TRANSCANADA PIPELINES LIMITED ENERGY EAST PIPELINE PROJECT

Background Report on Potential Engineering and Safety Considerations Associated with Proposed Energy East Pipeline Project

Ontario Energy Board

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Task and objective:
To prepare a report summarizing the key engineering and safety considerations associated with the proposed Energy East Pipeline Project.

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Reference to part of this report which may lead to misinterpretation is not permissible.

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Draft	2014-01-20	First issue of Draft Report	Erin Doerffer	Kim Maddin	Jake Abes
1	2014-03-11	Final Report issued after submission of Project Description to NEB	Erin Doerffer	Kim Maddin	Jake Abes
2	2014-03-14	Amended Figure 1	Erin Doerffer	Kim Maddin	Jake Abes

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1 OVERVIEW OF THE ONTARIO ENERGY BOARD PROCESS

The Ontario Minister of Energy has asked the Ontario Energy Board (OEB or the Board) to prepare a report on TransCanada PipeLines Limited's (TransCanada) proposed Energy East Pipeline project. Specifically, in a letter dated November 12, 2013, the Minister asked the Board to examine and report on the project from an Ontario perspective and to consider the implications of the following:

a. The impacts on Ontario natural gas consumers in terms of prices, reliability and access to supply, especially those consumers in eastern and northern Ontario.
b. The impacts on pipeline safety and the natural environment in Ontario.
c. The impacts on local communities and Aboriginal communities in Ontario.
d. The short and long-term economic impacts of the project in Ontario.

To support the preparation of this report, the Minister has asked the Board to consult broadly and transparently with the people of Ontario, including local communities, stakeholders and First Nations and Metis communities, focusing on the above issues and providing a forum for Ontarians to express their views on the proposed Energy East Pipeline project.

The key steps in the OEB's planned process are illustrated below:

Figure 1: The OEB's Planned Process

Details regarding each of the steps will be issued in due course.

2 DNV GL'S ROLE IN THE ONTARIO ENERGY BOARD PROCESS

The OEB has retained DNV GL (Det Norske Veritas) to provide expert advice on the engineering, and pipeline safety and integrity considerations that relate to the Energy East Pipeline project.

DNV GL is a global provider of risk management services with the purpose of safeguarding life, property and the environment. Organized as an independent, autonomous foundation, DNV GL balances the needs of business and society, based on its independence and integrity. With its vision of creating a global impact for a safe and sustainable future for its customers and, ultimately, society at large, DNV GL serves a range of high-risk industries, with a special focus on the maritime and energy sectors.

DNV GL has been asked to prepare this Background Report on the proposed Energy East Pipeline project. This report will briefly describe the regulatory oversight that will apply to the proposed pipeline project; provide an overview of the proposed project; outline the engineering, and pipeline safety and integrity considerations typically used to assess such projects; and identify potential high-level engineering, and pipeline safety and integrity impacts of the project within the province of Ontario.

In addition to this Background Report, DNV GL will also prepare a second report entitled Report on Potential Impacts on Ontario (the Impact Report). The Impact Report will include information that TransCanada will file with the National Energy Board on the proposed project (see section 4). It will also outline the potential impacts to customers in northern and eastern Ontario with regard to engineering and pipeline safety and integrity considerations in relation to the Energy East Pipeline project.

All materials will be posted on the Board's website.

3 REGULATORY OVERSIGHT OF THE ENERGY EAST PIPELINE PROJECT

The proposed Energy East Pipeline project falls under the jurisdiction of the National Energy Board (NEB), the federal regulatory agency that exercises jurisdiction over interprovincial and international oil and gas pipelines. Pipelines that are designed, constructed, operated, converted or abandoned under NEB jurisdiction must comply with the requirements of the NEB Act and the NEB Onshore Pipeline Regulations (NEB OPR), which are enacted by the NEB Act. In addition, adherence to the latest edition of Canadian Standards Association (CSA) standard CSA Z662 – Oil and Gas Pipeline Systems (CSA Z662) is a mandatory requirement as it is incorporated by reference in the NEB OPR. Both the NEB OPR and CSA Z662 include requirements for pipeline design, materials selection, installation, testing, operation and maintenance, abandonment, etc. Furthermore, new pipeline construction greater than 40 kilometers (km) in length requires an Environmental and Socio-Economic Assessment (ESA) under the NEB Act and an assessment under the Canadian Environmental Assessment Act, 2012 (CEA Act, 2012).

