



National Energy
Board

Office national
de l'énergie

Investigation under the *National Energy Board Act*

In the Matter of:

**30 September 2009 release of gas and
subsequent fire at the Enbridge Gas
Distribution Inc. Lisgar Gate Station in
Mississauga, Ontario**

November 2012

November 2012

Canada

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List of Abbreviations and Definitions

ASME	American Society of Mechanical Engineers
Board or NEB	National Energy Board
EGD	Enbridge Gas Distribution Inc. – operator of the pipeline
Hazard	Source or situation with a potential for harm in terms of injury or ill health, damage to property, damage to workplace environment, or a combination of these.
Immediate Cause	The protective or mitigative measure that failed, which leads directly to the occurrence of an incident.
IR	Information Request
NEB Act	<i>National Energy Board Act</i>
MOL	Ontario Ministry of Labour
NPS	Nominal Pipe Size (inches)
OD	Pipe outside diameter
O&M	Operations and Maintenance work
OPR-99	<i>Onshore Pipeline Regulations, 1999</i>
psi	Pounds per square inch
Risk	Combination of the likelihood and consequence(s) of a specified hazardous event occurring.
Somerville	Robert B. Somerville Co. Limited
Root Cause	The protective or mitigative measure that failed, allowing for a subsequent failure (immediate cause) that leads directly to an incident.
ROW	Right-of-way
TSSA	Technical Standards and Safety Authority

Chapter 1

Executive Summary

On 30 September 2009, Enbridge Gas Distribution Inc. (EGD) reported that a contractor had damaged an NPS 2 blowdown valve connected to an NPS 24 gas line while performing work within the boundaries of the Lisgar Gate Station in Mississauga, Ontario. Subsequently, the gas ignited, damaging a building and destroying several vehicles and construction equipment. No workers or members of the public were injured, although adjacent businesses, including a strip mall and day care, were evacuated as a precautionary measure. Damage to the environment was limited to local soil and vegetation inside the fenced area of the station property.

The National Energy Board (NEB or the Board) deployed NEB staff to the incident site to ascertain facts related to the incident and to determine the cause and contributing factors that led to the incident. As part of its site investigation, NEB staff instructed EGD to arrange for a third party to conduct a metallurgical analysis of the evidence gathered from the incident site.

During the course of the NEB investigation, the Ontario Ministry of Labour (MOL) charged EGD and its contractor, Robert B. Somerville Co. Ltd. (Somerville), with violations to the Ontario *Occupational Health and Safety Act*. These regulatory prosecutions concluded with guilty pleas in March 2012 (EGD) and July 2011 (Somerville).

The NEB's investigation included several meetings with EGD, including meetings among EGD and NEB senior management. The purpose of the meetings, beyond addressing the particulars of the incident, were to make certain that EGD understood the NEB's expectations regarding improvements to the processes and procedures used by EGD in conducting its work.

The Board's investigation of this incident concludes with the publishing of the attached report. In the report, the Board makes the following findings as to the cause and contributing factors of the incident:

Immediate Cause

- A gas release and subsequent fire occurred when contact was made with a nipple on a blind flange that had been installed on the end of a length of existing pressurized pipeline.

Contributing Factors

The NEB identified the following factors that contributed to the event:

- inadequate contractor oversight;
- ineffective operational control;
- inadequate communication between company and contractor staff; and
- inadequate hazard identification and mitigation

In response to this report, EGD will be required to demonstrate to the Board the implementation of measures to prevent a recurrence. The NEB will conduct compliance verification activities with EGD in order to verify that corrective actions have been adequately implemented to address the systemic factors identified.

The NEB has concluded its investigation and has made eight (8) findings as to incident cause and contributing factors, the details of which are included in this report.

Scope and Objectives of Investigation Under the *National Energy Board Act (NEB Act)*

2.1 Authority of the NEB to Investigate

The scope of the NEB investigation into this accident was determined in accordance with the Board's mandate as set out in the NEB Act, more particularly, subsection 12(1.1):

12(1.1) The Board may inquire into any accident involving a pipeline or international power line or other facility the construction or operation of which is regulated by the Board and may, at the conclusion of the inquiry, make

(a) findings as to the cause of the accident or factors contributing to it;

(b) recommendations relating to the prevention of future similar accidents; or

(c) any decision or order that the Board can make.

In light of the authority of the Board set out under subsection 12(1.1) of the Act, the objectives of the NEB investigation were to:

- gather all evidence related to the accident;
- conduct an analysis of the evidence;
- make findings as to the cause or factors contributing to it;
- make recommendations relating to the prevention of future similar accidents; and
- make any decision or order the Board can make, as appropriate, to prevent similar accidents from occurring.

2.2 Jurisdiction and History

2193914 Canada Limited owns, and EGD operates, an NPS 24 pipeline in Ontario (the Pipeline). The Pipeline extends some 44 km from Pine Valley Drive in Vaughan, Ontario, westerly to Steeles Avenue in Brampton, Ontario, and then southerly on the east side of Winston Churchill Boulevard, Mississauga, Ontario to a point opposite EGD's measurement and regulation station on the west side of Winston Churchill Boulevard to the property line of EGD's Lisgar Station. The Pipeline is presently interconnected with EGD's distribution system at 20 separate locations. See Maps in Appendix I for the relative location and overview of the Lisgar Gate Station.

