique problems.

Pipeline Quality

Over time pipeline quality can deteriorate leading to cracks and corrosion and overall material failure. As a result, pipeline performance can decline or may fail. They can become defective with cracks and ruptures that later cause leaks and major spills.[13]

Natural Hazards and Extreme Weather

Natural hazards or extreme weather events such as ice storms, heavy rains and flooding or erosion can have severe consequences to pipeline infrastructure by

[12] Ibid.
[13] Susan Christpherson and Dave Kushan, "A New Era of Crude Oil Transport: Risks and Impacts in the Great Lakes Basin," *Community and Regional Development Institute*, no. 15 (November, 2014), September 9, 2015.
https://cardi.cals.cornell.edu/sites/cardi.cals.cornell.edu/files/shared/documents/CardiReports/A-New-Era-of-Crude-Oil-Transport.pdf.

puncturing, cracking, displacing pipelines. These events could also create major challenges in the event of a pipeline incident.[14]

Monitoring and Remoteness

Pipelines require constant monitoring and any undetected issues could result in incidents. Furthermore, there is a risk of delayed incident identification and delayed emergency response. In the event of an emergency, responders may be delayed in assessing and addressing the incident, not only because many pipelines transport oil from remote regions that are difficult to access but also because they are hidden and buried deep underground.[15] In many cases infrastructure such as roads may even need to be built in order to reach the accident site.

Impacts of Possible Pipeline Incidents

Environment

In many cases, oil pipelines run through environmentally sensitive areas. A pipeline incident could jeopardize the surrounding environment or have downstream effects if combined with a body of water. In addition, incidents can have potentially severe adverse effects if the spilled product seeps deep into soil, requiring a significant period of time to clean up. If a pipeline failure is experienced, alteration of the local geology can cause earth movements and landslides, surface disturbance can cause harm to vegetation and a fragmentation of habitat can negatively affect wildlife.[16]

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[14] Tim Williams, *Pipelines: Environmental Considerations*Parliament of Canada, Agriculture, Environment and Natural resources,[2012]).
[15] Christpherson and Kushan, *A New Era of Crude Oil Transport: Risks and Impacts in the Great Lakes Basin*, September 9, 2015
[16] Williams, *Pipelines: Environmental Considerations*

Human Health and Safety

The proximity of pipelines to groundwater sources can cause serious contamination that may have a detrimental impact on communities. Furthermore, construction of pipelines can cause disturbances to local communities, and alter air quality.[17]

Economic

In addition to the costs incurred in cleanup activities, an oil spill may negatively impact the regional economy. In many cases, pipeline spills can adversely affect local land values and business activities. Furthermore, it can be costly to cleanup pipeline spills. Depending on the magnitude and size of the spill, remediation activities alone have been recorded to be as high as one billion Canadian dollars; this does not include lost revenue from a non-functioning pipeline. [18]

Advantages of Crude Oil Transport by Rail

While pipelines have been the preferred mode of transport for crude oil transportation, transport by rail has some advantages. First, rail offers a greater speed to market, having the product reach destinations faster means producers are paid quicker, and refining and downstream activities take place sooner.[19] It also takes a short period of time to construct a loading terminal, around 12 months, according to CAPP. Transport by rail can utilize an already existing North American network. Currently, rail tracks are in place to multiple destinations allowing for

[17] Christpherson and Kushan, *A New Era of Crude Oil Transport: Risks and Impacts in the Great Lakes Basin*, September 9, 2015

[18] Matt McClure, "Plains Midstream Canada Expands Maintenance Approach After Spills, Audit," *The Calgary Herald*, sec. Business, March, 20, 2014, 2014.

[19] Canadian Association of Petroleum Producers, *Transporting Crude Oil by Rail in Canada*

flexibility and the option to re-route. With this existing network, there is the ability to reach from the east to the west coast across Canada and the US. Transport by rail is also scalable.[20] Producers and transporters of crude can adjust the volumes of product shipped and wait for additional cars to be available or can move a smaller number of cars. There is also the option of sending a mix of products, where cars are sent with a multitude of commodities to minimize the cost of shipments. Product integrity can be preserved since in rail cars the product is isolated, and there is no loss of quality between the point of origin and the destination. Also, there is no mixing of a given grade of crude between the origin and the destination. Therefore buyers can be sure that they are receiving the product they have purchased. Finally, capital investment is low. Typically the cost to build train terminals range from $30-50 million with a capital payout of 5 years or less.[21]

Disadvantages of Crude Oil Transport by Rail

Tank-Car Design

The DOT-111 or Class 111 tank car is the car, which is most frequently used to ship crude oil. Many problems have been identified with this type of tank-car, including being prone to structural failure, an inability to withstand impact and head shields that are prone to puncture. The deficiencies that have been identified with these rail cars has resulted in an amendment to the *Transportation of Dangerous Goods*

[20] Ibid.
[21] Ibid.

Regulations, (TC 117 Tank Cars),[22] requiring their refurbishment and/or phasing out.[23]

Crossings

In rail transport there are many unmonitored crossings, which create a risky zone of incident where accidents can occur between the railcars and automobiles, busses or individuals. These accidents can lead to derailments and can increase the possibility of spills and explosions. Monitoring these crossings is the responsibility of local law enforcement agencies that does not always have adequate resources to ensure safe and accident free railway crossings.[24]

Regulatory Regime

As identified earlier, it is only in recent years that we have been transporting large volumes of crude by rail. With this new emphasis on oil by rail transport, our regulatory regimes need to be updated and made more stringent. Many have criticised the regulation of crude by rail as inadequate, especially after the tragic accident of Lac-Mégantic. Prior to this disaster, Transport Canada was not aware of the risks associated with crude oil transport by rail. After the accident, new regulations for emergency response protocols and tank car design were released.[25] In addition, many studies were commissioned to evaluate the safety regulations for all federally regulated modes of transport. While this review is taking place,

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[22] "Railway Investigation Report R13D0054," last modified August, 20, accessed September, 10, 2015, http://www.bst-tsb.gc.ca/eng/rapports-reports/rail/2013/r13d0054/r13d0054.asp.
[23] Christpherson and Kushan, *A New Era of Crude Oil Transport: Risks and Impacts in the Great Lakes Basin*, September 9, 2015
[24] Ibid.
[25] "Regulations Ammending the Transport of Dangerous Goods Regulations (TC 117 Tank Cars)," Government of Canada, last modified May, 1, accessed September, 10, 2015, http://www.gazette.gc.ca/rp-pr/p2/2015/2015-05-20/html/sor-dors100-eng.php.

dangerous goods are still being transported everyday by rail, and they will not be affected by the new regulations until implemented; this interim period poses a danger to public safety and the environment. Furthermore, classification plays an important role. Improper classification of crude oil can make emergency response more difficult. Lastly, since rail cars can be loaded and unloaded at different sites, re-routed, or mixed between shipments this can make product classification confusing since responders may be unaware of what products are contained in the cars if they have changed hands multiple times making transport risky.

Human Capital Planning

As the volume of crude oil transported by rail has increased dramatically in the last five years, coupled with strained pipeline capacity, there is a lack of recruitment and training of employees to cope with increased movement of crude and implement the regulations, health and safety protocols, and procedures. While operators are responsible for responding to emergencies involving the transportation of their product, it is still the responsibility of local municipalities to hire and maintain emergency responders such as fire fighters.[26] Therefore, it may be difficult for local municipalities to know how many emergency responders are required with the increase in crude oil transport. There needs to be clear communication between municipalities and the rail industry for the changing trends in crude oil transport.

[26] Christpherson and Kushan, *A New Era of Crude Oil Transport: Risks and Impacts in the Great Lakes Basin*, September 9, 2015

Impacts of Possible Rail Incidents

Environment

Oil spilling into water bodies and on land surfaces can have detrimental effects on the environment as well as on human activities. The most dangerous impact from railway incidents is the release of hydrocarbons and other toxic materials resulting in an explosion that can cause fire or contaminate the air and affect wildlife. [27]

Human Health and Safety

Apart from air contamination causing respiratory damage to residents in surrounding communities, the biggest threat to human life comes from the potential for a fire or explosion. The approved tracks that carry crude oil shipments often run in close proximity to dense urban areas, with a potential risk of fire and explosion. An oil spill could have a severe and long-lasting impact on a regional environment and economy can require evacuation, cause injury or even death.[28]

Economic

In the event of a catastrophe, the railroad companies may have insufficient insurance coverage to pay for accident damages. Damages include public investment to rebuild lives, soil or water remediation, and compensation for impacts on the local economy.[29] An explosion can inflict severe property damage that can disrupt

[27] Ibid.
[28] Ibid.
[29] Andy Blatchford, "Railway Says it can'T Pay for Lac-Megantic Disaster Cleanup," *The Globe and Mail*July, 30, 2013.

communities and neighborhoods and require massive economic efforts to repair and rebuild.

Emergency Response

Based on the above, we need appropriate regulatory foresight to mitigate the risks associated with crude oil transport. If we were to leave risk mitigation up to industry, we could not be certain pipeline and rail carriers would take due care to protect the environment and human health and safety beyond what is required to mitigate their own risks.[30] This is especially the case when shareholder risk is less than the damage an accident can cause.

Regulatory Bodies

Pipeline

The Canadian pipeline network is regulated at both the federal and provincial level. At the federal level, the Nation Energy Board (NEB) regulates 71 000 kms of pipeline that cross provincial boundaries in Canada and with the United States. The NEB has regulatory responsibility over oil and gas exploration and production on any land not regulated under provincial jurisdiction.[31] The National Energy Board Act establishes the main responsibilities of the NEB which include regulatory supervision over:

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[30] Bruce Campbell, *The Lac-Mégantic Disaster: Where does the Buck Stop?* (Ottawa, ON, CAN: Canadian Centre for Policy Alternatives,[2013]). http://site.ebrary.com/lib/ucalgary/docDetail.action?docID=10813204&ppg=1.

[31] "National Energy Board Fact Sheet," last modified August, 17, accessed September, 10, 2015, https://www.neb-one.gc.ca/bts/whwr/nbfctsht-eng.html.

- Construction and operation and abandonment of pipelines that cross any international or provincial borders including the associated tolls and tariffs
- Construction and operation of international and inter-provincial power lines
- Natural gas import, crude oil export, refined petroleum and electricity[32]

As of June 17, 2013, the Alberta Energy Regulator (AER) replaced the Energy Resources Conservation Board (ERCB) as the main regulatory body for the oil and gas industry in Alberta. The Alberta Energy Regulator (AER) regulates over 178 000 operating wells and 421 000 kms of pipelines in Alberta. The AER was established through the Responsible Energy Development Act (REDA). Under this act the AER operates at arm's length from the Government of Alberta.[33] The AER's mandate is to:

- Promote the safe, efficient and environmentally responsible development of energy resources over their full lifecycle in Alberta
- To allocate and conserve water resources, manage public land and promote environmental protection[34]

Rail

Canada's 48 000 kms of rail track are governed by Transport Canada (TC) at the federal level. TC works to ensure Canada's rail network is safe, secure, accessible, competitive and environmentally responsible.[35] Specifically in regards to the

[32] Ibid.
[33] "What we Do," , accessed September, 10, 2015, http://www.aer.ca/about-aer/what-we-do.
[34] Ibid.
[35] "What we Do," last modified May, 23, accessed September, 10, 2015, https://www.tc.gc.ca/eng/aboutus-whatwedo.htm.

transportation of dangerous goods, TC works with its partners to promote public safety in regards to dangerous goods transport by doing the following:

- Establishing standards and regulations for dangerous goods transport
- Monitoring compliance of shippers, consignors and importers with emergency response assistance plans (ERAP's) [36]
- Managing the Canadian Transport Emergency Centre to aid emergency response efforts in the event of accidents involving dangerous goods

In addition to TC, The Transportation Safety Board (TSB) exists to promote and advance transportation safety. The *Canadian Transportation Accident Investigation and Safety Board Act* is the legislation that governs TSB activities.[37] The TSB:

- Conducts independent investigations, including public inquiries into transport occurrences
- Identifies safety deficiencies and makes recommendations to reduce or eliminate safety issues to Transport Canada
- Publicly reports on any TSB investigations
- Reviews developments in transportation safety and identifies evolving areas of risk that need to be addressed

An investigatory agency needs to maintain public confidence, and for this reason, the TSB operates as an independent agency free from conflict of interest when

[36] Ibid.
[37] "Mandate," last modified July, 9, accessed September, 10, 2015, http://www.tsb.gc.ca/eng/qui-about/mission-mandate.asp.

investigating transportation issues and making recommendations. It reports directly to Parliament through the Leader of the Government in the House of Commons in order to fulfill their mandate.[38]

For the purpose of this paper we will compare the emergency response protocols of the AER for pipeline rather than the NEB to the TC requirements for rail. The reason being that the AER supervises more kms of pipelines than the NEB and follows the same basic regulatory structure.