The NEB publishes a Filing Manual, which is a guide to the information required in an application. In some cases, a company may file a project description in advance of its formal application. The project description is not an application and as such, is not binding; rather, it provides preliminary information about an expected application. TransCanada filed its project description with the NEB on March 4, 2014, and indicated that it expected to submit its formal application in the third quarter of 2014. The formal application must outline, among other matters, the engineering design, construction, environmental, and pipeline safety considerations. The NEB will assess the application for compliance with the NEB Act, its regulations, and applicable standards. It may ask for further information during the application process to address any issues specific to the proposed project.

If the proposed project is approved, the NEB will monitor compliance during construction and operation by performing compliance verification activities such as inspections, compliance meetings, emergency exercises, audits and investigations.

4 OVERVIEW OF TRANSCANADA'S ENERGY EAST PIPELINE PROJECT

TransCanada's existing natural gas transmission system consists of five parallel natural gas pipelines stretching more than 14,000 km from the Alberta-Saskatchewan border east to the Québec-Vermont border. TransCanada's Energy East Pipeline project will convert one of these pipelines from carrying natural gas to carrying crude oil. The proposed crude oil pipeline is approximately 4,500 km in length and would carry roughly 1.1 million barrels per day of crude oil from Alberta and Saskatchewan to refineries in Eastern Canada.

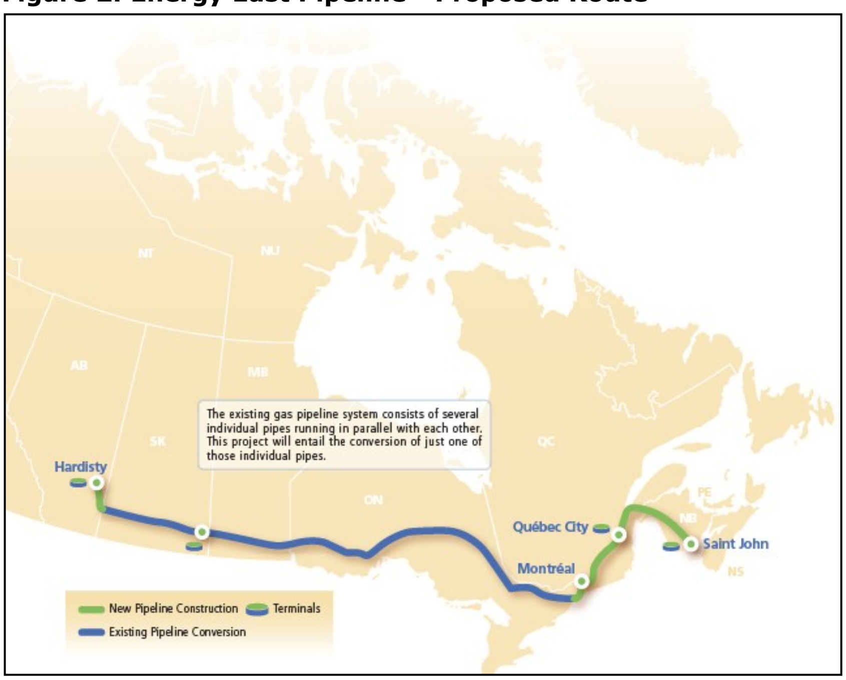
The Energy East Pipeline project would include the conversion of approximately 3,000 km of existing natural gas transmission pipeline to the carriage of crude oil, the construction of up to 1,500 kilometres of new pipe in Alberta, Saskatchewan, Manitoba, eastern Ontario, Québec, and New Brunswick to link up with the converted pipe, and four new oil terminals: one near Hardisty, Alberta, one near Moosomin, Saskatchewan, one near Rivière-du-Loup at Cacouna, Québec, and another in the Saint John, New Brunswick area. The project also includes marine tanker loading facilities in the Cacouna and Saint John areas.

