Page 60

is not relevant

14 Juillet 2010

From:	Chad Bunch
To: 19(1)	"[redacted]@tnpi.ca"
Cc:	[redacted]@tnpi.ca"; Dan Barghshoon; Alan Pentney; Kyle Sherwin; Erin Doerffer
Subject:	TNPI Montreal Feeder Pipeline, Integrity Inspection Report, August 4-5, 2010
Date:	Monday, August 16, 2010 12:02:59 PM
Attachments:	2010 08 05, Montreal Feeder Line Inspection Report.pdf 2010 08 05, Montreal Feeder Line AVC.pdf

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Hi [redacted]

As part of any NEB inspection, NEB staff prepare an inspection report highlighting construction activities and overall work site procedures observed. NEB Staff also prepare an Assurance of Voluntary Compliance (AVC) so that any non-compliances that were observed can be fixed. Please review the attached inspection report and AVC and provide comments on content and accuracy if you have them.

If you have any revisions, please let me know so they might be incorporated into the final report. If you have no comments on the inspection report, please **sign the first page below your name, and initial the pages** that follow on the bottom left corner above the footer. If you have no comments on the AVC, **please sign and date at the bottom of the page**. When you have completed this task, please scan the report and send it back to me via email (or you can fax to 403.292.5503). I will sign the report, initial likewise and, send a copy back to you for your records.

Also, please note that your signature does not translate into your agreement with the content of the inspection report; it only acknowledges that you have received it.

19(1)

I am not in the office today, but can be reached at 403[redacted]should you have any questions, comments, or concerns. I will also be back in the office tomorrow.

Regards.

Chad Bunch
Engineer, Integrity
Operations Business Unit
National Energy Board | Office National de l'énergie
Telephone | Téléphone: 403-221-3008
Facsimile | Télécopieur: 403-292-5503
Cell Phone | Cellulaire: 403-[redacted] 19(1)

Response to National Energy Board information request in respect to TNPI's leak on the Montreal Feeder System, July 14, 2010.

1. Q: Which weld joints will be dug up and can they be observed at the time of the replacement construction? If any of the weld joints on the 1995 relocation are not being excavated, please provide a rationale for not doing so.

   A: TNPI will expose all of the weld joints. All shrink wraps exposed to date have displayed some level of lack of proper adhesion.

2. Q: How were suspect sleeves identified and where are they located?

   A: Exposure of shrink wraps to date has been in trench to remove contaminated soil. The DCVG survey results are marked on the ground as of July 23 to locate any suspected coating holiday. All weld joints and 90 deg. bends will be exposed regardless of DCVG results. TNPI will attempt to correlate DCVG results with coating condition found at suspect sites. Based on a comparison of the as-built survey chainage and the DCVG results there appears to be a good correlation. See Chart pdf.

3. Q: Is TNPI exploring supplementary methods in addition to the DCVG survey to determine the integrity of the coating on this pipeline?

   A: Not at this point in time as TNPI is planning to expose all pipe that was installed as part of this 1995 replacement.

4. Q: Please provide a copy of the pipeline integrity management program that had been incorporated for this section of pipeline.

   A: Excerpts regarding the Montreal Feeder System from various TNPI Pipeline Integrity documents are attached. See Attached pdf.

5. Q: Please provide records of the integrity inspections and maintenance for the life of this particular pipeline (a summary table should be adequate for now).

   A: These records are available and will be compiled and forwarded. Detailed Close Interval Survey and Test Post inspections have been performed by various corrosion practitioners since the line was installed in 1996. Attached are pdf files showing the results in this particular section, as follows:

November/December 1996	**Corrosion Service**
October 1999	**Cathodic Technology Limited**
2002	**Corrosion Diagnostics Limited**
2005/2007 Test Post Survey	**Corrosion Diagnostics Limited**
2008	**Corrosion Diagnostics Limited**

6. Q: Please submit a schematic drawing illustrating the design method of anode installation, and photos of the as-found condition of the anode and other auxiliary equipment associated with the anode? An illustration of the connection to the pipe would be helpful.

   A: Field sketches showing the location where anodes were installed are attached. Additional records showing standard installations will be forwarded. Photographs were not taken of anodes found in the excavation; however they were described to be in excellent condition. See attached pdf.

7. Q: It is understood that there was some Polyken tape. What was the condition of the Polyken tape that was removed, and was there any evidence of disbondment?

A: Polyken tape on first bend exposed was definitely degraded by product exposure. A second bend was exposed and the Polyken tape was also found to be in poor condition due to improper application or soil movement.

8. Q: What measures would be necessary to convert this pipeline section to a state where in-line inspection could be accommodated? Has TNPI evaluated whether tether or crawler tools would work on this line?

A: Conversion to pigability with standard tools would be extensive; alignment, property and adjacent structures/facilities may make replacement with ILI capable bends very challenging. At least 11 bends would require replacement.

Consideration for tethered tools was started following this year's experience in Tank 106 dike area although no detailed follow-up started as yet. Tethered tools would require considerable downtime of the Montreal Feeder System and would seriously impact on shipments from Shell and Ultramar.

9. Q: Please provide a copy of all original construction or engineering documents that contained reference to field coating specifications.

A: This information is available and will be forwarded. See attached pdf files.

10. Q: Please provide a description of the inspection program or any other oversight TNPI had during the construction phase of the project including what TNPI had done to ensure that inspectors were competent.

21(1)(b) [redacted]

11. Q: Please provide a copy of the original inspection reports that were completed during the construction phase of the relocation project.

A: The inspector's notes are attached as well as a summary compiled by the Project Coordinator. See attached pdf – two files.

2010-07-28

Trans-Northern Pipelines Inc.

Detailed Report of Leak

from TNPI's 10" Diameter Pipeline

Montreal Feeder System

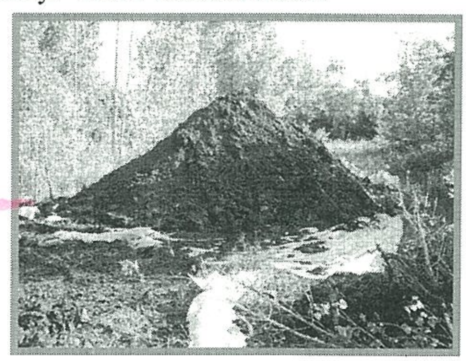
Montreal East

Province of Quebec.

July 14, 2010

Executive Summary:

Shortly before noon on July 14th, TNPI became aware of a Ministry of Environment (MDDEP) investigation into the source of product in the Lafarge Quarry in Montreal East. At the time, it was conveyed to TNPI that the MDDEP suspected the source of the product was from a leak experienced by Shell Canada Limited, near their Tank 106 last February. TNPI decided that it would investigate the condition of its Montreal Feeder System by walking the length of the lateral.



At 14:20 a TNPI inspector found evidence of product over the 10" pipeline adjacent to the Lafarge Roadway on Shell Canada Limited property. Dead vegetation was observed over an area 10 m x 10m. TNPI's Line Control centre was notified and the pipeline was shutdown pending confirmation of a leak on the pipeline.

During the on-site investigation TNPI collected a jar of product which had a density of 803 kg/M3, closely corresponding to the density of jet fuel. Jet fuel was being moved through the pipeline prior to TNPI's shutdown. In preparation for excavation, TNPI laid out tarpaulins upon which contaminated soil was to be placed. In addition, lined lugger bins had been ordered to be brought to the site.

After receiving emergency locates from Info-Excavation, TNPI began excavation of the pipeline over the area where product was evident on the ground surface at 19:00 hours on July 14th. By 23:00 hours approximately 10 metres of pipe had been exposed with no sign of a pipeline leak. Work ceased to allow the work crew to rest for the night.

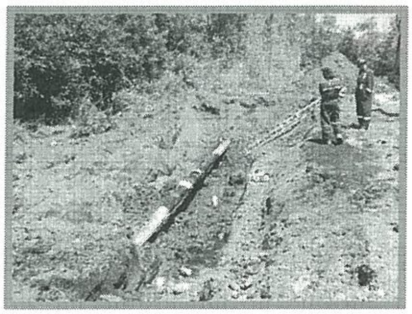
Excavation resumed at 07:00 hours on July 15th. At 12:20 hours the leak was identified at two corrosion pits near a girth weld that had not been adequately covered with a shrink sleeve during installation in 1995.

Leak Response and Temporary Repair:

In compliance to established protocols, TNPI notified the Transportation Safety Board of Canada of the incident at 19:00 hours even though TNPI did not have detailed information about the leak itself or whether one even existed.

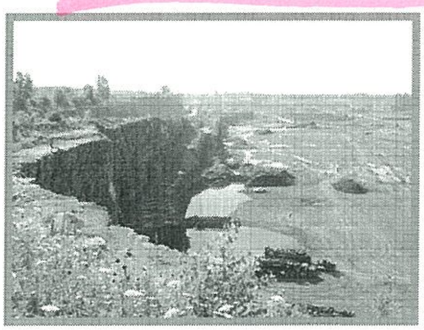
The MDDEP were aware of the investigation being conducted by Lafarge and Shell. TNPI kept all parties apprised of its investigation.

Prior to commencing excavation, TNPI appointed a Safety Watch and then conducted a tailgate meeting with the work crew. A light plant was ordered in anticipation that the excavation would endure into the evening hours.

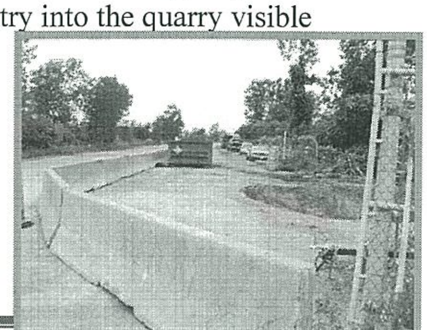


Excavation began around 19:00 hours and continued until 23:00 hours. Approximately 10 metres of pipe was exposed and a portion of the coating had been removed, with no sign of the source of the leak. Contaminated soils were piled on plastic sheeting and covered with tarpaulins. Work ceased for safety reasons, because the backhoe operator and others in the work crew had been working 17 hours and needed rest. An update was provided to the Transportation Safety Board at that time. Two labourers were left on site as watchmen overnight. The site is secured by chain link fencing.

On the morning of July 15th, there had been an accumulation of approximately 200 litres of petroleum product in the excavation. This was recovered by vacuum truck. Product was clearly observed to be weeping from the westerly side of the coating stripped pipe. Excavation continued towards the west where the pipeline trench contained numerous rocks and large boulders. The pipeline coating is wrinkled and a shrink sleeve over a weld was disbonded.



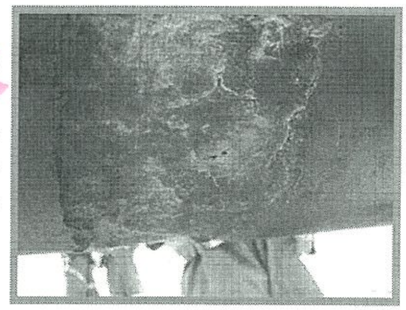
Lafarge also advised TNPI that it had noticed an accumulation of petroleum product on the surface of its retention pond in the bottom of the quarry pit. Newalta had previously dispatched a crew to install adsorbent booms in the pond to collect the product. Apparently, Lafarge had pumped off approximately 25,000 litres of oily/water waste from the retention pond since Saturday, July 10th. There are no obvious signs of product entry into the quarry visible on the walls of the quarry.



Shell Canada's fire department arrived on scene at 10:00 am and shut down all excavation activities until they were assured by TNPI that there were no hazards present. This interrupted work flow for 45 minutes.

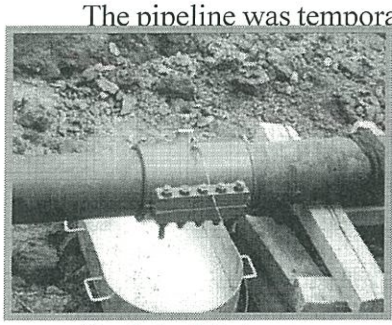
Work resumed and no obvious signs of leakage were identified on the 10 metres of pipe that had been fully exposed and stripped of its coating. Excavation was approximately 3 metres from the 90 degree bend within the Lafarge roadway. Traffic cones and a flag person were necessary to continue excavation along the roadway. Traffic cones were replaced by concrete jersey barriers.

Mission HGE, TNPI's environmental consultant, arrived on the scene and began exploring the possible pathway of the petroleum product from the pipeline location to the quarry. In addition, Mission HGE are tasked to determine the areal extent of the petroleum contamination in the vicinity of the leak and the concentration of hydrocarbons in the soils. Mission HGE has sampled the stockpiles of soil on site and, pending analysis, will determine the appropriate disposal options. Mission HGE and TNPI examined the swamp east of the pipeline and did not observe any evidence of hydrocarbon contamination.



At 12:20 hours on July 15th, the leak was discovered to be two corrosion pits located 8" east of the first weld east of the 90 degree bend adjacent to the Lafarge roadway and fence. There is a 4" wide band of pipe circumference that appears to have been missed during the application of the shrink sleeve that was applied over the weld joint. Corrosion pitting is evident from the 3:00, through 6:00 and to the 9:00 position on the pipe, with the two leaking corrosion pits located at the 6:00 position.

Throughout this investigation, TNPI has been in contact with representatives of the National Energy Board and the Transportation Safety Board. Preliminary reports were sent to these agencies by e-mail, followed up by telephone exchanges.



The pipeline was temporarily repaired by application of a PLIDCO split sleeve leak clamp at 14:30 hours. Following installation, the pipeline pressure was raised to 300 psi but the clamp began to leak. Various attempts were made to stop the clamp from leaking to no avail. It was decided to leave the Montreal Feeder System depressurized and out of service for the night.

TNPI monitored the condition of the PLIDCO sleeve over night with a watchman and a vacuum truck on standby.

On July 16, two representatives from the National Energy Board arrived on the site (Meredith Wright and Erin Doerffer) and attended the morning tailgate safety meeting. Product that had accumulated in the excavation overnight was vacuumed before the excavation was re-sloped. Another PLIDCO repair clamp was brought to the scene and applied over the leaking defects. The pressure on the Feeder System was again raised to 300 psi and held for 40 minutes. This time the clamp held. TNPI returned the pipeline to service at 15:30 hours to resume delivery of jet fuel from Ultramar to Dorval Airport. The average pressure within this segment of the Feeder System is 220 psi.

Security personnel were assigned to the site over the weekend to monitor the condition of the clamp.

This practice will continue until the clamp is removed from the pipe.

Permanent Repair:

The leaking defect under the PLIDCO split repair sleeve will be cut-out of the pipeline and replaced with a segment of pretested pipe. This work is tentatively scheduled to proceed during the week of August 2nd, subject to the findings of TNPI's ongoing investigation into the condition of the other portions of this 1995 vintage segment of pipeline.

Follow-up Investigations:

To ensure that there are no other locations on this segment of 1995 pipe with coating voids, TNPI's cathodic protection consultant, CORRPRO has conducted a detailed close interval survey designed to identify coating holidays (DCVG Survey). The survey results indicate that there are indeed other areas where the coating appears suspect. Suspect areas will be inspected by excavation and appropriate action will be taken.

In addition, TNPI excavated the remainder of the pipe in both the easterly direction and the northerly direction to check the condition of the pipeline coating for disbondment. The yellow jacket coating was discovered to be wrinkled and disbonded where the petroleum product has dissolved the primer under the polyethylene jacket. Canusa shrink sleeves applied over the welds was also found to be disbonded and in one case it appears the shrink sleeve was shifted to expose the pipe.

Segments of pipe which were coated with Polyken tape, namely the 90 degree bends were also found to be disbonded.

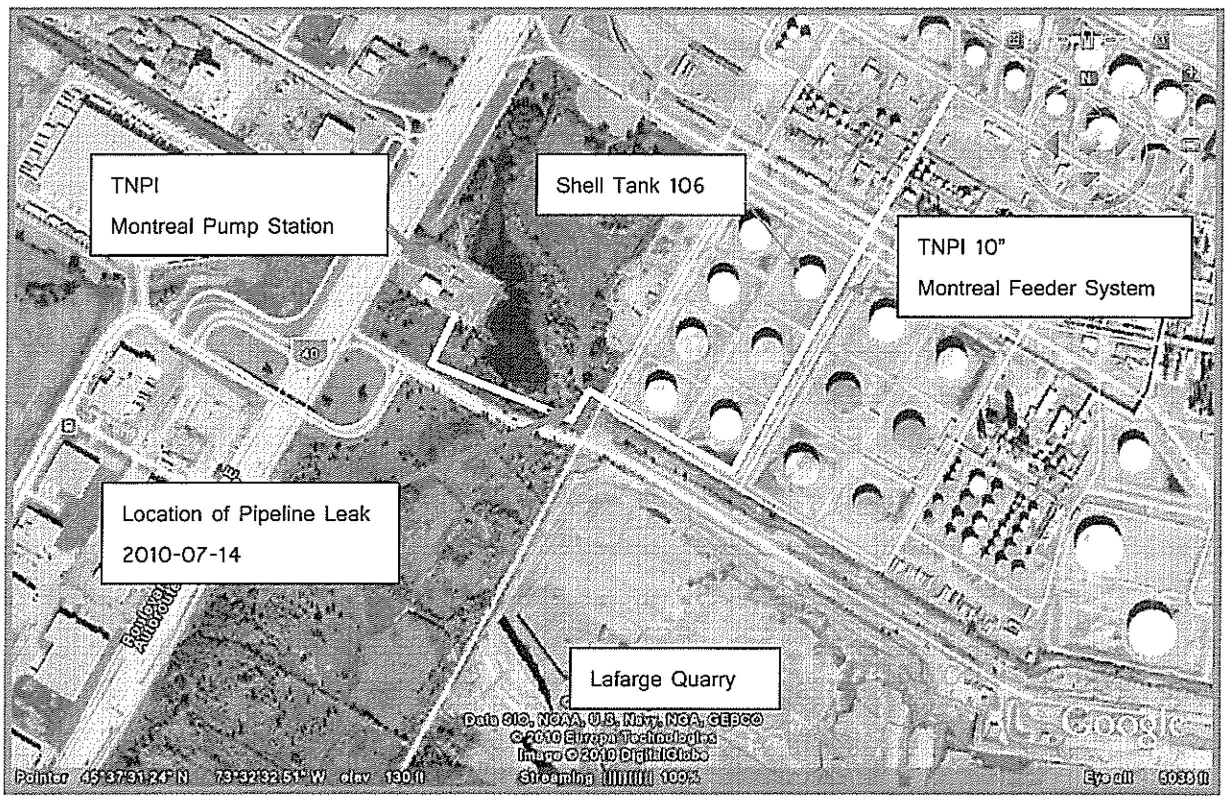
Mission HGE continued with delineation at the site and coordinated the excavation and disposal of contaminated soils.

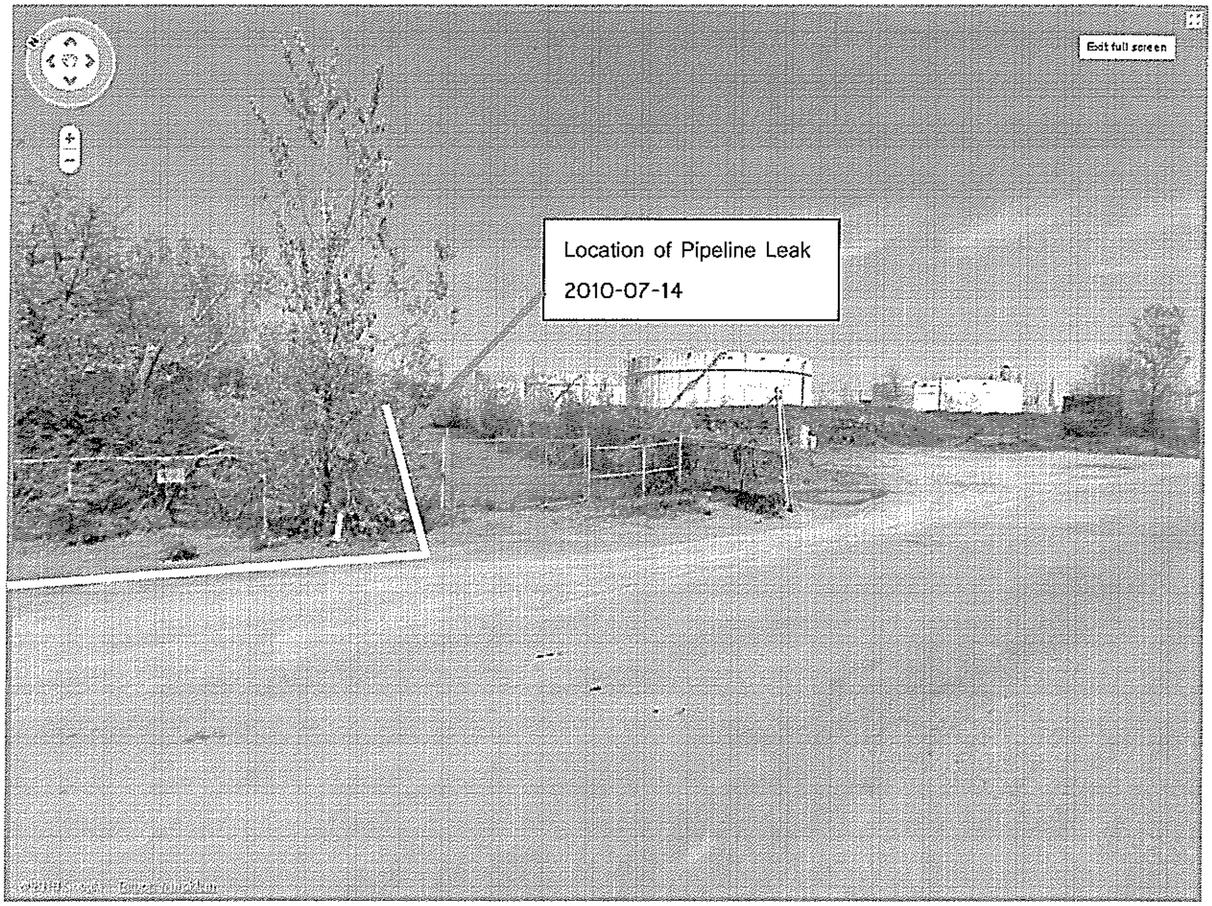
Site Location Reference:

MP-1A0, R/W-11, Mile Post 2.12
Part of lot 69
Parish of Pointe aux Trembles
Montreal East, Quebec

Drawing: Brunet, Tetreault & Associates
Relocation Distance 3+01.85 metres
8-11432 – December 11, 1995

Property Owner: Shell Canada Limited





The Photograph at left, taken during construction of the pipeline relocation in 1995, depicts the exact location where the pipeline leak was discovered on July 15th. The location of the leak is 8" east of the first weld east of the 90 degree bend adjacent to the Lafarge roadway and fence.

Summary of Pipeline Characteristics:

The 10" pipeline was originally constructed in 1952 and was subsequently relocated to its current location in 1995. The relocated pipeline was originally coated with a yellow jacket polyethylene coating.

- Pipeline 273.1 mm x 7.8 mm nominal wall, CSA Grade 317

Cathodic protection of the pipeline is supplied by magnesium anodes and impressed current rectifiers. Every three years, TNPI performs close interval pipe to soil potential corrosion surveys along the entire Montreal Feeder System. Annually, TNPI takes pipe to soil potential at test stations located throughout the Feeder System. To date all potentials have been in accordance with NACE criteria. During excavation of the pipeline in search for the leak, the pipe to soil potential nearest the leak site was -1600 mv $CuCuSO_4$ on the ground surface and -1300 mv $CuCuSO_4$ nearer to the excavated pipeline.

ILI surveys have not been conducted throughout this pipeline segment due to the presence of numerous short radius bends and other pipeline fittings.

Operating Certificates:

The 10" pipeline was constructed in 1995 under the National Energy Board Order XO-T2-8-95. The pipeline was hydrostatically tested to 11,410 kPa and is allowed to operate at 4964 kPa (720 psi), equivalent to the ratings of all 300 ANSI series fittings on the Montreal Feeder System.

Underlying Cause(s):

The primary underlying cause of the incident is corrosion due to an improperly aligned and improperly installed Canusa shrink sleeve that was installed in 1995. Secondly, the presence of magnesium anodes in close proximity to the leak site and the apparent levels of cathodic protection present, as identified in previous close interval surveys failed to protect the pipeline from corrosion. An explanation for the cause of the corrosion and the failure to detect active corrosion is needed. The current belief is high resistivity soil and rock impair cathodic protection and that rocks in the backfill shield the pipe from receiving adequate protective values nearest the pipe.

Corrective Actions:

The 1995 segment of pipe will be fully exposed and inspected. Coating which is found to be damaged or disbanded will be replaced with Kema Tape. The pipeline will be backfilled with padding material to a minimum depth of 12" over the pipeline. Large rocks, present in the existing soil will not be used for backfill. The magnesium anodes removed during excavation will be replaced and connected to the pipeline through testposts.

[redacted] 19(1)

Pages 74 to 75

are withheld pursuant to sections

21(1)(a), 21(1)(b)

of the Access to Information Act

Alan Pentney

From:	19(1)	[redacted]@tnpi.ca>
Sent:		Monday, July 26, 2010 10:22 AM
To:		Alan Pentney
Cc:		Daphne.Snelgrove@bst-tsb.gc.ca; Chad Bunch; Dan Barghshoon; Erin Doerffer; Kyle Sherwin; Marc Pauzé; Meredith Wright; Ryan Petersen; Wes Elliott
Subject:		Re: TNPI - Montreal Feeder Line Leak Information Request
Attachments:		MFS Leak IR 1 - NEB.doc.DRF; Montreal Feeder Leak Report.doc.DRF

Alan...attached is a revised incident report...I will update this as information flows from the site to my office and will distribute on a regular basis with new information. Also attached is a response to your 11 IR's. Note that some of the questions refer to an attachment, which I will forward to you tomorrow...I need to scan the information into the system to attach them to the document...this will follow.

Work on site is proceeding with excavation of the pipeline. Approximately 1/2 is already exposed.

I must leave the office today from 1:00 - 4:30 and will return tomorrow.

[redacted] 19(1)

>>> "Alan Pentney" <Alan.Pentney@neb-one.gc.ca> 7/20/2010 11:22 PM >>>
Hello [redacted] 19(1)

As I mentioned in our first teleconference, I am slated to act as a liaison between TNPI and the NEB on all of the incidents under investigation by the NEB. I will be contacting Mr. [redacted] to discuss this. 19(1)

Thank you for the update on this incident. I would appreciate being kept informed of changes in status on this incident on a daily basis in writing. It would be helpful if the updates addressed the following topics (where appropriate):

1. Emergency Management,

2. Environment,

3. Safety, and

4. Integrity.

Addendums to the original report or emails would be satisfactory. I will then inform the appropriate NEB persons.

Your commitment to advise us as soon as possible of the replacement construction schedule on the Montreal Feeder Line is appreciated. NEB personnel that are anticipated to attend that occurrence are:

- Dan Barghshoon, Environmental Specialist, and
- Chad Bunch, Integrity Engineer.

With regard to integrity matters, and to aid the investigation, please provide the following information and responses to questions:

1. Which weld joints will be dug up and can they be observed at the time of the replacement construction? If any of the weld joints on the 1995 relocation are not being excavated, please provide a rationale for not doing so.

2. How were suspect sleeves identified and where are they located?

3. Is TNPI exploring supplementary methods in addition to the DCVG survey to determine the integrity of the coating on this pipeline?

4. Please provide a copy of the pipeline integrity management program that had been incorporated for this section of pipeline.

5. Please provide records of the integrity inspections and maintenance for the life of this particular pipeline (a summary table should be adequate for now).

6. Please submit a schematic drawing illustrating the design method of anode installation, and photos of the as-found condition of the anode and other auxiliary equipment associated with the anode? An illustration of the connection to the pipe would be helpful.

7. It is understood that there was some polyken tape. What was the condition of the polyken tape that was removed, and was there any evidence of disbandment?

8. What measures would be necessary to convert this pipeline section to a state where in-line inspection could be accommodated? Has TNPI evaluated whether tether or crawler tools would work on this line?

9. Please provide a copy of all original construction or engineering documents that contained reference to field coating specifications.

10. Please provide a description of the inspection program or any other oversight TNPI had during the construction phase of the project including what TNPI had done to ensure that inspectors were competent.

11. Please provide a copy of the original inspection reports that were completed during the construction phase of the relocation project.

Regards,

Alan Pentney

National Energy Board

Direct (403) 299-3726

Cell (403) [redacted] 19(1)

19(1)

-----Original Message-----
From: [redacted] mailto: [redacted] @tnpi.ca]
Sent: July 19, 2010 2:46 PM
To: Daphne.Snelgrove@bst-tsb.gc.ca; Alan Pentney; Dan Barghshoon; Meredith Wright; Ryan Petersen; Wes Elliott
Subject: Updated Incident Report - Montreal Feeder System

19(1)

Gentlemen...I will be on the road over the next couple of days and can be reached at [redacted]hould you require further information about the Feeder System Leak...the attached report is still preliminary...other investigations are underway at TNPI, principally the Corrosion Survey and Environmental delineation by Mission HGE...

TNPI understands that the NEB want to be kept apprised of the cutout/replacement schedule...we will give you plenty of notice so that your reps can attend the defect cutout.

[redacted] 19(1)

Page 80

is not relevant

Pages 81 to 82

are duplicates

Where the pipeline is laid on or within 100 metres (300 feet) of an AC power transmission right-of-way for a distance of over 300 metres (1000 feet), the CONTRACTOR shall measure the induced voltage in the pipe prior to and frequently during the period when workmen might contact any section of pipe over 100 metres (300 feet) long.

Should the measured voltage between pipe and ground exceed 15 volts RMS, the CONTRACTOR shall render the pipe safe for human contact by grounding and/or attaching equipotential grids. Such voltage measurements and ground and/or grid attachment shall be approved in all aspects by the COMPANY INSPECTOR.

11. COATING

All line pipe will be yard coated in accordance with the COMPANY Specifications covering yard coating of pipe. All casing pipe will be cleaned, primed and yard coated.

Coated pipe shall be handled and transported at all times with approved equipment and transport to prevent damage to the coating. Pinch bars, chain or cable slings or any other pipe handling equipment found or known to be injurious to the coating shall not be used. Where it is necessary to support the coated pipe on skids over the ditch prior to lowering-in, the pipe shall be supported on skids which have been padded with burlap bags with sawdust, straw or equivalent padding material approved by COMPANY'S INSPECTOR.

The coating shall be checked at all points of support, for holidays during or immediately prior to the lowering-in operations and all holidays shall be repaired by the CONTRACTOR at his cost to the satisfaction of COMPANY'S INSPECTOR.

Sections of coated pipe being tied into the line shall be lifted and not dragged or pulled into position. The length of such sections shall be regulated so as to allow their handling without damage to the coating.

At stream crossings or at any other locations which cannot otherwise be constructed and where it is necessary to pull or drag sections of line into place, the coated pipe shall be protected at CONTRACTOR'S expense for labour only by means of approved rockshield and wood lathing securely banded to the pipe.

The uncoated section of pipe at each field weld between joints shall be manually coated only after the weld has been inspected and passed by a COMPANY INSPECTOR. CONTRACTOR shall furnish all labour, equipment, tools, supervision and material not otherwise specifically mentioned in these Specifications and shall stand any and all expense necessary for cleaning, priming, re-enamelling and re-wrapping of the pipe necessary to meet these Specifications.

It shall be the responsibility of COMPANY'S INSPECTOR to examine and approve CONTRACTOR'S coating operations and to ascertain if the coating applied conforms to specification.

CONTRACTOR will furnish an approved high voltage electrical holiday detector and, CONTRACTOR shall furnish at his own expense the necessary labour and equipment to operate and move such electrical holiday detector along the pipe line. The CONTRACTOR will make a detailed inspection of the coating for holidays and damage to the coating with the above electrical holiday detector immediately preceding the lowering or back-filling where necessary of the pipe in the presence of a COMPANY INSPECTOR.

All holidays and damaged places in the coating shall be repaired by the CONTRACTOR to the satisfaction of the COMPANY INSPECTOR so that the holiday detector, when passed over the repaired area, will not disclose any holiday or incompleteness of the coating.

Where the pipe coating is damaged due to lowering in or back-filling operations, the CONTRACTOR shall immediately cease said backfilling operations and repair any and all damage to the pipe coating at his expense and to the satisfaction of the COMPANY INSPECTOR.

Regular shaped fittings such as hotbends, elbows and tees shall be primed and hand wrapped with 15 cm (6 inch) wide plastic tape; such wrapping to be continuous and free of voids with a minimum overlap of at least 1/2 the width of the tape.

Insulating flanges shall have a double wrap of 15 cm (6 inch) wide plastic tape applied to cover the gap between flanges, and shall be further coated with a mastic material supplied by the COMPANY.

12. LOWERING IN

(a) Method and Time of Lowering Pipe

The pipe normally shall be lowered into the trench using catch-off tractors and rubber tired dollies or by the use of canvas slings or equivalent; minimum width of canvas slings is 152.4 mm (6 inch).

When lowering the pipe, the unsupported length of straight pipe or pipe containing sag or overbend shall not exceed 30 metres (100 feet). The catch-off tractors shall be equipped with cradles sized sufficiently to prevent local buckling of the pipe. All side bends shall be supported to minimize torsional stress in the pipe.

All such repairs to damaged or defective coating shall be approved by the INSPECTOR before backfilling.

(f) Timing of Lowering In

The time of the lowering in operation and the amount of pipe to be lowered in shall take into account the required backfilling operation in the event of unstable ditch walls or inclement weather. The lowering in operation may be stopped if the required backfilling operation cannot keep up.

(g) Sand Padding

When the ditch has been excavated in rock or stoney ground, and when required by the INSPECTOR, the pipe must be lowered on sand bags or sand padding. If sand bags are used they shall be tied shut and weigh a minimum of 31.75 kilograms (70 pounds). If sand padding is used, it shall be a minimum thickness of 30 cm (12 inches).

13. BACKFILLING

The CONTRACTOR is advised that if the INSPECTOR so requests, all the pipe lowered in shall be backfilled the same day due to the possible sloughing in of the ditch walls or water floating the pipe in the ditch.

Backfilling after dark shall not be permitted unless sufficient lighting approved by the COMPANY INSPECTOR is available. Backfilling shall not commence until the depth of cover, elevation or other survey information has been obtained by the COMPANY INSPECTOR.

(a) Approval of INSPECTOR

The trench shall not be backfilled unless and until the pipe has proper fit therein and the required space for cover. Before any section of trench is backfilled it is the CONTRACTOR'S responsibility to first secure the approval of the INSPECTOR. If, due to the exigencies of the Work, some section is backfilled without the INSPECTOR'S approval and the INSPECTOR so requests, the CONTRACTOR shall uncover the pipe for inspection.

(b) Method of Backfilling

Initial backfilling shall be permitted as soon as the pipe is lowered into the trench. This backfilling shall be performed by means of a backfilling machine of the slip-board or auger type or other equipment approved by the COMPANY INSPECTOR.

Bell-holes and short sections of trench at locations of tie-ins, slack loops, creek banks, etc., may be backfilled as soon as practicable upon completion of the operation being performed and tamping shall be employed where necessary in the opinion of the INSPECTOR.

(c) Protection of Coated Pipe

When the backfill material contains hard clods, stones, broken rocks, pieces of wood, etc., the INSPECTOR may request that the trench be backfilled to a depth 0.3 metres (12 inches) above the top of the pipe with selected loose soil, the intention being that no material shall be placed in the trench which might damage the protective coating on the pipe. When sufficient loose soil for the protection of the coated pipe is not available, as in the case of a trench excavated in rock, the necessary loose soil to form a pad in the trench bottom and to fill to a depth of 0.3 metres (12 inches) above the top of the pipe shall be procured and hauled by the CONTRACTOR if so requested by the INSPECTOR. Sand padding shall be considered padding the trench bottom and for backfilling to a depth 0.3 metres above the top of pipe where required in rock ditch.

(d) Compaction, Tamping and Rip-Rapping

Where the trench has been dug through driveways, streets, roads or highways, or parking lots, the initial backfill material shall be wetted sand, placed evenly and carefully around and over the pipe in 15 cm (6 inch) layers.

Each layer shall be carefully compacted for further wetting and by tamping until 0.3 metres (1 foot) of cover exists over the pipe. The balance of backfill material shall be placed in 15 cm (6 inch) layers and shall be compacted by the use of mechanical tampers so that each layer has a density equal to or greater than that of the adjacent original material. The COMPANY and/or any public authority having jurisdiction over such driveways, streets, roads, highways or parking lots may require that the balance of the backfill be purchased material, such as gravel, crushed rock or other material and that the surface be repaved. The CONTRACTOR shall comply with the above requirements and the COMPANY will reimburse him for the cost of the materials purchased for such purpose.