Causes for Incidents and Accidents

Accidents can happen for many reasons. For each mode of transport, we can group these into three main areas: material failure, human error and third party error as outlined in the following chart.[39] [40] [41] [42]

	Pipeline	Rail
Material Failure	• External pipe corrosion • Pipe damage: dents, scrapes, gouges leading to corrosion • Internal pipe corrosion • Joint failure • Overpressure failure • Pipe failure due to stress cracking, fatigue, mechanical damage, hydrogen induced cracking • Valve failure: blowouts, packing leaks, pig trap failures • Seam rupture • Girth weld failure	• Brake system defects • Slid flat wheel defects • Broken rail • Wheel fatigue leading to cracking • Wheel car subsurface porosity • Wheel fracture • Roller bearing failure • Axle failure • Wheel tread deterioration

[38] Ibid.
[39] Alberta Energy Regulator, *Report 2013-B: Pipeline Performance in Alberta, 1990-2012* (Calgary, Alberta: Alberta Energy Regulator,[2013]).
[40] Railway Association of Canada, *2014 Rail Trends*,[2014]).
[41] "Rail," last modified February, 8, accessed September, 10, 2015, http://www.bst-tsb.gc.ca/eng/rail/index.asp.
[42] Melissa T. Baysari et al., "Classification of Errors Contributing to Rail Incidents and Accidents: A Comparison of Two Human Error Identification Techniques," *Safety Science* 47, no. 7 (8, 2009), 948-957.

Third Party Error	• Pipeline damage due to third parties through excavation or interference	• Third party collision
Human Error	• Construction damage: improper backfilling, improperly applied coatings or application of damaged coatings, faulty alignment • Operating over the license limit • Failure at installation at compressor, pump or meter station • Operator error	• Skill based errors • Driver violations • Rail traffic controller error • Rail track switch error • Communication errors between rail traffic instructor and conductor • Traffic signal error • Overloaded cars affecting speed • Errors applying brakes
Other	• Earth movement: changes in watercourse, slope movements • Erosion • Vandalism • Lightning • Flooding • Animal interference	• Debris on track • Vandalism • Weather interference • Earth movement

Pipeline Emergency Protocol

In November of 2009 the AER released *Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry*. Directive 071 derives its authority from the Oil and Gas Conservation Regulations, pursuant to the Oil and Gas Conservation Act, and the Pipeline Regulation, pursuant to the Pipeline Act. Directive 071 applies to pipeline operators regulated by the AER.[43] The goal of Directive 071 is to:

[43] "Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry," Alberta Energy Regulator, last modified November 24, accessed September 9, 2015, https://www.aer.ca/documents/directives/Directive071-with-2009-errata.pdf.

- Ensure that appropriate emergency response plans (ERPs) are in place to respond to incidents that present significant hazards to the public and the environment
- Ensure that there is an effective level of preparedness to implement ERP's
- Ensure that there is the capability in terms of trained personnel and equipment to carry out an effective emergency response to incidents

While Principles 1 and 2 are important to increase the likelihood of appropriate response, Principle 3 focuses on achieving public safety through action during a specific incident. The purpose of emergency preparedness and response is to establish a decision framework and action plan so that the licensee can quickly and effectively respond to an emergency. The overall goal is to protect public safety and minimize impacts to the environment through implementation of an ERP. An ERP addresses emergency scenarios, potential hazards to the public, and systems required for effective response.[44]

Rail Emergency Response Protocol

Transport Canada is responsible for establishing the safety protocols for railway procedures. It has the overarching responsibility to protect people, property and the environment. However, it is the railway companies that must ensure safe operations. Federally regulated railway companies are required to establish a Safety

[44] Ibid.

Management System (SMS) which needs to be approved by the TSB.[45] Transport Canada has required federally regulated railway companies to have SMSs in place since 2001. The SMS requirements for railways are contained in the *Railway Safety Management System Regulations* under the *Railway Safety Act*.[46] An SMS is a framework created by the rail operator that integrates safety into daily operations. Further to SMSs, railway operators need to create and adhere to an approved Emergency Response Assistance Plan (ERAP). *The Transportation of Dangerous Goods Act 1992,* applies to all federally regulated modes of transport including pipeline, marine, air, road and rail. The act requires that before a company can transport or import certain dangerous goods they must have an approved ERAP.[47] An ERAP is a plan that describes what should be done in the event of a transportation emergency involving the designated dangerous goods. The ERAP is meant to assist local emergency responders by providing them with the information they need at the scene of an incident.[48] While it is the responsibility of the railway operator is to provide local emergency responders with technical experts and specially trained and equipped emergency response personnel at the scene of the incident, they also need to identify the local emergency responders available in case of a rail incident. In addition, the local municipality is often involved in the case of emergency by providing their resources, such as firefighters. Operators must identify in their ERAP which emergency resources are available to them and where

[45] "Safety Management Systems- Frequently Asked Questions," last modified July, 29, accessed September, 10, 2015, http://www.tc.gc.ca/eng/railsafety/railsafety-faq-969.html#sms.
[46] Ibid.
[47] "Emergency Response Assistance Plans (ERAPs)," last modified March, 9, accessed September, 10, 2015, https://www.tc.gc.ca/eng/tdg/erap-menu-72.htm#sec1.
[48] Ibid.

additional resources can be called upon in need of additional assistance.

Methodology

In order to evaluate the emergency response protocols required by the AER and TC, we will review two incidents for each mode of transport and evaluate if the rules were adequate in addressing all outcomes associated with crude oil spills. By looking primarily at "large incidents" (based on volume), we can evaluate a range of issues not applicable to smaller and medium sized spills. For the purpose of this evaluation, we will classify a large spill as anything involving a release of 100 barrels or more of crude oil, equivalent to 15 890.67 litres or more.

For reference, spill sizes can be classified as:
Large = 100 barrels or more
Medium = 5-100 barrels
Small = 0-5 barrels

For reference, conversion factors are as follows:
1 cubic metre (m^3) = 6.293 barrels
1 cubic metre (m^3) = 1000 litres
1 barrel = 158.987 litres[49]

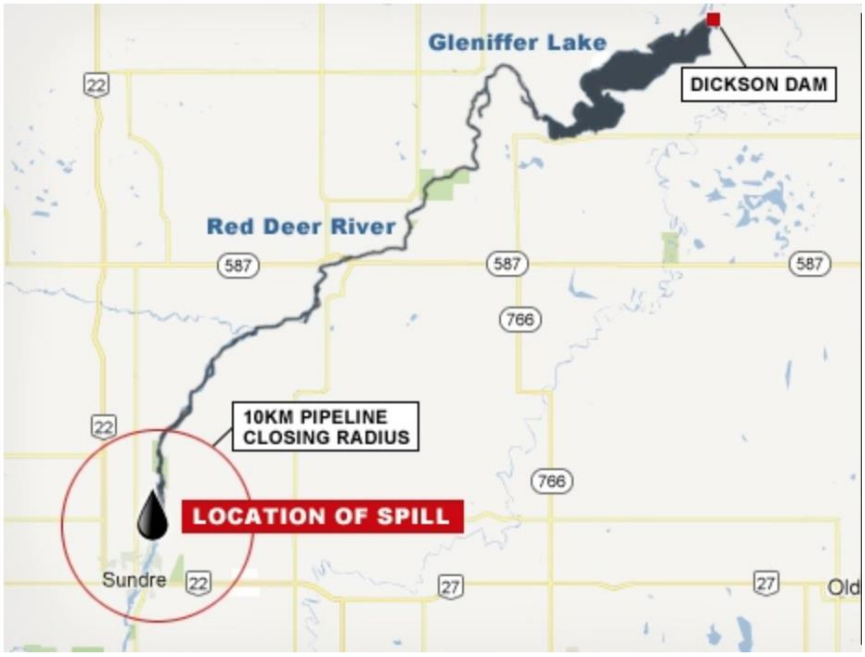
Pipeline

Incident 1[50]

Pipeline company: Plains Midstream Canada ULC Plains
Incident date: June 7, 2012
Incident location: West bank of the Red Deer River, 3 km north of Sundre, Alberta
Release amount: 462.75 m^3 equivalent to 462 750 litres

[49] Canadian Association of Petroleum Producers, *Transporting Crude Oil by Rail in Canada*
[50] "Plains Midstream Canada ULC AER Investigation Report," last modified March, 4, accessed September, 10, 2015, http://www.aer.ca/documents/reports/IR_20140304-PlainsRangeland.pdf.

Total cleanup cost: $61 million



At 17:41 pm on June 7, 2012, Plains detected abnormal operating conditions on its 12 Rangeland south pipeline and signaled an alarm. This alarm was the first indicator of a pipeline incident and subsequent release of crude oil. At 18:00 Plains detected a flow into the pipeline, at 18:15 the Plains control room operator began to examine the unexplained flow, which included activating personnel to look into any mechanical issues and identify possible release locations. In addition, Plains initiated precautionary closures of valves associated with the pipeline in suspected release areas. At 19:34, the Sundre Petroleum Operators Group (SPOG), an industry-based organization whose purpose is to be involved in emergency response efforts in the Sundre area, received a report from a landowner that hydrocarbon smell and oil sheen were detected on the river. Plains issued a pipeline incident notification system report and activated its ERP. At 21:57a SPOG hired helicopter identified the release site and confirmed that the Rangeland pipeline was the source. At 21:40

Plains contracted SWAT consulting and confirmed that equipment and personnel had been mobilized for emergency response. At 22:07 Plains classified the spill as a level 2 emergency. At 22:10 SPOG sent a communication alert to residents confirming the release, listed response activities, and provided contact information. After declaring a level 2 emergency, Plains activated its ERP and began response efforts which included setting up an emergency operations centre, activated an incident command post, emergency response equipment and contracted SWAT to lead spill response and recovery efforts on the Red Deer River and Gleniffer Lake. The AER established contact with Plains at 21:57 once the spill was confirmed. Crude released from the pipeline flowed downstream and affected several land owners along the water, communities located on both sides and about 40 km downstream of the release site were also affected. Plains shut down all of its pipelines in the release area and contracted third parties to do the following:

- Set up a logistics team to mobilize supplies, services and equipment
- Deploy a spotting team to detect downstream sheen
- Request water intake closures downstream
- Notify residents
- Deploy booms and continuous monitoring
- Establish security access points
- Identify all stakeholders and transients

Outcome

Overall, it took four hours and twenty-six minutes from the time the initial alarm was raised and to the time the incident was classified as a level two emergency.