The Pipeline was formerly owned and operated by TransCanada PipeLines Limited (TCPL) and, at the time of TCPL ownership, comprised most of TCPL's former line 200-1 between compressor station 130 in Maple, Ontario and a sales meter station, which is now the site of EGD's Lisgar measurement and regulation station.

The Pipeline was constructed by TCPL in 1957 as part of a larger pipeline system that was under the Board's jurisdiction. In 1985, TCPL abandoned a portion of the larger pipeline system in-situ and constructed a new NPS 36 pipeline in the same right-of-way (ROW) as the Pipeline.

Pursuant to Board Order MO-22-87 and MO-23-87¹ both dated 12 August 1987, Consumers' Gas (Canada) Ltd., purchased a 39 kilometre portion of Line 200-1 and leased its associated ROW from TCPL, extending from Pine Valley Drive in Vaughan to Steeles Avenue in Brampton, Ontario. On 17 December 1992, the Board issued Order MO-14-92, pursuant to sections 58 and 74 of the NEB Act, to Consumers' Gas (Canada) Ltd., granting it leave to purchase a portion of Line 200-1 from TCPL. On 17 September 2004, and as set out in Board Order XG-Z009-06-2005 dated 3 March 2005, EGD notified the Board that Consumers' Gas (Canada) Ltd. changed its name to 2193914 Canada Limited. Accordingly, 2193914 Canada Limited holds the ROW for the Pipeline pursuant to two leases from TCPL and one easement from the City of Mississauga.

The pipeline is in the Board's jurisdiction, as it is located within an NEB-regulated ROW and is subject to the Board orders referred to above. Accordingly, upon arrival on site in response to the incident, NEB staff determined that the actual release of gas that subsequently caused the fire was from the Pipeline, which was under the Board's jurisdiction. EGD operates the Pipeline for 2193914 Canada Limited and the operations and maintenance work (construction activities) at the Lisgar Station was being conducted by Robert B. Somerville Co. Limited (Somerville).

¹ Board Order XGM-17-87 authorized Consumers' Gas (Canada) Ltd. to construct and install certain interconnecting pipeline facilities, and exempted it from certain sections of the NEB Act. Board Order MO-22-87 authorized the purchase of the pipeline MO-23-87 exempted certain facilities from certain sections of the NEB Act and authorized the operation of the 39.01 km pipeline facilities. On 19 October 1987, pursuant to Board Order GPLO-C31-26-87, the Board granted Consumers' Gas (Canada) Ltd. leave to open for the transmission of gas through the 39.01 km of pipeline and related facilities. Finally, on 23 September 1987, the Board issued Board Orders AO-1-XGM-17-87 and AO-1-MO-23-87 to amend Orders XGM-17-87 and MO-23-87 to more clearly and particularly describe the facilities that were the subject of the Orders.

2.2.1 Authority to Conduct Work

The NEB received a notice of Operations and Maintenance (O&M) on 17 December 2008 outlining the work to be conducted at two locations. Work at the Lisgar Station included the following:

- installation of approximately 80 m of NPS 24 steel pipe;
- installation of a NPS 24 pig launcher;
- installation of up to 20 m of NPS 8 steel pipe;
- decommissioning of approximately 70 m of NPS 16 steel pipe; and
- decommissioning of approximately 62 m of NPS 20 steel pipe.

2.3 Incident Investigation Methodology

The NEB investigation into the Lisgar Station release of gas and fire included the following components:

- a) site observation, photographs and information gathering;
- b) interviews;
- c) information requests;
- d) analysis of evidence;
- e) determination of findings; and
- f) report.

On 5 October 2009, NEB staff conducted a site visit to the EGD Lisgar Station. After meeting with the Ministry of Labour, the Technical Standards and Safety Authority (TSSA), Somerville staff and EGD staff, the NEB Inspector confirmed that the section of pipe involved in the incident was under NEB jurisdiction. NEB Inspectors toured the site and took photographs.

Factual Information

3.1 Incident Narrative

On 30 September 2009, EGD reported that a contractor had damaged a NPS 2 nipple connected to a NPS 24 gas line while performing work within the boundaries of the Lisgar Station. The incident caused natural gas to escape and ignite, producing a flame approximately 50 metres in height.

The EGD contractor (Somerville) was conducting planned work at the Lisgar Station. During the installation of new pipe, a 2-inch nipple at the centre of a blind flange that was isolating the pressurized NPS 24 pipe was contacted, resulting in a gas release from the nipple, which ignited. The subsequent fire damaged a building and destroyed several vehicles and construction equipment. Damage to the environment was limited to local soil and vegetation within the fenced area of the station.

Seven workers had to evacuate the excavation and the work site; all did so safely and without injury. Gas was shut off and the local fire department responded. The fire began at approximately 10:50 hrs Eastern Daylight Time (EDT) and was extinguished at 11:50 hrs EDT. The fire partially destroyed an approximately 3.66 metre by 2.44 metre building at the Lisgar Station as well as damaging vehicles and construction equipment. The Transportation Safety Board (TSB) was initially contacted and immediately informed the NEB, which activated its Emergency Operations Centre and dispatched NEB staff to the scene. The TSB did not conduct an investigation into the incident. The MOL conducted an investigation into the incident.