As illustrated in Figure 2, the Energy East Pipeline project is comprised of three major pipeline segments. First, new pipeline would be built from Hardisty, Alberta to Burstall, Saskatchewan. Second, the converted pipeline would run from Burstall, Saskatchewan to a point near Cornwall, Ontario. Finally, new pipeline would be built from Cornwall, Ontario to Saint John, New Brunswick. The Energy East Pipeline would deliver oil to existing refineries in Montréal, near Québec City, and in Saint John, as well as the marine loading facilities.

The project is expected to parallel the Trans-Canada Highway for the majority of the route. Approximately 70% (i.e., 3,000 km/4,500 km) of the proposed Energy East Pipeline project is already in the ground and, of the remaining 30% new build portion, more than half will parallel existing rights-of-way.

Subject to regulatory approval from the NEB, construction is anticipated to begin in early 2016. The exact route being proposed will be determined after the NEB completes its public consultation and regulatory review process.

Figure 2: Energy East Pipeline - Proposed Route



Source: www.energyeastpipeline.com

5 GENERAL ENGINEERING, PIPELINE SAFETY AND INTEGRITY CONSIDERATIONS

The general technical considerations in this section have been developed on the basis of a review of NEB requirements, including CSA Z662, as well as recent project applications before the NEB. A summary of the information provided in the Project Description is provided for each topic. Section 5.1 is particularly relevant for new pipelines. Section 5.2 is specifically relevant to pipeline projects involving a change in the fluid transported in the pipeline (service fluid). Section 5.3 is relevant for all pipeline projects.

5.1 Considerations for New Pipelines

5.1.1 Engineering Design

The NEB has stated that, in determining whether a proposed project meets regulatory requirements, it assesses "whether the facilities are appropriately designed for the properties of the product being transported, the range of operating conditions, and the human and natural environment where the facilities would be located." The particular focus of this assessment varies with the specifics of each construction project. Recent issues which have been assessed in detail by the NEB include:

- Pressure design, which takes into account pipeline maximum operating pressure and pressure cycling (repetitive fluctuations in pipeline pressure) among other factors;
- Depth of cover, which is the measure of distance between the top of the pipeline and the ground surface;
- In-line inspection capability, to determine whether or not the pipeline has been designed to allow for internal inspection tools that are used to monitor the condition of the pipeline;
- Design for population density and land usage, which affect the wall thickness and valve locations along the pipeline, among other things;
- Geotechnical issues, which refer to the movement of the earth; for example, frost heave, slope instability, or earthquakes;
- Design for emergency response capability along the pipeline route, which influences valve type, location and spacing, which, in turn, has an effect on the potential volume of oil released should a leak occur; and
- Pressure control and overpressure protection, which are systems or devices that regulate or limit the pressure in a pipeline to prevent damage to the pipeline should the pressure exceed a set limit.

The maximum operating pressure of the new sections is planned to be higher than that of the conversion sections, but is not specified in the Project Description.

Regarding in-line inspection, the Project Description states that "launcher and receiver facilities will be installed to ensure that the entire pipeline can be cleaned and inspected by in-line cleaning and inspection tools." This is typical for a modern pipeline.

TransCanada is in the process of public consultation regarding population density and land usage. Valve placement and wall thickness will be determined during detailed design.

Similarly, geotechnical issues, if any, will be addressed during detailed design. The Project Description states that geotechnical studies are planned.

Mainline block valves (also called shutoff valves) are planned for every pump station, plus other locations as appropriate. The locations would be determined during detailed design and would take into account populated areas, municipal water intakes, and other concerns such as environmental sensitivity. TransCanada plans to operate the Energy East pipeline from its Operations Control Centre in Calgary, Alberta. Emergency response is addressed in further detail in sections 5.3.1.3 and 6.3 of this report.

With respect to pressure control, the Project Description states that pressure will be controlled by adjusting the speed of the pumps along the route.

5.1.2 Material Specifications

CSA Z662 stipulates that materials and equipment that will become part of a pipeline system shall be suitable for the conditions to which they are to be subjected. Material specifications generally refer to specifications for steel pipe and components. For steel pipe, the specifications would include:

- Material properties (e.g. pipe grade (strength), notch toughness);
- Pipe manufacturing process; and
- Dimensional requirements (e.g. diameter, minimum wall thickness, tolerances).