In the repair of railroad ditches, highway or road ditches, irrigation or drainage ditches, river, creek or canal banks, ravines and other drainage or water courses, the COMPANY and/or any authority having jurisdiction over the same may require rip-rapping using logs, earth-filled, sand-filled, or gravel-filled bags, stone or other like materials. The CONTRACTOR shall comply with such requirements and the COMPANY will reimburse him for purchased materials and for placing of same.

Rock may be encountered along sections of the proposed route. The Contractor shall be reimbursed in accordance with the Technical Specifications, Section 8. All rock shall be excavated by mechanical means.
Only clean fill shall be used for backfill in the pipe trench.

Contaminated soil must be reported to the Company Inspector and Shell. Contaminated spoil shall be contained in a manner such that contaminants do not leach into the surrounding soil and water. Contaminated spoil is to be transferred to the Refinery treatment site. Clean fill is also available from Shell. The Contractor shall be reimbursed for the handling of contaminated soil on a "cost plus" basis in accordance with the schedule of rates filed with the bid.

The Contractor shall be responsible for the disposal of all unsuitable spoil. Use of Shell or Lafarge property for this purpose must be negotiated by the Contractor.

Sand padding or like material is required within 30 cm of the pipeline. Rock shield may be an acceptable alternative if approved by the Company Inspector.

Materials

The Company shall deliver all coated pipe to the job site. The Contractor shall be responsible for off loading.

All other materials to be supplied by the Company shall be picked up by the Contractor at the Company's Lancaster maintenance yard.

Site Access

The gate for the Lafarge quarry access road closes at 20:00 daily. Access beyond that time shall be arranged by the Contractor with the quarry Manager, Denis Lacouline, (514) 640-6130 ext 208.

A minimum width of 7 metres is required for quarry access traffic at all times. Brief stoppages of traffic for equipment and material unloading must be arranged with the quarry Manager.

Access to the south section of the route beyond the quarry road fence shall be gained through the main Shell Refinery entrance on Sherbrooke Street. Shell must be aware of all activities within this section of the work area. The area must be secured nightly once the fence has been cut.

Protection and support of all exposed facilities as directed by facility owners.

Clearing and disposal of brush and timber within the pipeline servitude.

Protection of topsoil as identified in the Environmental Specifications.

Excavation of the operating pipeline at tie-in locations.

Excavation and shoring of pipeline trench in accordance Provincial Safety Codes and Shell requirements.

Hauling and disposal of surplus spoil and debris.

Dewatering of excavations in accordance with the Environmental Specifications.

Stringing, bending and welding of approximately 345 metres of pipeline including weld caps and fittings for hydrostatic testing.

'Jeeping' of the new pipeline.

Coating of all weld joints and the repair of all coating holidays.

Assisting with the hydrostatic testing of line pipe under the direction of the Company representative.

Tie-in welding of new pipeline to existing pipeline including welding of tapping nipples.

Supply of nitrogen and successful displacement of product from the abandoned section of pipeline into tanker truck. Filling of abandoned pipe section with low strength concrete grout. Approximate volume of abandoned section is 12 cubic metres.

Lowering-in and sand padding of the replacement pipe.

Backfilling and compaction of all excavations.

Restoration of all sites in accordance with the Environmental Specifications and land owner requirements.

Installation of pipeline markers.

3.0 Materials to be Supplied the Company

a) approximately 345 m of coated, 273.1 mm O.D. line pipe,

b) 'shrink wrap' sleeves for field joint coating,

c) hydrostatic testing heads, fittings and equipment,

d) displacement pigs,

e) 50 mm tapping nipples,

f) pipeline marker signs.

The value of materials supplied by the Company is estimated to be $30,000.

The Contractor will be responsible for unloading and stock piling the line pipe at the job site. The remaining materials are to be picked up at the Company's Lancaster maintenance yard.

The Contractor will supply all other materials incidental to the completion of the work.

4.0 Site Access

Access may be attained through the Company's Montreal Pump Station, Shell Refinery and the Lafarge Quarry Road.

Access through the Company's Pump Station shall be limited to activities associated with hydrostatic testing, product displacement and tie-in welding.

Access through or along the Lafarge Quarry road shall not block quarry truck traffic. The use of the quarry road shall be subject to the conditions set out by the quarry Manager at the site meeting on September 19.

5.0 Stake Outs

The Company Representative will be responsible for staking out the location of the operating pipeline and the easement limits prior to the commencement of the work.

The Contractor shall be responsible for the stake out of all utilities and drain tiles.

National Energy Board | Office national de l'énergie

Incident Field Report

File Number: 2010-073

Pipeline/Facility Name: TNPI 10 inch feeder line

Location: Montreal, Quebec

Date of Incident: July 14, 2010

Date(s) of Field Visit: July 16, 2010

NEB Investigation Staff: Erin Doerffer, Meredith Wright

Description of Incident

Hydrocarbon (mainly Jet Fuel) leak from a 10 inch feeder TNPI pipeline in Montreal, Quebec.

Summary of On-Site Activities

- Tail gate meeting commenced at 0730hrs
    - o Discussed muster site, gas monitoring, safety around heavy equipment, adverse weather conditions, what to do if encountering contaminated soil
- Plan for the Day
    - o Remove contaminated soil. Soil placed in lugger bins; bins stored on side road and tarped appropriately in case of rain.
    - o New Plidco sleeve arrived from Toronto at approx 1330hrs and was installed
        - Held 300 psi for 45 minutes, then was observed for 45 minutes with product flowing at 200 psi.
    - o Cut out and repair tentatively planned for early next week
    - o Excavation of contaminated soil will expose one more shrink sleeve
    - o Other shrink sleeves will be exposed for inspection early next week based on results of most recent close interval (CP) survey
- Site control
    - o Flag men contracted by TNPI and agreed upon with LaFarge to control access to site, and to slow trucks coming in and out of quarry. Several trucks per minute pass site of excavation.
    - o Fencing around trench, concrete barrier between trench and road
    - o Command post trailer on scene
    - o Established parking
    - o Sign-in log book
- Safety Manual pocket book distributed to all on scene. Contractors requested to read and sign back page and return (available in English and French).
    - o NEB staff observed contractors consulting the manual.
- Working Conditions
    - o High humidity, warm, cloudy and windy. Thunderstorms predicted but did not occur.

- Water was available for workers and was brought in twice a day, snacks were available
- Command trailer was air conditioned
- Port-o-potty on scene
- Gas monitoring in trench: 0% LEL; 20.9% O_2 (personal gas monitors)

- Decontamination
  - Containment tub with absorbent pads was placed at access ladder of trench for contractors to decon boots while exiting
- PPE
  - There was PPE readily available on scene (e.g. half-mask respirators, hearing protection, gloves, glasses, etc.)
  - Workers in trench used respirators, fall arrest harness in addition to Level C PPE.
- Lafarge provided NEB staff and TNPI with a tour of quarry to observe seeping product from quarry wall
  - Hydro vac truck on scene in quarry to remove oily water.
  - Booms in place. Water sampling results expected by Monday morning. Water normally drains into main sump and is pumped into river; no hydrocarbons observed in main sump at this time.
  - Work near quarry wall to mitigate seepage not permitted at this time due to unsafe conditions (rock fall hazard)
    - Cage must be installed prior to work activities
    - LaFarge and TNPI are discussing options for response to seeping product through quarry wall
  - TNPI staff exited trench while scheduled quarry blast occurred at approx 1430 hrs. Vibration monitoring in place at excavation. No issues.
- Shell staff (fire crew) present intermittently throughout the day. Shell work permit in place. Date on permit is inaccurate; there is a verbal agreement between Shell and TNPI that work may continue until job complete.
- Stakeholders
  - Excavation site only affects Shell and LaFarge properties
  - Pipeline supplies jet fuel to Dorval (Trudeau International) airport

Site Description

Please see TNPI preliminary incident report

Safety Issues

- No major issues

Environmental Issues

- Hydrocarbons continue to seep into Lafarge quarry – source not identified at this time
- Contaminated soil cleanup ongoing

Integrity Issues

- Second Plidco sleeve installed, no leaks observed. Line operating at 200 psi.

Security Issues

- No major issues

NEB Staff Follow-up Requirements and/or Recommendations

- Recommend requesting updates on:
  - Oily water/hydrocarbon seepage into quarry
  - Extent of contaminated soil
  - Integrity digs to inspect shrink sleeves
  - Monitoring for or managing leaks if line goes into operation

Investigators: Erin Doerffer, Meredith Wright

Note: An unsigned PDF version can be input into the database when the signed copy is sent to IDS

Distribution:

Trans-Northern Pipelines Inc.
Inter Office Correspondence

To: [redacted] 19(1) 95-12-04

From: [redacted] 19(1)

Subject:AFE 95135

OCT 30/95
PRE JOB MEETING WITH CONTRACTOR AT MT STATION.

NOV 01/95
PIPE WAS DELIVERED TO SITE AT 08:00 HRS.
SURVEYOR STAKED OUT R/W. 0830-1400 HRS

NOV 02/95
NATIONAL TOOK SHELL AND TN SAFETY COURSE THIS DATE.
TRAILOR ECT... DELIVERED TO SITE.

NOV 03/95
CLEARED R/W AND COMMENCED EXCAVATING NORTH SIDE OF SWAMP.

NOV 06/95
CONTINUED EXCAVATING IN TN YARD. CALLED RECUBEC TO TAKE SAMPLES OF EXCAVTION.PURCHASE TWO ROLLS OF POLYETHOLENE TO CONTAIN FILL AND COVER IT.

NOV 07/95
EXCAVATED APPROX. 13M OF EXISTING 10" LINE AT SOUTH END OF TIE IN AND EXCAVATED NEW R/W AT SOUTH END.REQUESTED 90 DEGREE ELBOWS.

NOV 08/95
EXCAVATED NORTH R/W .TN TO LAFARGE.PURCHASED ONE ROLL OF POLYETHOLENE.

NOV 09/95
FINISHED NORTH END TO LAFARGE FENCE. CONTRACTO JUST KILLING TIME TODAY.DIDN'T WANT TO OPEN ALONG SIDE OF ROAD FOR WEEKEND.

NOV 13/95
WELDER TESTED TODAY. EXCAVATED 120M ALONG SIDE OF LAFARGE RD. RECIEVED POLY PIG AND ELBOWS.

NOV 14/95
WELDER. FITTERS AND XRAY TECH TOOK SHELL SAFETY COURSE TODAY.WELDER DID FIVE WELDS TODAY.EXCAVATED 85M OF TRENCH TODAY. HAD TO GET PERMIT FROM THE CITY OF MT EAST TODAY.

NOV 15/95
WEATHER TO MISERABLE TO WELD CREW GONE HOME.

NOV 16/95
INSTALLED SIX ANODES IN TRENCH OF LAFARGE RD.WELDER WELDED SIX WELDS TODAY.TWELVE JOINTS OF PIPE WAS LOWERED INTO TRENCH.PADED WITH STONE DUST AND PARTIALY BACKFILLED.

NOV 17/95
WELDER DID SIX WELDS TODAY. SURVEYOR TOOK SHOTS OF PIPE ALONG RD. MADE ASHOULDER FOR LAFARGE RD WITH GRAVEL.

NOV 20/95
WELDER DID FIVE WELDS TODAY. LOWERED IN FOUR JOINTS OF PIPE AND PARTIALY BACKFILLED. (SOUTH END)
ALSO WORKED ON SHOULDER OF RD.

NOV 21/95
WELDED FOUR WELDS TODAY. COMPLETED BACKFILLING SOUTH TRENCH TODAY.
WELDER AND FITTER NOT TO AMBITIOUS TODAY.

NOV 22/95
SURVAYED SOUTH PORTION AND BP LINE .SIX WELDS DONE TODAY. LOWERED FIVE JOINTS.

NOV 23/95
WELDED TOGETHER TEST HEAD. THREE THREADOLETES 90 DEGREE AND 45 DEGREE ELBOWS. INSTALLED SCRAPER PIG. WRAPED PIPE WITH INSULATION AND POLYETHOLENE. PARTIALY BACKFILLED NORTH TRENCH.

NOV 24/95
SURVEYED THE REST OF THE LINE. RAN SIZING PLATE. THEN RAN POLY PIG WITH WATER FROM SHELL FIRE HYDRANT. BACKFILLED MORE OF NORTH TRENCH.INSULATED MORE PIPE.

NOV 26/95
SET UP AND START PRESSURE TEST. STARTED TEST AT 1400 HRS. USED NATIONALS MEN TO HELP WITH TEST.

NOV 27/95
PROBLEMS WITH TEST, LINE TO DEAD WEIGHTS FROZEN DUE TO MALFUNCTION OF HEATING CABLE.BOUGHT TWO NEW CABLES AND ALSO INSULATED LINE TO DEAD WEIGHTS.

NOV 28/95
FINISHED TEST AT 0400 HRS.REMOVED PRESSURE LINES AND DEWATERED PIPE.EXCAVATED IN TN YARD FOR BELL HOLE.

NOV 29/95
SHELL DID NOT AGREE WITH TN PROCEDURE AND WOULD NOT ISSUE PERMIT.PIPE WAS TAPPED . DRAINED. COLD CUT. SHELL WANTED AN AIR BAG FILLED WITH NITROGEN INSTALLED.SOUTH TIE IN WAS FINISHED BY 1530 HRS.NORTH END TIED IN AND X-RAYED BY 2230 HRS.

NOV 30/95
PURGED OLD LINE WITH NITROGEN AND RAN DISPLACEMENT PIG. FILLED OLD LINE WITH GROUT.INSTALLED TWO LEADS TO PIPE FROM TEST

POST AT NORTH AND SOUTH END.

DEC 01/95
FINISHED BACKFILLING AND INSTALLED FENCE AT TN AND LAFARGE.

19(1) [redacted]

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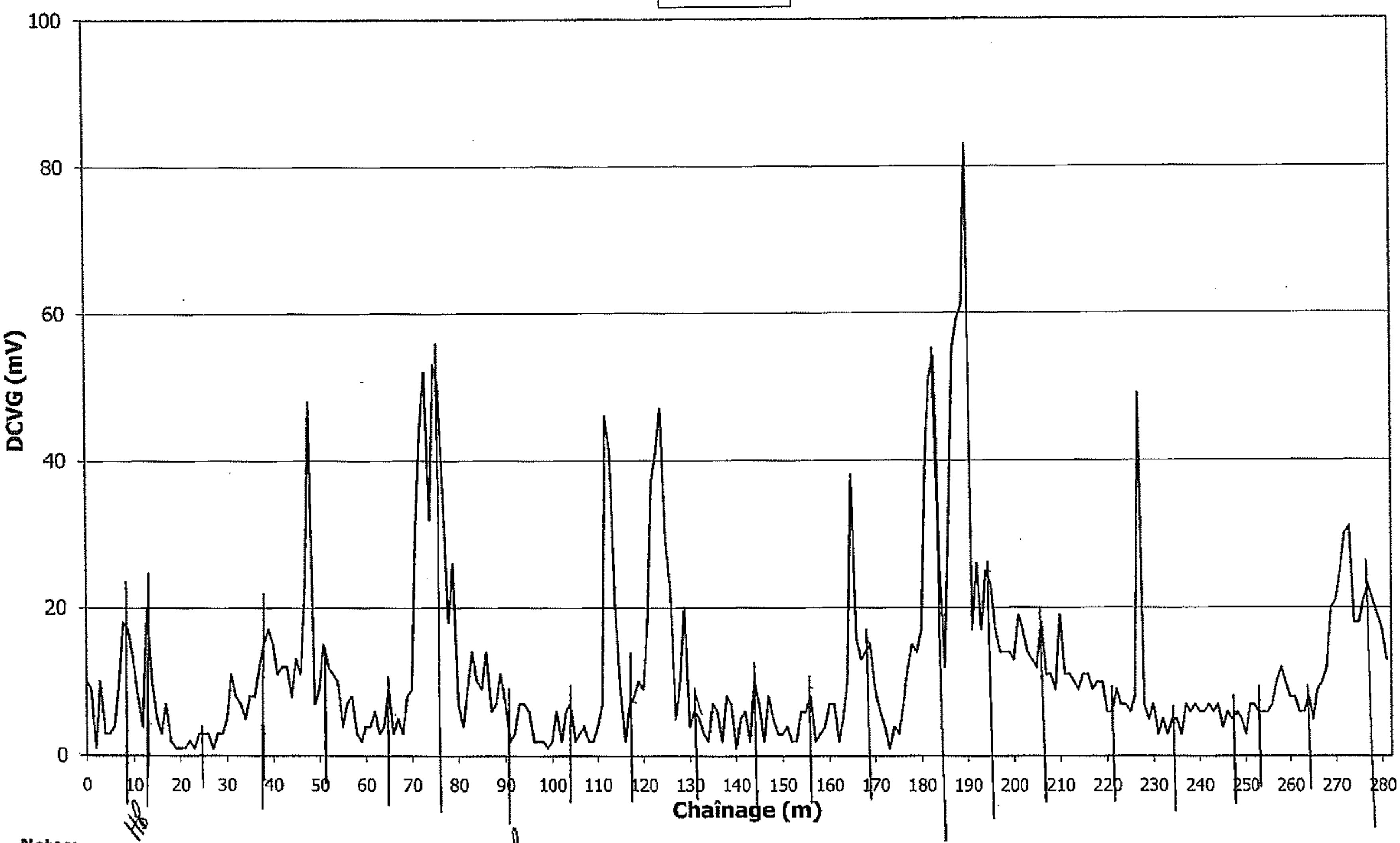
corrpro®
1985, 55e Avenue | Dorval QC H9P 1G9
Tél.: 514-636-0085 | Fax: 514-636-8671

Évaluation du revêtement - Essais DCVG

???

???



Notes:
1. Redresseur TNPI/SUNCOR à OFF.
2. Redresseur site TNPI à OFF.
3. Lectures Δ V ON/OFF à tous les mètres (side drain).

Information sur la conduite: 19(1)
???

WELD JOINTS - APPROXIMATE LOCATION

10/07/27

A0009802_1-000096

Trans-Northern Pipelines Inc.
Inter Office Correspondence

To: [redacted] 19(1) 95/11/01

From: [redacted]

Subject: MT FEEDER RELOCATION

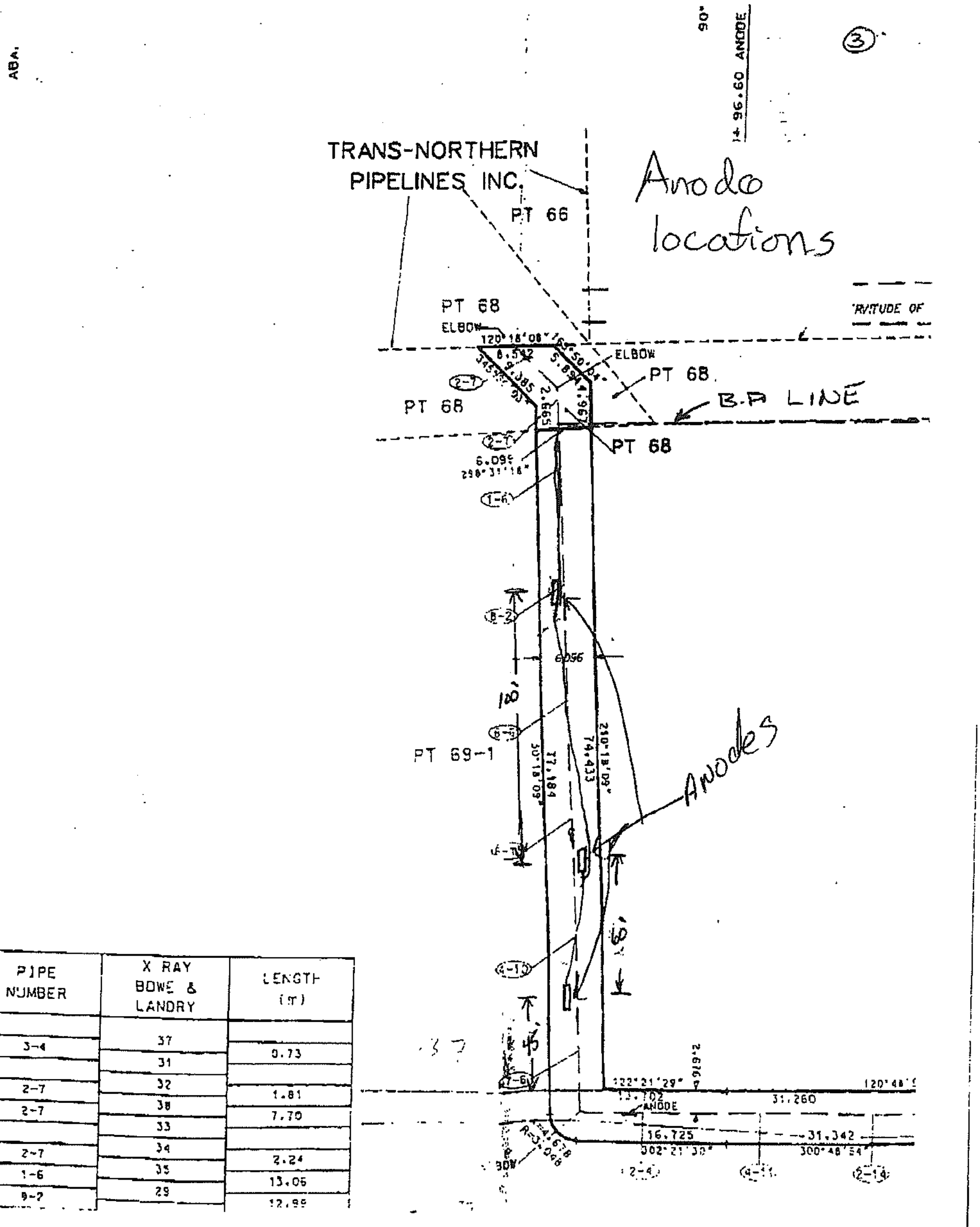
19(1)

[redacted] I suggest we install anodes every 100′ on new relocation.

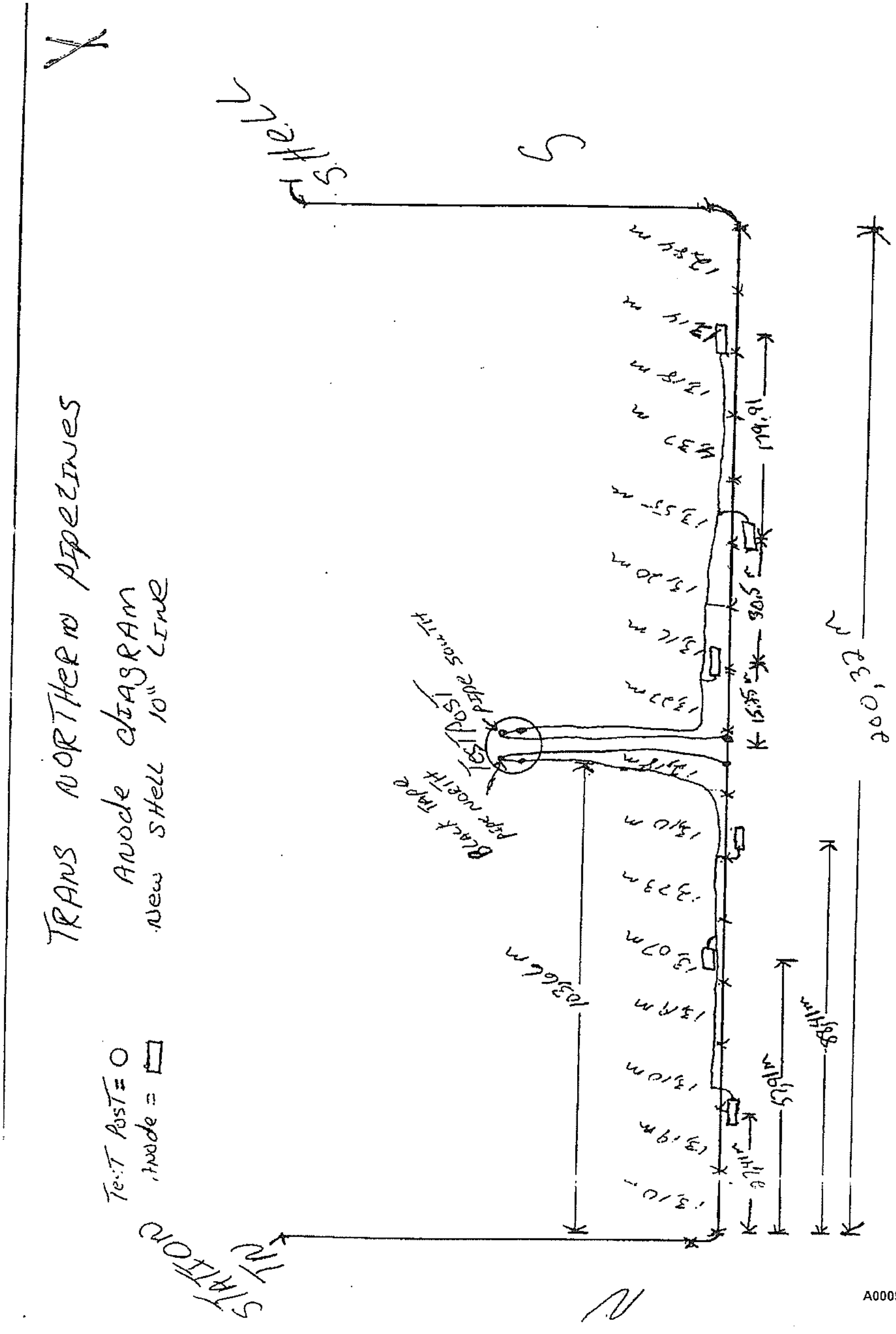
CP 'design'
↳ generally consistent with previous practice.

19(1)

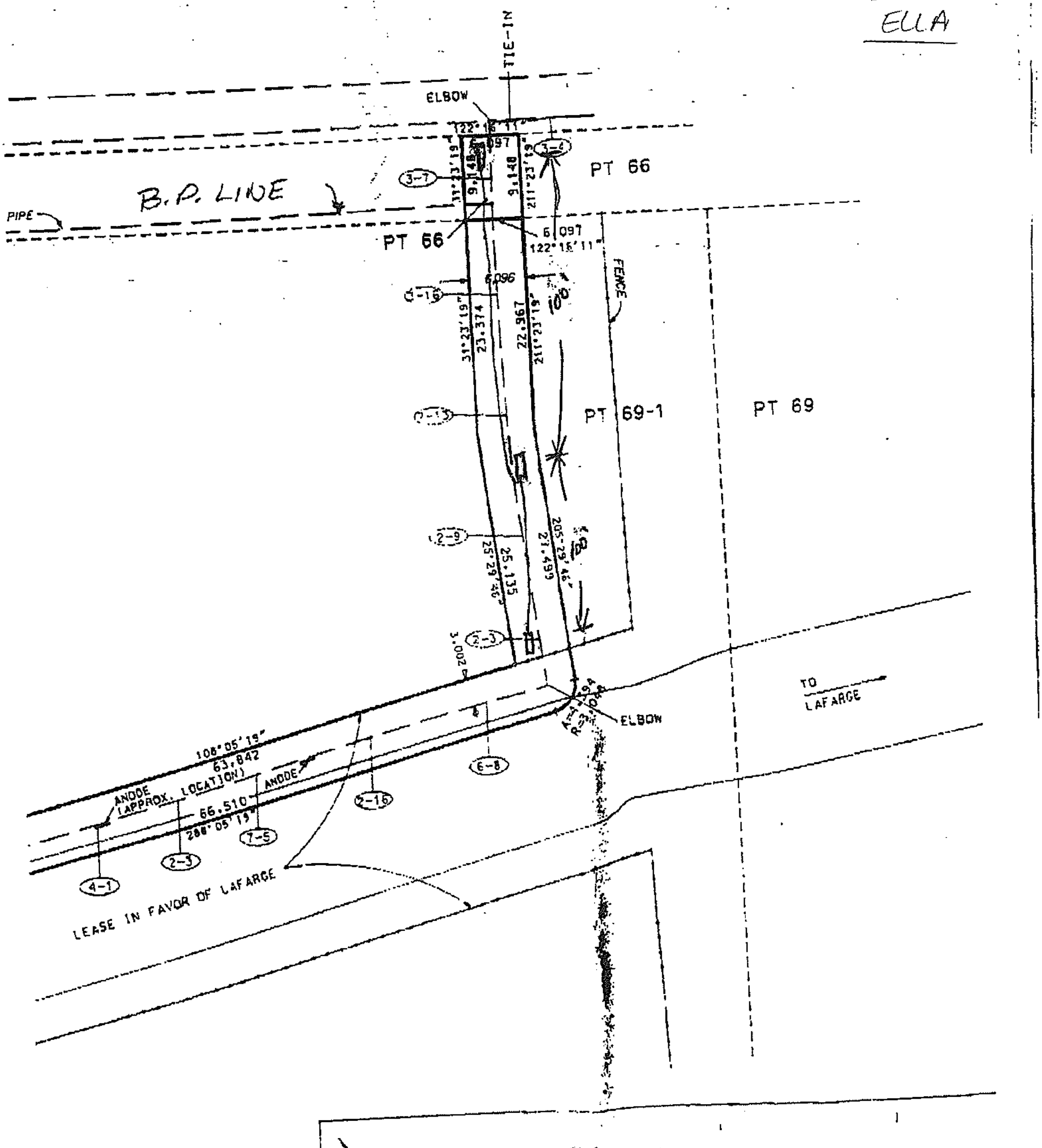
[redacted] Thanks



PIPE NUMBER	X RAY BOWE & LANDRY	LENGTH (m)
	37	
3-4	31	0.73
2-7	32	1.81
2-7	38	7.70
	33	
2-7	34	2.24
1-6	35	13.05
9-7	29	12.99


TRANS NORTHERN PIPELINES
Anode Diagram
New Shell 10" Line
Test Post = O
Anode = □
Shell
S
N
STATION
Test Post
Black tape pipe north
pipe south
1036.6m
200.32 m
179.61
30.5
15.35

M1
ELLA



AFE 96001

Trans-Northern Pipelines Inc.

Inter-Office Memo

To: File

From: [redacted] 19(1) **Date:** Oct/Nov. 95

Subject: <u>Montreal Refinery Replacement - AFE 94016</u>

The following is a summary of progress as reported daily by the site inspector.

Mon. 95-10-30

Project kick-off and safety meeting on site with contractor superintendent, foremen, TN inspector, Area Foreman and coordinator. Refer to minutes. 345m of pipe coated at Shaw Hannon. Contractor contacts Shell and Lafarge regarding access restriction.

Tues. 95-10-31 19(1)

Contractor's trailer on site. [redacted] requests two poly-pigs.

Wed. 95-11-01

Pipe delivered and off-loaded. Surveyor stakes-out construction centre-line.

Thur. 95-11-02

Bender requests bending specs. Brush clearing commences. Discussion on bending requirements with [redacted] 19(1)

Fri. 95-11-03

Commenced excavating tie-in site at MT manifold. Evidence of product in soil and ground water reported by 'phone at 17:20. Brush clearing completed.

Mon. 95-11-06

Continue excavating ditch for tie-in at MT. Soil samples taken for contamination classification. Soil is wet and contains rocks. Concern expressed over suitability for use as back-fill. Trench

water to be discharged through filter bag(s) and into spill recovery well point furthest from manifold.
Treat as confidential extra for now. Riser comprises 90 deg. vertical el., 90 deg. hor. el. toward west, 90 deg. hor. el. toward swamp. Esso line is directly over Shell line. Bender cannot guarantee good bending for 90 deg. in a single joint. Consider substituting 1.5D, L.R. forged elbows. Deflection for all els. to be confirmed by [redacted] 19(1)

Tues. 95-11-07

19(1)

Confirmed with [redacted] three, 90 deg. L.R. elbows; one 45 deg. L.R. el.; one, 90 deg. S.R. el. New line will cross over Esso line at 1 metre depth and 3-inch clearance. Recubec confirms "A" level contamination - can dispose at $30/Tonne plus $115 transportation per trip. Daylighting Shell tie-in site. Stringing pipe.

Wed. 95-11-08

Recubec report in hand - confirms B-C level contamination. Forged fittings to be delivered Mon. 95-11-13. Welder qualification set for 95-11-13. Ditching between TN manifold and Lafarge road. Completed ditching between Shell tie-in and Lafarge road. Two extra weld caps and a poly pig required.

Thurs. 95-11-09

Completed ditching between TN manifold and Lafarge road. Stringing pipe. Contractor shutting down at 14:00. Prefers to wait for welder qualification before excavating Lafarge road.

Fri. 95-11-10

Shut down for Rememberence Day.

Mon. 95-11-13

19(1)

Ditched 120m along quarry road. Fill contains lots of rubble. Shell ([redacted]) allowing contractor to stockpile on land north side of swamp. No problem with field joining within refinery limits providing gas tests are taken and passed. Welder ([redacted]) passed RT - awaiting mechanical results. Back-bevelling required for fittings. 19(1)

Tues. 95-11-14

Welders qualified also Safety certified by Shell. Ditched remainder of quarry road for a total of 205 m. Stringing and welding along quarry road. NDE started at 13:00. Montreal East demanded construction permit ($53).

Wed. 95-11-15

Shut down due to weather. Surveyor requests job spec. emphasizing legal requirements.

Thur. 95-11-16

Completed welding and lowering-in 30m along quarry road. Installed 6 anodes c/w test station along road. Stations and leads to be installed on remaining sections - anodes may not go in until 1996. Progress meeting sets hydro-test for Nov. 24 and tie-in for Dec. 1/2 (tentative).

Fri. 95-11-17

Possible extra for gravel on quarry road shoulder. Completed laying and backfilling along road.

Mon. 95-11-20

Installed four joints, el. on Shell end of reroute. Backfilled and surveyed.

Tues. 95-11-21

Welding progress slowed to four welds. Finished Shell side of reroute. Backfilled except for survey points. Installed el. and one joint at MT end.

Wed. 95-11-22

Welded five joints and one el.at MT end. Welding expected to be complete by tomorrow.

Thurs. 95-11-23

Completed welding on MT end. Backfilled and insulated for hydro-test. Inserted scraper.

Fri. 95-11-24

Run scraper and fill with water. Surveyor to calculate delta in line fill - (349m-206m=143m) 143m x .052m^2 = 7.4m3

Sun. 95-11-26

Commence hydrostatic test set up at 08:30 to 10:00. Squeeze up completed at 12:00. Commenced test at 14:00..

Mon. 95-11-27 19(1)

Met with Shell ([redacted] to discuss proposed tie-in procedures. Shell wants $1.50 to #.50 per bbl to reprocess any jet fuel pumped into trucks. To be confirmed. Security rep. did not show. Hydrostatic test still in progress - squeeze line freezing.

Tue. 95-11-28

Shell Day Ops. Supervisor refuses to approve Tie-in Procedures as proposed. Shell wants clay plug at their end of tie-in. Issue deffered to Calgary office-no resolution as of 17:30. TN to mobilize tie-in crew for 07:30 regardless. Hydrostatic test finished.

Wed. 95-11-29

Shell issues permission to tie-in at 09:30. Drain down delayed to 10:00. First tie-in weld commenced at 14:00. Second tie-in completed at 22:30.

Thur. 95-11-30

Purged and grouted abandoned line. Backfilled Shell end of reroute. Installed test leads.

Fri. 95-12-01

Backfilled TN end of reroute. Repaired some fences. Final clean up will take place in summer 1996.