There were no injuries to members of the public as a result of the incident. Several businesses in the area, including a neighbouring day-care centre and strip mall, were evacuated as a precaution, and traffic was affected while emergency responders were on site.

On 22 July 2011, Somerville pleaded guilty to failing to provide information to workers to protect the health and safety of those workers, which is in violation of the Ontario *Occupational Health and Safety Act*. The Ontario Court of Justice sentenced Somerville to a \$50,000 fine.²

On 26 March 2012, EGD pleaded guilty to failing to take every precaution reasonable in the circumstances for the protection of a worker, which is in violation of the Ontario *Occupational Health and Safety Act*. The Ontario Court of Justice sentenced EGD to a \$50,000 fine.³

² <http://news.ontario.ca/mol/en/2011/07/pipeline-contractor-fined-50000-after-fire.html>

³ <http://news.ontario.ca/mol/en/2012/04/enbridge-gas-distribution-inc-fined-50000-after-fire.html>



Figure 1. Lisgar Gate Station

3.2 Location and Description of the Work

The Lisgar Station shown in Figure 1 is located in Mississauga, Ontario, south of Highway 401 on Winston Churchill Boulevard at Aquataine Avenue (Appendix I).

The O&M works were to be conducted in two phases. Phase 1 involved installing new pipe and a pig launcher/receiver at the Winston Churchill and Steeles District Station. Phase 2 pertained to the Lisgar Station, with the previously described work commencing in August 2009.

The NEB conducted an inspection of the Lisgar Station on 17 August 2009; the date construction commenced. NEB staff found the site to be in the early stages of construction, and at that time there was minimal work taking place on station property, and excavation had not commenced. Most of the work being conducted at that time was welding of pipe which was positioned along the side of the road leading to the station. As part of the inspection NEB staff found documentation to support the occurrences of safety meetings. However, during the investigation EGD could not produce evidence that the safety meetings were continuing to occur. The

17 August 2009 inspection identified two non-compliances, both relating to the absence of welders' log books on site. These non-compliances were corrected, and NEB inspectors subsequently confirmed compliance.

These O&M works were part of an ongoing Integrity Management Program undertaken by EGD in accordance with CSA Z662 Oil and gas pipeline systems standard requirements. Between 2004 and 2009, EGD had completed nine similar installations under this program for its NPS 24 and NPS 30 high and extra-high pressure gas distribution lines.

Results of the Investigation under the NEB Act

This section presents the results of the investigation under the NEB Act in terms of the:

- findings as to cause and factors contributing to the incident, pursuant to paragraph 12(1.1)(a) of the NEB Act; and
- corrective actions taken by EGD.

Examination of the evidence, documents gathered, and interviews conducted indicate that the incident was preceded by a number of contributing conditions and unsafe acts. As a result, the investigation determined the immediate cause and the root causes (latent conditions and management system failures), which were present during the incident and/or prior to its occurrence.

4.1 Immediate Causes

4.1.1 Metallurgical Analysis

EGD contracted a third party to conduct a metallurgical failure analysis of the physical evidence gathered at the site, which included the blind flange and the nipple that had been installed in the centre of the blind flange. The nipple, shown in Figure 2 below, was threaded at one end and capped at the other. The independent laboratory examination determined that the measurements of the nipple were typical of a NPS 2 Schedule 80 pipe and that the chemical composition, microstructure and hardness conformed to that required by ASME SA 105-1989.

The metallurgical examination of the pipe nipple noted dents on the nipple cap and damage to the threads. The examination also revealed that the threaded section of the nipple had been bent and that thread crests were deformed. Damaged threads were also noted on the blind flange where the nipple had been attached.



Figure 2. Pipe nipple that had been installed in the centre of the flange.

4.1.2 Rotational Movement of the Pipe just Prior to the Incident

Rotational movement was requested by the welders to facilitate the welding. Workers on site at the time of the incident explained that two separate movements took place to rotate a section of the pipe to be welded while being held by an excavator in a position aligned with the pressurized pipe with the blind flange with nipple on the end. During the first movement, the EGD-designated representative was on site and supervised the rotation of the pipe while monitoring to ensure that it would not hit the nipple and cap. With that task completed, the designate left the site to purchase supplies. Shortly thereafter, the welders requested that the pipe be further rotated to a better position for welding. This second movement occurred without the designate on site and without anyone providing visual confirmation of the location of the pipe in relation to the nipple. It was during this second movement that the nipple was ejected out of the blind flange, likely after being struck by the pipe being rotated.

NEB staff developed schematics and calculations to determine the rotational movement required to create the conditions that could have resulted in failure of the nipple. These calculations are provided in Appendix II. The calculations support the conclusion that if the contractor completed the second rotational movement of the section of pipe being welded, as interviews revealed, then this section of pipe would have contacted the nipple and possibly bent it as the pipe was moved into its desired position.

When asked if the damage observed on the nipple and blind flange was consistent with this possible scenario, the author of the metallurgical examination indicated that it was.

Based on the above information, the Board makes Finding 1:

Finding 1. Contact with the existing pressurized gas pipeline is considered the immediate cause of the 30 September 2009 gas release and fire at the Lisgar Gate Station.
--

4.2 Root Causes

4.2.1 Legal Requirements

4.2.1.1 Maintenance Safety Manual

Section 20 of the NEB's *Onshore Pipeline Regulations, 1999* (OPR-99), provides that:

31. (1) A company shall develop a maintenance safety manual and shall submit it to the Board when required to do so.