Until the time that Plains' pipeline was identified as the source, it was SPOG that coordinated response efforts. Plains established an information centre for local residents to ask questions of Plains, SMOG, the AER and Alberta Health Services (AHS) which had also been dispatched. Plains worked with community leaders and regulators to mitigate potential impacts such as potable water delivery and to provide signage to indicate where cleanup operations were ongoing, a community response phone line, and a website with response information. Since the incident occurred in a rural area with multiple land uses and with the potential for many members of the public to be affected, communication and engagement with stakeholders was challenging. While Plains did take many steps to engage the local community, the investigation found that this communication was delayed and inconsistent and only occurred in response to direction from the AER. Overall, Plains' communication efforts were deemed inadequate. In addition, an audit found that Plains did not update their ERP strategy, a requirement of Directive 071 and failed to conduct a public awareness program in the identified emergency zone.

Incident 2[51]

Pipeline company: Pembina Pipeline Corporation (Pembina)
Incident date: June 15, 2008
Incident location: Legal Subdivision 13, Section 26, Township 33, range 5, 5km North of Sundre
Release amount: 23.55 m^3 equivalent to 23 550 litres
Total cleanup cost: $5 million

[51] "Pembina Pipeline Corporation ERCB Investigation Report," last modified February, 11, accessed September, 10, 2015, http://www.aer.ca/documents/reports/IR_20090219_PembinaPipelineFailure.pdf.

At 9:07pm on June 15, 2008 Pembina detected a possible release in its Cremona crude oil pipeline. The pipeline had been shut in since 7:17pm as part of normal operating procedure. At 9:14pm a command to close the crude valve was issued. The crude was not isolated until 10:02pm. At 10:38 the ERCB Red Deer field centre was notified by Pembina of the incident. At 10:49 Pembina became aware of hydrocarbon odors along the Red Deer River. High river flows and river murkiness made immediate pipe inspection and crude containment impossible. The Pembina ERP was activated, an incident command post was established and staff and equipment were mobilized. The release site was identified on June 16, the following day, in the morning using helicopter surveillance. The released oil had flowed 33km downstream into Gleniffer Lake. Drinking water intakes to the lake were shut off and Pembina trucked in water resources for residents until the intakes were restored. To minimize impact on wildlife, scare cannons were set up early on in response activities to ward of migratory birds and other wildlife. On June 17, Pembina initiated cleanup activities including a water-sampling program. The Alberta Emergency Management Agency (AEMA)* activated the government emergency operations centre to coordinate government and agency response, the ERCB set up its own incident command post to handle updates. In the days following the spill from June 18 onwards, Pembina did the following:

- Monitored the break site for more releases
- Posted hazard signs until the area was declared safe

* The Alberta Emergency Management Agency (AEMA) leads the coordination, collaboration and co-operation of all organizations involved in the prevention, preparedness and response to disasters and emergencies.

- Continued cleanup activities and water sampling
- Instituted a program of public meetings and open houses

Outcome

Pembina contacted all required agencies, provided an appropriate response to the spill in terms of water monitoring and remediation, used all the necessary resources, maintained communication and provided updates to all parties throughout the incident including the public and regulatory bodies. The investigation found that Pembina adequately followed all protocols set forth in Directive 071.

Pipeline Findings

In both pipeline incidents, the regulations addressed all possible action required in an event of a crude oil spill. Specifically, the regulations addressed requirements for identification, remediation, accident classification, and communication to multiple parties, requirements to set up an incident response centre, signage and equipment and personnel use. However, in both cases there were areas for improvement surrounding communication. In the Plains incident, while there was adequate direction in the emergency response protocol, the operator did not adequately communicate with the public and associated stakeholders. In addition, the regulators and vested agencies needed to establish a unified regulatory agency structure to communicate with the Government of Alberta due to spilled product entering water resources used for municipal agricultural and industrial activities. Furthermore, in the Pembina incident, while the operator adhered to all

requirements for emergency response the ERCB still designated its own incident command post to handle communication with interested parties.

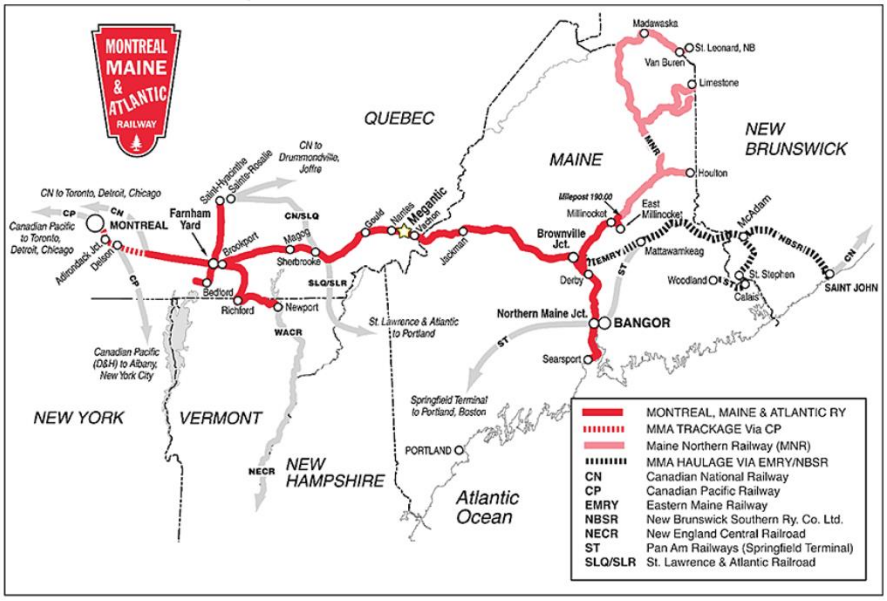
When reviewing the emergency response requirements and comparing them to the outcomes of the spill in both cases, it appears that the communication piece is currently the only portion that could benefit from a more streamlined approach. It is perhaps more appropriate for the AER to coordinate all communication activities to allow for a management of information and provide consistency and clarity to all stakeholders and interested parties. The AER could designate staff to be on site to coordinate communication protocols for news releases and announcements between other regulatory bodies such as AHS, ESRD, Government of Alberta, as well as disseminating information to the public.

Rail

Incident 1[52]

Rail Carrier: Montreal, Maine and Atlantic Railway (MMA)
Incident date: July 6, 2013
Incident location: Lac-Mégantic, Quebec
Release amount: 6 000 000 litres
Total cleanup cost: $1 Billion

[52] Transportation Safety Board Canada, *Railway Investigation Report R13D0054*



On July 6, 2013, at 1:00 am an eastward bound MMA train, which had been parked unattended for the night in Nantes, Quebec began to roll. At around 1:15 am the train approached the centre of the town of Lac-Mégantic, Quebec, where 63 tank cars carrying 6 000 000 litres of petroleum crude oil and 2 box cars derailed. The train travelled approximately 7.2 miles from Nantes, reaching a speed of 65 mph. The spilled crude oil caused fires and explosions and destroyed 40 buildings, 53 vehicles and caused 47 fatalities. As a result of the spill there was environmental contamination of the downtown area and of the adjacent river and lake. Furthermore, 2000 people were evacuated and the spilled crude made its way into the city's sanitary and storm sewer system by way of manholes. Approximately 100 000 litres of crude oil ended up in Mégantic Lake and the Chaudière River due to surface flow, underground filtration, and sewer systems. Immediately after the accident the Lac-Mégantic Fire Department was notified with incoming 911 calls. More than 1000 firefighters from 80 different municipalities and from 6 counties in

the state of Maine participated in the response. The primary task was focused on evacuating people and preventing further spread of the fire to nearby infrastructure. Once the dangerous goods involved were identified, emergency responders assessed the situation and used foam concentrate to control and reduce the fire. The fire department had to arrange transport of the foam from a refinery 180 kms away. The foam concentrate arrived in the afternoon and the fire was under control at 6am the following morning and completely extinguished by 11am that same day, July 7, 2013. The crude oil recovery and cleanup began immediately after the fires were extinguished and the area was stabilized- approximately two days after the accident.

Outcome

Various organizations arrived at the accident site to provide assistance to the first responders. These included CN rail, the Railway Association of Canada, both federal and provincial governments, the importer (Irving Oil Commercial G.P), representatives of the petroleum industry and environmental remediation companies. During the hours and days after the accident, regular meetings were held with all stakeholders. These meetings established priorities, determined what action should be taken, response methods, and the impact of the overall operations. The firefighters on site found it difficult to do their job given the pile-up of cars. All of the 911 calls made in response to the accident were responded to promptly and the response escalation worked as it was designed to. While the firefighters on site were not specifically trained for this type of disaster, the emergency response was well coordinated. In addition, many responders from nearby cities and counties

were available. The various fire departments successfully coordinated their efforts to contain the site and ensure public safety. Evacuations were also conducted efficiently. In response to the tragic accident, numerous insurance claims and law suits have been brought forward. After the accident it was learned that MMA only had insurance to cover up to $25 million worth of costs. The entire cleanup and remediation as a result of the spill has been estimated to be close to the $1 billion mark. Furthermore, the province of Quebec and town of Lac-Mégantic have spent millions in site cleanup each taking legal action against MMA for reimbursement of legal costs. In addition, multiple law suits for compensation of injury and loss of life have been brought forward. MMA did not have enough insurance to pay for damages to the victims of the accident and their creditors and as such filed for bankruptcy. Furthermore, 25 companies were accused of responsibility in the accident and have been agreed to participate in a group fund totaling $431.5 million to pay the victims for damages in return for release of any further legal liability. From this fund, approximately $111 million would be distributed to families and $200 million is meant to be distributed to the town of Lac-Mégantic and the Government of Quebec for cleanup costs.[53] Finally, three MMA employees have been charged with 47 counts of criminal negligence causing death. The trial has been delayed to December of this year. [54]

[53] Sidhartha Banerjee, "Accused in Lac-Megantic Rail Disaster Case to Return to Court in December," *CTV News Montreal*September, 8, 2015.
[54] Staff, "Lac-Megantic Explosion," *Global News*July, 13, 2015.

Incident 2[55]

Rail Carrier: Canadian Pacific Railway (CP Rail)
Incident date: April 3, 3013
Incident location: White River, Ontario
Release amount: 101 700 litres
Total cleanup cost: Unknown

Figure 1. Derailment location (source: Canadian Pacific Railway [CP] System Rail map)

On April 3, 2013, at about 7:50am, a CP rail train was moving east bound at 34.9 miles per hour on the Heron Bay Subdivision when it experienced an undesired emergency brake application at Mile 9.16 near White River, Ontario. Subsequent inspection determined that 22 cars had derailed, 7 of which were dangerous goods tank cars loaded with crude oil. During the derailment, a number of cars rolled down an embankment. Two of the dangerous goods tank cars released approximately 101 700 litres of crude oil, and another non-dangerous goods tank car released approximately 18 000 litres of canola oil. There were no injuries.

[55] "Railway Investigation Report R13T0060," last modified January, 30, accessed September, 10, 2015, http://www.bst-tsb.gc.ca/eng/rapports-reports/rail/2013/r13t0060/r13t0060.asp.

At 9:05 the TSB was advised of the accident and by 9:30 sent investigators to the site. CP Rail dispatched emergency responders and began site mitigation activities. Local residents reported a fire at the derailment site, which was responded to by the local fire department. Fire department logs indicate that the fire department was dispatched to a flare-up of released product at the accident site at 20:55. The fire was extinguished, and the fire department returned to the station at 22:55. The TSB arrived on site at about 23:30. When TSB arrived it was noted that there was no formal incident command structure in place, no way to keep track of staff on-site and no safety briefings had been conducted. Moreover, access to the site was unrestricted and no safety perimeter had been set up. The night of the accident, CP commissioned an environmental consultant to commence air monitoring and sampling activities. Following the initial fire, the White River Fire Department was on site 24 hours a day in addition to other fire departments from surrounding areas. A number of clean up and remediation activities commenced including, ground water monitoring, soil excavation, disposal of released product and water treatment.