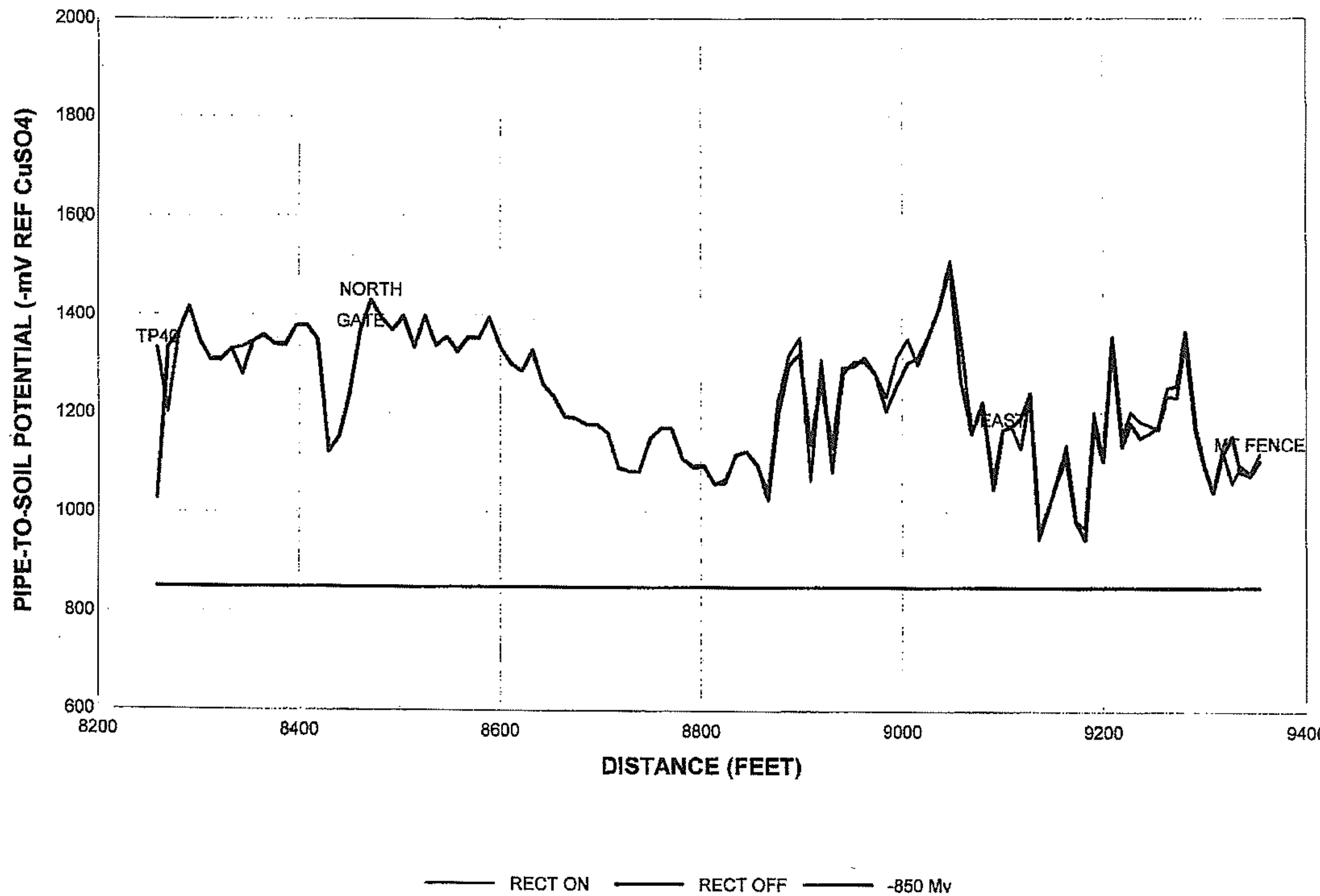
Feeder System from Shell to Montreal Terminal

The feeder system extends from the Shell refinery adjacent to Montreal Terminal, through the Ultramar storage facilities, returns to the shell property and finally to Montreal Terminal. The pipe is cathodically protected by a combination of sacrificial anodes and two impressed current systems.

The feeder system fully meets both the –1000mV and –850mV criteria. The only area requiring attention is at chainage 3600 across for the old Ultramar pump house. The pipe is exposed in a ditch and the coating requires repair.

The charted data is shown on the following pages.

TRANS-NORTHERN PIPELINES INC.
FEEDER SYSTEM SHELL FENCE TO MT FENCE



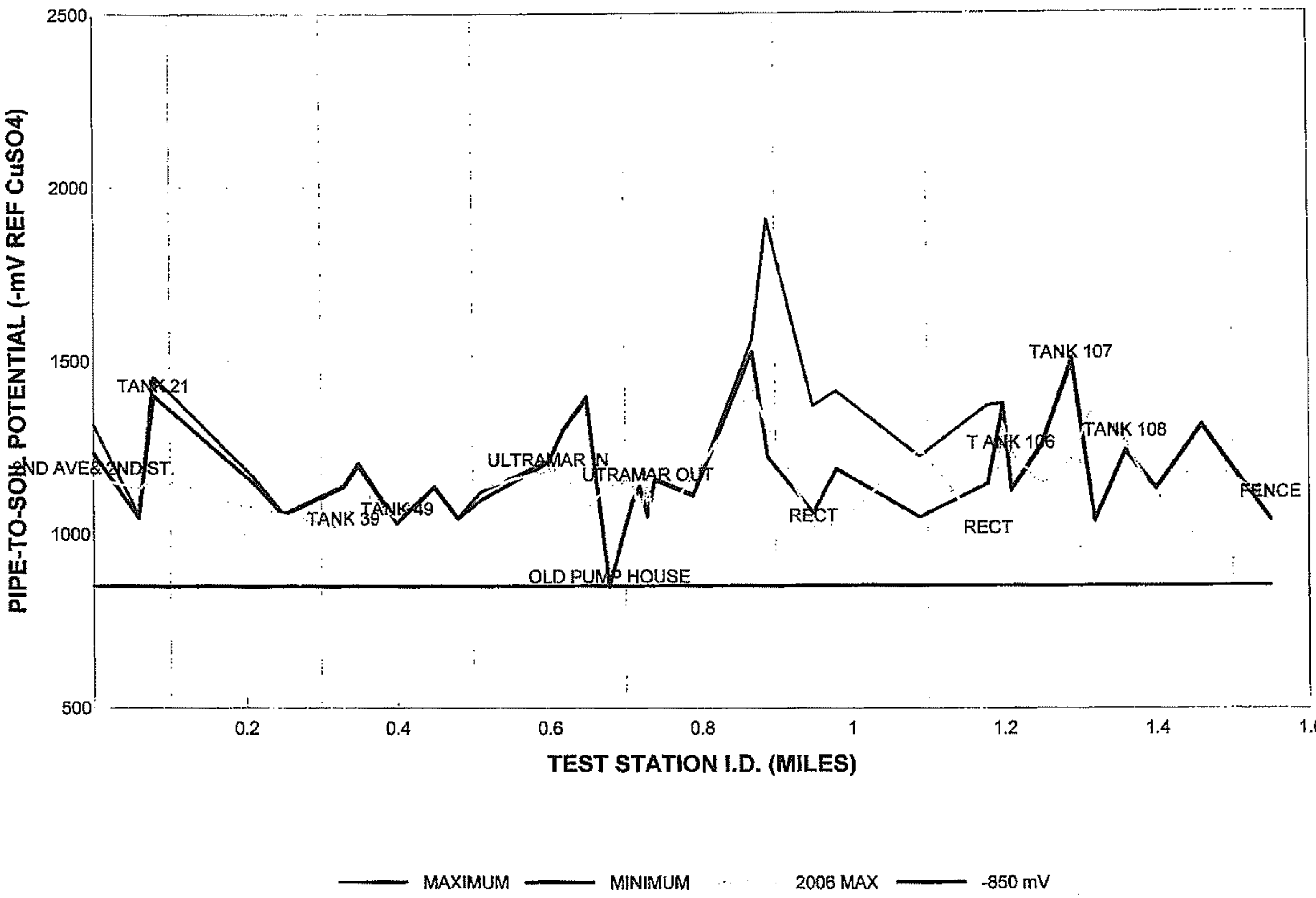
TNPI 2007 TEST POST AND STATION SURVEY

MONTREAL FEEDER SYSTEM		CATHODIC PROTECTION - MAGNESIUM ANODES AND RECTIFIERS								
MTFEEDER07		P/S POTENTIAL			P/S POTENTIAL		P/S POTENTIAL		P/S POTENTIAL	
TP ID	LOCATION	2007 MAX	2007 MIN		2006 MAX	2006 MIN	2005 MAX	2005 MIN	2004 MAX	2004 MIN
0		1316	1236				1176	1164		
0.06		1056	1048				1144	1132		
0.08		1456	1400				1188	1164		
0.15		--	--	BAD TEST LEADS			1244	1236		
0.21		1168	1152				1088	1076		
0.25		1060	1056				1064	1056		
0.33		1140	1136				1024	1016		
0.35		1208	1200				1146	1138		
0.4		1036	1032				1052	1044		
0.45		1138	1136	REPLACE FINK TS			1188	1176		
0.48		1046	1044	REPLACE ALUMINUM HEAD			1176	1162		
0.51		1122	1098				1144	1134		
0.6		1212	1208				1198	1186		
0.62		1304	1300				1202	1188		
0.65		1396	1388				1088	1074		
0.68		850	849	PUMP HOUSE REMOVED			1154	1142		
0.71		1096	1092				1196	1154		
0.72		1139	1136				1074	1062		
0.73		1060	1050				1194	1144		
0.74		1160	1156	CARSONITE BROKEN			1022	1012		
0.79		1113	1109				1176	1166		
0.8		--	--	BAD TEST LEADS						
0.87		1556	1522				1421	1408		
0.89		1904	1222	REPLACE TS			1622	1310		
0.95		1368	1060	RECTIFER 2 VOLTS 3 AMPS			1466	1022		
0.98		1408	1188				1222	1024		
1.09		1222	1046				1268	1245		
1.18		1368	1144				1044	988		
1.19				RECTIFER			1146	1138		
1.2		1372	1368	IF BONDED C/S 650			1342	1312		
1.21		1128	1124				1228	1232		
1.25		1256	1252				1186	1144		
1.29		1504	1488				1254	1218		
1.32		1040	1036				1398	1372		
1.36		1240	1236				1284	1266		
1.4		1132	1128	REPAIR TS			1104	1092		
1.41				MISSING			1216	1204		
1.46		1312	1308				1222	1218		
1.55		1042	1038				1096	1088		

NOT SURVEYED 2004
NOT SURVEYED 2006 - NO ACCESS

16(2)(c)

TRANS-NORTHERN PIPELINES INC.
2007 TEST STATION SURVEY MT FEEDER



conditions encountered during the course of the survey. The following sections describe the individual areas surveyed. Where there was an area of non-compliance with the criteria, the corresponding chart is included with the text. A complete set of charts is contained in the appendices at the end of this report.

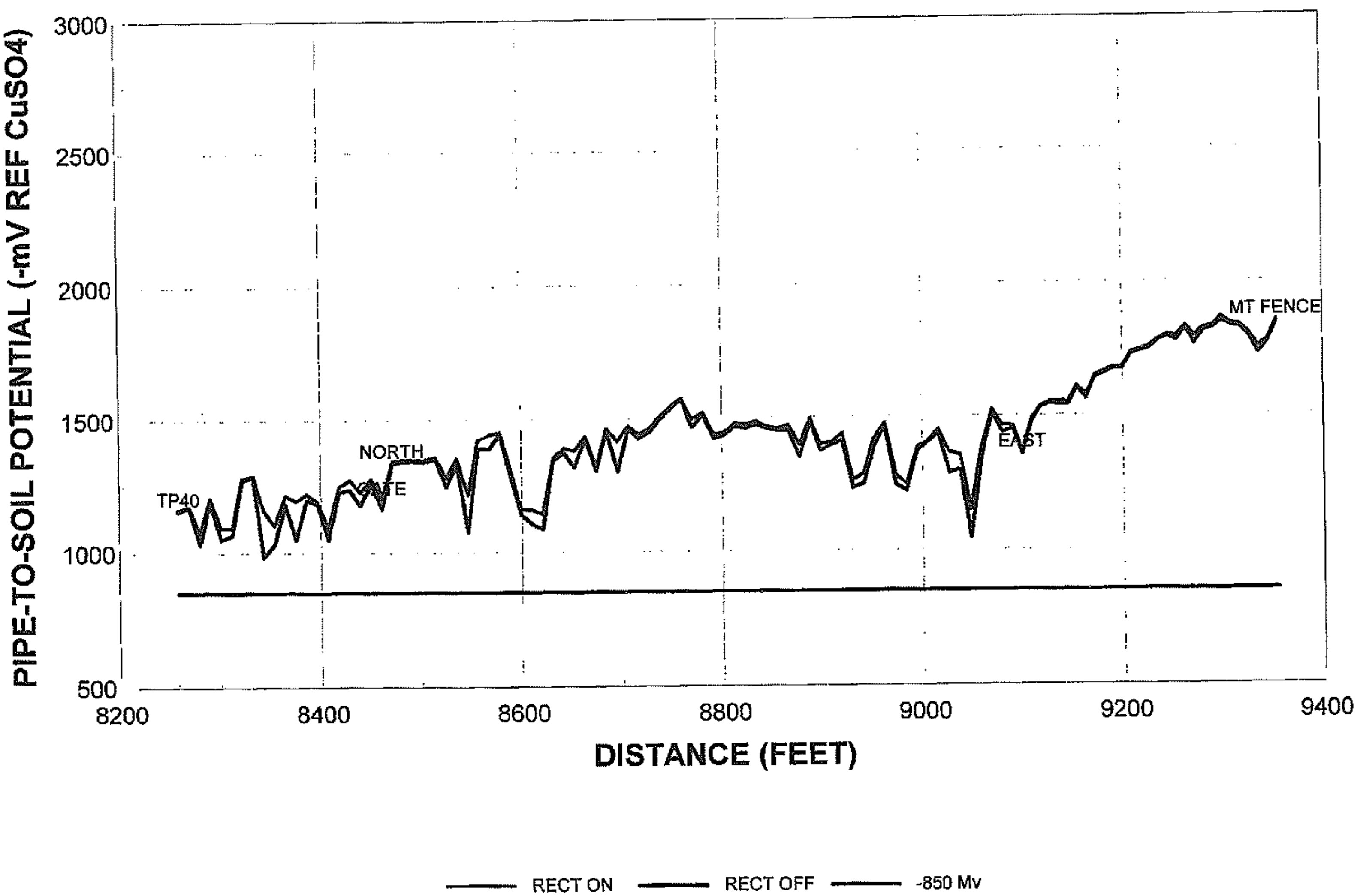
Feeder System – Shell Refinery to Montreal Terminal

There is no chainage data associated with the mapping available for this section of the system. Distances were therefore taking as read from the wire dispenser and test station numbers have been inserted according to the 1998 report on the test station installation. Magnesium anodes protect the feeder system with two impressed current rectifiers installed near test posts 26 and 27. As can be seen from the charts, there is little difference between the ON and OFF potentials over most of the feeder system. This is due to the fact that the sacrificial anode system is not interrupted. In the vicinity of the rectifiers, the difference between the ON and PFF potentials is apparent.

The feeder system meets the cathodic protection criteria with the exception of the areas in the vicinity of test post 33 and test post 35. These two areas fall with the spill containment for tanks 107 and 108. The charted data shows the potentials rise and fall as the survey crosses over the magnesium anode locations. Additional anodes will be required in this area. The chart on the following page shows the area discussed.

TNPI 2002 CLOSE INTERVAL POTENTIAL SURVEY

TRANS-NORTHERN PIPELINES INC.
FEEDER SYSTEM SHELL FENCE TO MT FENCE



CORROSION DIAGNOSTICS LIMITED

The section of 16" main line from Hwy 117 to Hwy 15 exhibits adequate levels of cathodic protection.

The section of 16" main line from Boulevard Ste Rose to Boulevard Mattawa exhibits adequate levels of cathodic protection.

The graphical results of this survey are shown under Tab # 16.

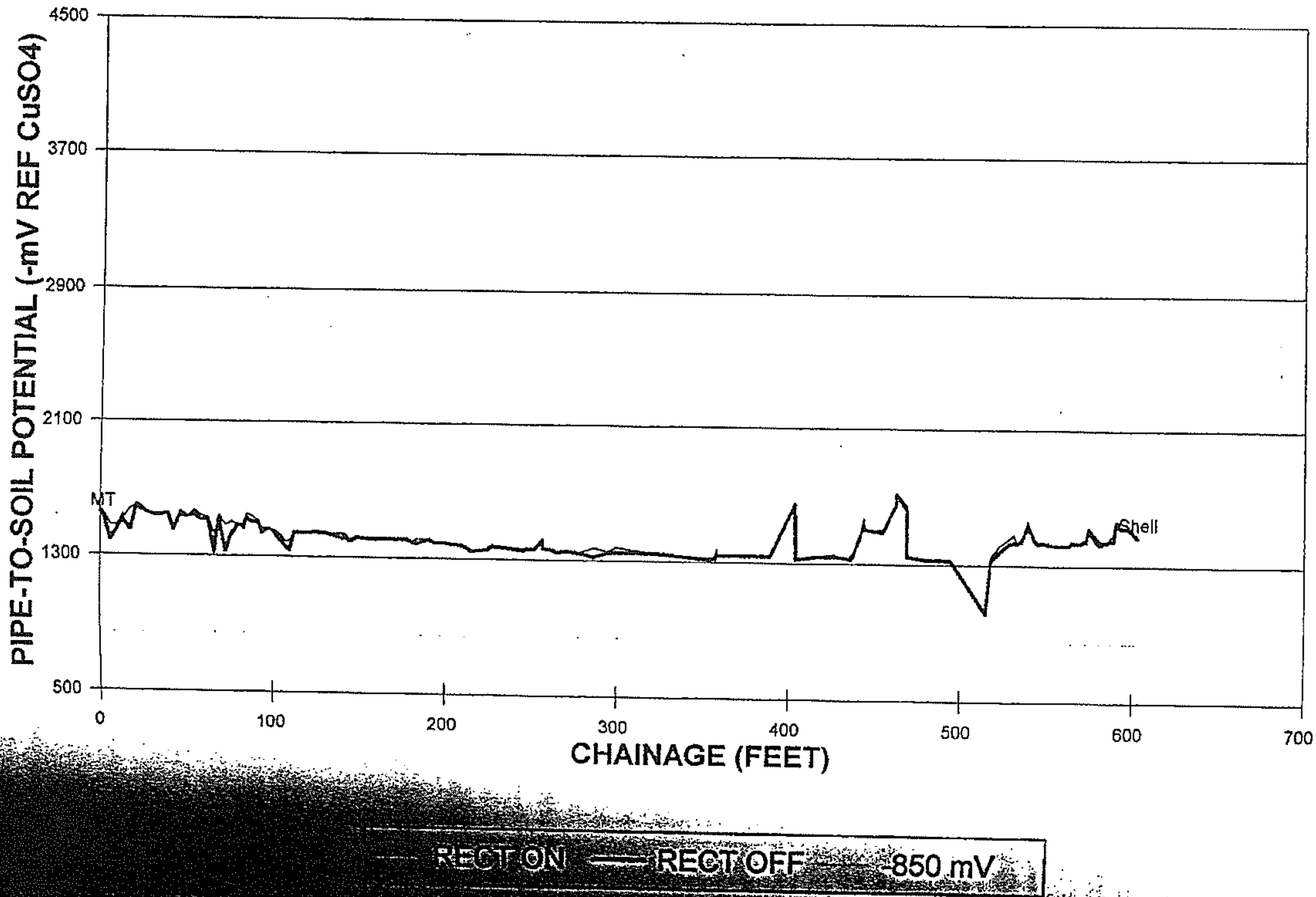
Montreal Shipper Lines

The shipper lines from the Shell pump house to Montreal Terminal exhibits potentials indicative of cathodic protection. [redacted] 16(2)(c)

The graphical results of this survey are shown under Tab # 17.

TRANS-NORTHERN PIPELINES INC.

Montreal 10" line: MT to Shell P.S.



A0009808_2-000112

CORROSION SERVICE

CATHODIC PROTECTION - DATA SHEET DS-B

COMPANY: Trans Northern Pipelines Inc.
DATE: December 16th 1996
ADDRESS: Shell Refinery, Montreal East
SYSTEM: TNPI Potential survey following remedial work (as left)

HALF-CELL LOCATION	STRUCTURE CONNECTION	STRUCTURE POTENTIALS WITH REFERENCE TO A $Cu:CuSO_4$ ELECTRODE (-mV)			REMARKS
		ON	OFF	Static	
Tank #107 step	pipeline	845	835		
	pipeline	1067	1060		
	pipeline	1096	1088		
	pipeline	1013	1006		
	pipeline	1175	1167		
	pipeline	1038	1031		
	pipeline	1089	1075		
	pipeline	875	865		
	pipeline	860	850		
	pipeline	815	805		
	pipeline	837	828		
	pipeline	881	872		
	pipeline	905	898		
Tank #108 step	pipeline	962	956		
	pipeline	955	948		
	pipeline	1088	1079		
	pipeline	1015	1006		
Test station #30	pipeline	845	840		Isolating flange
	pipeline	845	840		
	pipeline	932	908		
	pipeline	1010	993		
Bend north	pipeline	1016	1000		

ADDITIONAL REMARKS:

CORROSION SERVICE

CATHODIC PROTECTION - DATA SHEET DS-B

COMPANY: Trans Northern Pipelines Inc.
DATE: December 16th 1996
ADDRESS: Shell Refinery, Montreal East
SYSTEM: TNPI Potential survey following remedial work (as left)

HALF-CELL LOCATION	STRUCTURE CONNECTION	STRUCTURE POTENTIALS WITH REFERENCE TO A $Cu:CuSO_4$ ELECTRODE (-mV)			REMARKS
		ON	OFF	Static	
Test station #31	pipeline	1063	1053		
	pipeline	1020	1012		
	pipeline	990	980		
	pipeline	1087	1078		
	pipeline	1037	1029		
	pipeline	1137	1128		
	pipeline	1162	1152		
	pipeline	1362	1357		
Test station #32	pipeline	1253	1243		
	pipeline	1093	1085		
	pipeline	1088	1082		
	pipeline	785	779		
	pipeline	1096	1090		
	pipeline	1012	1006		
	pipeline	1300	1300		
	pipeline	972	967		
	pipeline	1018	1014		
	pipeline	929	918		
	pipeline	1085	1077		
	pipeline	1075	1068		
Test station #33	pipeline	1161	1154		
	pipeline	1178			

ADDITIONAL REMARKS:

CORROSION SERVICE

CATHODIC PROTECTION - DATA SHEET DS-B

COMPANY: Trans Northern Pipelines Inc.
DATE: December 16th 1996
ADDRESS: Shell Refinery, Montreal East
SYSTEM: TNPI Potential survey following remedial work (as left)

HALF-CELL LOCATION	STRUCTURE CONNECTION	STRUCTURE POTENTIALS WITH REFERENCE TO A $Cu:CuSO_4$ ELECTRODE (-mV)			REMARKS
		ON	OFF	Static	
	pipeline	1210			
	pipeline	1260			
	pipeline	1300			
	pipeline	1360			
	pipeline	1405			
Fence	pipeline	1457			
Bend north	pipeline	1413			
	pipeline	1411			
	pipeline	1390			
	pipeline	1435			
	pipeline	1387			
	pipeline	1367			
	pipeline	1367			
	pipeline	1435			
	pipeline	1376			
	pipeline	1370			
	pipeline	1373			
	pipeline	1421			
	pipeline	1381			
Test station #34	pipeline	1393			
	pipeline	1399			
	pipeline	1448			

ADDITIONAL REMARKS: The above following data sheet indicate "ON" readings only as this new section of pipeline is protected with sacrificial magnesium anodes cadwelded directly to the pipe.

CORROSION SERVICE

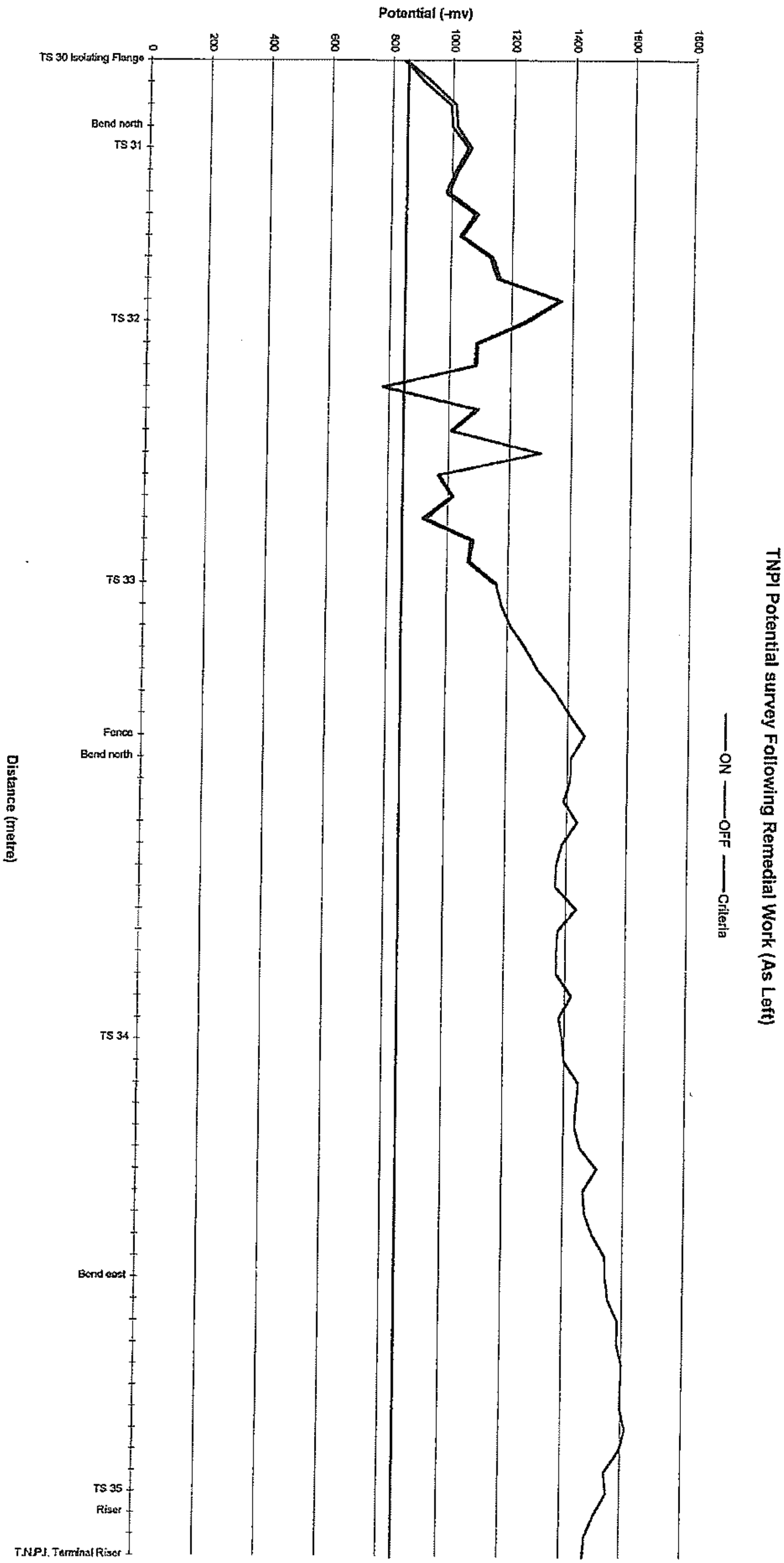
CATHODIC PROTECTION - DATA SHEET DS-B

COMPANY: Trans Northern Pipelines Inc.
DATE: December 16th 1996
ADDRESS: Shell Refinery, Montreal East
SYSTEM: TNPI Potential survey following remedial work (as left)

HALF-CELL LOCATION	STRUCTURE CONNECTION	STRUCTURE POTENTIALS WITH REFERENCE TO A $Cu:CuSO_4$ ELECTRODE (-mV)			REMARKS
		ON	OFF	Static	
	pipeline	1442			
	pipeline	1436			
	pipeline	1455			
	pipeline	1511			
	pipeline	1467			
	pipeline	1472			
	pipeline	1498			
	pipeline	1540			
Bend east	pipeline	1543			
	pipeline	1553			
	pipeline	1586			
	pipeline	1583			
	pipeline	1601			
	pipeline	1598			
	pipeline	1596			
	pipeline	1614			
	pipeline	1595			
	pipeline	1545			
Test station #35	pipeline	1554			
Riser	pipeline	1514			
	pipeline	1485			
T.N.P.I. Terminal riser	pipeline	1477			

ADDITIONAL REMARKS:

CORROSION SERVICE



A0009809_5-000117

Pages 118 to 437

are not relevant

National Energy Board | Office national de l'énergie

ASSURANCE OF VOLUNTARY COMPLIANCE/PROMESSE DE CONFORMITÉ VOLONTAIRE

Activity # / Activité n°	1011-209	**Date**	August 4 -5, 2010

Company / Société	Trans-Northern Pipelines Inc.
Location / Emplacement	10040 Autoroute Metropolitaine, Montréal, Québec
Facility / Installation	TNPI NPS 10, Montreal Feeder System 19(1)

Company Representative / Représentant(e) de la société	19(1) [redacted] Name / Nom	Manager Field Services Title / Titre	[redacted] Telephone / Téléphone	(905) 770-8675 Facsimile / Télécopieur
Officer or NEB Representative / Agent(e) ou représentant(e) de l'ONÉ	Chad Bunch Name / Nom	Engineer Title / Titre	403-221-3008 Telephone / Téléphone	1-403-292-5503 Facsimile / Télécopieur
	444 Seventh Avenue SW Calgary AB T2P 0X8 | 444, Septième Avenue S.-O., Calgary (Alberta) T2P 0X8			

No./N°	Item / Sujet	Completion Date / Date du redressement
1	Welding inspection parameters were not recorded consistently and the conclusion on the weld inspection report was erroneous. Welding inspection was done by a person in training. Subsection 54(1) of the Onshore Pipeline Regulations (OPR) and Subsection 54(2) states "An inspection shall be performed by a person who has sufficient expertise, knowledge, and training to competently carry out the inspection." It is doubtful that the parameters would have been recorded inconsistently or that the erroneous conclusion on the "Weld Compliance Report" would have been made by a competent inspector or by a person in training who had adequate oversight and support while learning. Therefore TNPI was in non compliance with Subsection 54(2) of the OPR. TNPI will ensure that its welding inspection procedure is updated to include methods for oversight and support of staff that are in training, and will submit its updated procedure and a written commitment that it will follow the procedure to Chad Bunch (chad.bunch@neb-one.gc.ca).	16 September 2010

Assurance	Promesse
I, the undersigned company representative or employee, hereby: 1. declare that I have read this document and understand what action is required; 2. agree to take such action and to have it completed on or before the completion date indicated above; and 3. agree to inform, in writing, the Officer/NEB Representative named below, within seven (7) days from the above completion date, what remedial action has been taken. 19(1)	Je, soussigné(e), représentant(e) ou employé(e) de la société, par la présente : 1. déclare avoir lu le présent document et comprendre le redressement nécessaire; 2. conviens de prendre les mesures nécessaires et de m'assurer que le tout soit terminé au plus tard à la date de redressement indiquée ci-dessus; 3. conviens d'informer par écrit l'agent(e) / le(la) représentant(e) de l'ONÉ nommé(e) ci-dessous des mesures correctives qui ont été prises, dans les sept (7) jours suivant la date de redressement indiquée ci-dessus.

Company Representative / Représentant(e) de la société	[redacted]	2010-08-18 Date
Officer or NEB Representative / Agent(e) ou représentant(e) de l'ONÉ	Signature	Aug 18, 2010 Date

Template revision: 18/06/2008

Canada

19(1)

From: Chad Bunch
To: [redacted]tnpi.ca"
Cc: [redacted]@tnpi.ca"; Dan Barghshoon; Alan Pentney; Kyle Sherwin; Erin Doerffer
Subject: TNPI Montreal Feeder Pipeline, Integrity Inspection Report, August 4-5, 2010
Date: Monday, August 16, 2010 12:02:59 PM
Attachments: 2010 08 05, Montreal Feeder Line Inspection Report.pdf
2010 08 05, Montreal Feeder Line AVC.pdf

Hi [redacted]

As part of any NEB inspection, NEB staff prepare an inspection report highlighting construction activities and overall work site procedures observed. NEB Staff also prepare an Assurance of Voluntary Compliance (AVC) so that any non-compliances that were observed can be fixed. Please review the attached inspection report and AVC and provide comments on content and accuracy if you have them.

If you have any revisions, please let me know so they might be incorporated into the final report. If you have no comments on the inspection report, please **sign the first page below your name,** and **initial the pages** that follow on the bottom left corner above the footer. If you have no comments on the AVC, **please sign and date at the bottom of the page.** When you have completed this task, please scan the report and send it back to me via email (or you can fax to 403.292.5503). I will sign the report, initial likewise and, send a copy back to you for your records.

Also, please note that your signature does not translate into your agreement with the content of the inspection report; it only acknowledges that you have received it. 19(1)

I am not in the office today, but can be reached at [redacted] should you have any questions, comments, or concerns. I will also be back in the office tomorrow.

Regards.

Chad Bunch
Engineer, Integrity
Operations Business Unit
National Energy Board | Office National de l'énergie
Telephone | Téléphone: 403-221-3008
Facsimile | Télécopieur: 403-292-5503
Cell Phone | Cellulaire: 403[redacted] 19(1)

From:	[redacted] 19(1)
To:	Alan Pentney
Cc:	Chad Bunch; Dan Barghshoon
Subject:	Montreal Feeder System - Update
Date:	Thursday, July 29, 2010 8:53:28 AM
Attachments:	1998 COREXCO.pdf MFS Leak IR 1 - NEB.doc

Attached is a revised update...I overlooked one of the CIS reports by Corexco in 1998. Information is underlined and excerpt from report is attached.

Oil Movement have scheduled the cutout for next Wednesday/Thursday.

[redacted] 19(1)

From: [redacted] 19(1)
To: Alan Pentney
Cc: Chad Bunch; Dan Barghshoon
Subject: Revised Update and additional information
Date: Wednesday, July 28, 2010 1:47:56 PM
Attachments: SPECS.pdf
1996 CIS SURVEY.pdf
1999 CIS SURVEY.pdf
2002 CIS SURVEY.pdf
2008 CIS SURVEY.pdf
MFS Leak IR 1 - NEB.doc
2005 2007 TP SURVEY.pdf

Good day Alan...attached is an update of yesterday's information together with information on Cathodic Protection Surveys and Coating Specifications...I have underlined the two areas that I have revised since yesterday's transmission.

Tomorrow I will forward a draft delineation plan to you showing the proposed location of the boreholes in and around the quarry. We need to get permission from Lafarge for this work. In addition, we are also hoping to receive information from Shell that may alter this draft work plan.

As of an hour ago, Field Services advise that excavation is going well and should be completed by Friday afternoon, meaning that the entire 300 metres of 1995 will be exposed and ready for coating repair and eventual backfill.

Field Services advise that tapping nipples will be welded to the pipe in the vicinity of the Plidco to gear-up for a draindown and pipeline replacement next Wednesday or Thursday. Your inspectors Dan and Chad should plan to be on site Wednesay morning if possible. I have copied both of them into this e-mail.

The draindown will not take all that long to achieve as the Feeder System is quite short and there are block valves in close proximity to the cutout site.

Please call me if you want additional details.

[redacted] 19(1)

Page 459

is not relevant

Preliminary Incident Report

Flange Leak: Riviere des Prairies Check Valve
February 27, 2010 – St. Vincent de Paul, Quebec

Around noon hour (11:50 a.m.) on February 27th, Trans-Northern Pipelines Inc. (TNPI) Line Control received a telephone call from TNPI's Quebec emergency service call centre that a representative from Environment Canada had called to report the presence of gasoline escaping from the TNPI pipeline near 6175 Levesque Boulevard East in Laval, Quebec. Line Control immediately shut down both operating pipelines through Montreal and after confirming the location address, closed upstream and downstream valves. TNPI's emergency response team was activated and dispatched to the location. TNPI was advised that local emergency services had been working in this area since Friday afternoon, February 26th, responding to a call from a pedestrian who noticed a brown coloured liquid in Ruisseau Lapiniere, a creek adjacent to the TNPI pipeline crossing. Environment Quebec and Environment Canada officials believed the source of the liquid was from an upstream industrial plant. In their continued investigation on Saturday product was observed escaping from the vault containing TNPI's valve. Within an hour of the initial call to the Company, TNPI personnel were on site and confirmed that fuel was escaping from a vault containing a 16" check valve. Subsequently additional TNPI emergency responders and contractors were dispatched to supplement resources already on the scene.

In compliance with established protocols, TNPI notified the Transportation Safety Board of Canada of the incident at 13:25 hours prior to having detailed information about the leak itself.

The leak was stopped on Saturday and product was contained. Response personnel continue to focus on the environmental response and have continued to work since Friday. TNPI's environmental consultant is on site to assist in directing the environmental response. Numerous agencies are present on site including the NEB who have had representatives on site since Sunday morning.

TNPI is actively engaged in a local "drain down" of the line that will allow the removal and replacement of the failed gasket on the 16" check valve.

Trans-Northern Pipelines Inc.
2010-03-02

Trans-Northern Pipelines Inc.