(2) The company shall keep a copy of the maintenance safety manual or the relevant parts of it at each maintenance site of the pipeline, in a location where it is accessible to every person engaged in maintenance at the site.

EGD did submit a maintenance safety manual⁴; however, it did not have a manual on site for the use of persons engaged in maintenance activities. NEB staff confirmed through Information Requests (IRs) that there was no safety manual on site. Having a manual on site may not have a direct effect on incident prevention, but it does provide information to maintenance and supervisory personnel regarding practices and procedures to be followed while conducting work, and it is a requirement of the OPR-99.

Based on the above, the Board makes Finding 2:

Finding 2. EGD did not demonstrate compliance with Section 31 of the OPR-99 by failing to have a copy of its maintenance safety manual on site.

4.2.1.2 Communication and Supervision

Section 29 of the OPR-99 provides that:

29. (1) If a company contracts for the provision of services in respect of the maintenance of a pipeline, the company shall
- (a) inform the contractor of all special conditions associated with the maintenance;
 - (b) inform the contractor of all special safety practices and procedures necessitated by the conditions or features specific to the maintenance;
 - (c) take all reasonable steps to ensure that maintenance activities are conducted in accordance with the manual developed under section 31; and
 - (d) authorize a person to halt a maintenance activity in circumstances where, in the person's judgement, the maintenance activity is not being conducted in accordance with the manual developed under section 31 or is creating a hazard to anyone at the maintenance site.
- (2) The person referred to in paragraph (1)(d) must have sufficient expertise, knowledge and training to competently carry out the obligations set out in that paragraph.

Interviews with EGD staff, management, and contracted workers provided evidence that there was inadequate communication between EGD field staff and the contractor. Though contracted workers were aware that the pipeline (upstream of the work) contained some gas under pressure, they were not informed that the pipe immediately upstream and in the trench, where the work was being conducted, was operating at 370 psi and open to the pipeline system.

Based on the above information, the Board makes Finding 3:

⁴ Operations and Maintenance Manual for NEB Regulated Pipelines, July 2005 (2193914 Canada Limited and Niagara Gas Transmission Limited)

Finding 3. EGD did not demonstrate compliance with Section 29 of the OPR-99 by failing to adequately communicate hazards to contracted workers.

4.2.2 Operational Control

4.2.2.1 Hazard Identification and Risk Assessment

By the Company

Photos taken after the incident revealed that there was a blow-down nipple installed on the pipe within ten feet of the blind flange which could have been used to evacuate gas from the pipe. The investigation also revealed that EGD had planned to install a 2-inch valve and another short nipple to the nipple already on the blind flange to enable evacuation of gas from the section of pipe that was to be pressurized. The contractor informed EGD that they were introducing a hazard with this configuration, and the contractor and the company agreed to install the blind flange with a nipple and cap only. From the blind flange, the pipeline extended approximately 300 yard to a 24-inch line valve. EGD decided to keep this line valve open to enable detection of leaks. Consequently, with the line valve open, this section of pipe was at line pressure of 370 psi, even though it was not needed for system operation. This decision unnecessarily introduced a significant hazard to the workers.

In its Agreed Statement of Facts⁵, EGD indicated that the incident may not have occurred if all of the piping fabrication, installation, and construction could have been completed prior to tie-in with the system. Constructing in this manner would have resulted in the approximately 300 yards of pipe remaining disconnected from the system until such time as fabrication of all new piping had been completed.



Figure 3. Photos showing the valve and nipple in the pipe close to the blind flange - Provided by TSSA

The practice of allowing a blind flange to contain a nipple to enable the evacuation of gas prior to new pipe being welded to existing pipe system is a common practice in pipeline construction. This allows the continued operation of the system. Interviews revealed that this was typical practice for distribution pipeline systems. Some company practices require a closed valve

⁵ This statement was provided to the Ontario Court of Justice as part of its defense against the Ontario MOL charges. This document was provided in an IR response received 17 August 2012.

upstream of a blind flange that contains a nipple, or at a maximum one pipe length⁶ from the flange, to allow a margin of safety in the event that the nipple is damaged or fails during construction activities. This practice limits the volume of gas release at most to that contained in one length of pipe. In the case of this incident, the duration of the release would have been significantly shorter had the line valve been closed, even with 300 feet of line pipe under pressure, and it likely would have resulted in less damage.

Practices that may be considered typical for distribution, which are usually small diameter and lower pressure pipeline systems, cannot be applied to large diameter pipeline systems without appropriate hazard evaluations. Gas volume and pipeline size and pressure must be taken into consideration. EGD failed to fully assess the hazards of the pipeline system at the Lisgar Station.

Based on the above information, the Board makes Finding 4:

<p>Finding 4. EGD did not demonstrate adequate hazard identification and risk assessment of the 24-inch pressurized pipeline system at the Lisgar Gate Station.</p>
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By the Contractor

The *Enbridge Gas Distribution NPS 24 NEB Line Retrofit Project Construction Specifications (Part 7)* define the company's requirements for conducting hazard assessments and also state that the contractor is to continually identify hazards, assess risks, and implement acceptable controls. These specifications state that contractors must prepare a hazard assessment prior to the commencement of a project. Contractors must also specify the methods used to control or eliminate the hazards. NEB staff determined that a hazard assessment was conducted prior to the work being undertaken. The contractor was also tasked with conducting hazard assessments prior to the start of each phase of construction and either involve the workers in the assessment process or ensure that the results were reviewed with them. However, NEB staff determined that these other hazard assessments were not carried out.