Outcome

The derailment site was relatively remote and as a result TSB personnel did not arrive until the late evening on the day of the accident. Prior to TSB's arrival CP Rail emergency responders arrived and began containment and remediation activities. While CP Rail personnel did respond to the emergency quickly, the TSB reported that they were rarely available to communicate with TSB and provide information about the emergency as it was happening. Also, updates in regards to the crude oil

release were not forthcoming and there were significant gaps in CP Rail's response to the accident. Specifically:

- There was no formal CP command post in place
- Access to the site was virtually unrestricted
- There was no tracking of individuals accessing the site
- No site briefings were conducted
- Product and release information was not readily available
- Inadequate overview of the mitigation activities may have put personnel at risk

Rail Findings

In evaluating the emergency response protocols for rail transport, we can conclude that based on the two rail investigations emergency response efforts were varied. In terms of the Lac-Mégantic accident, the investigation deemed the response more than adequate considering the resources available, lack of training and sheer size and magnitude of the accident. In the White River incident, while the investigation found that site mitigation activities had been carried out appropriately, there were deficiencies in identifying and establishing security and communication.

At the time of both incidents ERAP's were not required for transporting crude oil. As a result, there was an inherent risk that the emergency response in both incidents could be insufficient since no plan was in place in case of such an accident. It was not until April 23, 2014, in response to a TSB Recommendation, that TC issued

Protective Direction No. 33 under the *Transportation of Dangerous Goods Act (*1992). This protective direction, in effect 150 days from the issue date, requires an ERAP for certain higher-risk hydrocarbons and flammable liquids, including crude oil and ethanol, when offered for transport or imported by rail in one or more tank cars that are each filled to 10% of capacity or more.

While we cannot look to the ERAP's required for crude and compare them to any incidents since they were released, we can apply them to the two rail occurrences reviewed earlier and determine, had they been available, would they have been able to manage each outcome of the crude oil spills. When looking at the requirements of the basic ERAP as outlined earlier there is no requirement to classify a level of emergency, incident zone identification, a detailed communication plan, possible evacuation of residents, relocation of residents, evacuation of nearby public facilities, cleanup and remediation, water and air quality monitoring, wildlife impacts and security measures. In both instances it would have been beneficial to have pre-planned for these factors; however the ERAP requirements do not specifically lay out requirements for these areas.

Conclusions

In reviewing and comparing the emergency response protocols for both modes of transport, it is evident that while the pipeline protocols are comprehensive and detailed, those for rail are slightly less so. The pipeline protocols adequately addressed every possible effect of crude oil spills and systematically outlined what

an operator should consider in the event of a spill. The AER has adequately addressed emergency response for pipeline incidents involving crude oil. Based on our review of these incidents, we recommend that the AER take over all communication during pipeline incidents to ensure a single message, proper flow of communication and consistency of information with all stakeholders involved.

While the ERAP requirement was not put in place prior to the two incidents reviewed, when applying the new ERAP framework to the two incidents it was determined that this protocol is slightly inadequate in addressing the possible effects of rail incidents involving crude oil. The ERAP requirements, much like the SMS, depend heavily on the operator. There is little complexity to the requirements, they are very high level, and can be interpreted in many ways. While it can be argued that rail accidents vary greatly depending on a variety of factors such as commodity transported, load size, and distance travelled, it is beneficial to have a more high-level regulation to provide operators with the freedom to respond based on each specific incident. However, considering that crude oil transport via rail can have catastrophic effects as witnessed in the Lac-Mégantic accident, the recommendation is to further develop the ERAP requirements to model those adopted by the AER for pipeline. Also, the current protocols for crude oil are fairly new, and while they currently may be deemed inadequate, as more crude is transported in Canada by rail, further experience with managing rail accidents will provide the opportunity to evolve and enhance these requirements.

In addition to requiring operators to carry out emergency response planning, mandatory reviews of ERP and ERAPs for each mode of transport should be conducted to ensure operators are prepared for accidents should they occur. Furthermore, with the changing nature of the crude oil market, especially by rail, this will instill confidence that the operators are prepared and held accountable for their actions.

Lastly, the following four areas have been specifically identified for further consideration in emergency response for crude oil transport:

1. The Impact of Different Types of Oil

One topic that emerges from discussions concerning crude oil transportation is the kind of crude oil being transported and the varying implications of different types of crude involved in major spills. Research indicates that different grades of crude with different properties such as higher Sulphur contents, sweet versus sour, heavy versus light, can be more or less corrosive, are more or less flammable, and when involved in an accident must be responded to differently depending on the grade of oil.[56] For example, one of the reason the Lac-Mégantic accident was so devastating was due to the Bakken crude oil being transported and its highly explosive nature compared to other grades of crude oil.

[56] Christpherson and Kushan, *A New Era of Crude Oil Transport: Risks and Impacts in the Great Lakes Basin*, September 9, 2015

2. Mixed Rail Shipments

Rail operators have the opportunity to move different kinds of cargo on the same load. While this can have financial benefits, mixed shipments involving different kinds of crude oil, or more dangerous hazardous goods can have more severe repercussions than if transporting a single kind of product. Mixing dangerous goods like propane, gasoline and crude can become significantly more hazardous in the event of a spill or accident when the different products are combined. Also, this makes it difficult for first responders to adequately assess the situation and respond appropriately as well as for operators to create an appropriate ERAP if they are never aware of what combinations of products will be shipped together. [57] In reviewing the rail incident reports on the TSB website, it was very rare that any spill only involved crude oil. , In most cases a crude oil spill was in combination with other hazardous goods such as propane. There is currently no easily accessible data detailing mixed shipments providing an analysis of the effects of these kinds of shipments on accidents. While it may be beneficial to regulate mixed shipments to better control the possible outcomes of an accident, this may not prove economically prudent and the cost may outweigh the benefit of rail transportation all together.

3. Remoteness

[57] Ibid.

The pipelines and rail routes in remote regions make it difficult to respond in the event of emergency. In many cases emergency response efforts are delayed or inefficient because of the remote nature of the spill. In the case of pipelines, roads and infrastructure often need to be built just to reach a spill site, and it can take days to have the appropriate personnel and infrastructure relocated to these remote areas to deal with an emergency. In the case of railways, while many travel through densely populated urban areas which poses its own problem in case of accident, many in fact do move through remote areas where there is minimal infrastructure to deal with an emergency. [58] In the earlier mentioned spill at White River, the remote location of the accident caused a delay in emergency response.

4. Insurance and Liability

While pipeline and railway operators are liable for the accidents and associated cleanup costs that happen on their watch, operators may not always have sufficient coverage to manage these expenses. Concerning pipelines, the operator has unlimited liability for costs and damages when it is found at fault or negligent. The AER works collaboratively with government and stakeholders to develop a liability management program for all energy sectors. Furthermore, this program ensures that companies have enough assets to deal with abandonment, remediation, and reclamation of their liabilities so Albertans are not left to pay out of pocket. [59] On May 14 of this year, the federal government announced new financial liability

[58] Ibid.
[59] "Closure - Abandonment, Reclamation and Remediation Fact Sheet," last modified June, accessed September, 10, 2015, http://www.aer.ca/documents/enerfaqs/Closure_FS.pdf.

legislation which states that federally regulated pipeline companies will be liable for all costs and damages up to $1 billion for major oil pipelines. In addition to this, companies will continue to have unlimited liability when found to be at fault or negligent. [60] In addition to new pipeline regulation, changes to the *Canada Transportation Act* and *Railway Safety Act* include new liability and compensation measures for federally regulated railways. The changes set out minimum insurance requirements and a compensation fund created through a levy on crude oil shippers. The updated regulations require a minimum level of insurance based on the type and volume of dangerous goods they transport. Insurance levels will vary from a minimum of $25 million for no or low quantities to a maximum of $1 billion for large quantities. [61] Prior to these amendments, railway operators were only responsible for ensuring they had available to them "sufficient insurance , including self-insurance, to compensate for matters that may arise out of an applicant's proposed construction or operation of a railway." [62] Since railway operations can vary based on volume, commodity mix, route and many other factors, prior to the recent changes the regulations did not set a specified amount of insurance coverage or minimum and maximum levels. These new requirements better equip pipeline and

[60] "Minister Rickford Announces Latest Actions to Enhance Canada's World-Class Pipeline Safety System," last modified May, 14, accessed September, 10, 2015, http://news.gc.ca/web/article-en.do;jsessionid=e0ca4513b010d95c39ff3265d418787455f57ec627b9f4dae134f7519ec2005b.e34Rc3iMbx8Oai0Tbx0SaxqObhr0?crtr.sj1D=&mthd=advSrch&crtr.page=1&crtr.dpt1D=6683&nid=848059&crtr.tp1D=1&crtr.lc1D=&crtr.aud1D=.

[61] "Government of Canada Introduces Legislation to Strengthen Rail Safety and Accountability," last modified February, 20, accessed September, 10, 2015, http://news.gc.ca/web/article-en.do?nid=937229.

[62] "Review of Railway Third Party Liability InsuranceCoverage Regulations," last modified June, 26, accessed September, 10, 2015, https://www.otc-cta.gc.ca/eng/publication/review-railway-third-party-liability-insurance-coverage-regulations.

railway operators when responding to emergencies. In addition, they provide confidence to the public that operators will be held accountable and do have the resources needed to manage large accidents and spills. This does however give rise to a few new issues. For one, smaller operators may not have access to this kind of insurance or assets and the requirements may force them out of the transportation business. Also, in many cases, such large insurance plans may not be readily available and operators may have to look beyond local or national companies for this kind of funding taking financial opportunity outside the Canadian market. Finally, if operators are able to find this type of insurance, providers may have their own requirements for pipeline and railway operations that could pose further economic hardships on companies.

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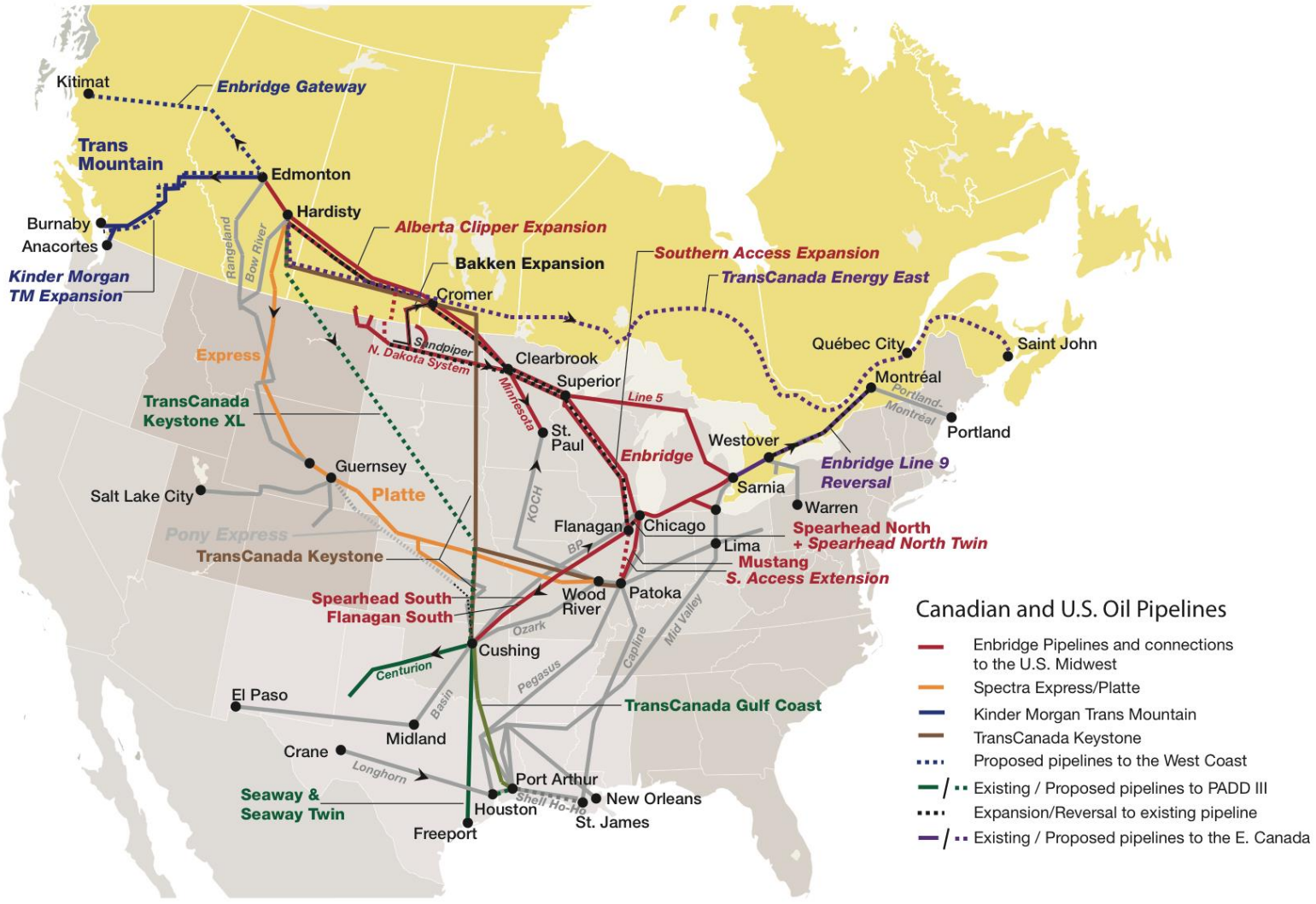
Appendix 1: Canadian Pipeline and Rail Routes