45 VOGELL ROAD, SUITE 310
RICHMOND HILL, ONTARIO L4B 3P6
TEL: (905) 770-3353 FAX: (905) 770-8675

2010 SEP -1 A 11:17

2010-08-31

National Energy Board
444 Seventh Avenue SW
Calgary, Alberta
T2P 0X8

Attention: **Ms. Anne-Marie Erickson**
Secretary of the Board

Subject: **Riviere des Prairies 16"Flange Leak, February 27, 2010**

Further to TNPI's report on the leak from a 16" insulated flange gasket near Riviere des Prairies on February 27, 2010, TNPI is enclosing a copy of the report "Failure Analysis on an Insulating Gasket"prepared by SGS Canada Inc.

In addition, TNPI is enclosing its corrective action plan. The first portion of this document reiterates TNPI's Insulated Gasket Assessment as related to the NEB in its letter dated 2010-08-23. The second portion, details TNPI's proposed Insulated Gasket Management Program.

If you have any questions, regarding TNPI's corrective actions in respect to insulated gaskets, please contact the undersigned.

Trans-Northern Pipelines Inc.

[redacted] 19(1)

Manager, Environment, Health, Safety and Security
905-[redacted]ext.[redacted]
[redacted]@tnpi.ca 19(1)

Insulated Gasket Assessment

The leak experienced on February 27th, 2010 at the Riviere des Prairies, Mile Post 6.4 was the result of a failed insulating gasket on a valve flange that was originally installed in 1972. TNPI had only experienced one other failure of an insulating gasket which occurred in February 1982, which was not a failure of the insulating gasket itself but rather the result of loose studs and nuts. TNPI has numerous other insulated gaskets on its pipeline system installed as early as 1952 which have never presented a problem.

Commitments to improve Pipeline Integrity

The results of the testing of any failed gasket are somewhat subjective. The report points to a failure of the neoprene facing. Insulated gasket failures are rare events in TNPI's experience. Physical inspection of gaskets requires that they be removed from the pipeline. This is not an easy feat as the process would require the draindown or purge of the pipeline contents to enable gasket removal. Gasket removal often destroys gasket integrity, rendering the inspection inconclusive.

There are 63 gaskets of the same design and material as the one that leaked at Riviere des Prairies in the TNPI system. Forty-three of these gaskets are in stations. Only 20 are on mainline block valve sites and few have a similar history to the Riviere des Prairies gasket, including a period of direct burial before valve vaults were installed throughout the TNPI system. TNPI has developed a program to inspect Type E, neoprene faced gaskets. We will perform detailed external examinations and remove and replace gaskets as operations allow. Judging the condition of the gaskets when removed from service, TNPI will reassess priorities as required.

Proposed Improvement

TNPI had suspended the use of neoprene faced insulating gaskets as more modern materials became available in the marketplace many years ago. In this respect process improvements have already been implemented.

Pending the physical inspection of other gaskets, TNPI has increased the inspection frequency at sites where insulated gaskets similar to the one at Riviere des Prairies are located. Formerly the inspection frequency for all valve sites was ten (10) days. This interval has been reduced to five (5) days.

An alternative to physical gasket inspection is condition monitoring of the environment in proximity to the gasket. TNPI is currently exploring various means to monitor vault sites with liquid level detectors such that any liquid in a vault, beyond a certain depth, would prompt an immediate response to investigate. New cellular technology has now made this monitoring possible where in the past establishing permanent power sources to some valve locations was prohibitive.

2010-08-23

Insulating Gasket Management Program

The following is an outline of an inspection and management program for insulating gaskets.

1. **Inventory Assessment**

   TNPI has determined that there are 43 Type E insulated gaskets at stations and 20 Type E gaskets at block valve sites throughout the system. The following work plan has been developed to ensure that other neoprene faces phenolic insulating gaskets are inspected on a regular basis using the following procedures.

   - Perform visual inspection complete with photographs of each site.
   - Visual inspection will include assessment of adherence of facing at edges of gasket, brittleness, corrosion evidence on studs and/or flange faces.
   - In order to visually inspect, or in order to clear corrosion deposits cleaning with air blast/water spray and protection with lubricant/coating (must be compatible with neoprene) to be considered.
   - Measure dielectic resistance across the insulating gasket as an indicator that gasket degradation may be taking place. (This information may not be conclusive by itself (ie. isolation could be spoiled numerous ways).
   - A procedure for in-situ inspections is to be developed and included in the Pipeline Maintenance Training Manual (PLMTM) for future reference.

Two Type E gaskets were inspected on July 13, 2010. Gaskets were inspected at Cummer Junction on V3 and V4. These gaskets were observed as able to be in 'good' condition. In particular there was no visible disbondment of the facing, the facing appeared to be free of cracking or brittleness, the gasket itself remained flexible within reasonable limits and facing condition was unchanged through any movement. Evidence could be seen that the flanges had been tape wrapped in the past. Only light corrosion at worst was visible on exposed components for flanges and studs.

The following listing has been divided into priority rankings based on the valve history, water ingress into vaults and operating pressure at the site.

Toronto System Locations

Inspection	Station	Valve	Block Valves	Check Valves	Type E	Comments
Priority						US (Upstream side)
1	BLB		X		1	upstream
2	BLB			X	1	upstream
3	BOS			X	1	upstream
4	GRB			X	1	upstream
5	BIN			X	1	upstream
6	BENWAY				2	both sides
				Total	7	

Inspection	Station	Valve	Block Valves	Check Valves	Type E	Comments
Priority						US (Upstream side)
1	HAJ	V1			1	upstream
2		V2			1	downstream
3	OA	M/l west of V34			1	mainline side
4		V27			2	3 way valve
5	CLJ	V1			1	downstream
6		V3			1	mainline side
7		10" m/l			1	downstream of V5
8	TAJ	V2			1	20 " side of valve
9		V8			1	Imperial side
10		V12			1	bottom flange
11	KEJ	V2			1	upstream
12		V3			1	upstream
13	BO	V2			1	downstream
14		V3			1	upstream
15	CA	V3			1	upstream
16	DR	V1			1	downstream
17			east		2	both sides
18	KS	V1			1	upstream

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19	CUJ	V1			1	down stream
20		10" m/l			1	upstream of V2
21	TA	V3			1	upstream
22	NT	V21			1	upstream
23				C23	1	upstream
24		Metro depot			1	secondary shipper one on each side
25		Shell shipper Lat			1	spool upstream of secondary shipper valve
26		Petrocan Pl			1	One on each side of valve
27		Shell shipper valve			1	One on each side of valve
28		elbow V61			1	down stream
29		Shell Shipper Lat			1	by fence north side
30	CL	V8			1	shipper side
				Total	32	

Montreal System Locations

Inspection	Station	Valve	Block Valves	Check Valves	Type E	Comments
Priority						
1			DDB		2	Originally Direct Buried
2			RDP		1	16"
3			RMB		1	US
4			16" MT		1	US
5			10" MT		1	US
6			OBB	Ottawa	1	Type E on North
7			NSR	Ottawa	1	Type E on North
8			GLB	Ottawa	1	Type E on South (Gallinger Block)
9			RDP north	Dorval	2	
10			RDP South	Dorval	2	
				Total	13	

Inspection	Station	Valve	Block Valves	Check Valves	Type E	Comments
Priority						
1	SJ	V6			1	DS
2		V1			2	
3		V3			1	DS
4	CM		E Block		1	W flange

5	OT	V4			1	kicker
6		Petro			1	check valve
7		Shell			1	flange on lateral
8	DV				1	Flange @ CAFAS
9	MT	V15			1	Refinery side Petro-Canada
10	CW	V7			1	shipper side
				Total	**11**	

2. Validate

TNPI will remove and inspect select station gaskets by pipeline draindown. The results of these inspections will assess gasket condition after removal to validate observations in action item 1.

The prime candidates for removal inspections are: SRJ V6 and V1, CM East Block, OT V4, NT V21. The check valves on the Nanticoke Pipeline are being considered in conjunction with planned pipeline cut-outs.

3. Standards/Specifications

TNPI needs to define standards or specifications for gaskets and sealing materials if no single comprehensive document readily exists. This document will be filed in TNPI's Engineering Standards documents.

4. Vault Instrumentation

TNPI will commit to installation of liquid level detection devices in vaults. These devices will be built into any new vault installations. A multi-year program of retrofitting existing vaulted valve sites will begin in 2011.

2010-08-31

FAILURE ANALYSIS ON AN INSULATING GASKET

19(1)

Attention of [redacted] **P.Eng.**

TRANS-NORTHERN PIPELINES INC.
45, Vogell Rd., Suite 310
Richmond (ON) L4B 3P6

SGS File N°: MET-10137-01 revision 1
PO N°: 33329
Date: May 28th, 2010 (June 3rd, 2010)
Number of pages: 15 (appendix included)

19(1)

Prepared by:
[redacted] P. Eng., Ph.D., CFEI
Senior Engineer [redacted]

19(1)

Reviewed [redacted]

19(1) [redacted] P. Eng., M.A.Sc [redacted]
Manager, Materials Engineering [redacted]

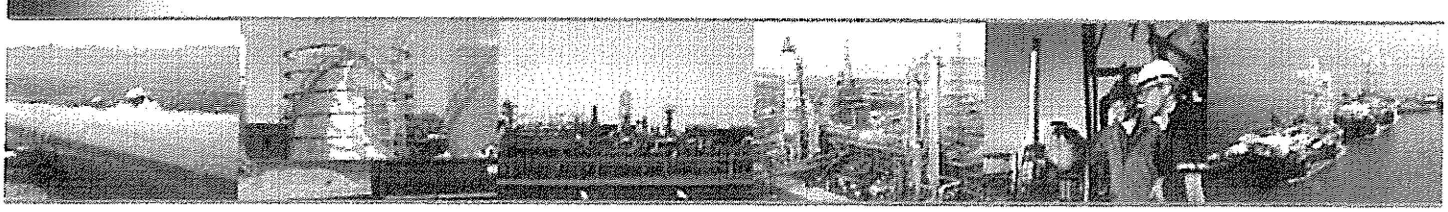


TABLE OF CONTENTS

1.0 MANDATE

TRANS-NORTHERN PIPELINES INC (TNPI) mandated SGS CANADA INC. to determine the root cause of the degradation experienced by an insulating gasket coming from the flange connection of a check valve, in the TNPI pipeline installation that operates from Montreal-East to Ste-Rose (Laval).

In order to make the necessary examination, the said gasket was shipped to our Montreal facility. The present report will consist of several sections. First, the available general information concerning the specimen will be presented. Evaluation of the degradation in the gasket, at both microscale and macroscale levels will be next addressed. The most probable cause of the failure will be detailed in the last section, Discussion/Conclusion.

2.0 GENERAL INFORMATION AND SPECIMEN PRESENTATION

The specimen under investigation is a Type E (full faced) insulating gasket used to seal and electrically insulate a flange connection in a pipeline. The pipeline operates from Montreal-East to Ste-Rose (Laval), being used to transport marketable gasoline (including RBOB-Reformulated Gasoline Blendstock for Oxygen Blending), diesel fuel, furnace oil, stove oil, and jet fuel. The gasket was mounted at a check valve on the pipeline between two NPS 16, ANSI 600 class (maximum allowable operating pressure 1440 psi) raised face flanges. The gasket comes from the east side (upstream) of the valve and it was installed in 1972, being in service ever since. The edges of the flanges were wrapped with tape in accordance with the gasket manufacture's recommendation (see Figure #1 for a view of the flange connections in as-found condition).

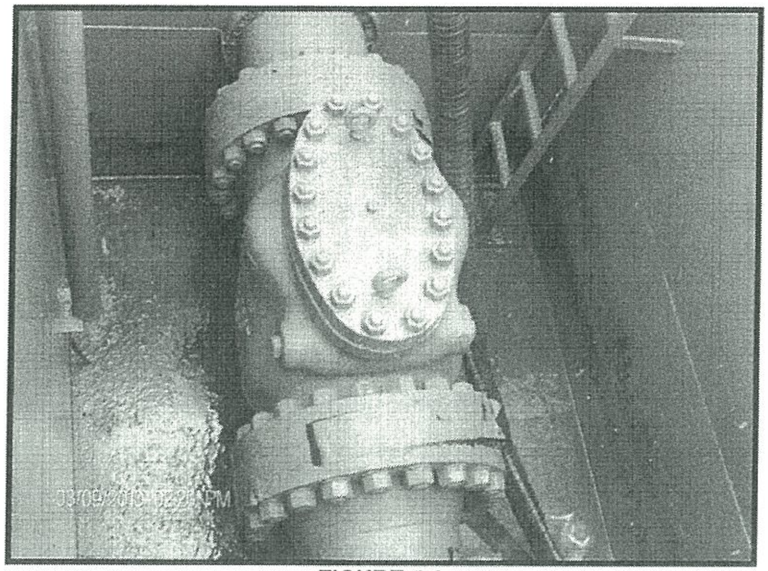


FIGURE # 1
Check valve in as-found condition
(picture taken during the excavations and provided by the client)

A leak occurred from this connection during February 2010. According to the client, when the gasket was removed, the flanges were found to be "in good condition", having the studs and nuts tight. However, the gasket itself seemed to have been damaged and was considered responsible for the spilling. Figures #2 to #6 show general images of the flanges and the gasket, during excavation operation.

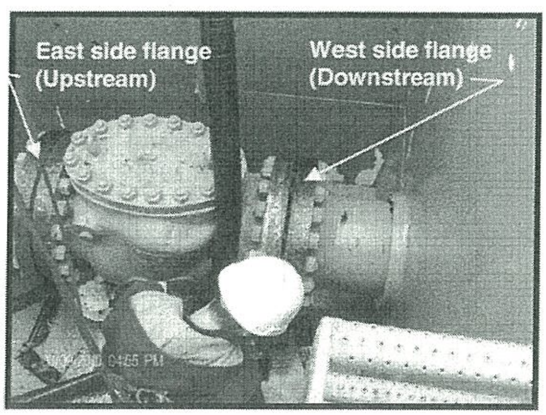


FIGURE # 2
General view of the check valve (picture taken during excavation and provided by the client)

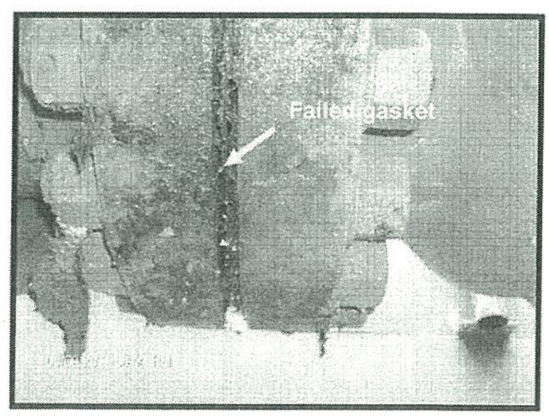


FIGURE # 3
Close-up view of the flange assembly on the east side of the valve (picture taken during excavation and provided by the client)

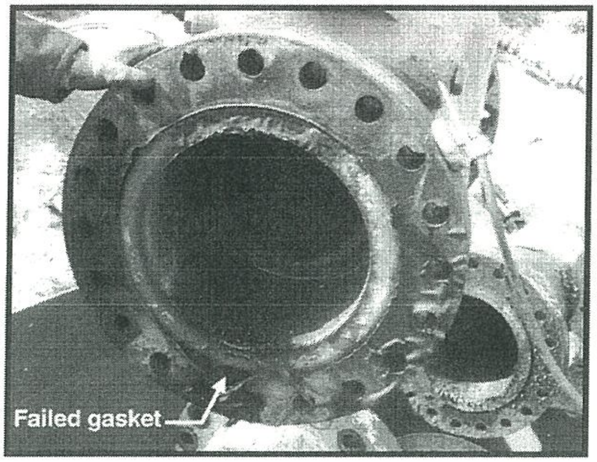


FIGURE # 4
General view of the failed gasket on the east side of the valve (picture taken during excavation and provided by the client)

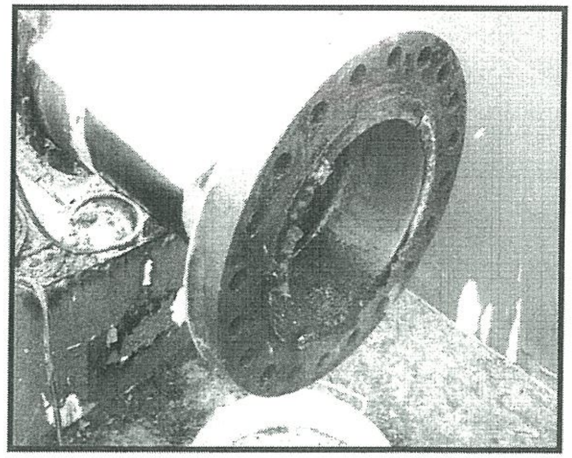


FIGURE # 5
General view of the flange on the east side of the valve (picture taken during excavation and provided by the client)

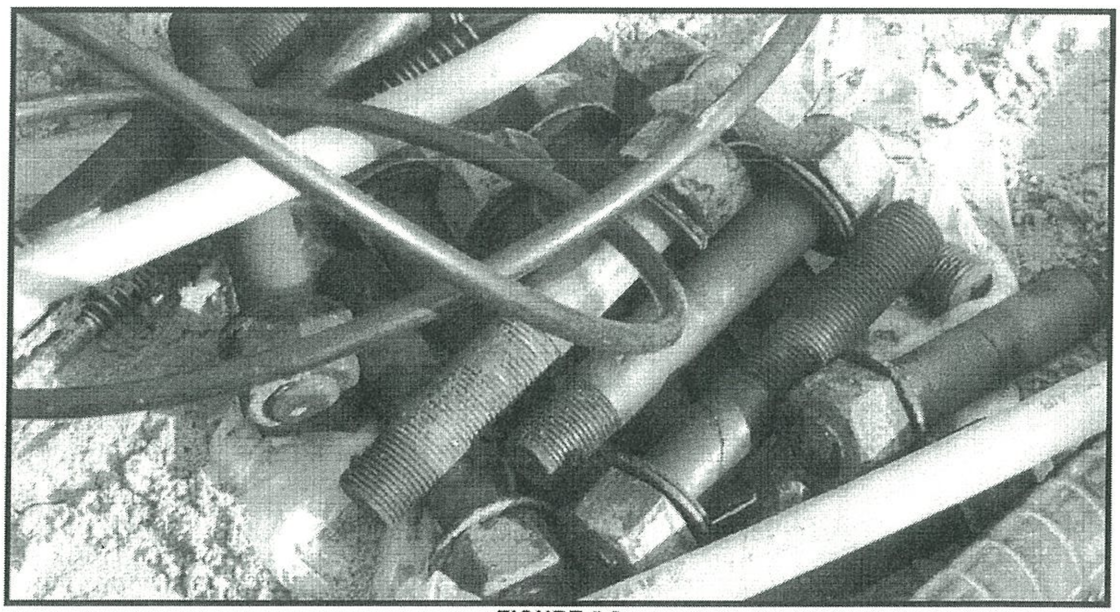


FIGURE # 6
General view of some of the bolts used to secure the flanges (picture taken during the excavations and provided by the client)

As the client informed us, the valve was originally buried in the earth. During 1992, it was excavated and a steel vault was installed to encapsulate the valve. The piping system in this area was cathodically protected at the moment of the original installation, in 1972. However, the fact that the valve was unburied made it susceptible to atmospheric corrosion inside the vault. In the case under investigation, corrosion in progression could indeed be noticed on metallic surfaces such as the faces of the flanges, the bolts and the flexitallic gasket on the west side of the valve (Figures #2 to #6).

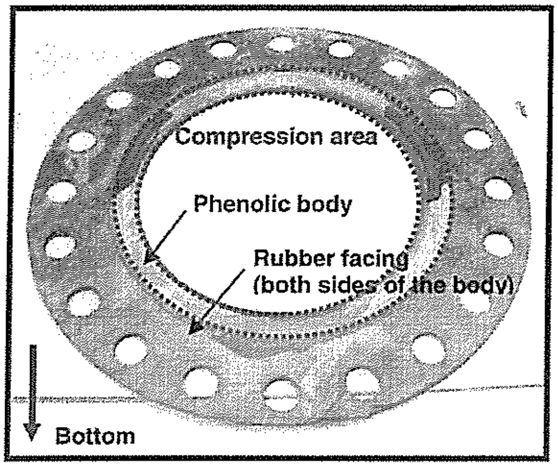
According to the documentation provided by the client the failed gasket is neoprene face phenolic, which means the gasket is composed of a medium-weave fabric, reinforced phenolic rigid body, faced with neoprene. This combination should insure both electrical insulation and sealing of the flange connection.

3.0 FAILURE ANALYSIS

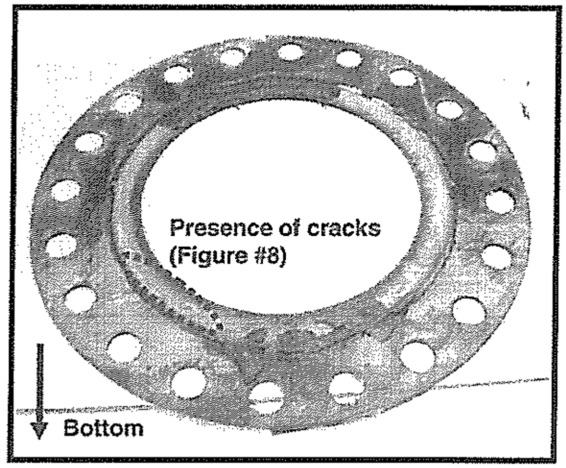
Failure analysis was conducted at both macro and micro scale in order to found the most probable cause of the degradation exhibited by the submitted gasket. Thus, visual examination of the degraded area, on both phenolic support and the neoprene faces, was followed by high magnification observation under a stereomicroscope. Scanning Electron Microscopy (SEM) was performed in the degraded area of the neoprene facing and Energy Dispersive X-rays (EDX) analysis was done on deposits found on the degraded gasket. Differential Scanning Calorimetry (DSC) and Fourier Transform Infrared Spectroscopy (FTIR) were performed to validate the use of the neoprene as facing in the failed gasket. The results of these analyses along with the most representative pictures taken during our investigation will be presented in the next sections.

3.1 Visual Examination

General images of the failed gasket, in as-submitted condition, are presented in Figures #7. The two faces of the gasket were labelled A and B at our laboratory and their position in Figures #7 is consistent with their position in the flange connection. Visual examination of the failed gasket first showed that the heavy damage exhibited by the gasket seem to be found rather in the rubber facing than in the phenolic body (Figures #7). Indeed, a closer look at the gasket found that the only apparent damage in the phenolic body is a circumferential cracking noted on one side and oriented towards the bottom of the connection, in the compression area (Figures #7).



a) Face A (West side of the gasket).



b) Face B (East side of the gasket).

FIGURES # 7
General image of the failed gasket, in as-submitted condition.

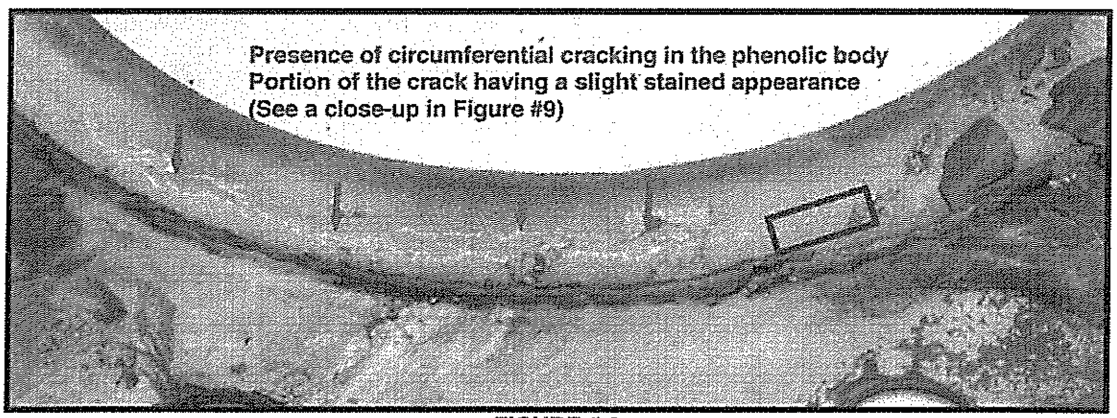


FIGURE # 8
Location and global appearance of the cracking found in the phenolic body.

This crack is more pronounced on the face B of the gasket which suggests that it originated on this side. According to the on-site observations, it was thought that a great portion of the crack was produced by manipulations during valve removal. However, since at one location the crack's edges seemed to have been stained and old-looking, it was thought that the crack was initiated prior to removal. This hypothesis was verified at our laboratory by visual observation. The stained appearance in the crack edges at this particular location was no longer visible when observed at high magnification and the morphology of the crack is the same on its length (Figure #9). Our observations suggest that this cracking was entirely produced during valve removal.

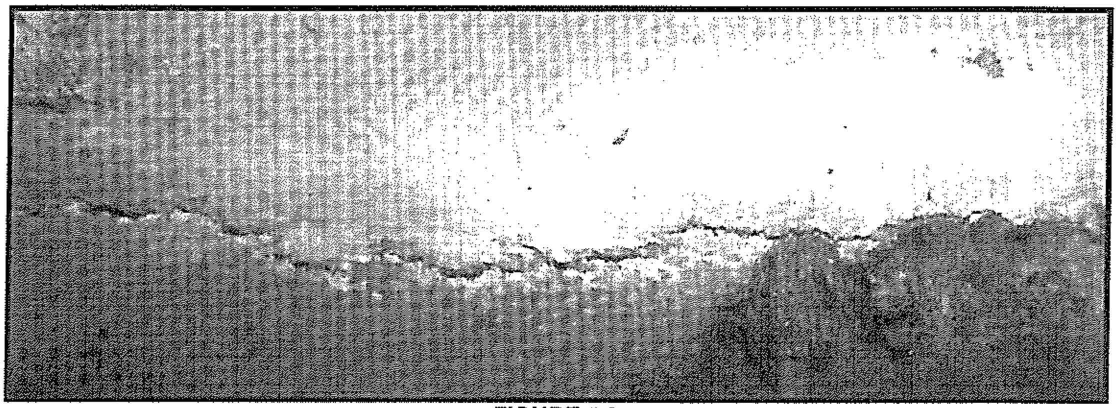


FIGURE # 9
Close-up view of the cracking found in the phenolic body.

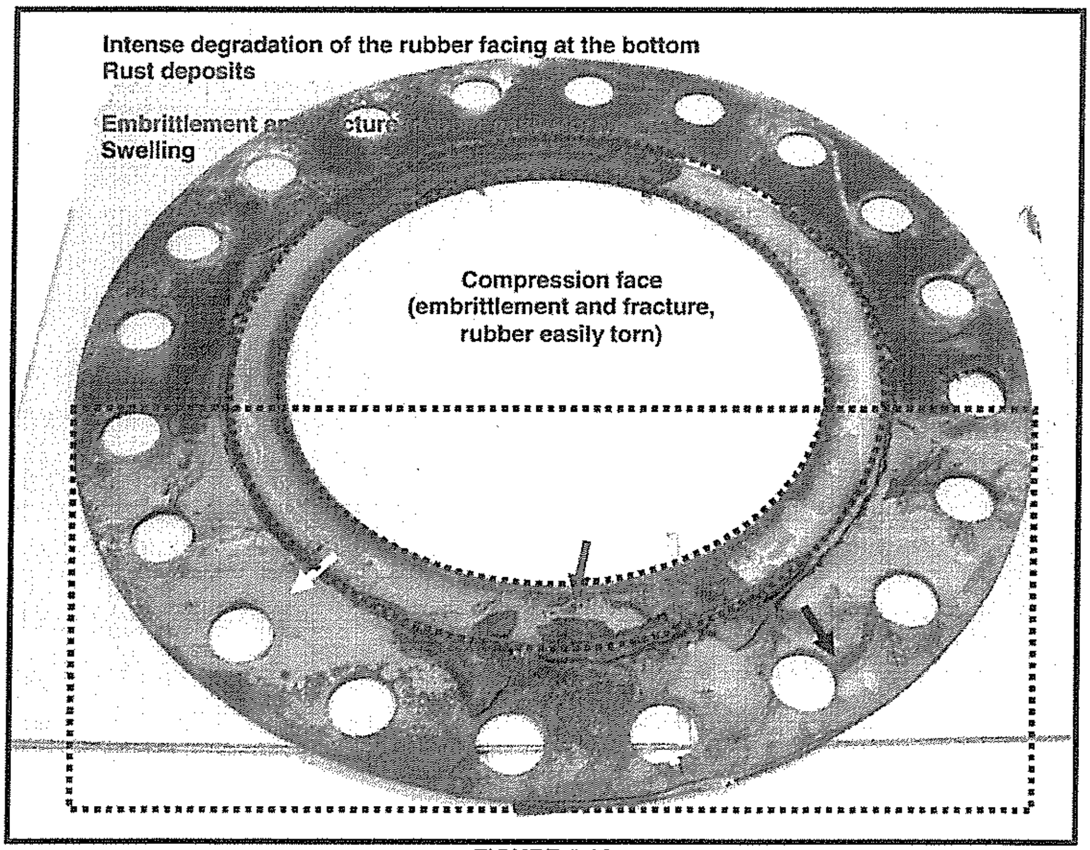


FIGURE # 10
Illustration of the degradation present in the rubber facing (face B, similar in face A).

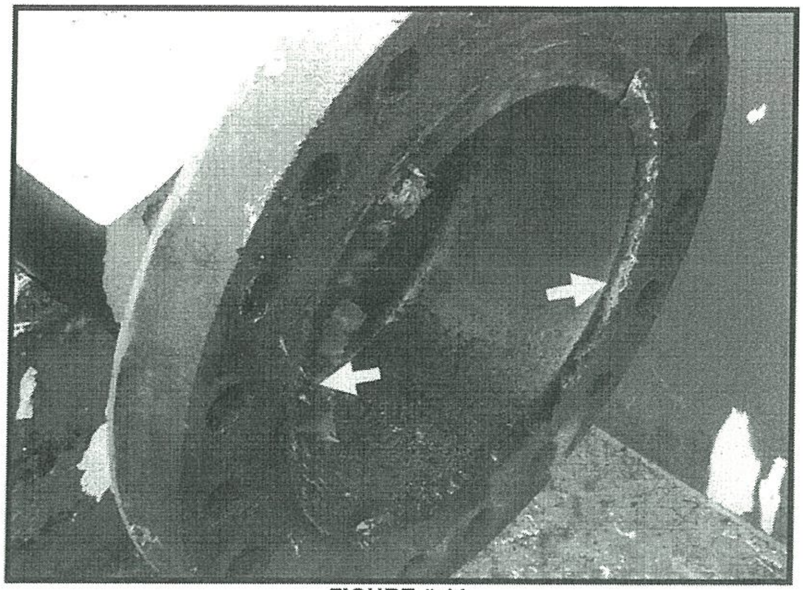


FIGURE # 11
Portions of rubber facing torn apart on the compression face during dismantling.

Visual observations of the rubber facing showed heavy degradation on both faces mostly located at the bottom side of the connection (Figure #10). Deposits and discoloration are present on almost all surfaces located at the bottom but the phenomenon seems less intense at the upper side (Figure #10).

In the area corresponding with the compression face of the gasket, i.e. the one between the raised faces of the flanges, most of the rubber facing is no longer in place (Figure #10). Pictures taken on-site clearly show that these portions adhered to the flange and were torn apart during disassembly (Figure #11). In the remaining portions on the gasket, and especially towards the bottom, the rubber has the same appearance of degradation as the rest of the facing.

More, at the bottom side of the gasket, including the compression area, the rubber facing can be easily peeled-off and broken (Figure #12). This is typical evidence of softening and embrittlement in rubbers, which made them easy to break by mere manipulation, a fact also confirmed at our laboratory. In these areas, another phenomenon associated with rubber degradation was noted: swelling (Figure #12). Finally, presence of heavy deposits of rust was observed on the bottom side of the exposed faces of the gasket. Heavy degradation of the phenolic body, in the form of embrittlement and fracture, was identified at the edges of some 4 holes (Figure #13).

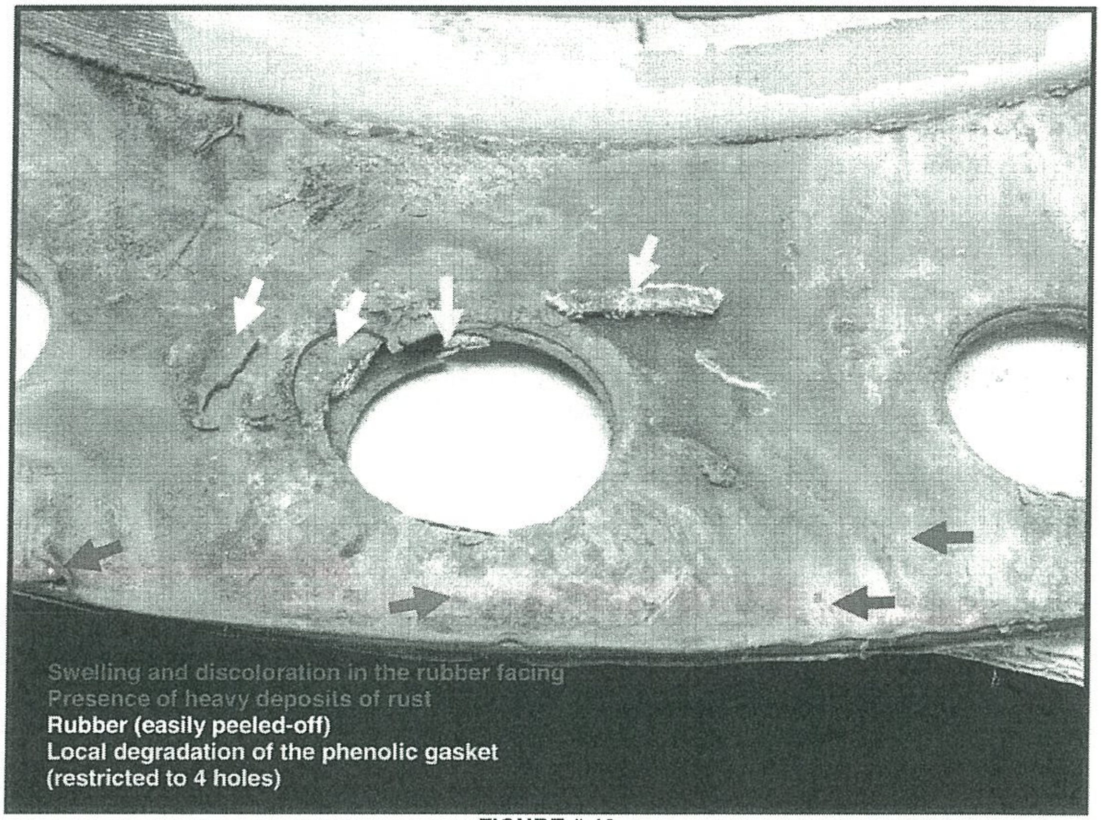


FIGURE # 12
Portions of rubber facing torn apart during dismantling.

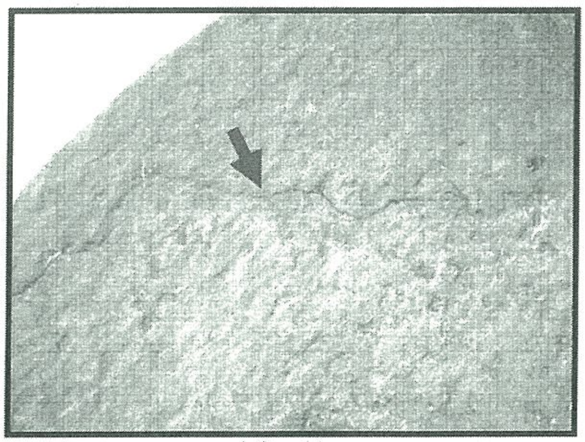
All indications previously described are significant at the bottom side of the gasket, i.e. the bottom side of the flange connection, and in the remaining of the compression area. In the upper side, the rubber facing degradation is less intense (Figure #10). More, in this area, no swelling was revealed although near the edges the rubber can be easily torn. Some yellowish deposits were present at the holes' edges (Figure #10).

Overall, the particular location of the most degraded area, that is, at the bottom side of the flange connection, is consistent with the presence of corrosion in progress in metallic parts (faces of flanges), which suggests that these two phenomena are related. This hypothesis will be verified during further analysis.