Based on this information, the Board makes Finding 5:

⁶ One pipe length is typically 18 to 25 feet.

Finding 5. EGD did not demonstrate adequate contractor oversight by failing to ensure that the requirements for conducting ongoing hazard identification and risk assessments were met.

4.2.2.2 Failure to Follow Procedures

During the response and field investigation, NEB staff found that the *EGD NPS 24 NEB Line Retrofit Project Construction Specifications, Article 13 – Lowering-in/Pipe Installation* state that pipe installation operations shall proceed only when the company representative or designate is present. As explained in the *Immediate Causes* section, the EGD-designated representative was absent when the second rotational movement of the pipe was completed and the nipple was hit.

Based on the above, the Board makes Finding 6:

Finding 6. EGD did not demonstrate control of its contractor by failing to ensure that the contractor adhered to the supervision of pipe lowering-in procedures as required by its policies.

4.2.2.3 Management Control

Management must demonstrate control over operational activities. A key element of this control is the communication of hazards, risks, and related mitigation to all potentially affected workers. Following interviews with senior EGD personnel, NEB staff determined that there was inadequate communication of operational risks and risk mitigation between the company's senior personnel and field staff.

Based on the above, the Board makes Finding 7:

Finding 7. EGD did not demonstrate adequate communication of hazards, risks and mitigation, which led to inadequate control of activities occurring at the maintenance site.

4.2.2.4 Contractor Control

Regardless of whether work is contracted to another organization, the Board expects that companies will be responsible for the safety of all workers and the public at its facilities. When companies choose to employ a contractor, they remain responsible for the safety performance of the contractor and its employees. This oversight requires effective communication with contracted workers and adequate supervision and control of their activities.

Safety meetings and tailgate or toolbox meetings form an integral part of the day-to-day hazard identification and communication process for workers. Outside the worker safety committee process, these meetings form part of the fundamental right of workers to know about the hazards they may be exposed to, participate in determining the related mitigation and controls, and to refuse dangerous work, where necessary.

The NEB expects companies to have a work permit system in place. This is always issued by the facility owner and typically by a company employee in control of the facility where work is being undertaken. The permit is provided to the contractor and outlines the work to be done, where the contractor can and can't work, and outlines specific precautions to be taken. The permit is then supposed to be reviewed with the workers forming part of the toolbox meeting. The work permit process provides companies with increased oversight and control of activities and allows for communication of site-specific information to contracted workers.

Evidence provided during interviews indicated that formal safety meetings were not documented and formal safe work permits were not prepared for any of the work conducted on the site. EGD indicated that both it and the contractor treated the terms and conditions contained in the contract to be the permission to proceed with the work.

Part 1.2.4 of the *Enbridge Gas Distribution Inc. NPS 24 NEB Line Retrofit Project Part 7 – Construction Specifications* outlines the requirement for conducting meetings. It includes daily tailgate meetings and weekly crew meetings. Part 1.3.2.2 of these specifications outlines the requirements for safe work permits.

Based on this information, the Board makes Finding 8:

<p>Finding 8. EGD did not demonstrate adequate contractor oversight and control by ensuring that the requirements for safety meetings and work permits as outlined in the contract were met.</p>

4.3 Corrective Actions taken by Enbridge Gas Distribution Inc.

As a result of the incident, EGD reviewed all practices and procedures related to testing, purging, and energizing pipelines as related to the practices and procedures outlined in the company's construction manuals and operating and maintenance manuals.

As a result of the review, EGD circulated a Safety Alert throughout its system in October 2009. The Safety Alert detailed the requirements for maintaining the integrity of new pipeline installations not ready to be put into service by purging them with nitrogen to 40 psi. These changes were subsequently incorporated into the practices and procedures in use throughout the company's pipeline system.

The company also conducted a comprehensive review of practices, policies, and procedures, and developed enhanced guidelines and templates to be used for major projects. The outcome of the review resulted in EGD developing contingency plans that include the scope of work, work resources, plans, purging and energizing plans, and a description of the training sessions required. The changes also include the requirement for weekly project update meetings.

EGD also developed, and continues to develop, detailed and upgraded training programs with specific training and refresher courses for all personnel.

4.4 The NEB's Regulatory Oversight

During the period covered by this investigation, the NEB continued its oversight of EGD through targeted compliance activities. As part of the investigation, several meetings with EGD occurred, including meetings between EGD and NEB senior management. The purpose of the meetings, beyond addressing the particulars of the incident, was to ensure that EGD understood the NEB's expectations regarding improvements to the processes and procedures used by EGD in conducting its work. NEB staff also monitored applications filed by EGD throughout the course of the investigation to make sure compliance verification activities were undertaken to scrutinize any new works that may be proposed by EGD.