Figure 1. Existing and Proposed Canadian & U.S. Crude Oil Pipelines[63]



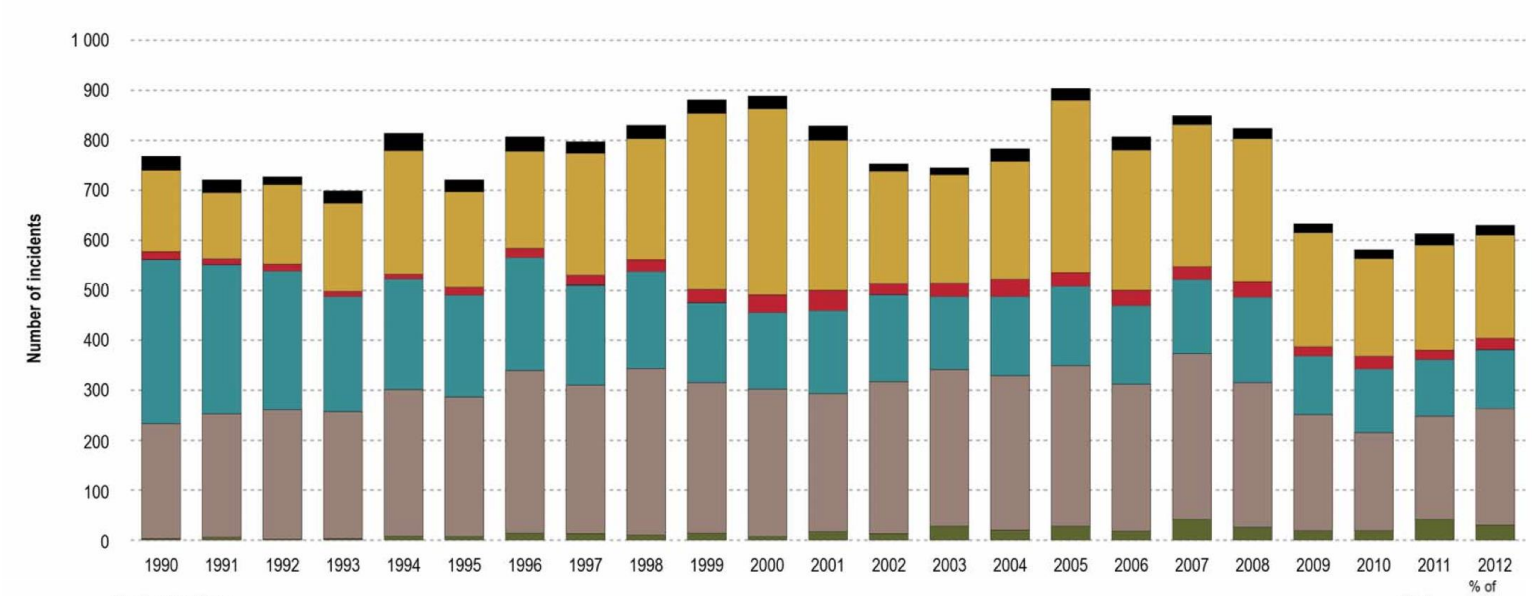
[63] Canadian Association of Petroleum Producers, *Crude Oil Forecast, Markets & Transportation.* Canadian Association of Petroleum Producers,[2015]).

Figure 2. North American Rail Network[64]

[64] Ibid.

Appendix 2: Pipeline Trends

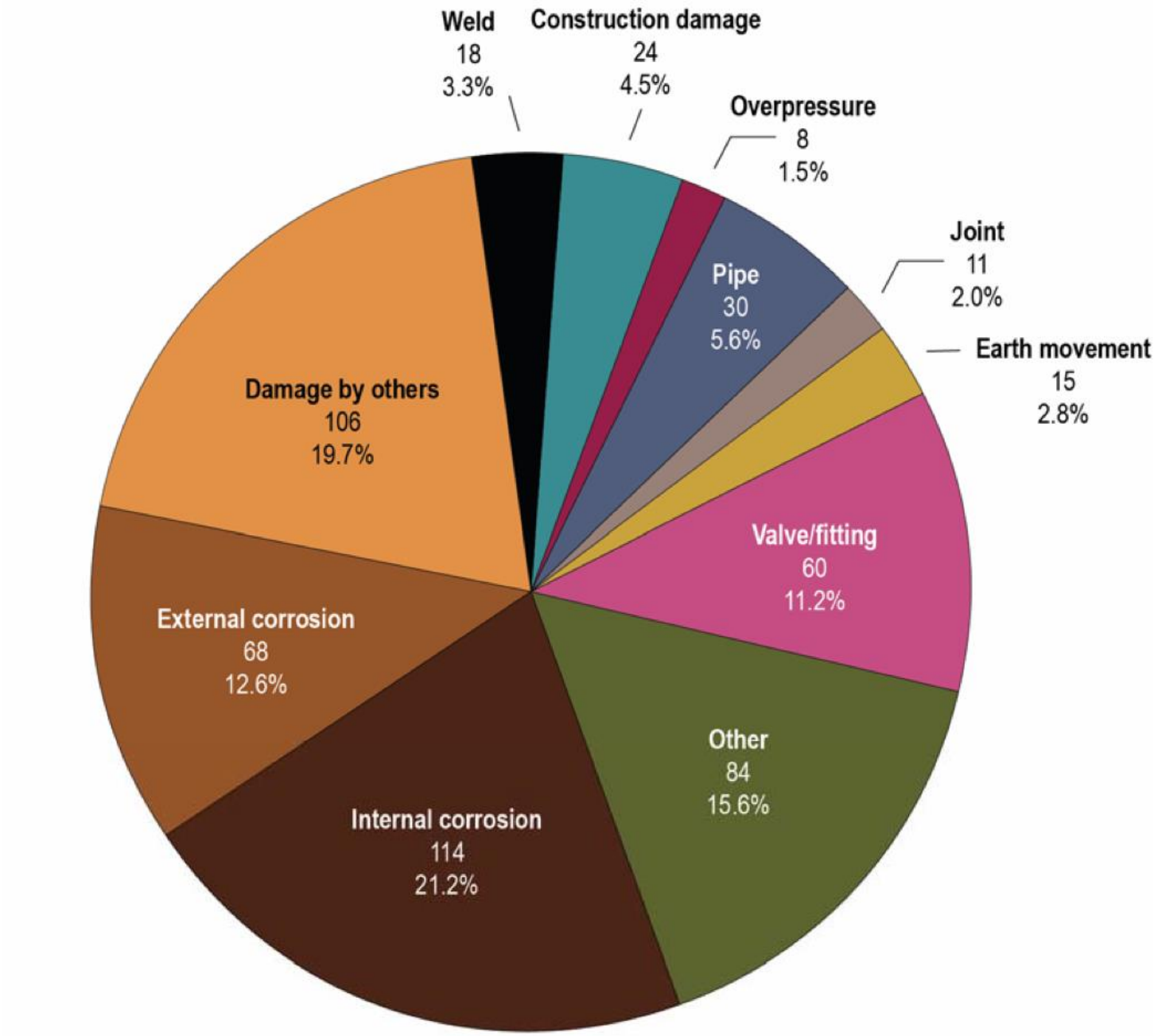
Figure 3. Pipeline incidents by substance category per year [65]



Number of incidents	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total	% of total
Crude Oil	28	26	16	25	35	24	29	23	27	27	26	29	15	14	25	24	27	18	21	18	18	23	20	538	3.1
Natural Gas	163	132	159	176	247	191	194	244	242	352	372	300	225	217	236	345	280	284	286	228	195	210	206	5 484	31.1
Sour Gas	16	12	14	11	10	16	19	20	24	27	36	41	22	27	35	27	31	26	31	19	26	19	23	532	3.0
Water	328	298	277	230	221	204	226	200	194	160	153	166	174	146	158	159	157	148	171	117	127	113	118	4 245	24.1
Multiphase	230	247	259	254	293	279	325	297	333	301	295	276	304	313	309	321	294	332	289	232	196	207	233	6 419	36.5
Other	3	6	2	3	8	7	14	13	10	14	7	17	13	28	20	28	18	41	26	19	19	41	30	387	2.2
Total	**768**	**721**	**727**	**699**	**814**	**721**	**807**	**797**	**830**	**881**	**889**	**829**	**753**	**745**	**783**	**904**	**807**	**849**	**824**	**633**	**581**	**613**	**630**	**17 605**	**100.0**