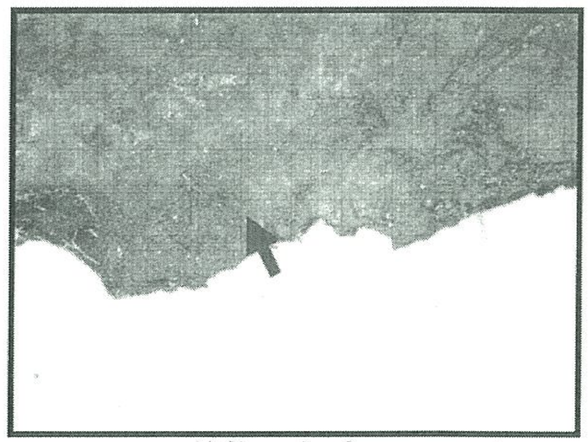
3.2 Low-Magnification Examination

Low-magnification examination was conducted on sections of rubber facing detached from the bottom side of the gasket, and from the compression area between the raised faces of the flanges, to assess the degradation at microscale. At about 63 X magnification, it was found that the rubber surface presents charring, cracking, perforations and indentations. All these features, equally present the compression area, are illustrated in Figures #13 and #14.

Besides these typical signs of deterioration, almost all rubber surfaces at the bottom area are covered in rust deposits adherent to the surface. Some white shiny particles were also noted, at the rubber surface, although their exact nature cannot be established.



a) Cracking.



b) Charred surface.

FIGURES # 13
Close-up views of the rubber surface in the bottom area of the gasket, in the compression area between the raised faces of the flanges (63X).

a) Perforation. a) Indentations.

FIGURES # 14
Close-up views of the rubber surface in the bottom area of the gasket, in the compression area between the raised faces of the flanges (63X).

3.3 Scanning Electron Microscopy (SEM)

Usually, an EDX (Electron Dispersion X-Ray Spectrometry) analysis that uses SEM techniques is performed in order to evaluate the presence of chemical elements in the degraded areas and in deposits coming from the bottom area of the gasket and from its compression face. This type of analysis provides a rather qualitative assessment of different compounds on a specified and very localized area. In the present case, the EDX analysis was conducted on deposits sampled in degraded areas of the rubber facing, in the bottom region. In this particular case, the EDX analysis aimed to determine whether chemical elements that could be considered aggressive for the rubber were present. Typical spectra of the analyzed deposits are presented in Figures #15 and #16. Presence of element gold (Au) must be disregarded as it was used to prepare the samples for analysis.

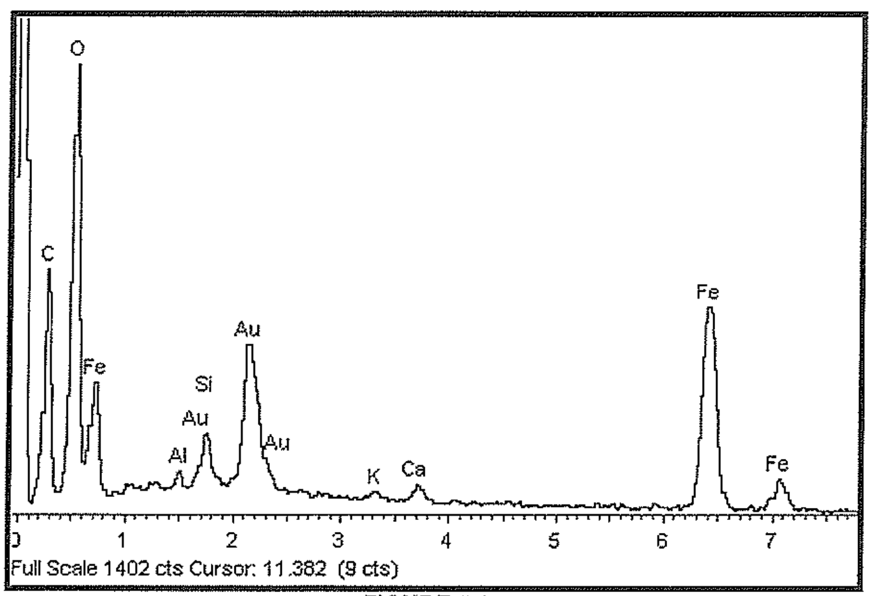


FIGURE # 15
EDX spectrum of the analyzed deposit.

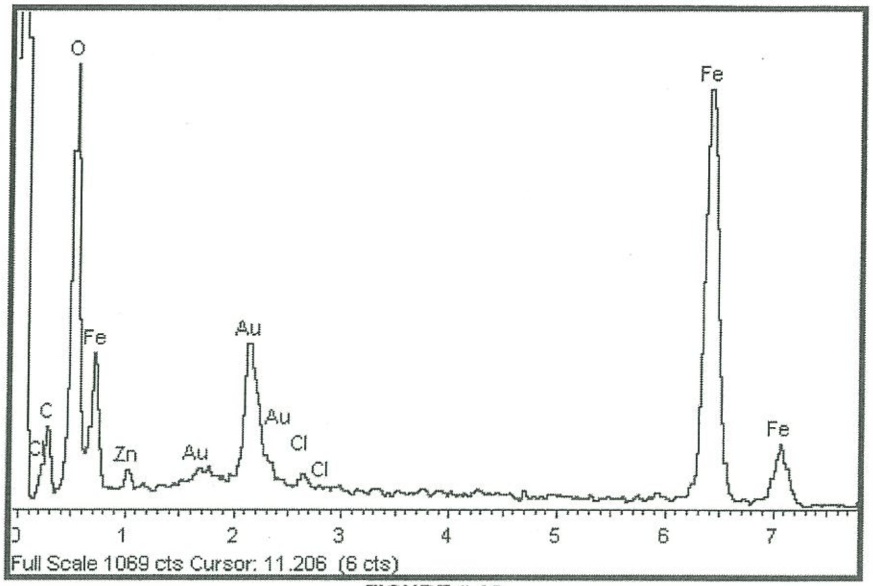


FIGURE # 16
EDX spectrum of the analyzed deposit.

As it can be observed on the EDX spectra, several chemical elements were found in the deposits present at the rubber facing surface. A significant amount of iron oxide was found, as well as carbon, calcium, potassium, zinc, and chlorine. Carbon and oxygen could come from the rubber degradation and from the gasoline transported by the piping system. Silicon could come from the sand and the earth nearby. Iron oxide, most likely in the form of rust, is a by-product of the corrosion process in the metallic parts. Zn could come from galvanizing in the metallic parts and could at the origin of the white particles previously noted at the rubber surface. Calcium, potassium and chlorine could be in form of salts and could be at the origin of the corrosion process in the metallic parts. Combined with water from condensation or from atmospheric humidity, these elements could form acids, such as HCl that can, at length, promote rubber degradation.

3.4 FTIR and DSC Analyses

Fourier Transform Infrared (FTIR) spectroscopy is an analysis that provides information about the chemical bonding or molecular structure of materials, whether organic or inorganic. The technique works on the fact that bonds and groups of bonds vibrate at characteristic frequencies. As such, a molecule exposed to infrared rays absorbs infrared energy at frequencies which are characteristic to that molecule.

Differential scanning calorimetry or DSC is a thermoanalytical technique in which the difference in the amount of heat required to increase the temperature of a sample and reference is measured as a function of temperature.

In the present case, FTIR and DSC analysis attempted to determine the type of polymer used for facing the gasket and thus to validate that this material is indeed neoprene. It was found that the said polymer is indeed of the elastomer type, but it is not a match for neoprene. The closest elastomer found in the machine library was shoe-rubber, but once again not a 100% match. This situation can be explained by three probable causes: (1) the degree of degradation and contamination in the polymer is too advanced and as such, the results are biased, (2) considering its age, the polymer could not be found in the machines' libraries, and (3) the polymer is closer to shoe rubber than to neoprene.

4.0 DISCUSSION/CONCLUSION

All findings of this investigation led to the conclusion that the most probable cause of the leak produced in the flange connection of the check valve is pronounced degradation of the rubber facing of the gasket used in the flange connection. Rubber facing degradation significantly diminished the sealing properties of the gasket. Most likely this degradation was the result of natural aging of the rubber accelerated or facilitated by the corrosion in progress in the adjacent metallic components, i.e. the flanges. It is our opinion that the cracking in the gasket phenolic body was entirely produced during valve removal and as such had no role in the gasket failure.

Corrosion in the flanges was the result of humidity and condensation phenomena inside the vault, undoubtedly promoted by the fact that the connection was no longer protected by the pipeline cathodic protection system. Chemical elements in the deposits found at the rubber surface could have combined with water from condensation and atmospheric humidity to form strong acids, harmful for both metal and rubber.

Our attempts to validate if the right elastomer was used, i.e. neoprene, were unsuccessful, as already explained. Any of the hypotheses formulated could be possible. The degradation and contamination itself could bias the results and as such, the data obtained are not matches for a known product. On the other hand, if the polymer is not a neoprene but a shoe-rubber, this could explain its low resistance to degradation. Finally, it can be possible that the polymer at hand is not available in the machine library, i.e. it was not a registered trade mark.

5.0 RECOMMANDATIONS

Regardless the true nature of the elastomer used for the gasket facing, it is obvious that the corrosion installed in the adjacent metallic parts played a role in its degradation. Corrosion was the direct result of the fact that the connection was now exposed to air in the vault and no longer protected by the pipeline cathodic protection system. It would be recommended that visual inspection be conducted on similar flange connections (installed in vaults) to determine if corrosion in progress is present in the metallic components. Inspection of gaskets, and particularly of their rubber facings, should be done in connections in which corrosion is detected. Gaskets in which rubber facing degradation is observed should be replaced to prevent the loss of sealing.

Alan Pentney

From:	Luke Furmidge
Sent:	Thursday, March 04, 2010 12:49 PM
To:	PUTAWAY PUTAWAY
Subject:	FW: Information Requested - TNPI flange Leak - Laval - Incident 2010-029
Attachments:	Torque Procedures 2.pdf.DRF; Torque Procedures 1.pdf.DRF

-----Original Message-----
From: Chad Bunch
Sent: Tuesday, March 02, 2010 1:58 PM
To: Luke Furmidge
Subject: FW: Information Requested - TNPI flange Leak - Laval

For distribution.

Chad

19(1)
-----Original Message-----
From: [redacted] [mailto: [redacted] @tnpi.ca]
Sent: Tuesday, March 02, 2010 1:11 PM
To: Chad Bunch
Cc: [redacted] 19(1)
Subject: Information Requested - TNPI flange Leak - Laval

Chad, following up on your email request of Monday, March 1st, 3:34
p.m.:

As of Tuesday afternoon at 14:00 hrs we continue to drain down the segment of line downstream of the leak site in order to execute our investigation and repair. The leaking flange has not been broken yet.

Root Cause Determination

TNPI will make every effort to preserve the failed gasket in its entirety if possible. All components will be retained for examination by TNPI as to failure mechanism, and third party examination will be employed if necessary. Prior to disassembly, samples of any corrosion products will be taken from the subject flange and catalogued and retained for possible analysis.

Repair Plan

TNPI will fully remove the 16" check valve to allow inspection of all four flange faces. They will be cleaned, inspected and repaired as necessary before reassembly. The existing insulated flange kit on the upstream side of the valve will be replaced with a new 16" flexitallic gasket. New studs and nuts will be utilized in the reassembly and TNPI torquing procedures will be used to tighten the flanges. (The procedures are attached at the end of this note.)

TNPI has decided that the existing valve vault will be removed. This action is being taken primarily to gain access under the vault for the removal of contaminated soil and also to facilitate a safe work environment for personnel accessing the valve and flanges.

As a result of this decision, photographic record of the pre-disassembly conditions should also be facilitated. TNPI personnel will also take note of flange alignment and offset throughout the disassembly and assembly process.

In response to your question about the type, brand and model of the gasket, the gasket in place at the failed joint is a Maloney Flange Insulation ENDW with neoprene facing, 16", 600#, with polyethylene sleeves. It was purchased and installed in 1972 at the time of the installation of the 16" line. Its purpose as an insulated flange was to segment the line for cathodic protection.

While TNPI will respond with more detailed information in the future as per your request, I can give you the following information today:

1. No irregular operating characteristics have been identified from an initial review of our Line Control records during the period since our last vault inspection.
2. TNPI's normal inspection practice is to visit and inspect every vault location at a frequency of no greater than every 10 days.
3. The most recent vault inspection of the site in question was conducted 7 days prior to the identification of product in Ruisseau Lapiniere.
4. TNPI has reviewed the leak detection records for the period prior to the leak and no abnormalities have been identified.
5. TNPI's SCADA leak detection system is designed to detect any 13 m3 loss in a maximum 1-hour period. This incident is clearly below detection limits.
6. To be confirmed, but initial investigation suggests this flange has never been opened since original installation in 1972.

As I noted, further information and more detailed specifics will be forwarded to you within the prescribed 7-day period.

A copy of TNPI's torquing specification and procedure is attached to this file.

[redacted] **19(1)**

President & CEO
Trans-Northern Pipeline Inc.
Richmond Hill, Ontario.
L4B 3P6

[redacted] **19(1)**

11.5 Torquing Procedures

11.5.1 General: The objective of applying torque to nuts and bolt heads is to effect a seal along mating surfaces of flanges and closures. That is to say that the work of torque is transfered to a restraining pressure. Torque is defined as the twisting moment around a point created by the application a force on a moment arm at a given distance from the point. Therefore, torque can be changed by altering the applied force or the length of the arm.

In most of TNPI's applications, there are four critical components in the system:

1) nuts, 2) studs, 3) gaskets, 4) flanges.

There may be minor variations of the basic categories such as the nut and stud being replaced by a hex head bolt and flanges being replaced by a removable cover and fixed base (ie. filter vessels) and gaskets by O-rings. Regardless, the overlying principals are the same.

The seal is achieved by balancing out the competing interests of each of the components. Once the system is loosely assembled the process is as such:

a) As torque is applied to the nuts the nuts are forced by the thread to travel towards the joint to be sealed. This places the studs into tension.

b) The reactive force resulting from the bolt tension is the compressive force of the nut onto the flanges and in turn this is transmitted through to the gasket.

The competing interest mentioned above are the toque must be sufficient to effect enough compressive force to contain the systems internal pressure yet not exceed the tensile strength of the stud and its threads nor the compressive strength of the gasket nor the strength of the flanges (flange distortion is most likely to occur if initial line up is improper, ie. trying to pull flanges together across a large gap or uneven torquing). Given that the material properties are fixed for all the components the factor which is under our control is the torque applied.

The single most important factor in application of the correct torque is the lubrication of the threads. Surface irregularities will cause wide variations in the resultant stud tension for the same torque applied stud to stud. Lubrication is the only means of developing a consistent set of conditions for the nuts and studs. There is also the obvious benefit of ease of installation.

11.5.2 Procedure: a) Ensure all materials are available and of proper rating:
- flanges meet design pressure requirement (Figure 1 and Table 1, 2, and 3).

- studs and nuts are proper size and type for flanges (Table 1, 2, and 3). All studs shall be ASTM-A-193 Grade B7; all nuts shall be ASTM-A-194 Class 2H (Table 4).
  - gaskets are suitable for contained product, size, function (ie. insulating gaskets) (Table 5, 6, and 7).
  - appropriate lubricant
  - all materials are free from defect

  Spare consumable materials (ie. gaskets, nuts, and studs) should be included on materials estimates and on hand at the job site to allow for defective pieces and damage on site. A good rule of thumb is to allow for 5% above the minimum requirement. Joints which must be uncoupled after hydrostatic testing require duplicate gaskets.

b) Throughly clean threads, nut faces and flange where nut face bears. Use new washers if old washers are fouled with paint and dirt which can not be removed. If roughness or irregularity is present, dress it out to as near a perfect surface as possible.

c) Apply lubricant evenly to studs and nut threads. Torque Tables 8, 9, and 10 are based upon application of Threadease or equivalent spray type petroleum based lubricants.

d) Flange bolt holes should line up precisely. Gap between flange faces should be just enough to accommodate gasket. Flanges faces should be parallel. Piping design should take into account locations where line up is a chronic problem and allow for field fitting of components to avoid 'forcing' a fit. Inform the Supervisor and/or Project Co-ordinator if line up problems are anticipated or encountered.

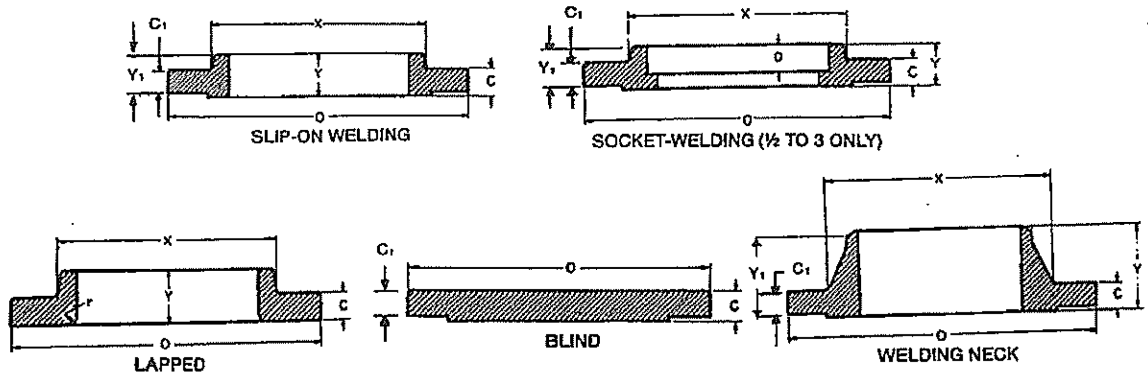
e) For horizontal piping runs, the bottom studs should be inserted first, then the gasket, then the remaining studs. This will allow the gasket to sit on the bottom studs to ensure gasket is centred. When disassembling flanges, the bottom bolts should be the last out. This will prevent the gasket from falling out and the flange can be quickly closed if required.

f) Tighten the nuts by hand in the order as shown in attached Figure 2. Begin the application of torque to the nuts in the same order. Avoid use of hammer wrenches if at all possible as it is impossible to control torque applied in this manner. Maximum specified torque should not be applied in one single pass. Flexitalic gaskets require no more than 30% of specified bolt stress be achieved on the initial set, the remainder on subsequent pass(es). 3L Filters recommend three passes of 60, 80 and 100% desired torque.

g) It is good practice to check the torque on connections within two weeks of installation. Steel has a property known as creep which will tend to deform the steel over time after the initial deformation due to an applied load.

ANSI B16.5 FLANGES

FIGURE 1



NOTES:

1. Dimensions in the following six tables are in inches.
2. For slip-on, socket-welded, and lapped flanges, the bore corresponds to the O.D. of B36.10 pipe plus a small tolerance.
3. For weld neck flanges, the bore will be determined by the I.D. of the pipe to be attached. The supplier should be consulted for availability.
4. Lengths of stud bolts do not include the height of the unthreaded points.

DIMENSIONS OF ANSI B16.5 CLASS 150 FLANGES AND FLANGE BOLTS

TABLE 1

Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange Min. C	Diameter of Hub X	Length Through Hub: Slip-on Socket Welding Y	Length Through Hub: Lapped Y	Length Through Hub: Welding Neck Y	Depth of Socket D	Diameter of Bolt Circle	Diameter of Bolt Holes	Number & Diameter of Bolts	Length of Bolts: Stud Bolts 0.06-In. Raised Face	Length of Bolts: Stud Bolts Ring Joint	Length of Bolts: Machine Bolts 0.06-In. Raised Face
1/2	3.50	0.44	1.19	0.62	0.62	1.88	0.38	2.38	0.62	4 1/2	2.50	—	2.00
3/4	3.88	0.50	1.50	0.62	0.62	2.06	0.44	2.75	0.62	4 1/2	2.50	—	2.25
1	4.25	0.56	1.94	0.69	0.69	2.19	0.50	3.12	0.62	4 1/2	2.75	3.25	2.25
1 1/4	4.62	0.62	2.31	0.81	0.81	2.25	0.56	3.50	0.62	4 1/2	2.75	3.25	2.50
1 1/2	5.00	0.69	2.56	0.88	0.88	2.44	0.62	3.88	0.62	4 1/2	3.00	3.50	2.50
2	6.00	0.75	3.06	1.00	1.00	2.50	0.69	4.75	0.75	4 5/8	3.25	3.75	2.75
2 1/2	7.00	0.88	3.56	1.12	1.12	2.75	0.75	5.50	0.75	4 5/8	3.50	4.00	3.00
3	7.50	0.94	4.25	1.19	1.19	2.75	0.81	6.00	0.75	4 5/8	3.75	4.25	3.25
3 1/2	8.50	0.94	4.81	1.25	1.25	2.81	—	7.00	0.75	8 5/8	3.75	4.25	3.25
4	9.00	0.94	5.31	1.31	1.31	3.00	—	7.50	0.75	8 5/8	3.75	4.25	3.25
5	10.00	0.94	6.44	1.44	1.44	3.50	—	8.50	0.88	8 3/4	4.00	4.50	3.25
6	11.00	1.00	7.56	1.56	1.56	3.50	—	9.50	0.88	8 3/4	4.00	4.50	3.50
8	13.50	1.12	9.69	1.75	1.75	4.00	—	11.75	0.88	8 3/4	4.25	4.75	3.75
10	16.00	1.19	12.00	1.94	1.94	4.00	—	14.25	1.00	12 7/8	4.75	5.25	4.00
12	19.00	1.25	14.38	2.19	2.19	4.50	—	17.00	1.00	12 7/8	4.75	5.25	4.25
14	21.00	1.38	15.75	2.25	3.12	5.00	—	18.75	1.12	12 1	5.25	5.75	4.50
16	23.50	1.44	18.00	2.50	3.44	5.00	—	21.25	1.12	16 1	5.50	6.00	4.75
18	25.00	1.56	19.88	2.69	3.81	5.50	—	22.75	1.25	16 1 1/8	6.00	6.50	5.00
20	27.50	1.69	22.00	2.88	4.06	5.69	—	25.00	1.25	20 1 1/8	6.25	6.75	5.50
24	32.00	1.88	26.12	3.25	4.38	6.00	—	29.50	1.38	20 1 1/4	7.00	7.50	6.00

DIMENSIONS OF ANSI B16.5 CLASS 300 FLANGES AND FLANGE BOLTS

TABLE 2

Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange Min. C	Diameter of Hub X	Length Through Hub: Slip-on Socket Welding Y	Length Through Hub: Lapped Y	Length Through Hub: Welding Neck Y	Depth of Socket D	Diameter of Bolt Circle	Diameter of Bolt Holes	Number & Diameter of Bolts	Length of Bolts: Stud Bolts 0.06-In. Raised Face	Length of Bolts: Stud Bolts Ring Joint	Length of Bolts: Machine Bolts 0.06-In. Raised Face
1/2	3.75	0.56	1.50	0.88	0.88	2.06	0.38	2.62	0.62	4 1/2	2.75	3.00	2.25
3/4	4.62	0.62	1.88	1.00	1.00	2.25	0.44	3.25	0.75	4 5/8	3.00	3.50	2.50
1	4.88	0.69	2.12	1.06	1.06	2.44	0.50	3.50	0.75	4 5/8	3.25	3.75	2.75
1 1/4	5.25	0.75	2.50	1.06	1.06	2.56	0.56	3.88	0.75	4 5/8	3.25	3.75	2.75
1 1/2	6.12	0.81	2.75	1.19	1.19	2.69	0.62	4.50	0.88	4 3/4	3.75	4.25	3.00
2	6.50	0.88	3.31	1.31	1.31	2.75	0.69	5.00	0.75	8 5/8	3.50	4.25	3.00
2 1/2	7.50	1.00	3.94	1.50	1.50	3.00	0.75	5.88	0.88	8 3/4	4.00	4.75	3.50
3	8.25	1.12	4.62	1.69	1.69	3.12	0.81	6.62	0.88	8 3/4	4.25	5.00	3.75
3 1/2	9.00	1.19	5.25	1.75	1.75	3.19	—	7.25	0.88	8 3/4	4.50	5.25	3.75
4	10.00	1.25	5.75	1.88	1.88	3.38	—	7.88	0.88	8 3/4	4.50	5.25	4.00
5	11.00	1.38	7.00	2.00	2.00	3.88	—	9.25	0.88	8 3/4	4.75	5.50	4.25
6	12.50	1.44	8.12	2.06	2.06	3.88	—	10.62	0.88	12 3/4	5.00	5.75	4.25
8	15.00	1.62	10.25	2.44	2.44	4.38	—	13.00	1.00	12 7/8	5.50	6.25	4.75
10	17.50	1.88	12.62	2.62	3.75	4.62	—	15.25	1.12	16 1	6.25	7.00	5.50
12	20.50	2.00	14.75	2.88	4.00	5.12	—	17.75	1.25	16 1 1/8	6.75	7.50	6.00
14	23.00	2.12	16.75	3.00	4.38	5.62	—	20.25	1.25	20 1 1/8	7.00	7.75	6.25
16	25.50	2.25	19.00	3.25	4.75	5.75	—	22.50	1.38	20 1 1/4	7.50	8.25	6.50
18	28.00	2.38	21.00	3.50	5.12	6.25	—	24.75	1.38	24 1 1/4	7.75	8.50	6.75
20	30.50	2.50	23.12	3.75	5.50	6.38	—	27.00	1.38	24 1 1/4	8.25	9.00	7.25
24	36.00	2.75	27.62	4.19	6.00	6.62	—	32.00	1.62	24 1 1/2	9.25	10.25	8.00

DIMENSIONS OF ANSI B16.5 CLASS 600 FLANGES AND FLANGE BOLTS

TABLE 3

Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange, Min. C_1	Diameter of Hub X	Length Through Hub: Slip-on Socket Welding Y_1	Length Through Hub: Lapped Y_1	Length Through Hub: Welding Neck Y_1	Depth of Socket D	Diameter of Bolt Circle	Diameter of Bolt Holes	Number & Diameter of Bolts	Length of Stud Bolts: 0.25 in. Raised Face	Length of Stud Bolts: Male & Female also Tongue & Groove	Length of Stud Bolts: Ring Joint
1/2	3.75	0.56	1.50	0.88	0.88	2.06	0.38	2.62	0.62	4 1/2	3.25	3.00	3.00
3/4	4.62	0.62	1.88	1.00	1.00	2.25	0.44	3.25	0.75	4 5/8	3.50	3.25	3.50
1	4.88	0.69	2.12	1.06	1.06	2.44	0.50	3.50	0.75	4 5/8	3.75	3.50	3.75
1 1/4	5.25	0.81	2.50	1.12	1.12	2.62	0.56	3.88	0.75	4 5/8	4.00	3.75	4.00
1 1/2	6.12	0.88	2.75	1.25	1.25	2.75	0.62	4.50	0.88	4 3/4	4.25	4.00	4.25
2	6.50	1.00	3.31	1.44	1.44	2.88	0.69	5.00	0.75	8 5/8	4.25	4.00	4.50
2 1/2	7.50	1.12	3.94	1.62	1.62	3.12	0.75	5.88	0.88	8 3/4	4.75	4.50	5.00
3	8.25	1.25	4.62	1.81	1.81	3.25	0.81	6.62	0.88	8 3/4	5.00	4.75	5.25
3 1/2	9.00	1.38	5.25	1.94	1.94	3.38	—	7.25	1.00	8 7/8	5.50	5.25	5.75
4	10.75	1.50	6.00	2.12	2.12	4.00	—	8.50	1.00	8 7/8	5.75	5.50	6.00
5	13.00	1.75	7.44	2.38	2.38	4.50	—	10.50	1.12	8 1	6.50	6.25	6.75
6	14.00	1.88	8.75	2.62	2.62	4.62	—	11.50	1.12	12 1	6.75	6.50	7.00
8	16.50	2.19	10.75	3.00	3.00	5.25	—	13.75	1.25	12 1 1/8	7.75	7.50	7.75
10	20.00	2.50	13.50	3.38	4.38	6.00	—	17.00	1.38	16 1 1/4	8.50	8.25	8.75
12	22.00	2.62	15.75	3.62	4.62	6.12	—	19.25	1.38	20 1 1/4	8.75	8.50	9.00
14	23.75	2.75	17.00	3.69	5.00	6.50	—	20.75	1.50	20 1 3/8	9.25	9.00	9.50
16	27.00	3.00	19.50	4.19	5.50	7.00	—	23.75	1.62	20 1 1/2	10.00	9.75	10.25
18	29.25	3.25	21.50	4.62	6.00	7.25	—	25.75	1.75	20 1 5/8	10.75	10.50	11.00
20	32.00	3.50	24.00	5.00	6.50	7.50	—	28.50	1.75	24 1 5/8	11.50	11.25	11.75
24	37.00	4.00	28.25	5.50	7.25	8.00	—	33.00	2.00	24 1 7/8	13.00	12.75	13.25

GASKET DIMENSIONS FOR ANSI B16.5 Class 150

Flanges and Flanged Fittings

TABLE 5

Nominal Pipe Size*	Gasket I.D.	Flat Ring O.D.	Full Face Gasket O.D.	Full Face Gasket No. of Holes	Full Face Gasket Hole Diameter	Full Face Gasket Bolt Circle Diameter	Large Male and Female O.D.	Large Tongue and Groove I.D.	Large Tongue and Groove O.D.
½	0.84	1.88	3.50	4	0.62	2.38	1.38	1.00	1.38
¾	1.06	2.25	3.88	4	0.62	2.76	1.69	1.31	1.69
1	1.31	2.62	4.25	4	0.62	3.12	2.00	1.50	2.00
1¼	1.66	3.00	4.63	4	0.62	3.50	2.50	1.88	2.50
1½	1.91	3.38	5.00	4	0.62	3.88	2.88	2.12	2.88
2	2.36	4.12	6.00	4	0.75	4.75	3.62	2.88	3.62
2½	2.88	4.88	7.00	4	0.75	5.50	4.12	3.38	4.12
3	3.50	5.38	7.50	4	0.75	6.00	5.00	4.25	6.00
3½	4.00	6.38	8.50	8	0.75	7.00	5.50	4.75	6.50
4	4.50	6.88	9.00	8	0.75	7.50	6.19	5.19	6.19
6	5.56	7.75	10.00	8	0.88	8.50	7.31	6.31	7.31
6	6.62	8.75	11.00	8	0.88	9.50	8.50	7.50	8.60
8	8.62	11.00	13.50	8	0.88	11.75	10.62	9.33	10.62
10	10.75	13.38	16.00	12	1.00	14.25	12.75	11.25	12.75
12	12.75	16.13	19.00	12	1.00	17.00	15.00	13.50	15.00
14	14.00	17.75	21.00	12	1.12	18.75	16.25	14.75	16.25
16	16.00	20.25	23.50	16	1.12	21.25	18.50	16.75	18.50
18	18.00	21.62	25.00	16	1.25	22.75	21.00	19.25	21.00
20	20.00	23.88	27.50	20	1.25	26.00	23.00	21.00	23.00
24	24.00	28.25	32.00	20	1.38	29.50	27.25	25.25	27.25

Dimensions are in inches

GASKET DIMENSIONS FOR ANSI B16.5 CLASS 300

Flanges and Flanged Fittings

TABLE 6

Nominal Pipe Size	Gasket I.D.	Flat Ring O.D.	Large Male and Female O.D.	Large Tongue and Groove I.D.	Large Tongue and Groove O.D.
½	0.84	2.12	1.38	1.00	1.38
¾	1.06	2.62	1.69	1.31	1.69
1	1.31	2.88	2.00	1.50	2.00
1¼	1.66	3.25	2.50	1.88	2.50
1½	1.91	3.75	2.88	2.12	2.88
2	2.38	4.38	3.62	2.88	3.62
2½	2.88	5.12	4.12	3.38	4.12
3	3.50	6.88	5.00	4.25	5.00
3½	4.00	6.50	5.50	4.75	5.50
4	4.50	7.12	6.19	5.19	6.19
5	5.56	8.50	7.31	6.31	7.31
6	6.62	9.88	8.50	7.50	8.50
8	8.62	12.12	10.62	9.38	10.62
10	10.76	14.25	12.75	11.25	12.75
12	12.75	16.62	15.00	13.50	15.00
14	14.00	19.12	16.25	14.75	16.25
16	16.00	21.25	18.50	16.75	18.50
18	18.00	23.50	21.00	19.25	21.00
20	20.00	25.75	23.00	21.00	23.00
24	24.00	30.50	27.25	25.25	27.25

Dimensions are in inches

TABLE 4

1/2

A 193/A 193M

Mechanical Requirements

Grade	Diameter, in. [mm]	Minimum Tempering Temperature, °F [°C]	Tensile Strength, min, ksi [MPa]	Yield Strength, min, 0.2 % offset, ksi [MPa]	Elongation in 4 D, min, %	Reduction of Area, min, %	Hardness, max
Ferritic Steels							
B5 4 to 6 % chromium	up to 4 [100], incl	1100 [593]	100 [690]	80 [550]	16	50	...
B6 13 % chromium	up to 4 [100], incl	1100 [593]	110 [760]	85 [585]	15	50	...
B6X 13 % chromium	up to 4 [100], incl	1100 [593]	90 [620]	70 [485]	16	50	26 HRC
B7 Chromium-molybdenum	2½ [65] and under	1100 [593]	125 [860]	105 [720]	16	50	...
	over 2½ to 4 [65 to 100]	1100 [593]	115 [795]	95 [655]	16	50	...
	over 4 to 7 [100 to 180]	1100 [593]	100 [690]	75 [515]	18	50	...
B7M[A] Chromium-molybdenum	2½ [65] and under	1150 [620]	100 [690]	80 [550]	18	50	235 HB or 99 HRB
	4 [101.6] and under	1150 [620]	100 [690]	80 [550]	18	50	235 BHN or 99 R/B
	over 4 to 7 [101.6 to 117.8]	1150 [620]	100 [690]	75 [515]	18	50	235 BHN or 99 R/B
B16 Chromium-molybdenum-vanadium	2½ [65] and under	1200 [650]	125 [860]	105 [725]	18	50	...
	over 2½ to 4 [65 to 100]	1200 [650]	110 [760]	95 [655]	17	45	...
	over 4 to 7 [100 to 180]	1200 [650]	100 [690]	85 [585]	16	45	...

Class and Grade, Diameter, in. [mm]	Heat Treatment[B]	Tensile Strength, min, ksi [MPa]	Yield Strength, min, 0.2 % offset, ksi [MPa]	Elongation in 4 D, min, %	Reduction of Area, min %	Hardness, max
Austenitic Steels						
Classes 1 and 1D: B8, B8C, B8M, B8P, B8T, B8LN, B8MLN, all diameters	carbide solution treated	75 [515]	30 [205]	30	50	223 HB[C] or 96 HRB
Class 1A: B8A, B8CA, B8MA, B8PA, B8TA, B8LNA, B8MLNA, B8NA, B8MNA, all diameters	carbide solution treated in the finished condition	75 [515]	30 [205]	30	50	192 HB or 90 HRB
Classes 1B and 1D: B8N, B8MN, and B8MLCuN all diameters	carbide solution treated	80 [550]	35 [240]	30	40	223 HB[C] or 96 HRB
Classes 1C and 1D: B8R, all diameters	carbide solution treated	100 [690]	55 [380]	35	55	271 HB or 28 HRC
B8RA, all diameters	carbide solution treated in the finished condition	100 [690]	55 [380]	35	55	271 HB or 28 HRC
B8S, all diameters	carbide solution treated	95 [655]	50 [345]	35	55	271 HB or 28 HRC
B8SA, all diameters	carbide solution treated in the finished condition	95 [655]	50 [345]	35	55	271 HB or 28 HRC
Class 2: B8, B8C, B8P, B8T, B8N, and B8MLCuN, ¾ [20] and under	carbide solution treated and strain hardened	125 [860]	100 [690]	12	35	321 HB or 35 HRC
over ¾ to 1, [20 to 25] incl		115 [795]	80 [550]	15	35	321 HB or 35 HRC
over 1 to 1¼ [25.4 to 31.6] incl		105 [725]	65 [450]	20	35	321 HB or 35 HRC
over 1¼ to 1½ [32 to 40] incl		100 [690]	50 [345]	28	45	321 HB or 35 HRC
Class 2: B8M, B8MN, B8MLCuN[D] ¾ [19.05] and under	carbide solution treated and strain hardened	110 [760]	95 [665]	15	45	321 HB or 35 HRC
over ¾ to 1 [19.05 to 25.4] incl		100 [690]	80 [550]	20	45	321 HB or 35 HRC
over 1 to 1¼ [25.4 to 31.6] incl		95 [655]	65 [450]	25	45	321 HB or 35 HRC
over 1¼ to 1½ [31.6 to 37.9] incl		90 [620]	50 [345]	30	45	321 HB or 35 HRC

(Continued)

TABLE 4

2/2

Hardness Requirements

Grade and Type	Completed Nuts			Sample Nut after Treatment as in 7.1.5.2	
	Brinell Hardness	Rockwell Hardness		Brinell Hardness, min	Rockwell Hardness B Scale, min
		C Scale	B Scale		
1	121 min	...	70 min	121	70
2	159 to 352	...	84 min	159	84
2H	248 to 352	24 to 38	...	179	89
To 1½ in. [38.1 mm], incl	248 to 352	24 to 38	...	179	89
Over 1½ in. [38.1 mm]	212 to 352	38 max	95 min	147	79
2HM and 7M	159 to 237	22 max	...	159	84
3, 4, and 7	248 to 352	24 to 38	...	201	94
6 and 6F	228 to 271	20 to 28	...	...	...
8, 8C, 8M, 8T, 8F, 8P, 8N,	126 to 300	...	60 to 105	...	...
8MN, 8LN, 8MLN, and 8MLCuN	126 to 300	...	60 to 105	...	...
8A, 8CA, 8MA, 8TA,	126 to 192	...	60 to 90	...	...
8FA, 8PA, 8NA, 8MNA,	126 to 192	...	60 to 90	...	...
8LNA, 8MLNA, and 8MLCuNa	126 to 192	...	60 to 90	...	...
8R, 8RA, 8S, and 8SA	183 to 271	B 88 to C 25	...	...	...