The NEB believes that carefully designed, well-implemented, and regularly reviewed management systems provide pipeline companies with the tools necessary to conduct business in a manner that serves to keep people safe and protect the environment. The NEB holds its regulated companies accountable for the adequacy and effectiveness of their management systems in all their work processes, including the work conducted by contract workers. The findings as it relates to this incident can all be attributed to management system failures. To this end, the NEB will continue to conduct compliance activities with NEB-regulated companies like EGD to assess the effectiveness of the implementation of company management systems in the work they are undertaking.

Conclusions

The NEB will take all available actions to protect Canadians and the environment and requires pipeline companies to anticipate, prevent, manage, and mitigate potentially dangerous conditions associated with their pipelines. As part of this, the NEB expects regulated companies to demonstrate a proactive commitment to continual improvement in safety, security, and environmental protection, and to promote a positive safety culture as part of their management systems.

The gas release and fire that occurred on 30 September 2009 were preventable. Though no people were injured and the incident resulted in minimal impacts to public safety, the environment, or the economy, the potential impact of an event of this magnitude cannot be ignored.

All workers present at a construction site need to be made aware of the hazards so that they may participate in addressing those hazards and reducing risk. The operating company stated that certain actions were typical of construction and maintenance work on distribution lines. However, when work is conducted on or near pressurized gas piping, precautions need to be commensurate with the known and potential hazards and risks resulting from the activity, regardless of the industry definition applied to the system where the work is being conducted.

The NEB's investigation spanned September 2009 to March 2011; however, it was not concluded until after court proceedings between parties to this incident had been finalized to allow for the results of the proceedings to be considered in the NEB investigation. The Board makes 8 findings as to the cause of the incident and the factors contributing to it. The publishing of this report concludes the NEB's investigation.

The NEB will be following up with the company to determine if the corrective actions implemented by the company are in use and are adequate and effective.

Appendix I

Maps

Relative location of the Lisgar Gate Station in southwestern Ontario



Overview of the Lisgar Gate Station



Enbridge Gas Distribution - Lisgar Gate Station

Planned Work Under Section 58 and 74 of the National Energy Board Act

Legend

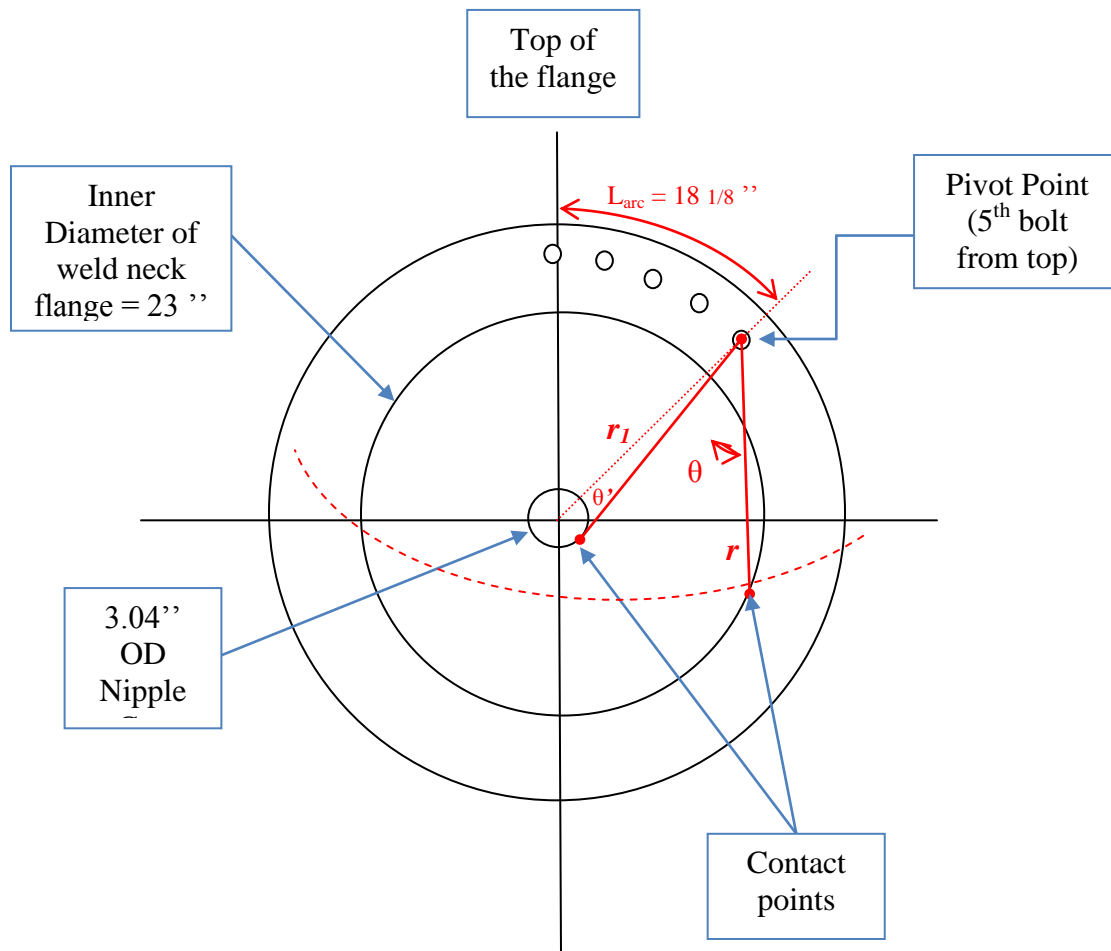
	Proposed NPS 24 Pig Launcher		NPS 16 (70m) Pipeline to be Abandoned		Residential
	New NPS 24 to be Installed		NPS 20 (62m) to be Abandoned		Church and Daycare
	8" Bypass Line		Study Area		Plaza
	Existing NPS 24 Pipeline		Gate Station		