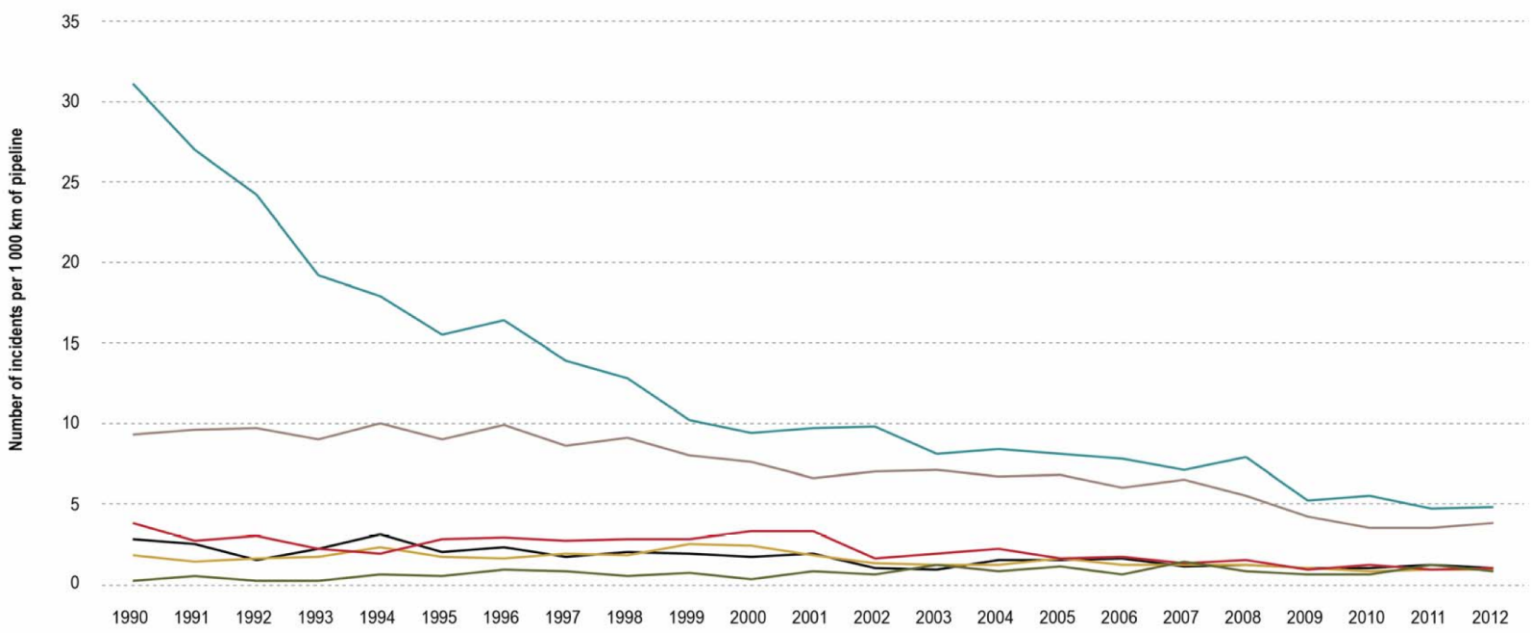
[65] Alberta Energy Regulator, *Report 2013-B: Pipeline Performance in Alberta, 1990-2012*

Figure 4. Crude oil pipeline incidents by cause for years combined 1990-2012[66]



[66] Ibid.

Figure 5. Average Frequency of pipeline incidents by year and substance[67]

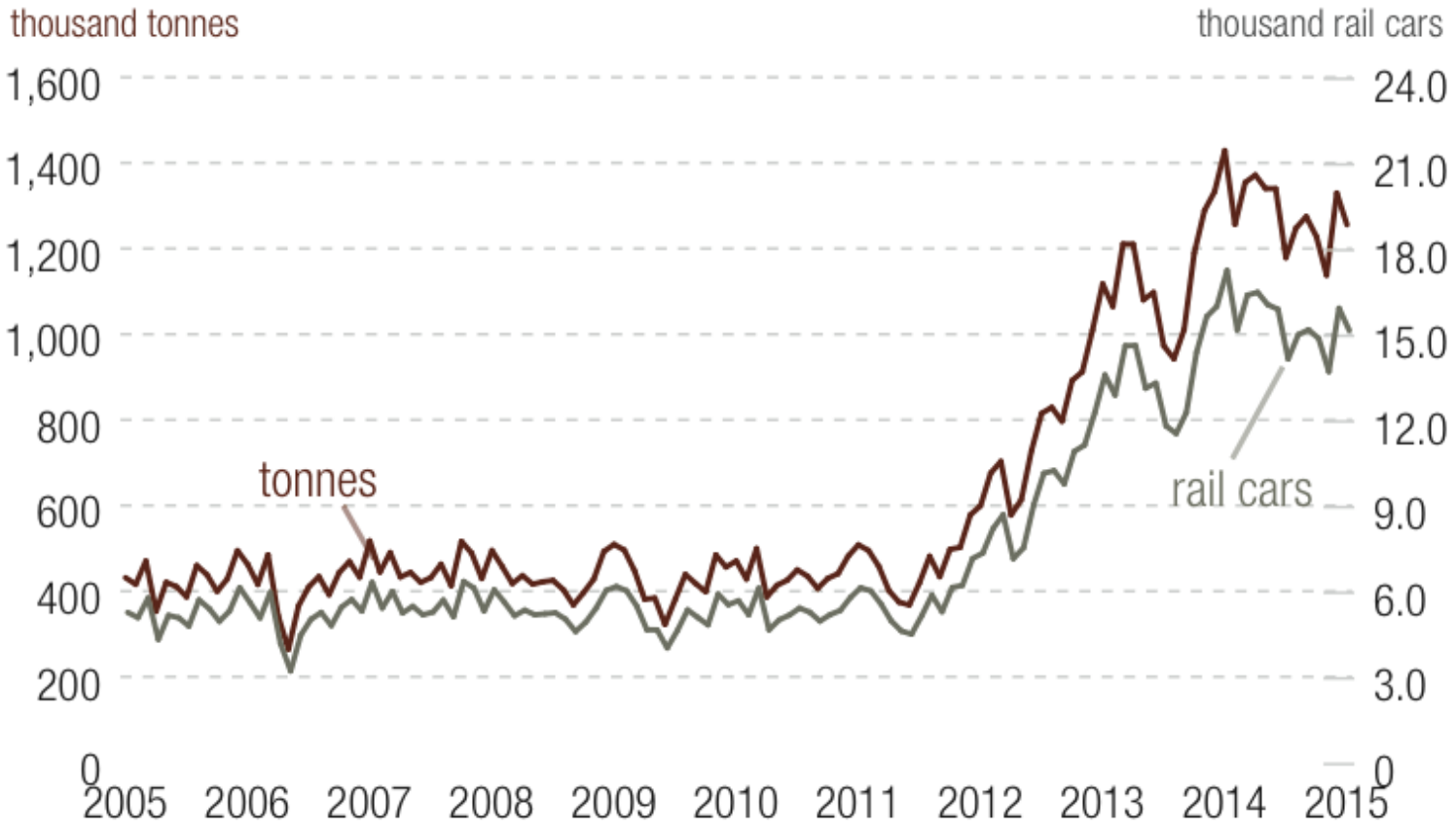


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Crude oil	2.8	2.5	1.5	2.2	3.1	2.0	2.3	1.7	2.0	1.9	1.7	1.9	1.0	0.9	1.5	1.5	1.6	1.1	1.2	1.0	1.0	1.2	1.0
Natural gas	1.8	1.4	1.6	1.7	2.3	1.7	1.6	1.9	1.8	2.5	2.4	1.8	1.3	1.2	1.2	1.6	1.2	1.2	1.2	1.0	0.8	0.9	0.9
Sour gas	3.8	2.7	3.0	2.2	1.9	2.8	2.9	2.7	2.8	2.8	3.3	3.3	1.6	1.9	2.2	1.6	1.7	1.3	1.5	0.9	1.2	0.9	1.0
Water	31.1	27.0	24.2	19.2	17.9	15.5	16.4	13.9	12.8	10.2	9.4	9.7	9.8	8.1	8.4	8.1	7.8	7.1	7.9	5.2	5.5	4.7	4.8
Multiphase	9.3	9.6	9.7	9.0	10.0	9.0	9.9	8.6	9.1	8.0	7.6	6.6	7.0	7.1	6.7	6.8	6.0	6.5	5.5	4.2	3.5	3.5	3.8
Other	0.2	0.5	0.2	0.2	0.6	0.5	0.9	0.8	0.5	0.7	0.3	0.8	0.6	1.2	0.8	1.1	0.6	1.4	0.8	0.6	0.6	1.2	0.8

[67] Ibid.

Appendix 3. Rail Trends

Figure 6. Canadian fuel oil and crude petroleum moved by rail: car loadings and tonnage[68]



[68] Canadian Association of Petroleum Producers, *Crude Oil Forecast, Markets & Transportation*, 1-42

Figure 7. Rail accidents by type of occurrence[69]

[69] Railway Association of Canada, *2014 Rail Trends*, 9-48

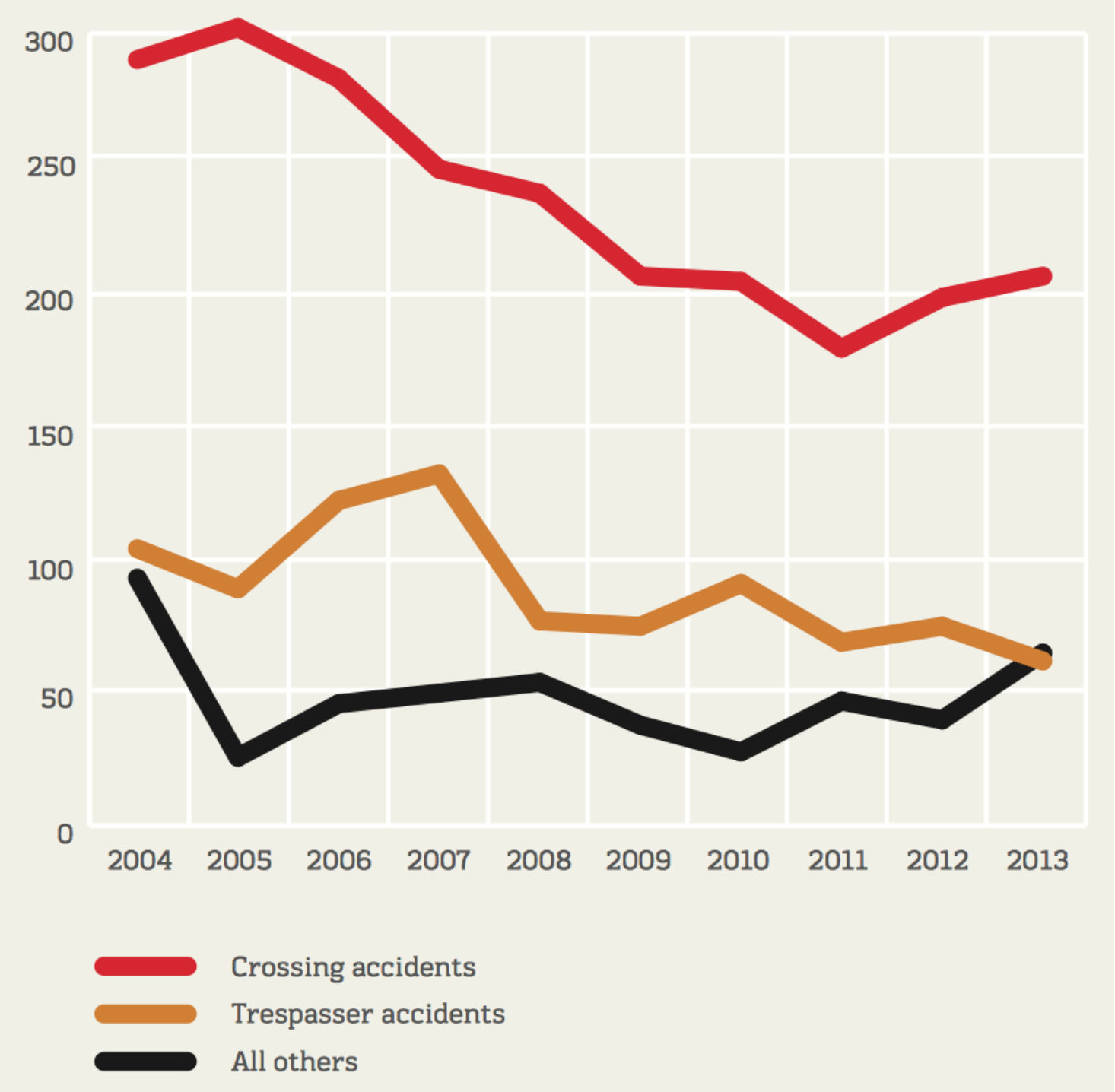


Figure 8. Railway occurrences in Canada[70]

[70] Jennifer Winter, *Safety in Numbers: Evaluating Canadian Rail Safety Data* (Calgary, AB, CAN: School of Public Policy, University of Calgary,[2014]). http://site.ebrary.com/lib/ucalgary/docDetail.action?docID=10863654&ppg=1.