Material specifications also include specifications for the external corrosion protection coating on the pipe.

The Project Description indicates that TransCanada intends to use pipe in sizes up to 1067 mm (NPS 42) in both the new and conversion sections.

5.1.3 Construction Specifications

Construction specifications are routinely developed and include requirements for:

- Right-of-way clearing and grading (i.e. removal of vegetation from the pipeline right-of-way);
- Handling, transport and storage of pipe and components, to ensure that no damage is sustained by the pipe or components;
- Welding and non-destructive testing, which consists of x-ray or ultrasonic processes to examine field welds for defects;
- Field joint coatings, which are applied to field welds to protect them from corrosion when the pipe is in service;
- Ditching and lowering-in;
- Backfilling;
- Crossings (e.g. river crossings, road crossings);
- Horizontal directional drilling, which is a method of installing a pipeline by pulling it through a hole drilled horizontally beneath the ground. This method is often employed to avoid environmentally sensitive areas such as wetlands or rivers, but may not always be possible depending on the area’s geology or other conditions; and
- Pressure testing, which consists of filling the pipeline with a fluid (usually water) and increasing the pressure to a level that is higher than the pressure at which the pipeline will operate in order to demonstrate that the pipeline is free from leaks and is able to operate above its intended operating pressure with a proven safety factor.

The Project Description states that in the new sections, a minimum construction right-of-way width of 32 m is expected in forested areas, and a width of 42 m in agricultural land. Other temporary workspace is expected to be required in some areas, such as for certain work related to the conversion. The construction right-of-way and temporary workspace would be reclaimed after the work is complete.

5.1.4 Quality Management

Defects originating from the pipe manufacturing process or construction can pose a risk to pipelines during operation. As a result, quality management has emerged as a critical issue for new pipeline construction. The NEB OPR requires a company to develop a quality assurance program to provide assurance that materials meet company specifications. The quality assurance program is expected to address critical aspects of pipe manufacture and construction including inspections and testing at the pipe mill, pipe and component handling requirements, inspection of anti-corrosion coating, and more. Companies must also develop and qualify welding procedures to demonstrate that they are suitable for the specific material used and conditions of each construction project, and must conduct non-destructive examination (NDE) of every weld during construction.

5.2 Considerations for Change in Service Fluid

5.2.1 Suitability of existing pipeline for a change in service fluid

Prior to a change in service fluid (e.g., conversion from natural gas to crude oil service), the company is required to conduct an engineering assessment to determine whether a pipeline system would be suitable for the new service fluid. CSA Z662 states that the following factors should be considered in the engineering assessment:

- Design basis of the pipeline, including service fluid, operating pressure and temperature range, and the general and site-specific loading conditions that are anticipated throughout its design life;
- Construction and testing specifications;
- Condition of the piping, including type, dimensions, and dimensional uncertainty of defects;
- Mechanism or mode of imperfection formation, growth, and failure;
- Material properties;
- Service history and future service conditions;
- Appropriateness of repair methods;
- External influences (including risk of 3rd party damage to the pipeline, induced AC current from nearby high voltage lines, ground movements, etc.); and
- Hazards and consequences of failure.

TransCanada plans to perform an in-line inspection of the pipelines to be converted while they are still in gas service, and would repair or replace the pipe as necessary.

5.3 Considerations for all Pipelines

5.3.1 Management System

The NEB OPR requires companies to have management systems that address their obligations for safety, security, and protection of the environment. The NEB describes a management system as providing "*a consistent framework for the design, development and implementation of protection programs, as well as for the cyclical planning, implementation, review and adjustment of operational activities…*"

Management system requirements do not change depending on the location, age, or condition of the pipeline. A management system must include a process for hazard identification and risk assessment which will identify those factors, among others, and describe the process for ensuring that appropriate mitigation or controls are put in place to address them.

In addition to the requirements of the OPR, CSA Z662 sets out requirements and guidelines for a Safety and Loss Management System.

The management system must apply to all company activities involved in the design, construction, operation or abandonment of a pipeline, as well as the following programs:

- Safety;
- Integrity management;
- Environmental protection;
- Pipeline control system and leak detection;
- Emergency management; and
- Security management.