Proof Load Using Threaded Mandrel

NOTE—Proof loads are not design loads.

Nominal Size, in. [mm]	Threads per Inch [25.4 mm]	Stress Area, in.², [mm²]	Proof Load, lbf [kN][A]					
			Grade 1		Grades 2, 2HM, 6 6F, 7M		Grades 2H, 3, 4, 7	
			Heavy Hex[B]	Hex[C]	Heavy Hex[D]	Hex[E]	Heavy Hex[F]	Hex[G]
¼ [6.4]	20	0.0316 [20.4]	4 130 [18.4]	3 820 [17.0]	4 770 [21.2]	4 300 [19.1]	5 570 [24.8]	4 770 [21.2]
5/16 [7.9]	18	0.0524 [33.8]	6 810 [30.3]	6 290 [28.0]	7 860 [35.0]	7 070 [31.4]	9 170 [40.8]	7 860 [35.0]
⅜ [9.5]	16	0.0774 [49.9]	10 080 [44.8]	9 300 [41.4]	11 620 [51.7]	10 460 [46.5]	13 560 [60.3]	11 620 [51.7]
7/16 [11.1]	14	0.1063 [68.6]	13 820 [61.5]	12 760 [56.8]	15 940 [70.9]	14 350 [63.8]	18 600 [82.7]	15 940 [70.9]
½ [12.7]	13	0.1419 [91.5]	18 450 [82.1]	17 030 [75.8]	21 280 [94.6]	19 160 [85.2]	24 830 [110]	21 280 [94.6]
9/16 [14.2]	12	0.182 [117]	23 660 [105]	21 840 [97.1]	27 300 [121]	24 570 [109]	31 850 [142]	27 300 [121]
⅝ [15.9]	11	0.226 [146]	29 380 [131]	27 120 [121]	33 900 [151]	30 510 [136]	39 550 [176]	33 900 [151]
¾ [19]	10	0.334 [215]	43 420 [193]	40 080 [178]	50 100 [223]	45 090 [200]	58 450 [260]	50 100 [223]
⅞ [22.2]	9	0.462 [298]	60 060 [267]	55 440 [247]	69 300 [308]	62 370 [277]	80 850 [360]	69 300 [308]
1 [25.4]	8	0.606 [391]	78 780 [350]	72 720 [323]	90 900 [404]	81 810 [364]	106 000 [472]	90 900 [404]
1⅛ [28.6]	8	0.790 [510]	102 700 [457]	94 800 [422]	118 500 [527]	106 700 [475]	138 200 [615]	118 500 [527]
1¼ [31.8]	8	1.000 [645]	130 000 [578]	120 000 [534]	150 000 [667]	135 000 [600]	175 000 [778]	150 000 [667]
1⅜ [34.9]	8	1.233 [795]	160 200 [713]	148 000 [658]	185 000 [823]	166 500 [741]	215 800 [960]	185 000 [823]
1½ [38.1]	8	1.492 [962]	194 000 [863]	170 040 [756]	223 800 [996]	201 400 [896]	261 100 [1161]	223 800 [996]
			All Types of Grade 8		Grade 8M (Strain-Hardened)		All Other Types of Grade 8 (Strain-Hardened)	
			Heavy Hex[H]	Hex[I]	Heavy Hex[J]	Hex[K]	Heavy Hex[L]	Hex[J]
¼ [6.4]	20	0.0316 [20.4]	2 540 [11.3]	2 380 [10.6]	3 480 [15.5]	3 160 [14.0]	3 950 [17.6]	3 480 [15.5]
5/16 [7.9]	18	0.0524 [33.8]	4 190 [18.6]	3 930 [17.5]	5 760 [25.6]	5 240 [23.3]	6 550 [29.1]	5 760 [25.6]
⅜ [9.5]	16	0.0774 [49.9]	6 200 [27.6]	5 810 [25.8]	8 510 [37.8]	7 740 [34.4]	9 675 [43.0]	8 510 [37.8]
7/16 [11.1]	14	0.1063 [68.6]	8 500 [37.8]	7 970 [35.4]	11 690 [52.0]	10 630 [47.3]	13 290 [59.1]	11 690 [52.0]
½ [12.7]	13	0.1419 [91.5]	11 350 [50.5]	10 640 [49.8]	15 610 [69.4]	14 190 [63.1]	17 740 [78.9]	15 610 [69.4]
9/16 [14.2]	12	0.182 [117]	14 560 [64.8]	13 650 [60.7]	20 020 [89.0]	18 200 [80.9]	22 750 [101]	20 020 [89.0]
⅝ [15.9]	11	0.226 [146]	18 080 [80.4]	16 950 [75.4]	24 860 [110]	22 600 [100]	28 250 [126]	24 860 [110]
¾ [19]	10	0.334 [215]	26 720 [119]	25 050 [111]	36 740 [163]	33 400 [148]	41 750 [186]	36 740 [163]
⅞ [22.2]	9	0.462 [298]	36 960 [164]	34 650 [154]	46 200 [206]	41 580 [185]	53 130 [236]	46 200 [206]
1 [25.4]	8	0.606 [391]	48 480 [216]	45 450 [202]	60 600 [270]	54 540 [243]	69 690 [310]	60 600 [270]
1⅛ [28.6]	8	0.790 [510]	63 200 [281]	59 250 [264]	75 050 [334]	67 150 [299]	82 950 [369]	75 050 [334]
1¼ [31.8]	8	1.000 [645]	80 000 [356]	75 000 [334]	95 000 [422]	85 000 [378]	105 000 [467]	95 000 [422]
1⅜ [34.9]	8	1.233 [795]	98 640 [439]	92 450 [411]	110 970 [494]	98 640 [439]	123 300 [548]	110 970 [494]
1½ [38.1]	8	1.492 [962]	119 360 [531]	111 900 [498]	134 280 [597]	119 360 [531]	149 200 [664]	134 280 [597]

[A] See limit for proof load test in 7.2.2.1. The proof load for jam nuts shall be 46 % of the tabulated load.
[B] Based on proof stress of 130 000 psi [895 MPa].
[C] Based on proof stress of 120 000 psi [825 MPa].
[D] Based on proof stress of 150 000 psi [1035 MPa].
[E] Based on proof stress of 135 000 psi [930 MPa].
[F] Based on proof stress of 175 000 psi [1205 MPa].
[G] Based on proof stress of 150 000 psi [1035 MPa].
[H] Based on proof stress of 80 000 psi [550 MPa].
[I] Based on proof stress of 75 000 psi [515 MPa].
[J] Based on proof stress of 110 000 psi [760 MPa] up to ¾ in. [19 mm]; 100 000 psi [690 MPa] ⅞ to 1 in. [22.2 to 25.4 mm]; 95 000 psi [655 MPa] 1⅛ to 1¼ in. [28 to 31.8 mm]; 90 000 psi [620 MPa] 1⅜ to 1½ in. [34.9 to 38.1 mm].
[K] Based on proof stress of 100 000 psi [690 MPa] up to ¾ in. [19 mm]; 90 000 psi [620 MPa] ⅞ to 1 in. [22.2 to 25.4 mm]; 85 000 psi [585 MPa] 1⅛ to 1¼ in. [28 to 31.8 mm]; 80 000 psi [550 MPa] 1⅜ to 1½ in. [34.9 to 38.1 mm].
[L] Based on proof stress of 125 000 psi [860 MPa] up to ¾ in. [19 mm]; 115 000 psi [795 MPa] ⅞ to 1 in. [22.2 to 25.4 mm]; 105 000 psi [725 MPa] 1⅛ to 1¼ i [28.6 to 31.8 mm]; 100 000 psi [690 MPa] 1⅜ to 1½ in. [34.9 to 38.1 mm].

GASKET DIMENSIONS FOR ANSI B16.5 CLASS 600

Flanges and Flanged Fittings

TABLE 7

Nominal Pipe Size	Gasket I.D.	Flat Ring O.D.	Large Male and Female O.D.	Large Tongue and Groove	
				I.D.	O.D.
½	0.84	2.12	1.38	1.00	1.38
¾	1.06	2.62	1.69	1.31	1.69
1	1.31	2.88	2.00	1.50	2.00
1¼	1.66	3.25	2.50	1.88	2.50
1½	1.91	3.75	2.88	2.12	2.88
2	2.38	4.38	3.62	2.88	3.62
2½	2.88	5.12	4.12	3.38	4.12
3	3.50	5.88	5.00	4.25	5.00
3½	4.00	6.38	5.50	4.75	5.50
4	4.50	7.62	6.19	5.19	6.19
5	5.56	9.50	7.31	6.31	7.31
6	6.62	10.50	8.50	7.50	8.50
8	8.62	12.62	10.62	9.38	10.62
10	10.75	15.75	12.75	11.25	12.75
12	12.75	18.00	15.00	13.50	15.00
14	14.00	19.38	16.25	14.75	16.25
16	16.00	22.25	18.50	16.75	18.50
18	18.00	24.12	21.00	19.25	21.00
20	20.00	26.88	23.00	21.00	23.00
24	24.00	31.12	27.25	25.25	27.25

Dimensions are in inches

TABLE 8

Recommended Torquing Limits and Resultant Compressive Force on Insulated Gaskets

150 Series ANSI Flanges

Flange Size	Stud Diameter	No. of Studs	Raised Face Surface Area	Recommended Torque (2)	Compressive/ Stud	Resultant Compressive Force on Gasket
2" Ø	5/8"	4	6.94 in^2	90 ft.lbs.	9090 psi	5239 psi
4" Ø	5/8"	8	17.25 in^2	90	9090	4216
6" Ø	3/4"	8	27.76 in^2	150	13590	3916
8" Ø	3/4"	8	38.61 in^2	150	13590	2816
10" Ø	7/8"	12	48.92 in^2	240	18855	4625
12" Ø	7/8"	12	63.62 in^2	240	18855	3556
16" Ø	1"	16	86.02 in^2	368	24795	4612

Notes:

1) Based on 150 ANSI Flange Series.
2) Based on applied stress of 50% yield strength of Alloy Steel Stud Bolts (90,000 SMYS).
3) Indicated Torque assumes that a lubricant is applied to the threads and the nut face.

GCR/83-07-08

TABLE 9

300 Series ANSI Flanges

Recommended Torquing Limits and Resultant Compressive Force on Insulated Gaskets

Flange Size	Stud Diameter	No. of Studs	Raised Face Surface Area	Recommended Torque (2)	Compression/ Stud	Resultant Compressive Force on Gasket
2" Ø	5/8"	8	6.91 in^2	90 ft.lbs.	9090 psi	10524 psi
4" Ø	3/4"	8	17.28 in^2	150	13590	6292
6" Ø	3/4"	12	27.81 in^2	150	13590	5864
8" Ø	7/8"	12	38.61 in^2	240	18855	5860
10" Ø	1"	16	48.82 in^2	368	24795	8126
12" Ø	1/2 ;"	16	63.62 in^2	533	32760	8239
16" Ø	1 1/4"	20	86.03 in^2	750	41805	9719

Notes:

1) Based on 300 ANSI Falnge Series.

2) Based on applied stress of 50% yield strength on Alloy Steel Stud Bolts (90,000 SMYS).

3) Indicated Torque assumes that a lubricant is applied to the threads and the nut face.

GCR/83-07-08

TABLE 10

600 Series ANSI Flanges

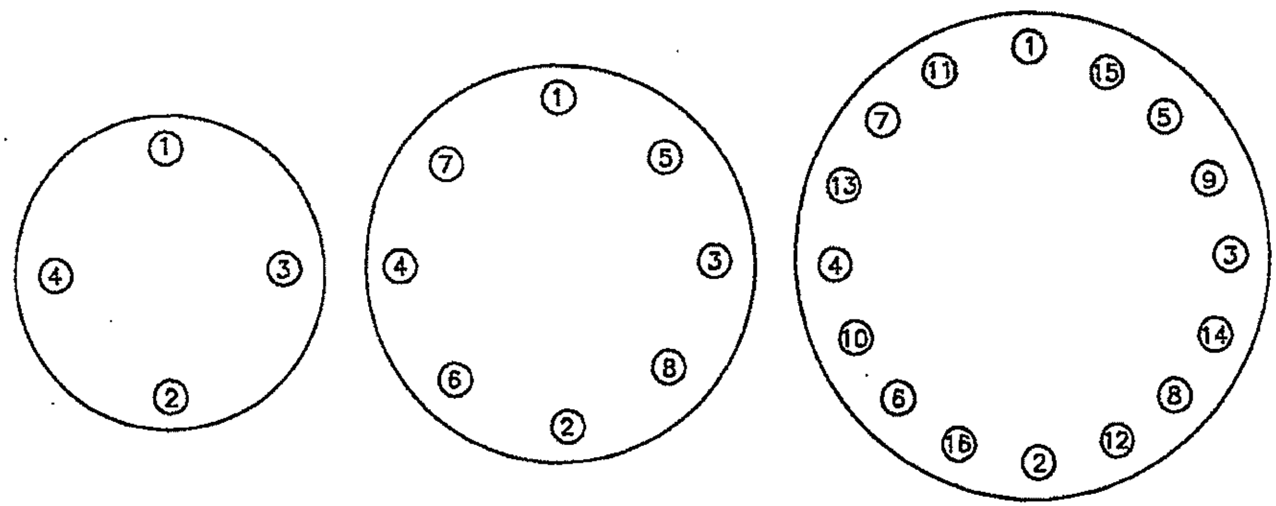
Recommended Torquing Limits and Resultant Compressive Force on Insulated Gaskets

Flange Size	Stud Diameter	No. of Studs	Raised Face Surface Area	Recommended Torque (2)	Compression/ Stud	Resultant Compressive Force on Gasket
2" Ø	5/8"	8	7.37 in^2	90 ft.lbs.	9090 psi	9867 psi
4" Ø	7/8"	8	18.55 in^2	240	18855	8131
6" Ø	1"	12	30.69 in^2	368	24795	9695
8" Ø	1 1/8"	12	42.94 in^2	533	32760	9155
10" Ø	1 1/4"	16	53.02 in^2	750	41805	12615
12" Ø	1 1/4"	20	68.28 in^2	750	41805	12245
16" Ø	1 1/2"	20	81.61 in^2	1200	63225	15494
20" Ø	1 5/8"	24	118.73 in^2	1650	75600	15282

Notes:
1) Based on 600 ANSI Flange Series
2) Based on applied stress of 50% yield strength of Alloy Steel Stud Bolts (90,000 SMYS)
3) Indicated Torque assumes that a lubricant is applied to the threads and the nut face

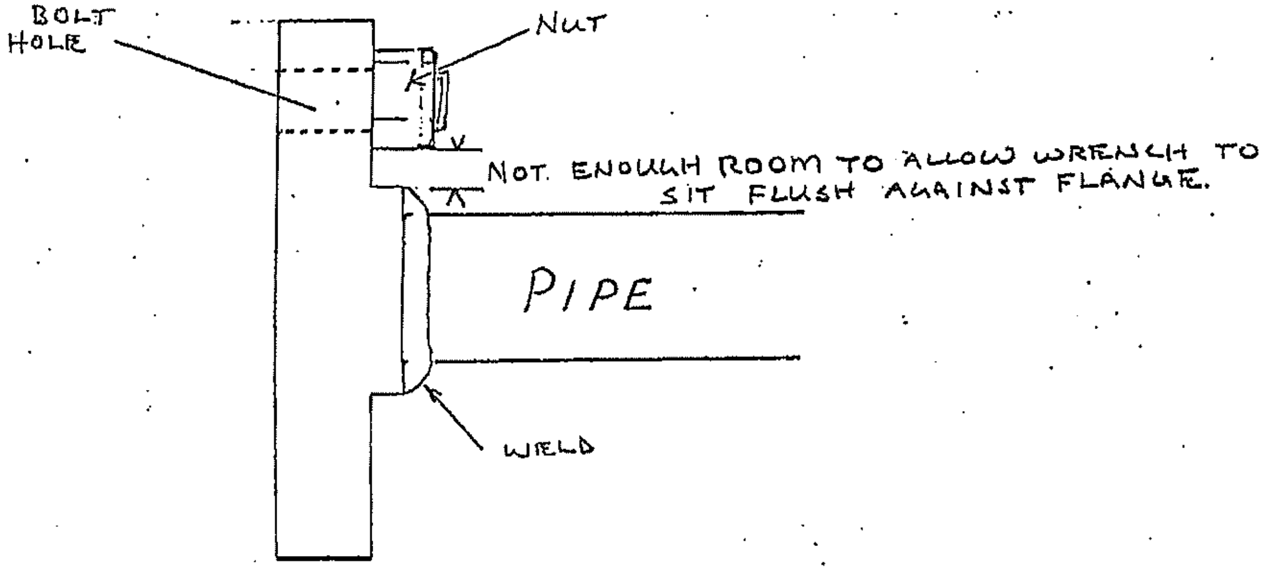
GCR/83-05-04

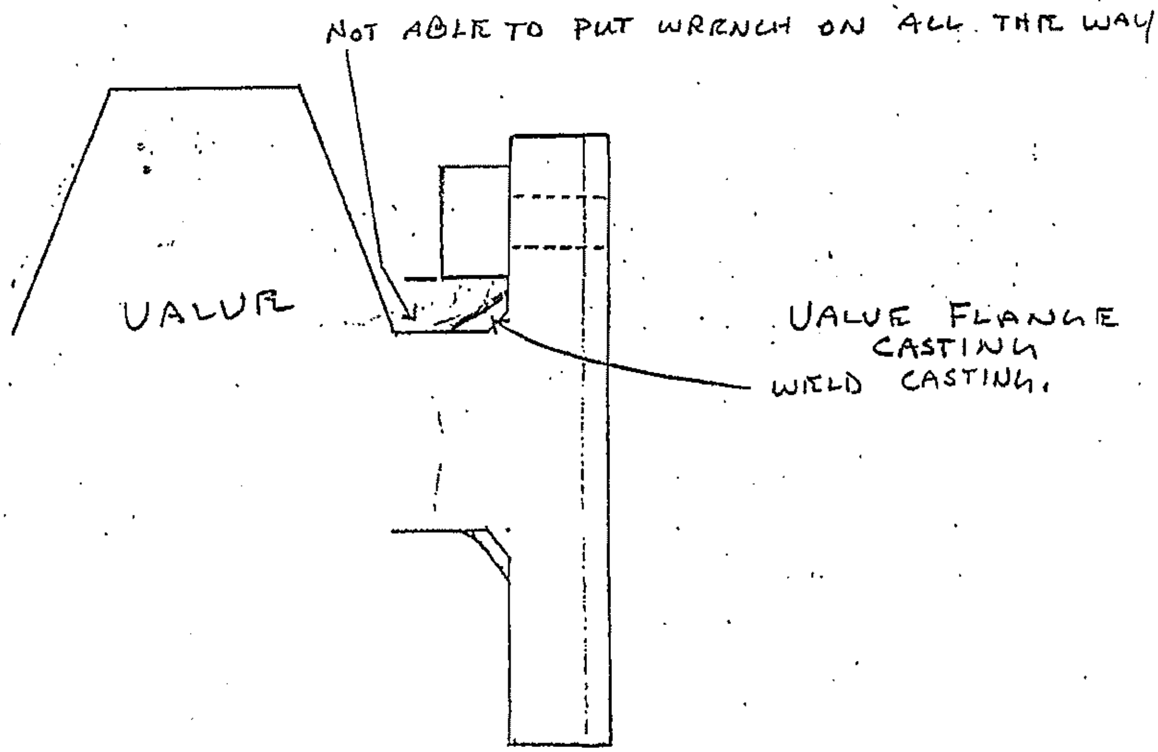
FIGURE 2



4 BOLT FLANGE   8 BOLT FLANGE   16 BOLT FLANGE

BOLTING-UP SEQUENCE





SOME VALVES THERE IS NO ROOM TO PUT WRENCH ON PERIOD

HAMMER WRENCH PROCEDURE

FORWARD

The "Hammer" or "Striking" Wrench is routinely used to tighten flange studs in areas where fittings are located close together preventing the use of air impact wrenches (or similar electrical tools). Any future manifold or piping design should provide sufficient space to permit the use of these automatic tools and eliminate the need for the Hammer Wrench.

The use of a Hammer wrench requires two men, the "Holder" and the "Striker". The "Holder" is the one in charge of the operation and gives all commands.

THE HOLDER

1. Tighten all studs by hand using the "Diagonal Clock" order (see diagram 1).

2. Using the same order, tighten each stud in the following manner. Position the wrench on the stud ensuring its face is flush against the outside face of the flange. If the wrench will not sit flush, use the other end of the stud to continue the process. (see diagram 2). Stabilize the wrench using the palm of an open hand ensuring no slack exists between the drive face of the wrench socket and outside stud face. It is imperative that the hand remain flat open and all potential pinch areas be identified and avoided before striking. Square the Striker's position so that his swing of the hammer will be in direct line with the contact surface on the wrench (see diagram 3) It must be emphasized that positioning of the Striker is the responsibility of the Holder.

3. When prepared to begin tightening (#1 & 2 above) indicate the signal word (usually "Strike") and proceed. NOTE that only the Holder issues commands, using the same siganl consistently throughout the operation. This avoids confusion.

4. Repeat for each stud, at a safe speed DO NOT RUSH OR HURRY THE PROCEDURE.

THE STRIKER

1. Before using the hammer, test swing against a wooden test piece to ensure the hammer head is tight. If the head is found to be loose DO NOT USE THE HAMMER IN THE TIGHTENING PROCEDURE.

THE STRIKER CONT'D.....

2. After being positioned by the Holder, stand with feet shoulder width apart so that the path centre line of the hammer passes between the legs.

3. Hand protection must be dry and oil free to prevent slippage.

4. After receiving the Holder's command, strike the wrench contact surface (see diagram 3) sqaurely. Repeat as required ONLY AFTER RECEIVING THE "STRIKE" COMMAND FROM THE HOLDER.

PROTECTIVE EQUIPMENT:

Both parties must wear eye, head and hand protection when using the hammer wrench.

COMMUNICATION:

Good communications between the Holder and the Striker are essential in the safe implementation of this procedure. Reviewing the above steps at the job site before commencing will reduce the risk of injury.

CW/MGM

86-03-10.

CW, MGM/ch

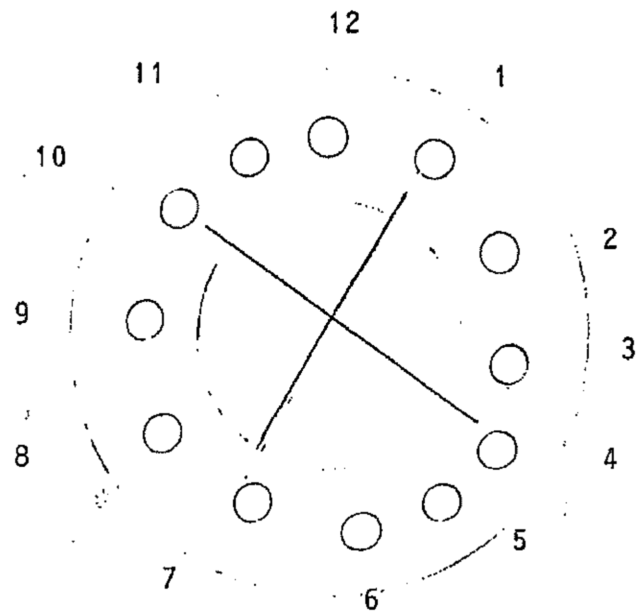
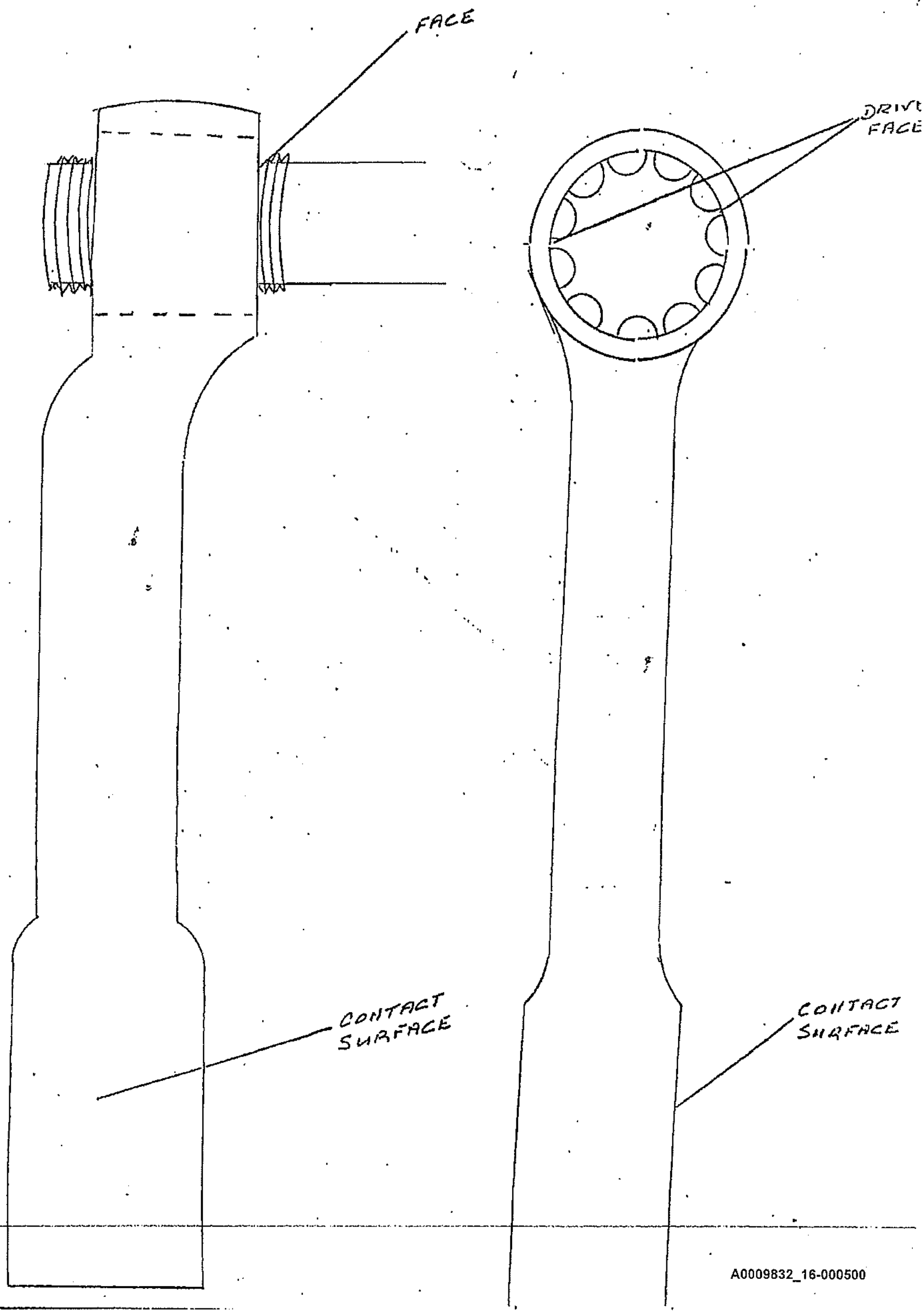


DIAGRAM 1

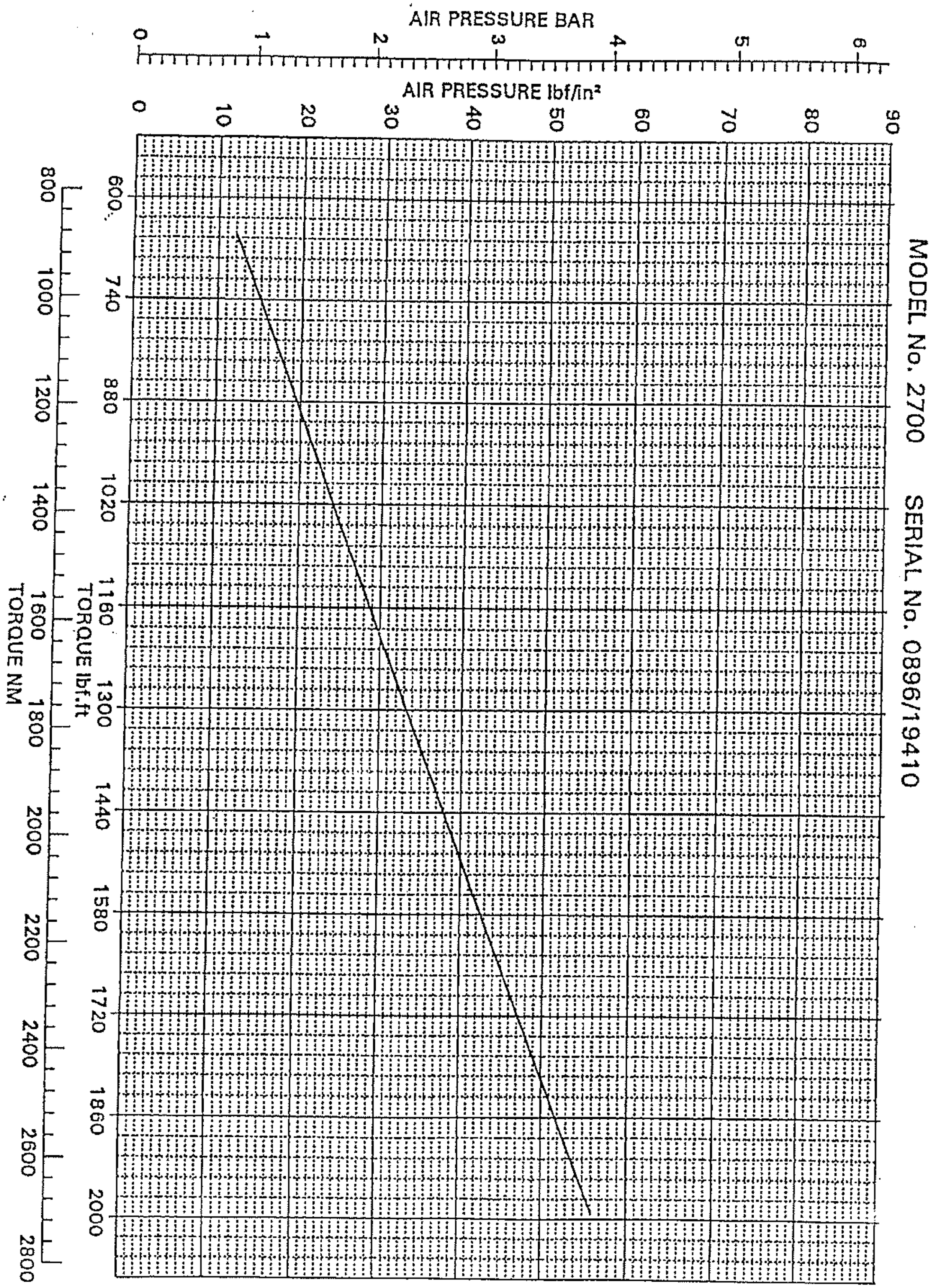
TIGHTEN STUDS 1-7-4-10. WHEN THESE ARE COMPLETE AND FLANGES ARE TIGHT, CONTINUE WITH REMAINING STUDS, IN A CLOCKWISE ORDER.


FACE
DRIVE FACE
CONTACT SURFACE
CONTACT SURFACE

COLOUR CODING FOR BLIND FLANGE IDENTIFICATION

(and mainline repair fittings)

DIAMETER	COLOUR	STENCIL/LABELLING			
16"	BLACK	600#			WHITE LETTERING
12"	RED	600#			
10"	WHITE	600#	300#	150#	BLACK LETTERING
8"	YELLOW	600#	300#	150#	
6"	GREEN	600#	300#	150#	WHITE LETTERING
4"	BLUE	600#	300#	150#	


AIR PRESSURE BAR
0 1 2 3 4 5 6
AIR PRESSURE lbf/in²
0 10 20 30 40 50 60 70 80 90
MODEL No. 2700 SERIAL No. 0896/19410
600 740 880 1020 1160 1300 1440 1580 1720 1860 2000
TORQUE lbf.ft
800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800
TORQUE NM

PNEUTORQUE WRENCHES

OPERATORS HANDBOOK (PART NO. 34068)

Total No. of pages - 40.

CE

PNEUTORQUE WRENCHES

OPERATORS HANDBOOK (PART NO. 34068)

Sound Level at Operator's Position: 85 dB

Method Of Sound Level Measurement: CEN/TC 255 N 184

Vibration Level at handle: Does not exceed 2.5 m/s^2

IMPORTANT: DO NOT OPERATE THE TOOL BEFORE READING THESE INSTRUCTIONS.

Pneutorque Wrenches are reversible, non impacting, torque controlled tools for threaded fasteners, and must always be operated with the following:-

- Clean dry air supply with a minimum flow of 19 litres/sec (40 CFM)
- Lubro Control Unit or similar Filter, Regulator & Lubricator Unit 1/2" Bore (12mm)
- Impact or machine Quality Sockets
- Reaction Plate

Where the intended usage is not with threaded fasteners, the safety of operation must be evaluated and appropriate precautions taken. Your distributor will be pleased to advise you.

These tools contain grease, which may cause an explosion hazard in the presence of pure oxygen. These tools contain aluminium alloy components which may cause a hazard in certain explosive environments. Please contact your distributor for details of solutions to these hazards.

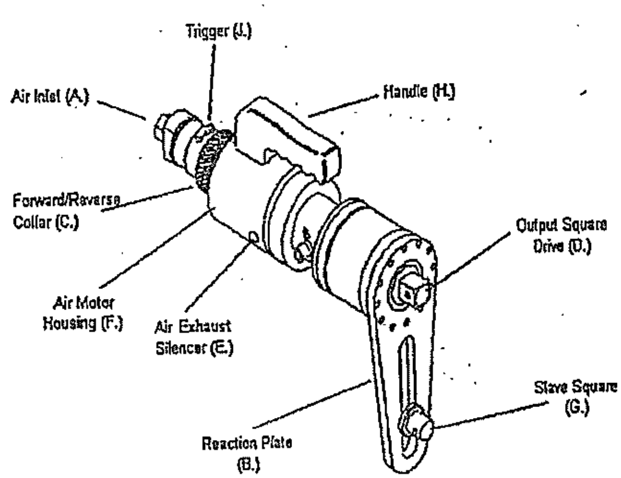


FIG 1

ASSEMBLY

1. Blow out all hoses before connecting.
2. Connect the wrench Air Inlet (A.) to the outlet side of the Lubro Control Unit using the 3 metre hose provided, observing the air flow direction arrows.
3. Connect air supply to the inlet side of the Lubro Control Unit using a minimum hose size of 1/2" bore (12mm). Avoid using 1/2" bore hoses of longer than 5 metres from the supply to the Lubro Control Unit as this will reduce the performance of the wrench.
4. Check oil level in lubricator and fill to correct level if required. (see "LUBRICATION")
5. a) If PT1 to 14, The bolts holding the reaction plate to the gearbox have a torque setting which is stamped onto the plate. The torque should be checked periodically.

   b) If PT 2700 or PT 5500, Remove the circlip from the spline, slide on the reaction plate, replace the circlip.

WARNING: TO AVOID HAZARD FROM WHIPPING AIR HOSES MAKE ALL CONNECTIONS TO THE TOOL BEFORE TURNING ON THE AIR SUPPLY.

TORQUE REACTION

When the Pneutorque is in operation the Reaction Plate (B.) rotates in the opposite direction to the Output Square Drive (D.) and must be allowed to rest squarely against a solid object or surface adjacent to the bolt to be tightened. (see figure 2).

WARNING: ALWAYS KEEP HANDS CLEAR OF THE REACTION PLATE WHEN THE TOOL IS IN USE OR SERIOUS INJURY MAY RESULT.