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Accidents	**1,075**	**1,129**	**1,054**	**1,432**	**1,332**	**1,352**	**1,413**	**1,476**	**1,371**	**1,320**	**1,179**	**1,043**	**1,076**	**1,023**	**1,011**	**1,066**
Main-track collisions	14	10	9	7	9	6	5	6	2	9	7	5	4	3	6	4
Main-track derailments	108	119	122	131	124	156	160	198	139	159	128	67	80	103	63	83
Crossing accidents	273	283	265	280	260	250	236	269	243	218	221	188	181	169	187	189
Non-main-track collisions	114	100	113	108	131	111	123	98	110	102	91	95	93	88	101	92
Non-main-track derailments	388	403	387	713	664	695	713	758	703	631	570	497	541	485	499	519
Collisions/Derailments involving track units	13	27	16	19	11	23	26	19	17	30	27	50	34	33	24	41
Employee/Passenger accidents	10	13	13	8	8	7	12	8	16	18	12	12	9	11	7	8
Trespasser accidents	78	95	78	80	73	65	100	83	91	101	73	72	81	67	74	57
Fires/Explosions	51	53	32	36	25	23	15	17	25	25	12	20	30	23	17	11
Other accident types	26	26	19	48	27	16	23	20	25	27	38	37	23	41	33	61
Accidents involving dangerous goods	**240**	**224**	**249**	**205**	**221**	**226**	**208**	**212**	**185**	**190**	**153**	**133**	**141**	**118**	**118**	**145**
Main-track derailments	25	19	30	17	25	38	37	32	18	35	23	11	13	21	6	12
Crossing accidents	8	8	12	7	6	3	11	15	5	6	4	3	7	1	4	5
Non-main-track collisions	56	48	50	40	48	37	44	44	41	41	33	32	26	20	21	26
Non-main-track derailments	136	133	149	128	129	139	106	112	109	100	84	81	88	71	86	97
Other accident types	15	16	8	13	13	9	10	9	12	8	9	6	7	5	1	5
Accidents with a dangerous goods release	**5**	**9**	**7**	**5**	**5**	**9**	**7**	**7**	**4**	**3**	**3**	**3**	**2**	**3**	**2**	**4**

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Reportable incidents	**438**	**333**	**330**	**329**	**308**	**294**	**257**	**245**	**220**	**223**	**216**	**207**	**160**	**204**	**204**	**216**
Dangerous goods leaker	272	167	188	194	167	150	131	123	82	88	64	78	40	51	63	93
Main-track switch in abnormal position	14	15	17	9	9	11	12	10	7	7	13	4	5	10	5	7
Movement exceeds limits of authority	107	115	102	101	99	102	95	91	101	106	111	106	102	118	120	95
Runaway rolling stock	20	15	9	10	18	13	11	16	12	13	16	11	5	15	9	10
Other reportable incidents	25	21	14	15	15	18	8	5	18	9	12	8	8	10	7	11

Figure 9. Selected categories of railway occurrences[71]

[71] Ibid.

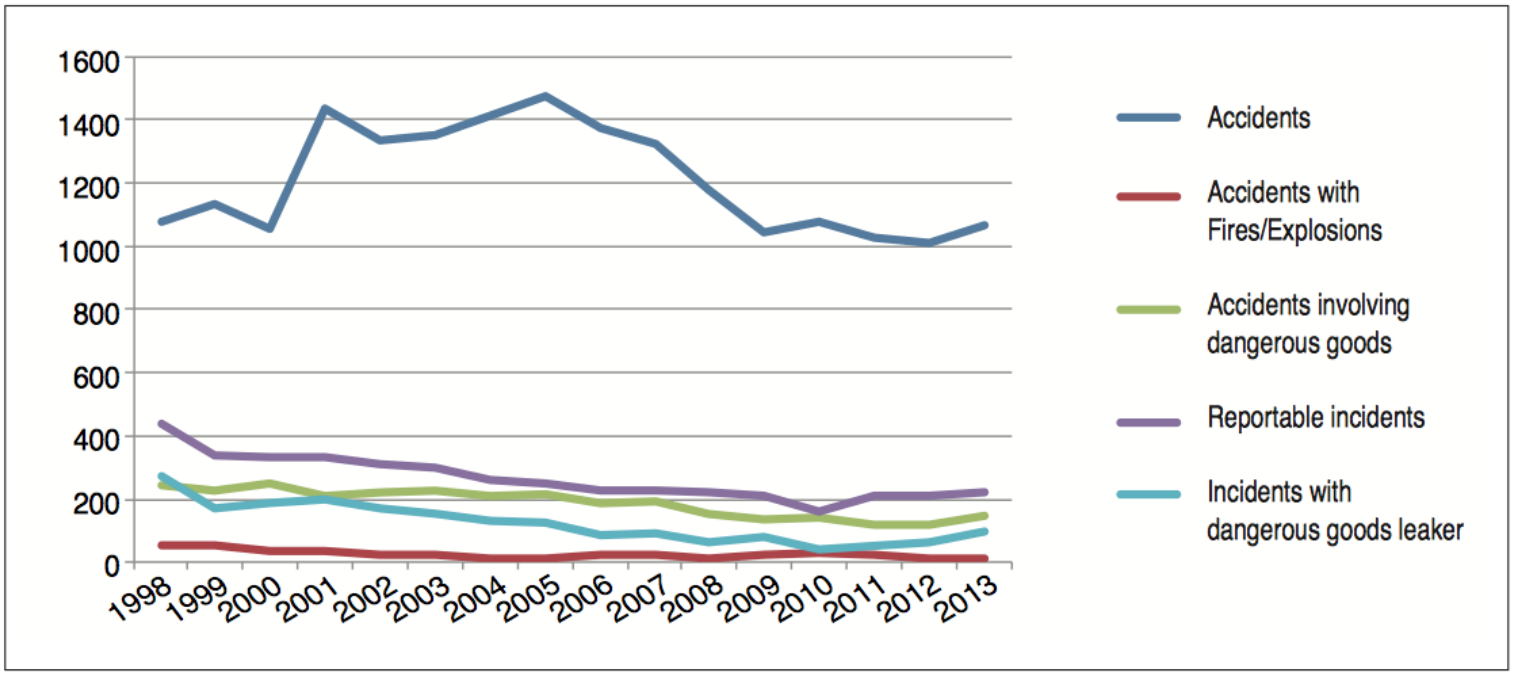


Figure 10. Measures of railway occurrence rates[72]

	Total Accidents	Accidents per				Main-track accidents per
		Million train kilometres	Thousand train hours	Million locomotive unit kilometres	Billion tonne kilometres	Million main-track train kilometres
1998	1,075	8.38	0.37	3.24	2.00	4.67
1999	1,129	8.89	0.39	3.75	2.02	4.83
2000	1,054	8.14	0.35	3.28	1.77	4.34
2001	1,432	11.16	0.48	4.58	2.43	4.99
2002	1,332	10.17	0.45	4.45	2.27	3.70
2003	1,352	10.33	0.44	4.45	2.22	4.18
2004	1,413	10.66	0.44	4.56	2.19	4.34
2005	1,476	10.82	0.45	4.65	2.19	4.67
2006	1,371	10.12	0.44	4.26	2.04	3.86
2007	1,320	9.97	0.41	4.21	1.95	4.83
2008	1,179	9.19	0.39	3.87	1.85	4.02
2009	1,043	9.64	0.44	4.04	1.82	3.70

Appendix 4. Definitions

[72] Ibid.

Pipeline incident as defined by the AER[73]

Failure:

An incident in which product is lost, either by a leak or a rupture.

Incident:

Any incident must be reported to the AER and would include a pipeline leak, a pipeline rupture, or the striking of a pipeline (hit), even if that strike does not cause any loss of product.

Hit:

A hit is an incident where a pipeline is struck but no product is lost.

Leak:

A leak is defined as a pipeline failure where a pipeline is losing product but might continue to operate until the leak is detected.

Release:

The loss of product from a pipeline. A pipeline incident or failure may result in more than one release, as gas, oil, and water are counted as separate product releases. This is why some charts indicate more releases than incidents.

Rupture:

A pipeline failure where a pipeline cannot continue to operate.

Reportable pipeline incident:

Any incident must be reported to the AER and would include a pipeline leak, a pipeline rupture, or the striking of a pipeline (hit), even if that strike does not cause any loss of product. Note that pressure-test failures, though reportable as incidents, are reported separately in this report to allow a differentiation between operational incidents and qualification incidents.[74]

More specifically:

- Any unrefined product release of more than 2 m^3 on lease

[73] Alberta Energy Regulator, *Report 2013-B: Pipeline Performance in Alberta, 1990-2012*
[74] "Compliance Dahsboard," last modified August, 31, accessed September, 10, 2015, http://www1.aer.ca/compliancedashboard/incidents.html?searchcol=1&searchstr=20151882.

- Any substance release that may cause, is causing, or has caused an adverse effect
- Any substance release off lease
- Any substance release into a water body
- Any pipeline release or pipeline break (including during pressure testing) Pipeline hits
- Any uncontrolled gas release of more than 30 000 m^3
- Any well flowing uncontrolled Any fire caused by a flare or incinerator Any fire causing a loss of more than 2 m^3 of oil or 30 000 m^3 of gas causing damage to a wellhead

Railway incidents as defined by TSB[75]

Railway occurrence:

Any accident or incident associated with the operation of rolling stock on a railway, and any situation or condition that the Board has reasonable grounds to believe could, if left unattended, induce an accident or incident.

Reportable railway accident:

An accident resulting directly from the operation of rolling stock, where:
1. A person sustains a serious injury or is killed as a result of:
    - Being on board or getting off the rolling stock, or
    - Coming into contact with any part of the rolling stock or its contents, or

2. The rolling stock:
    - Is involved in a grade-crossing collision
    - Is involved in a collision or derailment and is carrying passengers
    - Is involved in a collision or derailment and is carrying dangerous goods, or is known to have last contained dangerous goods the residue of which has not been purged from the rolling stock
    - Sustains damage that affects its safe operation, or
    - Causes or sustains a fire or explosion, or causes damage to the railway, that poses a threat to the safety of any person, property or the environment

Reportable railway incident

An incident resulting directly from the operation of rolling stock, where:
- A risk of collision occurs
- An unprotected main track switch is left in an abnormal position
- A railway signal displays a less restrictive indication than that required for

[75] "Report a Rail Occurence - what is a Reportable Occurence?" last modified June, 30, accessed September, 30, 2015, http://www.tsb.gc.ca/eng/incidents-occurrence/rail/.

the intended movement of rolling stock
- An unprotected overlap of operating authorities occurs;
- A movement of rolling stock exceeds the limits of its authority
- There is runaway rolling stock
- Any crew member whose duties are directly related to the safe operation of the rolling stock is unable to perform the crew member's duties as a result of a physical incapacitation that poses a threat to the safety of any person, property or the environment
- Any dangerous goods are released on board or from the rolling stock

Dangerous Goods

An accident is considered to have dangerous goods involvement if any car in the consist carrying (or having last contained) a dangerous good derails, strikes or is struck by any other rolling stock or object. It does not mean that there was any release of any product. Also included are crossing accidents in which the motor vehicle involved (e.g. tanker truck) is carrying a dangerous good.

Appendix 5: Pipeline Emergency Response Protocol

Protective Directive 071[76]

Corporate-level ERP Requirements

Site-specific ERPs are not required for every drilling, production, or pipeline operation in the province. When a site-specific ERP is not required, a corporate-level ERP is used by the licensee to handle emergency events.

1) The licensee must have a corporate-level ERP with preplanned procedures that will aid in effective response to an emergency.

The licensee is expected to determine the level of detail required to address each item in a corporate-level ERP based on the hazards and potential consequences of the emergency scenarios that its operations pose to the public and/or environment and to keep the plans current. Corporate-level ERPs do not require AER approval; however, the AER may request that they be submitted for review.