Some of these programs are discussed further in the following sections.

5.3.1.1 Integrity Management

The NEB OPR requires a company to develop, implement and maintain an integrity management program that anticipates, prevents, manages, and mitigates conditions that could adversely affect safety or the environment during the design, construction, operation, maintenance, or abandonment of a pipeline. Further, Annex N of CSA Z662 provides detailed guidelines for integrity management programs, including provisions for hazard identification, risk assessment and risk mitigation.

The Project Description indicates that TransCanada’s standard preventative maintenance programs and integrity management program would be used if the Energy East project is approved.

5.3.1.2 Pipeline Control System and Leak Detection

Leak detection and pipeline control, including the ability to remotely operate or shut down the pipeline, are critical elements of pipeline operation. The NEB’s regulations specify that the leak detection system must be appropriate to the product and the complexity of the pipeline, and that the company’s programs and management systems must provide the details on how the company will achieve this.

In addition, Annex E of CSA Z662 provides a recommended practice for leak detection. The NEB has in the past required companies to provide details about the pipeline control and leak detection systems during the application process.

The Energy East pipeline would be remotely controlled from TransCanada’s Calgary Operations Control Centre, as described in section 5.1.1 of this report.

5.3.1.3 Emergency Management

The NEB OPR requires companies to develop and maintain an emergency management program, that should include information relating to the assessment of hazards, the determination of response capability, the planning and implementation of emergency exercises, processes for the development of response procedures, processes for liaison with and continuing education of emergency response organizations along the pipeline route (police, fire departments, medical facilities etc.), and processes for liaison with and continuing education of the public along the pipeline route.

The NEB OPR additionally requires companies to develop and submit copies of its emergency response procedures to the NEB. Such procedures generally include roles and responsibilities in the event of an emergency, response procedures and contact lists.

The Project Description indicates that emergency response plans will be developed and response equipment will be stored along the pipeline route, with the cache locations to be determined based on risk assessment, community feedback, and other considerations. Operations staff based along the pipeline will be trained in TransCanada's emergency response procedures.

TransCanada plans to liaise with local emergency responders in developing its response plans. In the event of an incident, it would use a modified version of the Incident Command System to enter into a Unified Command with the appropriate agencies, and manage the response to the incident.

5.3.1.4 Security Management

The NEB OPR requires companies to comply with the Canadian standard CSA Z246.1, *Security Management for the Petroleum and Natural Gas Industry Systems*. This standard requires that a company develop a security management program to ensure that security incidents and threats to operations are identified, and that risks are assessed and managed through controls and response procedures. This security management program would include:

- Asset characterisation;
- Risk assessment;
- Threat assessment;
- Vulnerability assessment;
- Risk mitigation; and
- Communication and recommendations.

6 POTENTIAL ENGINEERING AND PIPELINE SAFETY CONSIDERATIONS FOR THE ENERGY EAST PIPELINE PROJECT

Although TransCanada has not yet filed its application with the NEB, and the Project Description did not address engineering in detail, it is possible to develop a preliminary list of potential considerations. These high level considerations are discussed in the following sections.

6.1 Quality Management

Given the critical importance of quality management during pipe manufacture and construction, it is believed that quality management will be a major consideration for the Energy East Pipeline project.

New pump stations are planned along the existing pipeline. Generally speaking, pump stations and other above-ground facilities are constructed in a modular fashion, with segments of piping and instrumentation pre-assembled in a fabrication shop, then transported to the site and bolted or welded in place. This allows the environmental conditions during construction, which can affect weld quality, to be more carefully controlled. The NEB has stated that it expects a company's quality management to extend to such fabrication.

6.2 Leak Detection

In a previous pipeline application before the NEB, TransCanada provided goals for its leak detection system, and committed to following CSA Z662 Annex E, which is a recommended practice for leak detection in liquid hydrocarbon pipelines.

The NEB has recently increased its scrutiny with regard to leak detection systems on oil pipelines, and has included conditions pertaining to leak detection in its recommendation for approval of the Northern Gateway project, issued December 19, 2013.

6.3 Emergency Management

Given that a significant portion of the Energy East Pipeline project will involve the conversion of an existing pipeline from natural gas to crude oil service, the nature of emergency management on the system will change. The consequences of a failure on a natural gas pipeline are significantly different from those of a crude oil pipeline.