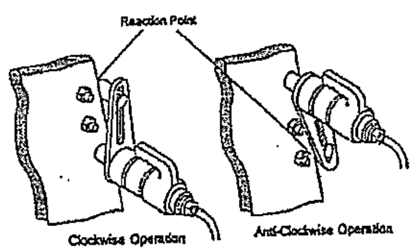


FIG 2

WARNING: CARE MUST BE TAKEN TO ENSURE THAT THE REACTION PLATE IS ONLY USED WITHIN THE LIMITATIONS SHOWN IN FIGURE 3.

For special applications or where extra deep sockets must be used the standard plate may be extended but only within the limitations shown in Figure 3.

WARNING: FAILURE TO OBSERVE THE LIMITATIONS SHOWN IN FIGURE 3 WHEN MODIFYING STANDARD REACTION PLATES MAY RESULT IN PREMATURE WEAR OR DAMAGE TO THE WRENCH.

Standard square drive extensions MUST NOT be used as these will cause serious damage to the wrench output drive. A range of nose extensions is available for applications where access is restricted and these are designed to support the final drive correctly.

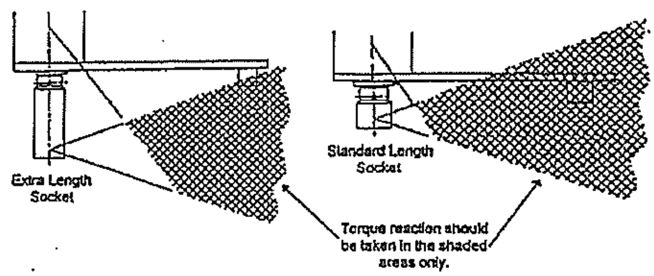


FIG 3

SETTING TORQUE FOR BOLT TIGHTENING

Every Pneutorque Wrench is supplied with an Air Pressure Graph which relates torque output to air pressure. Set the torque output as follows:-

1. Establish the air pressure required using the Air Pressure Graph.
2. Turn collar (C.) to set the tool direction, then squeeze and hold the trigger (J.).
3. Adjust the Lubro Control Unit pressure regulator until the correct pressure is shown on the gauge.

IMPORTANT: THE WRENCH MUST BE FREE RUNNING WHILE ADJUSTING THE AIR PRESSURE TO GIVE THE CORRECT SETTING.

WHILE THE WRENCH IS FREE RUNNING CHECK THAT LUBRO CONTROL UNIT IS SUPPLYING APPROXIMATELY SIX DROPS OF OIL PER MINUTE.

SETTING TORQUE FOR BOLT LOOSENING

1. Establish maximum air pressure from Air Pressure Graph or tool label and set air pressure as for bolt tightening.
2. Ensure that the collar is set to the 'REV' (reverse) position for right hand threads.

WARNING: EXCEEDING THE MAXIMUM AIR PRESSURE WILL OVER-LOAD THE WRENCH AND MAY CAUSE SERIOUS DAMAGE.

OPERATING THE WRENCH

1. Fit the wrench with the correct size impact or machine quality socket to suit the bolt to be tightened.
2. Fit the tool onto the bolt to be tightened with the Reaction Plate adjacent to the reaction point. See figure 2.
3. Slowly bring the Reaction Plate into contact with the reaction point by operating the wrench in short bursts.

WARNING: KEEP HANDS CLEAR OF REACTION ARM.

WARNING: IN USE, THIS TOOL MUST BE SUPPORTED AT ALL TIMES IN ORDER TO PREVENT UNEXPECTED RELEASE IN THE EVENT OF FASTENER OR COMPONENT FAILURE.

4. Keep the 'trigger' squeezed to its open position and collar turned fully until wrench stalls. If the 'trigger' is released or collar is turned back to the 'OFF' position before the wrench stalls, full torque will not be applied to the bolt.
5. Release the 'trigger' and turn Collar to 'off' and remove tool from bolt.
6. If the tool will not release from the bolt, turn collar to the opposite direction and squeeze the trigger for a fraction of a second.

TWO SPEED AUTOMATIC GEARBOX

Automatic gearboxes, where fitted, will 'run down' the nut at five times normal operating speed. No operator intervention is required. The wrench will automatically select low gear (ie. low speed, high torque) to apply final torque. Set the wrench exactly as described above.

TWO SPEED MANUAL GEARBOX

1. Set the air pressure as described above.
2. Set the gear selector to it's 'high' position and then follow the procedure 'Operating the Wrench'.
3. Where there are several bolts in the joint, eg. a flange, it is desirable to tighten all of the bolts with the tool in 'high' gear.
4. Set the gear selector to 'low' and apply final torque.

MAINTENANCE

To maintain optimum performance and safety, the following maintenance should be carried out:

1. Check that the bolts fastening reaction plate are tightened to the torque stamped onto the reaction plate.
   Frequency: Weekly
2. Replace the silencer material in the tool handle.
   Frequency: Every six months.

LUBRICATION

Air Lubricator and Air Motor:-

Shell Tellus 15, BP Energol H.P.L. 40, or equivalent good quality hydraulic oil.

Gearbox:-

The gearbox contains BP energrease LS-EP1. Under normal operating conditions it is not necessary to re-grease the gearbox.

Manufacturer's Name and Address:

Norbar Torque Tools Ltd
Beaumont Road
Banbury, Oxon
OX16 7XJ
United Kingdom
Tel: ** 44 (0) 1295 270333
Fax: ** 44 (0) 1295 269864

For Service Contact:

Pages 508 to 530

are duplicates

Trans-Northern Pipelines Inc.

Report of Leak
from TNPI's 16" Diameter Valve Flange
St. Vincent de Paul
Ville de Laval
Province of Quebec.
February 27, 2010

Executive Summary:

Around noon hour (11:48 am) on February 27th, TNPI Line Control received a telephone call from TNPI's Quebec emergency service call centre that a representative from Environment Canada had called to report the presence of gasoline escaping from the TNPI pipeline near 6175 Levesque Boulevard East in Laval, Quebec. Although system hydraulics did not indicate any anomalous conditions, Line Control shut down both operating pipelines through Montreal and after confirming the address location provided, closed upstream and downstream valves. TNPI's emergency response team contacted the initial caller to confirm the location. TNPI was advised that emergency services had been working at this site since Friday afternoon (February 26th) in response to a brown coloured liquid in the creek. Environment Quebec and Environment Canada officials believed the source of the liquid was from an upstream industrial plant. On the following morning, February 27, someone observed product escaping the vault containing TNPI's valve. Within an hour of the initial call to TNPI, TNPI personnel were on site and confirmed that fuel was escaping from a vault containing a 16" check valve on the north shore of the Rivieres des Prairies, adjacent to Lapiniere Creek. Additional TNPI emergency responders and contractors were dispatched to the scene.

Although the pipeline was fully depressurized, the flange leak itself could not be stopped completely until the valve was removed and re-inserted between the pipeline flanges with new replacement gaskets. During this time, leaking product was continuously collected on site by TNPI personnel. Final repairs were completed on March 3, 2010 and the pipeline was returned to service.

Based on the observed leakage at the time of notification, TNPI has calculated that the maximum amount of product that could have leaked from the pipeline since the last vault inspection (February 19) was 14 m3. The volume of product recovered from the vault was approximately 7

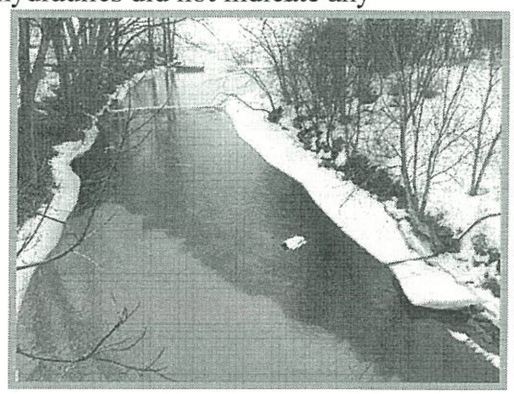
m3, therefore the maximum amount of product released to the environment is estimated to be 7 m3.

The escaped fuel soaked into the ground around the vault and seeped through the soil and rock to enter Lapiniere Creek to the north and the Riviere de Prairies to the south.

Contractor work crews focused on the environmental response and continue to work at the time of the submission of this report to capture as much of the escaped fuel as possible. TNPI's environmental consultant has been on site continuously to direct the environmental response and to develop TNPI's remediation plan.

Leak Response and Repair:

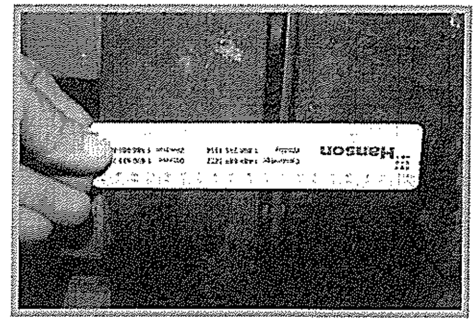
Around noon hour (11:48 am) on February 27th, TNPI Line Control received a telephone call from TNPI's Quebec emergency service call centre that a representative from Environment Canada had called to report the presence of gasoline escaping from the TNPI pipeline near 6175 Levesque Boulevard East in Laval, Quebec. Although system hydraulics did not indicate any anomalous conditions, Line Control shut down both operating pipelines through Montreal and after confirming the address location provided closed upstream and downstream block valves.



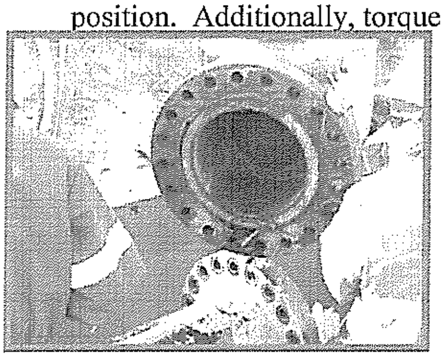
TNPI's emergency response team contacted the initial caller to confirm the location. Within an hour of the initial call to TNPI, TNPI personnel were on site and confirmed that fuel was escaping from a vault containing a 16" check valve. Additional TNPI emergency responders and contractors were dispatched to the scene.

TNPI was advised that emergency services had been working at this site since Friday afternoon (February 26th) in response to a brown coloured liquid in the creek. Environment Quebec and Environment Canada officials originally believed the source of the liquid was from an upstream industrial plant. On February 26th, Ville de Laval officials had installed a boom across Lapiniere Creek and were recovering the accumulated brown coloured liquid to keep it from entering the Riviere des Prairies.

At 11:40 am on February 27th, Environment Canada officials investigating the response discovered the previous day discovered product escaping the vault containing TNPI's valve. An Environment Canada employee measured the leak rate at 1 litre per minute, at which time TNPI's pipeline was operating at 392 psi. This information was later used to determine the maximum with multiple layers of adsorbent pads and wrapped with plastic sheeting to contain any residual escaping product. The area immediately outside of the vault was covered with plastic sheeting and then covered with sand to ensure there were no hazardous vapours around the vault and continuous monitoring was maintained. Remnants of the vault around the circumference of the pipeline were removed using torches. The work to allow unencumbered access to the pipeline was completed around midnight on March 2. However the drain down was not complete so removal of the valve could not commence until the following morning. Removal of the top portion of the vault allowed subsequent work at the leak site to be no longer classified as work in a confined space.



On March 3rd, prior to removing the valve, photographs were taken of both flanges at the 12:00, 03:00 and 09:00 positions. Photos at the 06:00 position were not possible due to the proximity of the vault base. The top of the gasket was marked with a "V" notch to indicate its original position. Additionally, torque testing of the bolts was conducted before attempting to undo any of the bolts from the flanges. All nuts were determined tighter than the specified 1200 fps. This was determined by hydraulic torque gauge.



All of the nuts and studs that were removed were in good shape with no evidence of corrosion or deterioration. The valve was easily removed without the need to spread the flanges indicating good alignment of the pipe segments. On removal the gasket was photographed and preserved in a plastic bag for future examination.

The pipe and valve flange faces were examined and deemed to be acceptable for re-insertion into the pipeline. This was performed without difficulty. The flange faces and bolt holes lined-up without the need for adjustment. New gaskets, studs and nuts were installed in both pipeline flanges. The insulating gasket was replaced with a standard flexitallic gasket since there was no need for isolation with the current cathodic protection system. After the valve was installed and the studs were torqued to specification the pipeline was re-filled with product from Montreal Pump Station.

The fillet welds of the two 2" tapping connections were inspected by NDE methods two days after welding, as these connections have now become permanent features on the 16" pipeline.

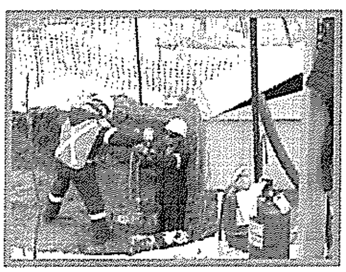
The repair was completed about 15:40 hours on March 3rd. After the pipeline was refilled with product, the pipeline section was pressurized to 800 psi and held for an hour so that the flange connections could be checked for leakage. None was evident. Operation of the pipeline was resumed at 20:42 hours on March 3, 2010. The pipeline had been out of service for 104 hours 52 amount of leakage that could have escaped the pipeline and valve vault.

Fuel which overflowed the vault soaked into the ground around the vault and seeped through the soil and rock to enter Lapiniere Creek to the north and the Riviere de Prairies to the south.

Equipment deployed on the previous day by the Ville de Laval was maintained and used by TNPI until it was replaced by TNPI's response contractor.

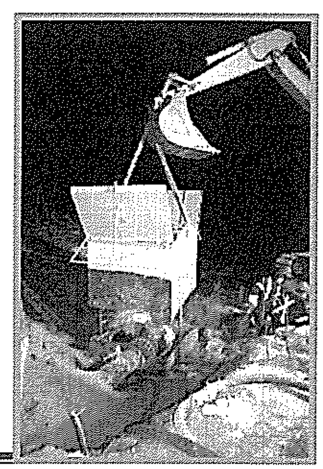
In compliance to established protocols, on confirmation of the leak, TNPI notified the Transportation Safety Board of Canada of the incident at 13:25 hours even though TNPI did not have detailed information about the leak itself.

The source of the leak was ultimately determined to be at an insulated gasket on the upstream side of the Riviere des Prairies check valve on the 16" pipeline. Emergency response contractors removed the accumulated water and product from the vault by vacuum truck. This action stopped the product from escaping the steel vault into the natural environment, but could not prevent the product from escaping the flange. Though the pipeline was shut down and isolated, the head pressure between St. Rose Junction and the valve was sufficient enough for the leak to persist until the pipeline could be drained.



Continuous vacuum truck extraction was necessary to prevent product from accumulating in the vault. A tub was placed under the leaking flange to concentrate the liquid for vacuum truck recovery. Once the leak was reduced to a safe level, safety precautions including flushing the vault with water to reduce hazardous vapours was performed. TNPI personnel entered the vault to assess and to confirm the source of the leak and to assess the type of repair required. It was determined that the pipeline would have to be drained of product to remove the valve and replace the gasket.

The pipeline was exposed on each side of the valve vault so that 2" tapping connections could be welded onto the pipeline. After the welding was completed, the pipeline was tapped and product removal began. Approximately 400 cubic metres of product was removed from the pipeline over a two day period using vacuum trucks and eventually air driven pumps.

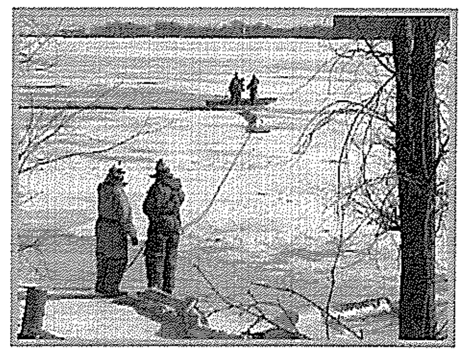


Throughout the entire ordeal the air was monitored with hazardous atmosphere detectors. To remove the valve from the pipeline, the top portion of the vault was first removed for worker safety and to allow easy access to the flange bolts with air and hydraulic wrenches, and to allow for eventual product recovery underneath the vault base.

A contractor was brought in to cut through the steel vault with an electric saw to create a safe work environment. The leaking flange was wrapped minutes. The flanges have been repeatedly checked and no further leakage has been observed.

Site Safety:

Throughout the entire emergency response, including the pipeline drain down and valve removal and reinstallation TNPI maintained a Safety Watch. TNPI's Safety Watch ensured that personnel were wearing the appropriate personal protective equipment and following proper work procedures. Hazardous atmosphere detectors were employed in the vault, in the excavation and around the site to monitor for explosive atmospheres and oxygen levels. At no time was there any indication of unsafe atmosphere exposure to personnel with the exception of inside the vault. During hot work, when removing the vault from around the valve, fire extinguishers were deployed in the event of fire.



All vacuum trucks were grounded when handling product from either the pipeline drain down or when pumping contaminated water or fuel from excavation pits or along the shorelines. Bonds were installed around the valve to ensure the potential of the pipe south of the insulated flanges was equal to the potential of the pipe north of the insulated flange. The closest rectifier on the pipeline was turned off to ensure there was no potential for electrical discharge when the valve was being removed.

CSRS/SIMEC was the prime contractor working on the surface of the ice and near the shorelines. Additional site rules were enforced to ensure that personnel were not exposed to hazardous conditions related to water and hypothermia. Personal flotation devices were mandatory for anyone working on the ice or water or within 10 feet of the shoreline. Workers used aluminium boats to travel over the ice surface. Travel lines were also used so that workers could be retrieved from shore in the event of ice failure. Workers also worked in pairs connected by lanyards. Whenever booms were winched or pulled by powered equipment, a wide berth was given in the event of rope failure and lash back. On two separate occasions, personnel fell through the ice and into the water. In both cases the water depth was shallow enough that the individuals were not fully immersed in cold water. Following the second event, personnel worked exclusively from aluminium boats when working on the ice.

Tailgate meetings were held regularly with crews as new personnel arrived on site and when work conditions were about to change. Temperature conditions changed daily, giving rise to varying hazardous walking hazards. In the morning when the ground surface was frozen, walking conditions changed from hard uneven surfaces to slippery, soft and wet conditions. In the late afternoon, conditions changed back to hard uneven ground. Walking conditions during darkness away from light plants was difficult across the hard uneven ground. On March 11th, an equipment operator walking up the excavation and slipped on the uneven surface striking his left hand on the embankment. The next day he was diagnosed with a broken ring finger.

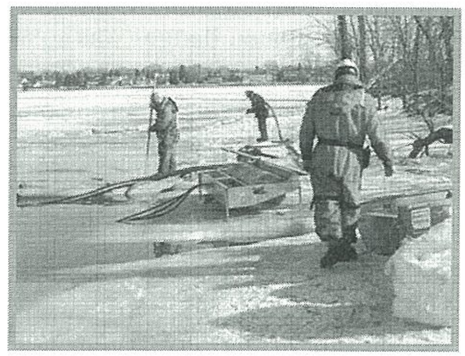
As spring daytime weather conditions improved there were more people walking by the site. Accordingly, a security fence was erected along the limit of Boulevard Levesque and the western perimeter of the site to prevent inadvertent intrusion. A secondary snow fence was erected around open excavations within the site.

During the evening hours security was posted at the site to prevent access and to prevent theft. Despite this security, one evening when the security guard was asleep in his vehicle, persons unknown stole a generator.

Wildlife Watch:

Early into the emergency response, one dead black duck was found by Environment Canada in Lapiniere Creek. Another oil laden duck was later captured on March 2nd and sent to a veterinary clinic for care. This duck died in the clinic March 17th. Two dead salamanders were found along the bank of Lapiniere Creek reportedly by Environment Canada.

On March 2nd a wildlife watch was established to monitor the site upstream of the valve vault for nesting birds and other animals and to monitor the shoreline and banks for product sheen. Twice each day, personnel would walk about 1000 feet upstream along Lapiniere Creek. This continued until March 11th after which the wildlife was conducted once each day until late March when the wildlife watch was suspended.



Shoreline Spill Response and Site Clean-up:

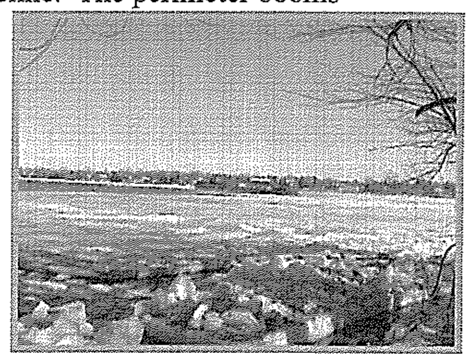
Immediately on responding to the site, a marine spill response contractor (CSRS/SIMEC) was retained by TNPI to assist with the spill response and initiate site clean-up. These activities went on for approximately three weeks until it was evident that the volume of product being recovered had declined substantially and became more manageable.

Upon arrival at the site the contractor installed booms in open water at the mouth of Lapiniere Creek and the Riviere des Prairies to capture and contain as much fuel as possible. Adsorbent booms and pad were also deployed. Oil skimmers were used to collect product within the booms and several vacuum trucks were also used to skim product off the surface of the water.

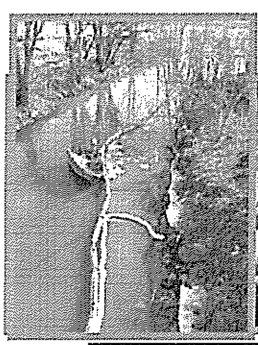
Oil recovery along the shore line was challenged by cold overnight temperatures and warm afternoon sun. The presence of ice and snow concealed the presence of oil and melting water spread the sheen over a broad area. The ice in Riviere des Prairies was slotted and booms were installed beyond the perimeter of the known sheen. At peak there was 1900 feet of booms installed across Lapiniere Creek and along Riviere des Prairies.

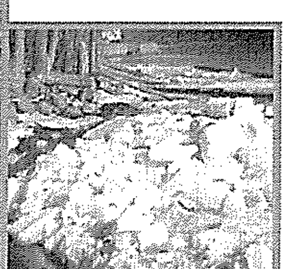
Product recovery along the shoreline required the additional slotting of ice to release the oil for recovery by vacuum truck and collection by adsorbent pads. Water deluge hoses were deployed along the shoreline to aid in melting the shoreline ice and to release additional product that had accumulated along the shoreline and under the ice. To avoid releasing large amounts of trapped fuel ice slotting and water deluge was performed in three (3) divisions that were encircled by booms. Hand shovels, rakes and pike poles were used to move sheen towards vacuum skimmers.

As the water flows in the Riviere des Prairies fluctuated and as the ice thickness deteriorated a floating backhoe was brought to the site on March 6th to break the river ice in order to establish a tighter perimeter but careful not to break the ice clinging to the shoreline. The perimeter booms installed along the Riviere des Prairies were removed and re-deployed closer to shore. During this process it was discovered that the oil had migrated upstream along the bank of Riviere des Prairies to a distance of 450 feet from the pipeline. This new division was bordered by additional floating boom. The total boom deployed in all divisions by the end of the day was 1650 feet. Shore line cleanup in this division continued by water deluge to melt the snow and ice and to displace the trapped oil onto the water surface where it was then collected by adsorbent pads, booms and by vacuum truck.



On March 11th, a Canadian Coast Guard hovercraft made several passes upstream and downstream on the Riviere des Prairies to break-up the ice sheet in the river as a flood control measure. During these passes, waves moved blocks of ice into the booms deployed along the shoreline. Some of the boom was destroyed by ice action. Other portions were displaced. The waves lapped the shoreline well above the static water level and initiated the release of more product and more sheen. It took work crews two days to re-establish the boom divisions that were disturbed by this action. In addition a change of wind direction forced the broken ice flows into the booms parallel to the river shoreline. When the wind direction changed two days later the broken ice flows eventually drifted downstream and the booms were re-secured.





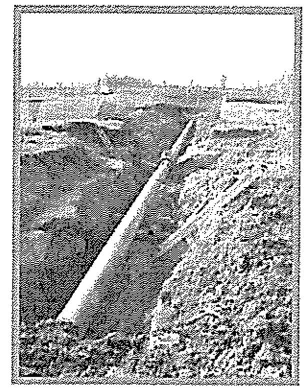
In each of the now seven (7) boom divisions, vegetative debris, leaves and other matter that had adsorbed oil sheen was collected and disposed of in plastic bags. When all evidence of sheen and product weeping in each boom division had disappeared most of the booms were removed from upstream towards the downstream direction along the river shoreline.

When the booms were removed from the water they were winched to shore and laid out on rolls of adsorbent padding to ensure any clinging oil product would not be transferred to the ground.

By the end of March 17th 900 feet of boom remains at the site along the bank of Lapiniere Creek and along the shore line of Riviere des Prairies near the 16" pipeline. On March 18th, CSRS/ SIMEC demobilized their trailers from the site. CSRS/ SIMEC will return as needed to maintain shoreline boom and assist with shoreline cleanup. Shoreline cleanup will continue until the seeping of hydrocarbons from the rock ledges along Lapiniere Creek ends. Installation of the recovery system and well pumping is believed to be the solution to prevent further product migration into the water.

Pipeline Excavation:

During the initial stages of TNPIs' response, contaminated soil that was removed from around the vault and the pipeline was initially placed on tarps and covered with plastic sheeting until soil samples were analyzed. It quickly became evident that the fuel that escaped the vault soaked into the ground around the vault appeared to have seeped along the 16" pipeline trench to enter Lapiniere Creek to the north and the Riviere de Prairies to the south. Sand padding that surrounded the 16" pipeline provided a convenient subsurface pathway from the valve in both directions.



Test pits excavated near the bank of Lapiniere Creek and near the Riviere des Prairies, confirmed TNPI's beliefs. To prevent further migration along the pipeline, bentonite plugs were installed near these test pits. TNPI continued to excavate the 16" pipeline by backhoe and by vacuum excavation between the bentonite plugs and the valve site. As the excavation continued, contaminated soils were placed into lugger bins for easy removal from site. All soils were analyzed prior to disposal at a licensed landfill site.

After the pipeline was fully exposed, TNPI determined that the coating on the 16" pipeline (coal tar enamel) was unaffected by the fuel spill and therefore did not require repair. Minor coating holidays were repaired with Kema tape. Following excavation and cleaning of the pipeline trench base and sidewalls by vacuum excavation the pipeline was again padded and then backfilled with clean granular materials.

The parallel 10" pipeline situated 30 feet or so west of the 16" pipeline was excavated at four locations to determine if any fuel had found its way to the 10" trench. None of the test pits revealed product or contamination. The pipeline was marked with flagging. Heavy equipment was confined to gravel road crossings that were constructed over the 10" pipeline, which is marginally shallower than the 16" pipeline.

Spill Volume and Recovery Calculations:

The estimated loss of product from the leaking flange was estimated based on the observation made by an Environment Canada employee who measured the leak rate at 1 litre per minute, at which time TNPI's pipeline was operating at 392 psi. Utilizing this information, the equivalent leak rate at various operating pressures was determined and applied to all product movements between the time of discovery at 11:40 am on February 27th and the last vault inspection at noon on February 19th. The resultant product of this calculation is 14 m3. Given the total vault volume of 9 m3 and a resident volume of water in the base of the vault of 2 m3 (the volume of water that was in the vault at the time of the last vault inspection), the volume of product that overflowed the vault is approximately 7 m3.

Analytical information from the soil concentrations was used to determine that the soils contained 2380 litres of fuel. Similarly analytical information from a limited number of water concentrations was used to determine that the water contained 5845 litres. Overall, the total product recovered is approximately 8225 litres of fuel.

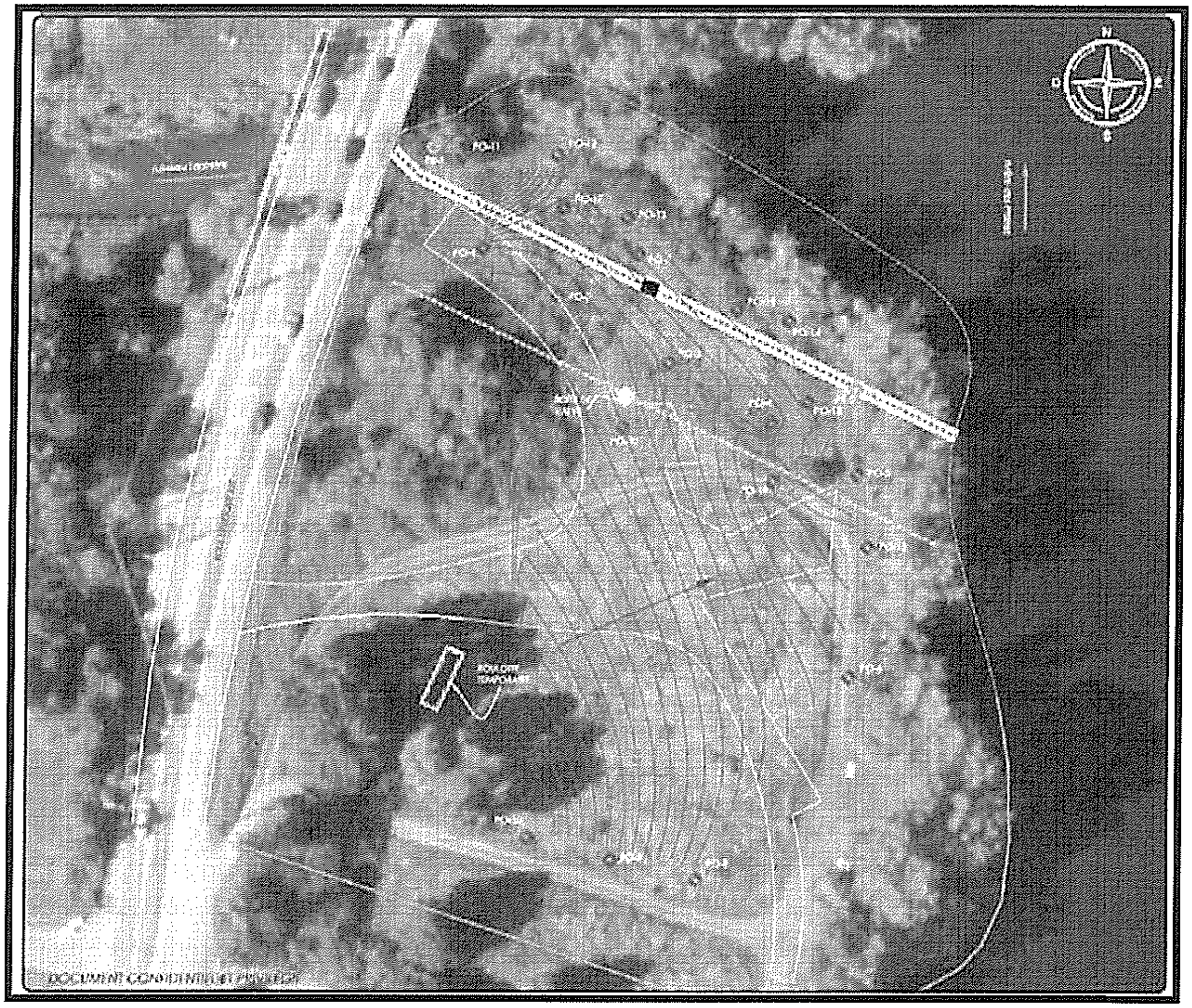
The difference between the amounts of product that theoretically escaped versus the amount that was theoretically recovered is due to the various assumptions that were made in both calculations. Variation of any of the assumptive values would alter the numbers themselves, but the two values corroborate closely.

Site Investigation and Remedial Action Plan:

TNPI's environmental consultant, Mission HGE assisted with characterization of soils and water quality. In addition to test pitting along the 10" pipeline, excavation of the 16" pipeline and sixteen (16) other test pits excavated on the site, nineteen (19) boreholes were drilled around the site to aid in delineation of subsurface contamination as shown on the attached site plan. Free product is being recovered from two wells using a Petrotrap. A detailed site remediation plan was submitted to authorities for a Certificate of Approval on April 12th.

In addition to Mission HGE, TNPI's insurance broker has retained the services of its own environmental consultant, Environmental Solutions Remediation Services (ESRS) to monitor site activities and to provide guidance. Both consultants continue to liaise with regulatory authorities to procure approval for the remediation plan.

Until the Certificate of Approval is issued, TNPI's consultants and contractor remain on scene to remove as much free product from the monitoring wells as possible. In addition, shoreline monitoring continues. Booms are re-positioned and adsorbent pads are changed as necessary.



Regulatory Notifications and On-site Representation:

TNPI notified the Transportation Safety Board of Canada (one window reporting protocol) on February 27th at 13:25 hours. TNPI was contacted by the National Energy Board at 13:50 hours. Representatives of the TSB (1)* and NEB (4) attended the site over the next two days. Other agencies that attended the site were: Corrections Canada (3), Environment Canada (2), Environment Quebec (2) and the Ville de Laval (1).

*(4) denotes the number of representatives that have attended the site at various times throughout the emergency response.

On-site Resources:

Throughout the emergency response and continuing to the date of this report, all parties have attended weekly meetings at the site. Minutes of the meetings have been circulated amongst all parties by e-mail. A construction trailer was acquired to facilitate on site coordination and to provide shelter for site workers.

Primary contractors on site were CSRS/SIMEC, Veolia vacuum services, Recubec vacuum services, Alary construction and Petrosol for contaminated soil disposal.

TNPI's environmental consultant is Mission HGE was retained early into the emergency response and continues to produce information relative to the remedial action plan.

Representatives from TNPI's insurance broker, Environmental Solutions (ESRS) were on site throughout the emergency response and for the development of the site remedial plan.

Public Notification and Media Attention:

The Ministry of Environment issued a press release on February 27th advising the public of the pipeline leak.

Early into TNPI's emergency response TNPI retained the services of Hill and Knowlton, communication consultant to provide information to the public and the media. On February 28th, the media consultant spoke to the media and any passersby at the site.

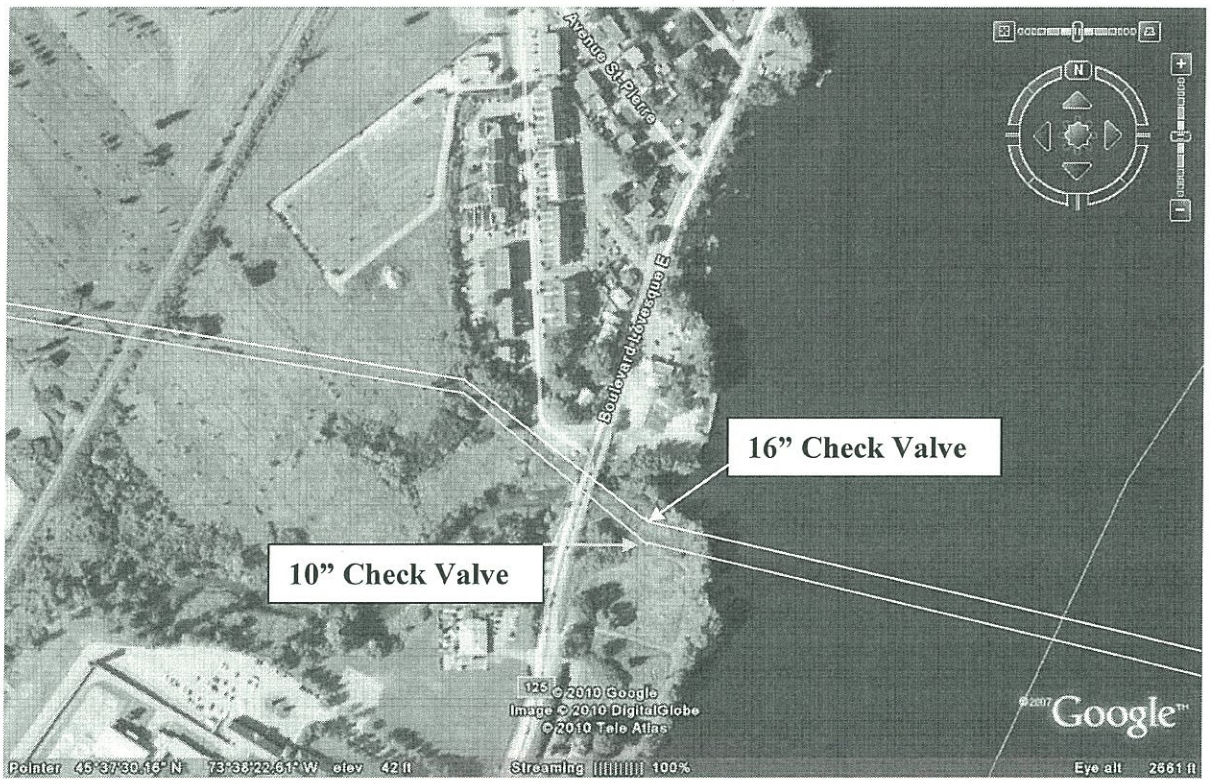
On March 1st, TNPI personnel knocked on the doors of the most immediate nearby residents and advised them of TNPI's activities at the leak site. On March 18, TNPI delivered 118 letters to residents in the community. No follow-up inquiries were received.