2) As a minimum, the licensee must include the following information in its ERP:

- Key licensee contacts
- A 24-hour licensee emergency contact telephone number
- A method of classifying incidents and response actions for specific incidents
- A communications plan that addresses
    - Communication with response team, support services, and government
    - Communication with the public and media
    - Downgrading and stand-down of emergency levels
- Responsibilities of personnel required to respond to an emergency
- Establishment of incident management systems
- Activation of a reception centre

3) The licensee must ensure that a call to its 24-hour emergency telephone number initiates immediate action.

4) The licensee must ensure that its 24-hour emergency telephone number is posted by way of a conspicuous sign erected at the primary entrance to all licensee wells and facilities.

Assessment Matrix for Classifying Incidents

[76] Alberta Energy Regulator, *Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry*, 95

The ERCB has developed an assessment matrix so that incidents can be classified and communicated to others by industry, local authorities, RHAs, and government agencies in a consistent manner throughout the province.
5) The licensee must include all the information in Appendix 4 in its corporate-level ERP.

6) The licensee must define appropriate actions, including public protection measures that would be taken for each level of emergency.

Communications Planning

The development and implementation of an effective communications plan is essential to emergency response.

7) In its corporate-level ERP, the licensee must

- Describe its procedures for contacting and maintaining communication with key licensee personnel, government agencies, support services, members of the public, and the media
- Clearly define the responsibility to contact the ERCB and other responders in the event of an emergency; the ERCB recommends that a communications flow chart be included in the ERP, identifying responsibilities by role
- Describe procedures that will be implemented during an incident to contact and maintain communication with directly impacted members of the public in order to keep them informed of the situation and the actions being taken; this includes plans for communicating the implementation of public protection measures, such as evacuation and sheltering in place for residents
- Describe procedures that will be used to inform and update the media and procedures in getting factual messages out to the public at large in an expeditious manner
- Describe procedures to downgrade and stand-down levels of emergency

Responsibilities of Personnel

8) The licensee must identify the roles and responsibilities of personnel required to effectively respond to an emergency. One or more functions can be assigned to an individual depending on the complexity of the potential response to an emergency.

Incident Management Systems

9) In its corporate-level ERP, the licensee must

- Describe how it will manage and coordinate a response to an emergency
- Address the roles and responsibilities of personnel at its on-site command post, the company regional emergency operations centre (REOC), and the corporate EOC

The licensee is expected to clearly outline the communication protocols and procedure to be used between these command centres to provide effective information flow among licensee representatives and other responders at the emergency site, corporate-level decision-makers, the ERCB, and other government departments and agencies. The ERCB strongly supports the use of the incident command system (ICS) as a means of ensuring consistent command and communication among all parties.

Reception Centre

10) In its corporate-level ERP, the licensee must set out the procedures for

- Activating a reception centre located at a safe distance from the release source
- Meeting and registering evacuees at the reception centre

Emergency Planning and Response Zones

An emergency planning zone (EPZ) is a geographical area surrounding a well, pipeline, or facility containing hazardous product that requires specific emergency response planning by the licensee.

1) The licensee must ensure that the actual size and shape of the final EPZ reflect

- Site-specific features of the area
- Information gathered during the public involvement program
- Factors such as population density, topography, and access/egress routes, which may affect timely implementation of emergency response procedures in the EPZ

Preparing for the Public Involvement Program

2) The licensee must identify all residents and local authorities within and adjacent5 to the EPZ.

3) If an EPZ intersects an urban density development, the licensee must include the entire development within the EPZ for the purpose of conducting the public involvement program.

4) If an EPZ includes a portion of an urban centre, the licensee is not required to identify each individual residence within the urban centre; however, contact must be made with the appropriate urban director(s) of emergency management to review key emergency response information and confirm and coordinate each party's roles and responsibilities.

5) Prior to commencement of the public involvement program, the licensee must confirm and coordinate roles and responsibilities in accordance with the protocols established with

- The local authorities
- The directors of emergency management (or designates/deputy directors) for all municipalities within and adjacent to the EPZ
- The local RHA or applicable federal health branch

6) The licensee must attempt to reach a mutual understanding with local authorities on the specific needs and roles and responsibilities of each party during an emergency and include a summary of the roles and responsibilities in its ERP reflecting the mutual understandings.

Public Information Package

Although the public information package may vary in content, it should contain sufficient information to ensure that the persons contacted understand the nature of the operation, the impact an emergency may have on them, the procedures in place to respond to an emergency, and the public protection measures.

Public Protection Measures

ERPs address key roles and responsibilities of responders to protect the public during emergency situations. The following identifies the public protection measures that the licensee is required to address in its ERP:

- Notification Within the EPZ
- Evacuation and/or Sheltering Within the EPZ
- Notification and Evacuation Outside the EPZ
- Ignition Criteria
- Isolation Procedures
- Air Quality Monitoring
- Maps
- Equipment List
- Mutual Aid Understandings
- Telephone Lists
- Plan Distribution
- Communications Planning
- Responsibilities of Personnel
- Incident Management Systems
- Record Keeping
- Downgrading and Stand-Down of Emergency Levels

Appendix 6: Rail Emergency Response Protocols

Safety Management Systems (SMS)[77]

A safety management system provides a proactive approach to identifying safety risks and to taking action to eliminate or mitigate those risks in order to prevent accidents and other dangerous situations.

The *Railway Safety Management System Regulations, 2015* apply to all companies that fall under the authority of the *Railway Safety Act*. This includes federal railway companies and local railway companies. Local railway companies are provincial short lines, light rail transit, and tourist trains that operate equipment on federally regulated tracks.

Federal railway companies need to develop and implement a safety management system, create an index of all required processes, keep records, notify the Minister of proposed changes to their operations, and file safety management system documentation with the Minister when requested.

More specifically, federal railway companies must develop and implement a safety management system that includes:

- Accountability: Identification of an accountable executive who is responsible for the company's safety management system
- A safety policy: A written company commitment to promoting railway safety
- Ensuring compliance with regulations, rules and other instruments: Includes listing the regulations, rules and other instruments that apply to the railway company, monitoring changes to them and ensuring company compliance
- Managing railway occurrences: A communicated procedure for employees to report an occurrence, such as an unplanned and uncontrolled train movement, to management and reviewing the occurrence
- Identifying safety concerns: Analysis to identify trends and repetitive situations that may be a safety concern
- Risk assessments: Evaluation of the level of risk of an identified safety concern or of risks that may be posed by a potential change to railway operations
- Remedial action: Taking action to address identified safety risks and evaluating the effectiveness of the action taken
- Safety targets and initiatives: Establishing annual safety targets and developing related initiatives to achieve each target
- Reporting contraventions and safety hazards: Procedure for employees to report to the railway company, without fear of reprisal, a safety hazard or contravention

[77] Transport Canada, *Safety Management Systems- Frequently Asked Questions*

- Managing knowledge: Listing the essential duties for safe railway operations, the positions performing those duties, and ensuring that employees in those positions have the required qualifications for performing each duty.
- Scheduling: Apply principles of fatigue science when scheduling work of certain railway employees
- Continual improvement: Continuous monitoring by the company of the implementation of its safety management system and the completion, by the company, of an internal audit of its system every three years

Federal railway companies and local railway companies operating on main track company must file the following safety management system information with the Minister of Transport upon request:

- Index of the company's safety management system
- Safety targets and initiatives
- Annual monitoring report
- Signed internal audit
- Risk assessments

Emergency Response Assistance Plans (ERAPs)[78]

The ERAP will describe the specialized response capabilities, equipment and procedures that will be used to support a response to incidents involving high-risk dangerous goods. The plan will also address emergency preparedness, including personnel training, response exercises and equipment maintenance. The ERAP plans supplement those of the carrier and of the local and provincial authorities, and must be integrated with other organizations to help mitigate the consequences of an accident. This integration is usually accomplished by working within an incident management system – usually an Incident Command System or ICS. The ICS is a system where multiple authorities and response organizations are integrated into a common organizational structure designed to improve emergency response operations. The Incident Commander is the person with overall responsibility for the response and is usually a senior member of the local fire or police department.

A Transport Canada approved ERAP is required by a person who imports or offers for transport a dangerous good consignment that requires an ERAP. Note that for the purpose of the TDG Act and Regulations, a person includes an organization or company. The term "offer for transport" is defined in the TDG Regulations as follows:

Offer for transport means, for dangerous goods not in transport, to select or allow the selection of a carrier to transport the dangerous goods, to prepare or allow the

[78] Transport Canada, *Emergency Response Assistance Plans (ERAPs)*

preparation of the dangerous goods so that a carrier can take possession of them for transport or to allow a carrier to take possession of the dangerous goods for transport.

The emergency response assistance plans must address the following basic elements of emergency response:

Hazard Identification and Analysis

A Potential Accident Analysis must be included in the plan as per the TDG Regulations, including an analysis of how an accidental release could occur, potential consequences related to a release and response actions that can be taken to mitigate the release or potential release.

Roles and Responsibilities

The roles and responsibilities of key personnel must be described in the plan, including senior-level management (for authorizations), technical advisors, team leaders, response team members, specialized resources that are critical to the response (e.g. media relations, medical resources).

Resources

The plan must include internal and external resources required for response, including response contractors, technical advisors and resources for specialized tasks (e.g. vent and burn).

Third Party Agreements (if applicable)

Third party agreements between the plan holder and the primary response contractor must be provided. Agreements between the primary response contractor and the subcontractors must also be provided describing the product(s) to which the subcontractors will respond and the resources they must supply. All copies of the agreements must be signed.

Emergency Response Procedures

The ERAP must include written procedures for critical tasks (e.g. product transfer, containment). Those procedures may be in a different document if referred to in the ERAP and provided with the application.

Contact Lists

The plan must include a contact list for internal and external resources that are required to support the response. For example, this would include contact information for response contractors, suppliers, poison control centres, air or marine charters.

Records

Records must be maintained for training and exercises related to the plan, equipment maintenance and ERAP activation and must be available to TDG Inspectors upon request. Documentation of accident response debriefs is also recommended. The plan holder must maintain a listing of emergency response activities related to response to products requiring an ERAP including a brief description of the remedial actions taken.

Plan Activation

The ERAP must specify the steps necessary for its activation in an emergency. It must include procedures to notify key response personnel.

Response Actions

The plan must describe the response actions that can be implemented to support a response (e.g. containment, confinement, transfer, neutralization)

Situation Assessment

A situation assessment is required to help responders define critical objectives and priorities for response. The situation assessment must be re-evaluated continuously and must address the following:

- The specific nature of the emergency (e.g. product, releases or potential for release, fire
- Modifying conditions (e.g. weather, location, topography)
- Potential threats to life, property and the environment
- Appropriate protective and corrective strategies
- Re-evaluation of the situation on a continuous basis

Resource Mobilization

The plan must address mobilization of response resources, including identification of persons with the authority to mobilize resources. Mobilization options must be appropriate for the geographical area of coverage and mode of transport (e.g. consider air and marine transport as appropriate).

Damage Assessment

The ERAP must address the assessment of damage to the means of containment to determine the best course of action (i.e. product transfer, depressurization, etc.). Resources with expertise in damage assessment must be identified in the plan. The plan should also identify the criteria or methodology used to conduct a damage assessment.

Training and Exercises

Response personnel identified in the ERAP must be trained on critical aspects of the response plan (e.g. product transfers, air monitoring, containment options, Incident command system, etc.). A training matrix must be included in the plan.

Equipment Availability and Maintenance

The plan holder or contractor must identify how the response equipment identified in the ERAP is adequate; available from a geographic perspective, can be used in a timely manner and serves its purpose. The response equipment must also be inspected and maintained in a state of readiness. Inspection and maintenance records must be retained and made available to a TDG inspector upon request.