It is expected that TransCanada will be required to demonstrate that it has, among other things, performed appropriate hazard assessments, procured sufficient and appropriate equipment to respond to emergencies, provided sufficient training to its responders and to emergency response agencies, and instituted a public awareness program for people who live or work along the pipeline route.

For example, in its assessment of a previous conversion project, the NEB focused on the technical and training implications of the change in service fluid from natural gas to crude oil. It requested details of the operators' and emergency responders' training, new operating procedures for liquid service, and emergency response procedures, including a program for liaison with community first responders.

Further, the NEB examined the project proponent's ability to respond to a major containment failure early in the project's lifetime, with specific focus on commissioning and the first year of operation.

6.4 Suitability of existing pipeline for a change in service fluid

As noted previously in section 5.2, for the portion of the project that requires conversion from natural gas to crude oil service, TransCanada will be required to conduct an engineering assessment to determine whether a pipeline system would be suitable for the new service fluid.

Some of the factors that will likely need to be considered in an engineering assessment for the Energy East Pipeline project are:

1. Whether the existing pipeline meets the requirements of the current CSA standards which address:
    - Pipe specifications[1] (i.e. requirements for pipe diameter, wall thickness, strength, etc.);
    - Coating specifications[2] (i.e. requirements for type of coating, and its application);
    - Construction specifications (i.e. requirements for the welding, field-coating, installation etc. of the pipe); and

[1] Refer to CSA Z245.1 – Steel Pipe
[2] Refer to CSA Z245.20 Series-10 – Plant-applied external coatings for steel pipe

- Design specifications[3] (i.e. requirements that take into account the pressure of the pipeline, population density around the pipeline, pipeline route, etc.).

2. An assessment of the condition of the existing pipeline:

   - Information on imperfections on the pipeline (i.e. dimensions, type, location, growth mechanisms, etc.);
   - Failure history of the pipeline;
   - Repair history of the pipeline;
   - Operating and maintenance history of the pipeline;
   - The effect of the change in operating conditions arising from the change in service fluid on the future integrity of the pipeline. Particular consideration will likely be given to the careful assessment of cyclic loading (repetitive pressure fluctuations causing changes in pipe stress) and fatigue associated with liquid service on the growth rate of existing features in the conversion section; and

3. The measures that may be necessary to make the pipeline suitable for the change in service fluid.

In order to perform an effective engineering assessment, it is expected that TransCanada will need to use a variety of methodologies to assess the system's current condition. Input data used to complete these assessments are based on the requirements included in CSA Z662 and may include mill test records, historical pressure test records, historical leak and failure data, historical repairs, in-line inspection data, measurements of pipe condition from field excavation, and cathodic protection records.

[3] Refer to CSA Z662 – Oil and Gas Pipeline Systems

7 REFERENCES

/1/ Energy East Pipeline website http://www.energyeastpipeline.com/home/route-map/ accessed 7 November 2013

/2/ National Energy Board website http://www.neb-one.gc.ca accessed 14 November 2013

/3/ Energy East Pipeline project description, filed with the National Energy Board on 4 March 2014

/4/ National Energy Board Filing Manual revision 2013-03

/5/ National Energy Board Onshore Pipeline Regulations (SOR/99-294)

/6/ National Energy Board Pipeline Crossing Regulations Part II (SOR/88-529)

/7/ CSA Z662-11 Oil and Gas Pipeline Systems

/8/ CSA Z246.1, Security Management for the Petroleum and Natural Gas Industry Systems

/9/ CSA Z245.1 – Steel Pipe

/10/ CSA Z245.20 Series-10 – Plant-applied external coatings for steel pipe

/11/ Reasons for Decision – TransCanada Keystone Pipeline GP Ltd. – OH-1-2007

/12/ Certificate OC-51 approving the Keystone Pipeline Project

/13/ Northern Gateway project draft conditions, dated 12 April 2013, filing reference number A3G7X1

/14/ Compliance Verification under the National Energy Board Act In the Matter of Enbridge Pipelines Inc. - Edmonton Control Room Inspection and Assessment

About DNV GL

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