Appendix II

Schematics and Calculations for Rotational Movement

Determination of the Maximum Allowable Rotation Angle Prior to Contact with the Inner Surface of the Weld Neck Flange and the Nipple Cap

Figure 1: Schematic of the flanges and nipple assembly (not to scale)



This schematic represents the flange and the nipple prior to the rotation movement initiated for completing the cap weld on the 45° tee connection. Calculations below will determine the angle of rotation θ , which would be necessary for the inside surface of the weld neck flange to contact the nipple cap using the 5th bolt from the top as a pivot point, as per the rotation movement that occurred just prior to the incident.

Observation of the flanges and nipple cap allows for the assumption that the inside of the weld neck flange and the outside of the nipple cap formed two perfect circles prior to the incident. Therefore, the contact point on the nipple cap between these two circles would be at the tangent point on the nipple cap circle of a straight line going through the center of the pivot point (5th bolt). The contact point on the inside of the weld neck flange would be located on the arc of a circle of the radius r , r being the distance between the center of the bolt (pivot point) and the contact point on the nipple cap. The angle of this arc between the two contact points is θ .

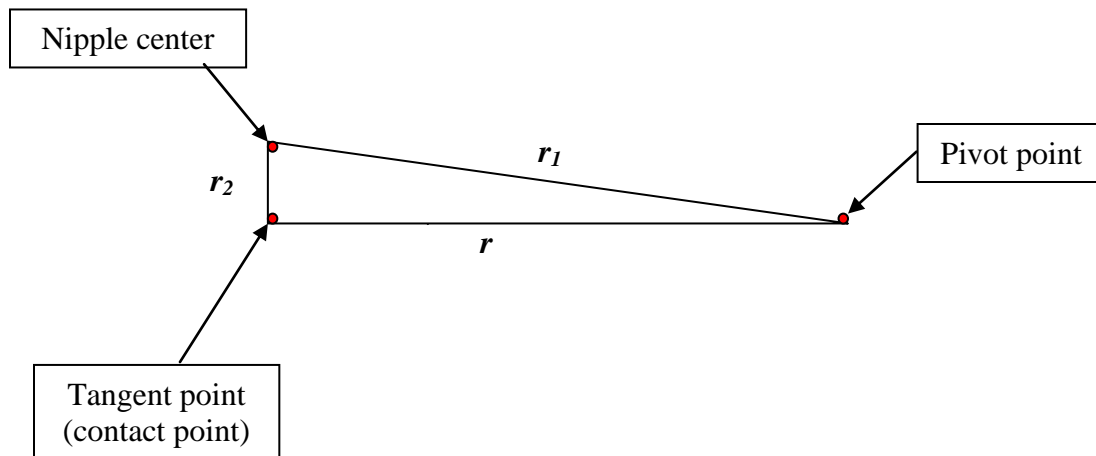
Here are some key dimensions necessary for the following calculations:

- Blind flange diameter = 37 inches
- Centre of bolt hole to blind flange edge = 35 inches
- Arc between the top of the flange (vertical axis) and the pivot point measure on the OD of the blind flange = 18.125 inches
- Nipple cap OD = 3.04 inches
- Inner diameter of the weld neck flange = 23 inches

Determining the angle θ' :

θ' is the smaller angle of a right triangle made of the pivot point, the contact point on the nipple cap (tangent point), and the center of the nipple cap. (See figures 1 and 2)

Figure 2: Right angle triangle made by the pivot point, the tangent point, and the center of the nipple



Distance between pivot point (center of the bolt) and center of nipple (r_1) is:

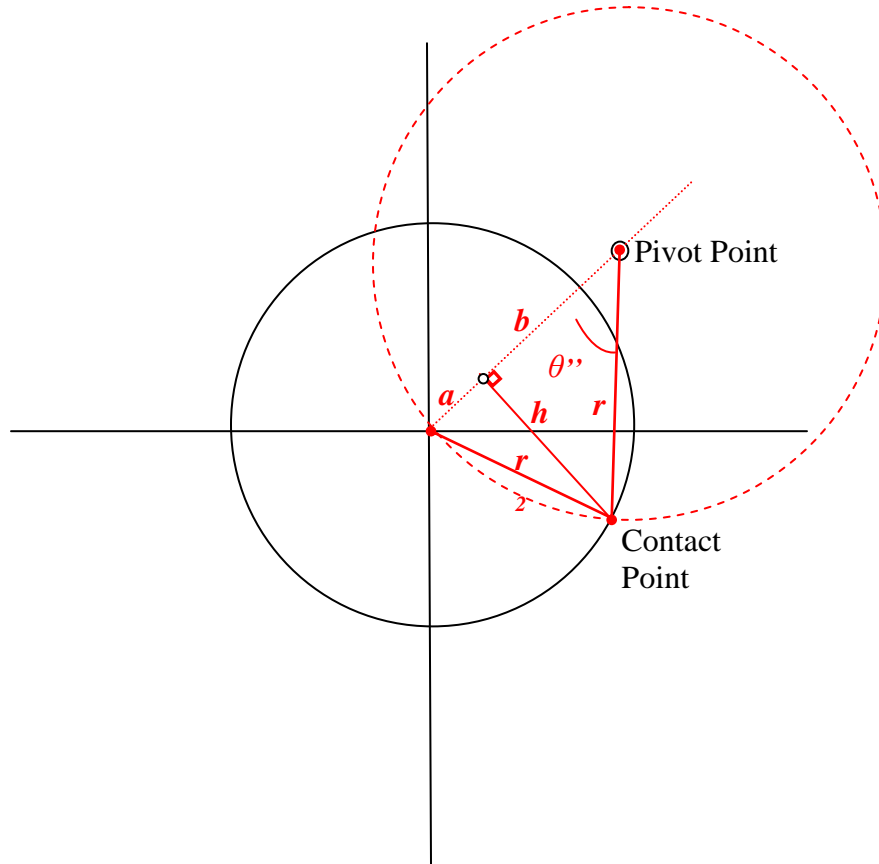
$$r_1 = 37 \text{ inches} / 2 - (37 \text{ inches} - 35 \text{ inches}) = 16.5 \text{ inches}$$

Radius of nipple cap (r_2): $r_2 = 3.04 \text{ inches} / 2 = 1.52 \text{ inches}$

Therefore: $r = (r_1^2 - r_2^2)^{1/2} = (16.5^2 - 1.52^2)^{1/2} = 16.43 \text{ inches}$

And the angle θ' is: $\theta' = \cos^{-1}(r/r_1) = 5.3^\circ$

Figure 3: Determining θ'' , the rotation angle between the contact point on the inner surface of the weld neck flange and the center of the flange (not to scale)



Determining θ'' , the rotation angle between the contact point on the inner surface of the weld neck flange and the center of the flange:

Two right angle triangles of height h are forming the bigger triangle made of the center of the flange, the pivot point, and the contact point on the inner surface of the weld neck flange. The first right angle triangle is made of the segment a , h and r_2 , r_2 being the inner radius of the weld neck flange (11.5 inches). The second right angle triangle is made of the segment b , h , and r , r being the radius of the arc between the contact points (16.43 inches). Also, the sum of the segments a and b is equal to the distance between the pivot point and the center of nipple which is r_1 (16.5 inches). Solving for the 3 equations below, we can determine that segments a and b are 4.08 inches and 12.42 inches respectively. Consequently:

$$a + b = 16.5$$

$$a^2 + h^2 = r_2^2 = 11.5^2 = 132.25$$

$$b^2 + h^2 = r^2 = 16.43^2 = 269.94$$

Then, we can solve for θ'' :

$$\theta'' = \cos^{-1}(b / r)$$

$$\theta'' = \cos^{-1}(12.42 / 16.43) = 40.9^\circ$$

Determining the angle of rotation θ which would be necessary for the inside of the weld neck flange to contact the nipple cap (see figure 1):

Therefore θ can be obtained by:

$$\theta = \theta'' - \theta' = 40.9^\circ - 5.3^\circ = 35.6^\circ$$

Based on the contractor employee interviews, the intent of the rotation movement of the weld neck flange was to bring the weld on the 45° tee to the vertical position in order to facilitate the welding of the cap pass. This would require a rotation of 45° of the weld neck flange and therefore would cause contact between the inner surface of the weld neck flange and the nipple, as the maximum allowable rotation angle to avoid this contact is only 35.6° . The interviews with the contractor revealed that the rotation happened in two movements: a primary larger rotation that brought the weld to an approximate 80° position and then a smaller secondary rotation where the failure occurred. Based on the calculations above, it would have been possible to rotate the weld neck flange up to 80.6° ($45^\circ + 35.6^\circ$) before contacting the nipple cap. Any further rotation would have required the nipple to bend. The interview statements are therefore consistent with the above calculation.

Appendix III

Summary of Findings as to Cause and Contributing Factors

- Finding 1.** Contact with the existing pressurized gas pipeline is considered the immediate cause of the 30 September 2009 gas release and fire at the Lisgar Gate Station.
- Finding 2.** EGD did not demonstrate compliance with Section 31 of the OPR-99 by failing to have a copy of its maintenance safety manual on site.
- Finding 3.** EGD did not demonstrate compliance with Section 29 of the OPR-99 by failing to adequately communicate hazards to contracted workers.
- Finding 4.** EGD did not demonstrate adequate hazard identification and risk assessment of the 24-inch pressurized pipeline system at the Lisgar Gate Station.
- Finding 5.** EGD did not demonstrate adequate contractor oversight by failing to ensure that the requirements for conducting ongoing hazard identification and risk assessments were met.
- Finding 6.** EGD did not demonstrate control of its contractor by failing to ensure that the contractor adhered to the supervision of pipe lowering-in procedures as required by its policies.
- Finding 7.** EGD did not demonstrate adequate communication of hazards, risks and mitigation, which led to inadequate control of activities occurring at the maintenance site.
- Finding 8.** EGD did not demonstrate adequate contractor oversight and control by ensuring that the requirements for safety meetings and work permits as outlined in the contract were met.