Though there have been a few reports in newspapers and some radio reports citing the emergency response, none of these was sufficient to draw attention to the site. One media reporter arranged for on-site interviews, but later declined to show-up.

Site Location Reference:

ML-7, R/W-2, Mile Post 6.4
Lot 323, St. Vincent de Paul
1,538,090 Cadastre du Quebec/Laval
Laval, Quebec

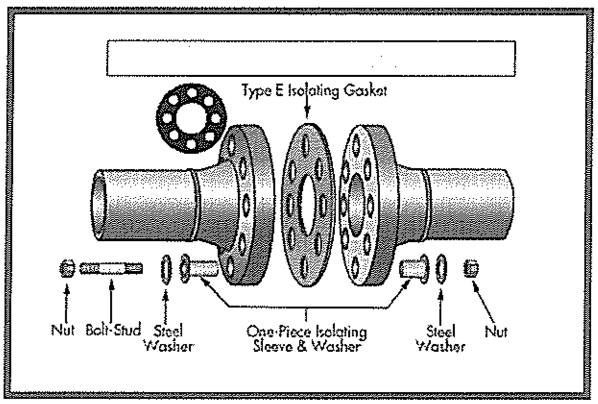
Property Owner: Corrections Service Canada



Summary of Pipeline Characteristics:

The 16" pipeline was constructed in 1972. The valve and gasket were installed at that time and included as part of the hydrostatic test for the pipeline.

- Pipeline 16.00" OD x 0.312" nominal wall, API 5LX Grade 52 line pipe
- Flanges are ANSI 600 class, with a 1440 WOG operating pressure ¼" raised face
- Check valve is Frankflo 16" ANSI 600 class, with viton soft goods kit
- Gasket is flexitalic 16" ANSI 600 class spiral wound
- Insulated gasket is F. H. Maloney, Type E neoprene faced phenolic



The steel vault was installed around the valve in 1994.

Operating Certificates:

The 16" pipeline was constructed in 1972 under order of the National Energy Board XO-3-72 and allowed to operate at 1411 psi pursuant to OPLO-2-17-72. Other orders in place for the pipeline are OPL-2-10-72 (ML-7) and AO-1-OP-239-72 (CR-267).

Information Requests and Orders:

TNPI has received three (3) e-mail information requests from the National Energy Board, dated March 2, 3 and 10, 2010.

In addition, TNPI has received several information requests, both e-mail and verbal from Environment Canada.

Failure Analysis:

TNPI has sent the failed insulated gasket to SGS Canada Inc., to determine the root cause of the gasket failure. The analysis is expected to be completed by May 28, 2010.

Underlying Cause(s):

To be determined.

Corrective Actions Taken or Planned by TNPI to Prevent Similar Incidents:

Full identification of correction actions will be determined when the root cause has been identified from the failure analysis report.

[redacted] 19(1)
2010-04-21

Preliminary Incident Report

Flange Leak: Riviere des Prairies Check Valve
February 27, 2010 – St. Vincent de Paul, Quebec

Around noon hour (11:50 a.m.) on February 27th, Trans-Northern Pipelines Inc. (TNPI) Line Control received a telephone call from TNPI's Quebec emergency service call centre that a representative from Environment Canada had called to report the presence of gasoline escaping from the TNPI pipeline near 6175 Levesque Boulevard East in Laval, Quebec. Line Control immediately shut down both operating pipelines through Montreal and after confirming the location address, closed upstream and downstream valves. TNPI's emergency response team was activated and dispatched to the location. TNPI was advised that local emergency services had been working in this area since Friday afternoon, February 26th, responding to a call from a pedestrian who noticed a brown coloured liquid in Ruisseau Lapiniere, a creek adjacent to the TNPI pipeline crossing. Environment Quebec and Environment Canada officials believed the source of the liquid was from an upstream industrial plant. In their continued investigation on Saturday product was observed escaping from the vault containing TNPI's valve. Within an hour of the initial call to the Company, TNPI personnel were on site and confirmed that fuel was escaping from a vault containing a 16" check valve. Subsequently additional TNPI emergency responders and contractors were dispatched to supplement resources already on the scene.

In compliance with established protocols, TNPI notified the Transportation Safety Board of Canada of the incident at 13:25 hours prior to having detailed information about the leak itself.

The leak was stopped on Saturday and product was contained. Response personnel continue to focus on the environmental response and have continued to work since Friday. TNPI's environmental consultant is on site to assist in directing the environmental response. Numerous agencies are present on site including the NEB who have had representatives on site since Sunday morning.

TNPI is actively engaged in a local "drain down" of the line that will allow the removal and replacement of the failed gasket on the 16" check valve.

Trans-Northern Pipelines Inc.
2010-03-02

Trans-Northern Pipelines Inc.

45 VOGELL ROAD, SUITE 310
RICHMOND HILL, ONTARIO L4B 3P6
TEL: (905) 770-3353 FAX: (905) 770-8675

2010 SEP -1 A 11:17

2010-08-31

National Energy Board
444 Seventh Avenue SW
Calgary, Alberta
T2P 0X8

Attention: **Ms. Anne-Marie Erickson**
Secretary of the Board

Subject: **Riviere des Prairies 16"Flange Leak, February 27, 2010**

Further to TNPI's report on the leak from a 16" insulated flange gasket near Riviere des Prairies on February 27, 2010, TNPI is enclosing a copy of the report "Failure Analysis on an Insulating Gasket"prepared by SGS Canada Inc.

In addition, TNPI is enclosing its corrective action plan. The first portion of this document reiterates TNPI's Insulated Gasket Assessment as related to the NEB in its letter dated 2010-08-23. The second portion, details TNPI's proposed Insulated Gasket Management Program.

If you have any questions, regarding TNPI's corrective actions in respect to insulated gaskets, please contact the undersigned.

Trans-Northern Pipelines Inc.

[redacted] 19(1)

Manager, Environment, Health, Safety and Security
905-[redacted]ext.[redacted]
[redacted]@tnpi.ca 19(1)

Insulated Gasket Assessment

The leak experienced on February 27th, 2010 at the Riviere des Prairies, Mile Post 6.4 was the result of a failed insulating gasket on a valve flange that was originally installed in 1972. TNPI had only experienced one other failure of an insulating gasket which occurred in February 1982, which was not a failure of the insulating gasket itself but rather the result of loose studs and nuts. TNPI has numerous other insulated gaskets on its pipeline system installed as early as 1952 which have never presented a problem.

Commitments to improve Pipeline Integrity

The results of the testing of any failed gasket are somewhat subjective. The report points to a failure of the neoprene facing. Insulated gasket failures are rare events in TNPI's experience. Physical inspection of gaskets requires that they be removed from the pipeline. This is not an easy feat as the process would require the draindown or purge of the pipeline contents to enable gasket removal. Gasket removal often destroys gasket integrity, rendering the inspection inconclusive.

There are 63 gaskets of the same design and material as the one that leaked at Riviere des Prairies in the TNPI system. Forty-three of these gaskets are in stations. Only 20 are on mainline block valve sites and few have a similar history to the Riviere des Prairies gasket, including a period of direct burial before valve vaults were installed throughout the TNPI system. TNPI has developed a program to inspect Type E, neoprene faced gaskets. We will perform detailed external examinations and remove and replace gaskets as operations allow. Judging the condition of the gaskets when removed from service, TNPI will reassess priorities as required.

Proposed Improvement

TNPI had suspended the use of neoprene faced insulating gaskets as more modern materials became available in the marketplace many years ago. In this respect process improvements have already been implemented.

Pending the physical inspection of other gaskets, TNPI has increased the inspection frequency at sites where insulated gaskets similar to the one at Riviere des Prairies are located. Formerly the inspection frequency for all valve sites was ten (10) days. This interval has been reduced to five (5) days.

An alternative to physical gasket inspection is condition monitoring of the environment in proximity to the gasket. TNPI is currently exploring various means to monitor vault sites with liquid level detectors such that any liquid in a vault, beyond a certain depth, would prompt an immediate response to investigate. New cellular technology has now made this monitoring possible where in the past establishing permanent power sources to some valve locations was prohibitive.

2010-08-23

Insulating Gasket Management Program

The following is an outline of an inspection and management program for insulating gaskets.

1. Inventory Assessment

TNPI has determined that there are 43 Type E insulated gaskets at stations and 20 Type E gaskets at block valve sites throughout the system. The following work plan has been developed to ensure that other neoprene faces phenolic insulating gaskets are inspected on a regular basis using the following procedures.

- Perform visual inspection complete with photographs of each site.
- Visual inspection will include assessment of adherence of facing at edges of gasket, brittleness, corrosion evidence on studs and/or flange faces.
- In order to visually inspect, or in order to clear corrosion deposits cleaning with air blast/water spray and protection with lubricant/coating (must be compatible with neoprene) to be considered.
- Measure dielectic resistance across the insulating gasket as an indicator that gasket degradation may be taking place. (This information may not be conclusive by itself (ie. isolation could be spoiled numerous ways).
- A procedure for in-situ inspections is to be developed and included in the Pipeline Maintenance Training Manual (PLMTM) for future reference.

Two Type E gaskets were inspected on July 13, 2010. Gaskets were inspected at Cummer Junction on V3 and V4. These gaskets were observed as able to be in 'good' condition. In particular there was no visible disbondment of the facing, the facing appeared to be free of cracking or brittleness, the gasket itself remained flexible within reasonable limits and facing condition was unchanged through any movement. Evidence could be seen that the flanges had been tape wrapped in the past. Only light corrosion at worst was visible on exposed components for flanges and studs.

The following listing has been divided into priority rankings based on the valve history, water ingress into vaults and operating pressure at the site.

Toronto System Locations

Inspection	Station	Valve	Block Valves	Check Valves	Type E	Comments
Priority						US (Upstream side)
1	BLB		X		1	upstream
2	BLB			X	1	upstream
3	BOS			X	1	upstream
4	GRB			X	1	upstream
5	BIN			X	1	upstream
6	BENWAY				2	both sides
				Total	7	

Inspection	Station	Valve	Block Valves	Check Valves	Type E	Comments
Priority						US (Upstream side)
1	HAJ	V1			1	upstream
2		V2			1	downstream
3	OA	M/l west of V34			1	mainline side
4		V27			2	3 way valve
5	CLJ	V1			1	downstream
6		V3			1	mainline side
7		10" m/l			1	downstream of V5
8	TAJ	V2			1	20 " side of valve
9		V8			1	Imperial side
10		V12			1	bottom flange
11	KEJ	V2			1	upstream
12		V3			1	upstream
13	BO	V2			1	downstream
14		V3			1	upstream
15	CA	V3			1	upstream
16	DR	V1			1	downstream
17			east		2	both sides
18	KS	V1			1	upstream

19	CUJ	V1			1	down stream
20		10" m/l			1	upstream of V2
21	TA	V3			1	upstream
22	NT	V21			1	upstream
23				C23	1	upstream
24		Metro depot			1	secondary shipper one on each side
25		Shell shipper Lat			1	spool upstream of secondary shipper valv
26		Petrocan Pl			1	One on each side of valve
27		Shell shipper valve			1	One on each side of valve
28		elbow V61			1	down stream
29		Shell Shipper Lat			1	by fence north side
30	CL	V8			1	shipper side
				Total	32	

Montreal System Locations

Inspection	Station	Valve	Block Valves	Check Valves	Type E	Comments
Priority						
1			DDB		2	Originally Direct Buried
2			RDP		1	16"
3			RMB		1	US
4			16" MT		1	US
5			10" MT		1	US
6			OBB	Ottawa	1	Type E on North
7			NSR	Ottawa	1	Type E on North
8			GLB	Ottawa	1	Type E on South (Gallinger Block)
9			RDP north	Dorval	2	
10			RDP South	Dorval	2	
				Total	13	

Inspection	Station	Valve	Block Valves	Check Valves	Type E	Comments
Priority						
1	SJ	V6			1	DS
2		V1			2	
3		V3			1	DS
4	CM		E Block		1	W flange

5	OT	V4			1	kicker
6		Petro			1	check valve
7		Shell			1	flange on lateral
8	DV				1	Flange @ CAFAS
9	MT	V15			1	Refinery side Petro-Canada
10	CW	V7			1	shipper side
				Total	**11**	

2. Validate

TNPI will remove and inspect select station gaskets by pipeline draindown. The results of these inspections will assess gasket condition after removal to validate observations in action item 1.

The prime candidates for removal inspections are: SRJ V6 and V1, CM East Block, OT V4, NT V21. The check valves on the Nanticoke Pipeline are being considered in conjunction with planned pipeline cut-outs.

3. Standards/Specifications

TNPI needs to define standards or specifications for gaskets and sealing materials if no single comprehensive document readily exists. This document will be filed in TNPI's Engineering Standards documents.

4. Vault Instrumentation

TNPI will commit to installation of liquid level detection devices in vaults. These devices will be built into any new vault installations. A multi-year program of retrofitting existing vaulted valve sites will begin in 2011.

2010-08-31

FAILURE ANALYSIS ON AN INSULATING GASKET

19(1)

Attention of [redacted] **P.Eng.**

TRANS-NORTHERN PIPELINES INC.
45, Vogell Rd., Suite 310
Richmond (ON) L4B 3P6

SGS File N°: MET-10137-01 revision 1
PO N°: 33329
Date: May 28th, 2010 (June 3rd, 2010)
Number of pages: 15 (appendix included)

19(1)

Prepared by:
[redacted] P. Eng., Ph.D., CFEI [redacted]
Senior Engineer

19(1)

Reviewed [redacted]

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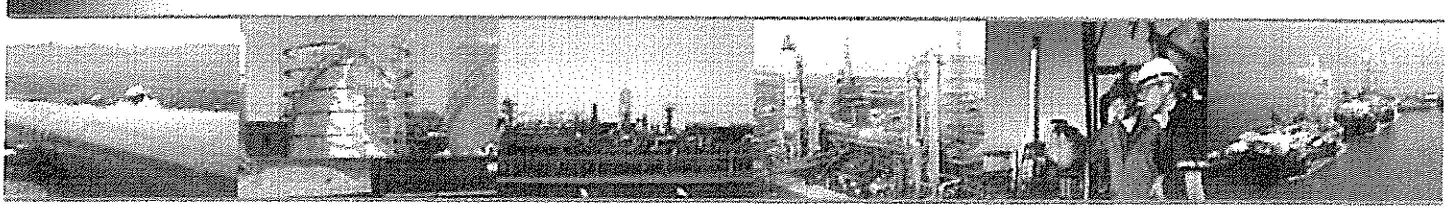
[redacted] P. Eng., M.A.Sc [redacted]
[redacted] Manager, Materials Engineering [redacted]



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1.0 MANDATE

TRANS-NORTHERN PIPELINES INC (TNPI) mandated SGS CANADA INC. to determine the root cause of the degradation experienced by an insulating gasket coming from the flange connection of a check valve, in the TNPI pipeline installation that operates from Montreal-East to Ste-Rose (Laval).

In order to make the necessary examination, the said gasket was shipped to our Montreal facility. The present report will consist of several sections. First, the available general information concerning the specimen will be presented. Evaluation of the degradation in the gasket, at both microscale and macroscale levels will be next addressed. The most probable cause of the failure will be detailed in the last section, Discussion/Conclusion.

2.0 GENERAL INFORMATION AND SPECIMEN PRESENTATION

The specimen under investigation is a Type E (full faced) insulating gasket used to seal and electrically insulate a flange connection in a pipeline. The pipeline operates from Montreal-East to Ste-Rose (Laval), being used to transport marketable gasoline (including RBOB-Reformulated Gasoline Blendstock for Oxygen Blending), diesel fuel, furnace oil, stove oil, and jet fuel. The gasket was mounted at a check valve on the pipeline between two NPS 16, ANSI 600 class (maximum allowable operating pressure 1440 psi) raised face flanges. The gasket comes from the east side (upstream) of the valve and it was installed in 1972, being in service ever since. The edges of the flanges were wrapped with tape in accordance with the gasket manufacture's recommendation (see Figure #1 for a view of the flange connections in as-found condition).

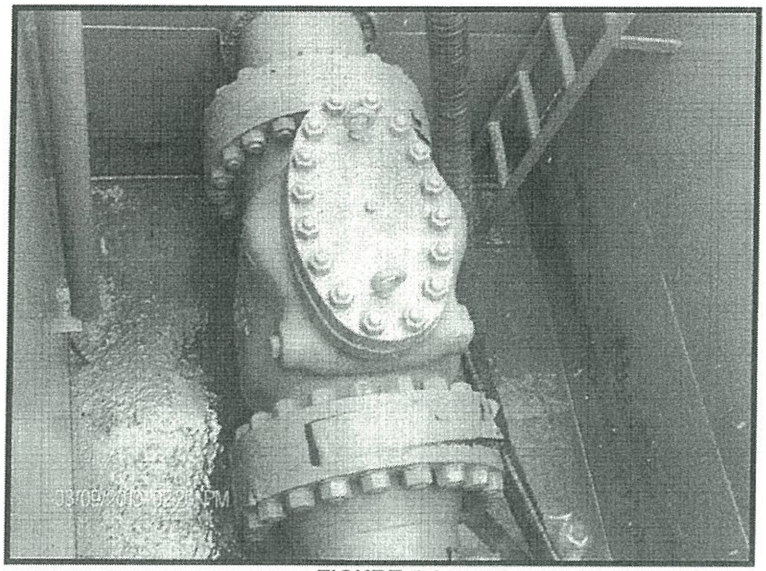


FIGURE # 1
Check valve in as-found condition
(picture taken during the excavations and provided by the client)

A leak occurred from this connection during February 2010. According to the client, when the gasket was removed, the flanges were found to be "in good condition", having the studs and nuts tight. However, the gasket itself seemed to have been damaged and was considered responsible for the spilling. Figures #2 to #6 show general images of the flanges and the gasket, during excavation operation.

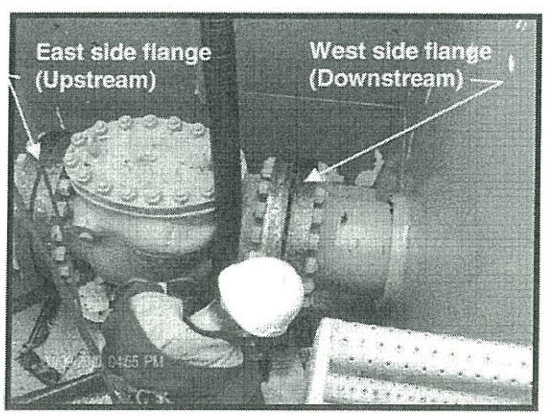


FIGURE # 2
General view of the check valve (picture taken during excavation and provided by the client)

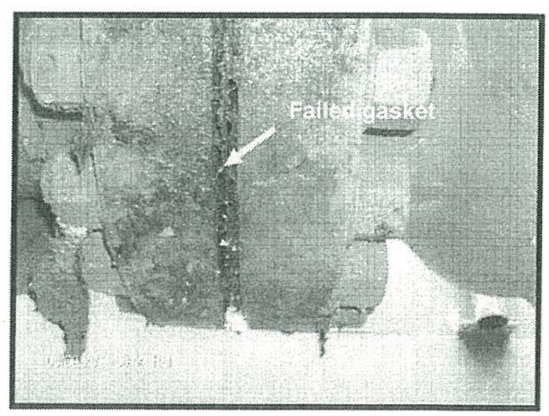


FIGURE # 3
Close-up view of the flange assembly on the east side of the valve (picture taken during excavation and provided by the client)

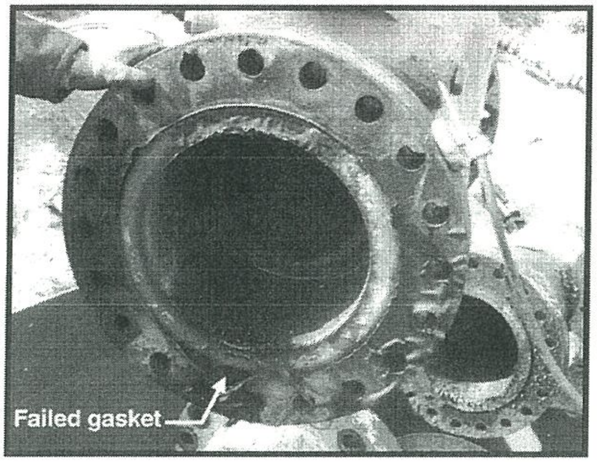


FIGURE # 4
General view of the failed gasket on the east side of the valve (picture taken during excavation and provided by the client)

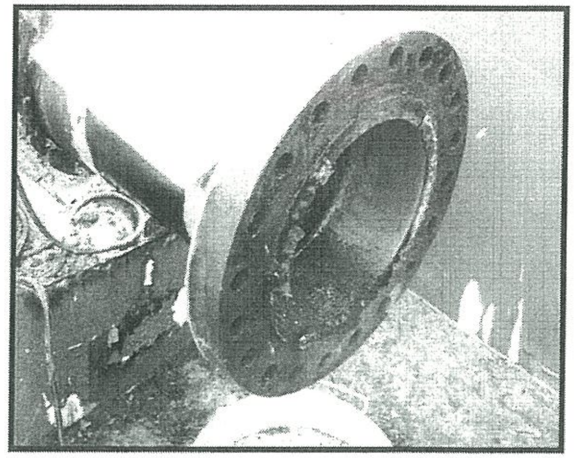


FIGURE # 5
General view of the flange on the east side of the valve (picture taken during excavation and provided by the client)

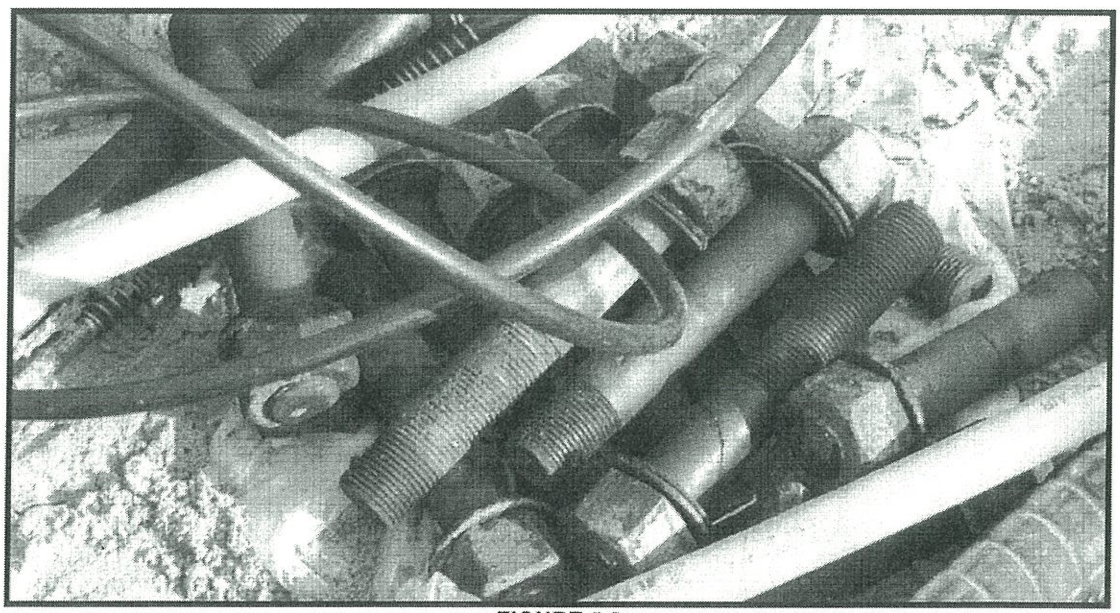


FIGURE # 6
General view of some of the bolts used to secure the flanges (picture taken during the excavations and provided by the client)

As the client informed us, the valve was originally buried in the earth. During 1992, it was excavated and a steel vault was installed to encapsulate the valve. The piping system in this area was cathodically protected at the moment of the original installation, in 1972. However, the fact that the valve was unburied made it susceptible to atmospheric corrosion inside the vault. In the case under investigation, corrosion in progression could indeed be noticed on metallic surfaces such as the faces of the flanges, the bolts and the flexitallic gasket on the west side of the valve (Figures #2 to #6).

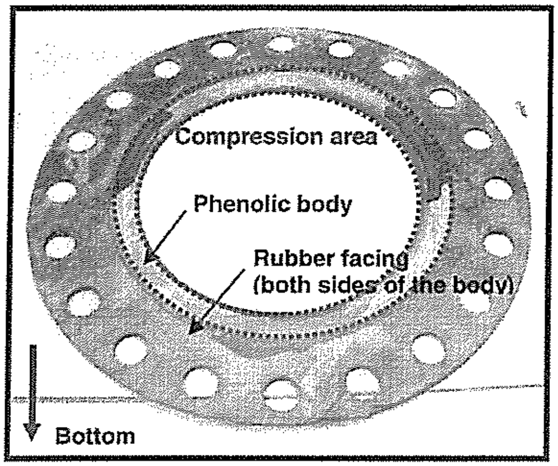
According to the documentation provided by the client the failed gasket is neoprene face phenolic, which means the gasket is composed of a medium-weave fabric, reinforced phenolic rigid body, faced with neoprene. This combination should insure both electrical insulation and sealing of the flange connection.

3.0 FAILURE ANALYSIS

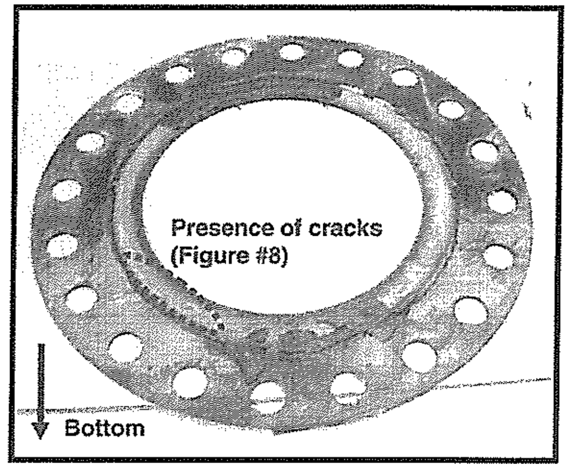
Failure analysis was conducted at both macro and micro scale in order to found the most probable cause of the degradation exhibited by the submitted gasket. Thus, visual examination of the degraded area, on both phenolic support and the neoprene faces, was followed by high magnification observation under a stereomicroscope. Scanning Electron Microscopy (SEM) was performed in the degraded area of the neoprene facing and Energy Dispersive X-rays (EDX) analysis was done on deposits found on the degraded gasket. Differential Scanning Calorimetry (DSC) and Fourier Transform Infrared Spectroscopy (FTIR) were performed to validate the use of the neoprene as facing in the failed gasket. The results of these analyses along with the most representative pictures taken during our investigation will be presented in the next sections.

3.1 Visual Examination

General images of the failed gasket, in as-submitted condition, are presented in Figures #7. The two faces of the gasket were labelled A and B at our laboratory and their position in Figures #7 is consistent with their position in the flange connection. Visual examination of the failed gasket first showed that the heavy damage exhibited by the gasket seem to be found rather in the rubber facing than in the phenolic body (Figures #7). Indeed, a closer look at the gasket found that the only apparent damage in the phenolic body is a circumferential cracking noted on one side and oriented towards the bottom of the connection, in the compression area (Figures #7).



a) Face A (West side of the gasket).



b) Face B (East side of the gasket).

FIGURES # 7
General image of the failed gasket, in as-submitted condition.

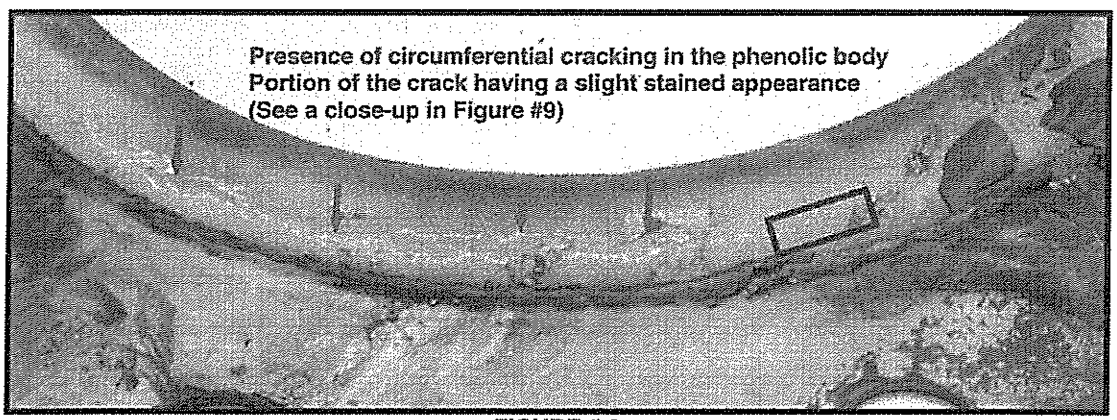


FIGURE # 8
Location and global appearance of the cracking found in the phenolic body.

This crack is more pronounced on the face B of the gasket which suggests that it originated on this side. According to the on-site observations, it was thought that a great portion of the crack was produced by manipulations during valve removal. However, since at one location the crack's edges seemed to have been stained and old-looking, it was thought that the crack was initiated prior to removal. This hypothesis was verified at our laboratory by visual observation. The stained appearance in the crack edges at this particular location was no longer visible when observed at high magnification and the morphology of the crack is the same on its length (Figure #9). Our observations suggest that this cracking was entirely produced during valve removal.

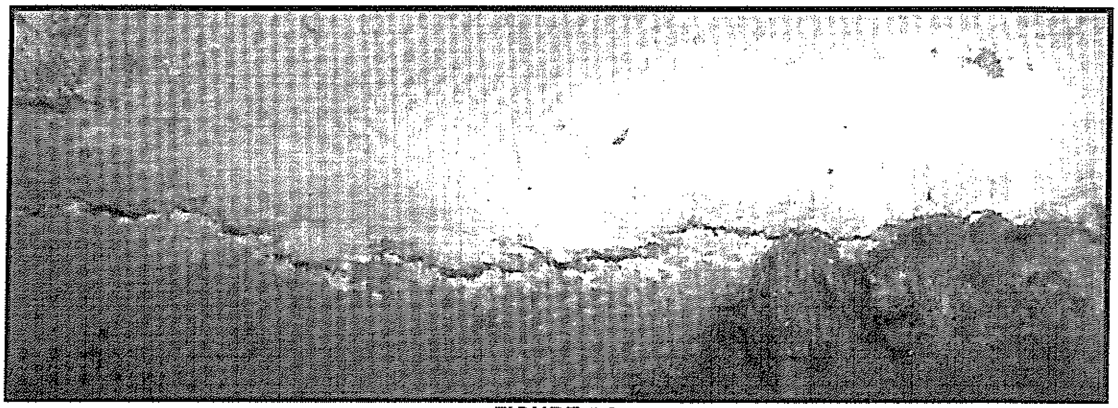


FIGURE # 9
Close-up view of the cracking found in the phenolic body.

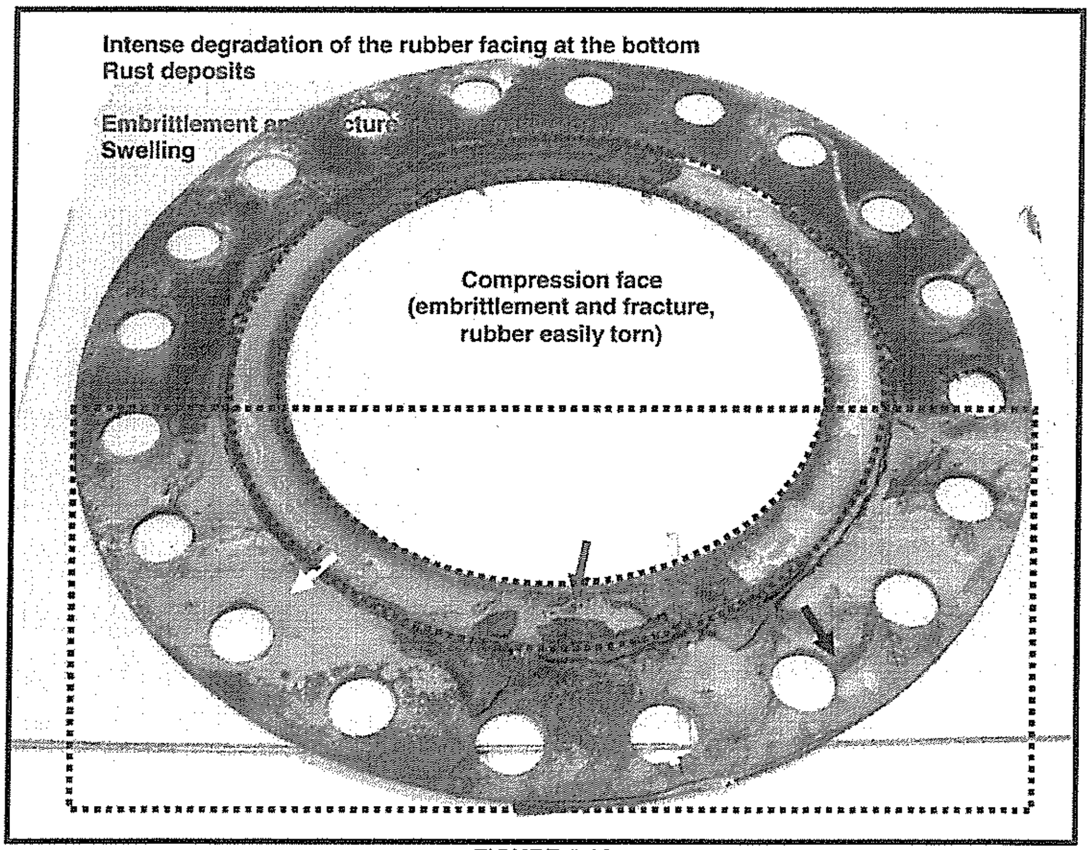


FIGURE # 10
Illustration of the degradation present in the rubber facing (face B, similar in face A).

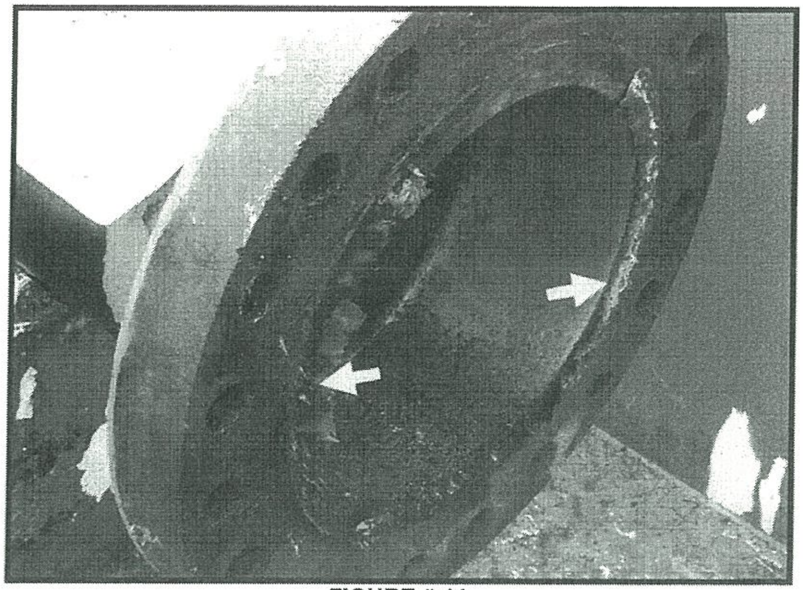


FIGURE # 11
Portions of rubber facing torn apart on the compression face during dismantling.

Visual observations of the rubber facing showed heavy degradation on both faces mostly located at the bottom side of the connection (Figure #10). Deposits and discoloration are present on almost all surfaces located at the bottom but the phenomenon seems less intense at the upper side (Figure #10).

In the area corresponding with the compression face of the gasket, i.e. the one between the raised faces of the flanges, most of the rubber facing is no longer in place (Figure #10). Pictures taken on-site clearly show that these portions adhered to the flange and were torn apart during disassembly (Figure #11). In the remaining portions on the gasket, and especially towards the bottom, the rubber has the same appearance of degradation as the rest of the facing.

More, at the bottom side of the gasket, including the compression area, the rubber facing can be easily peeled-off and broken (Figure #12). This is typical evidence of softening and embrittlement in rubbers, which made them easy to break by mere manipulation, a fact also confirmed at our laboratory. In these areas, another phenomenon associated with rubber degradation was noted: swelling (Figure #12). Finally, presence of heavy deposits of rust was observed on the bottom side of the exposed faces of the gasket. Heavy degradation of the phenolic body, in the form of embrittlement and fracture, was identified at the edges of some 4 holes (Figure #13).

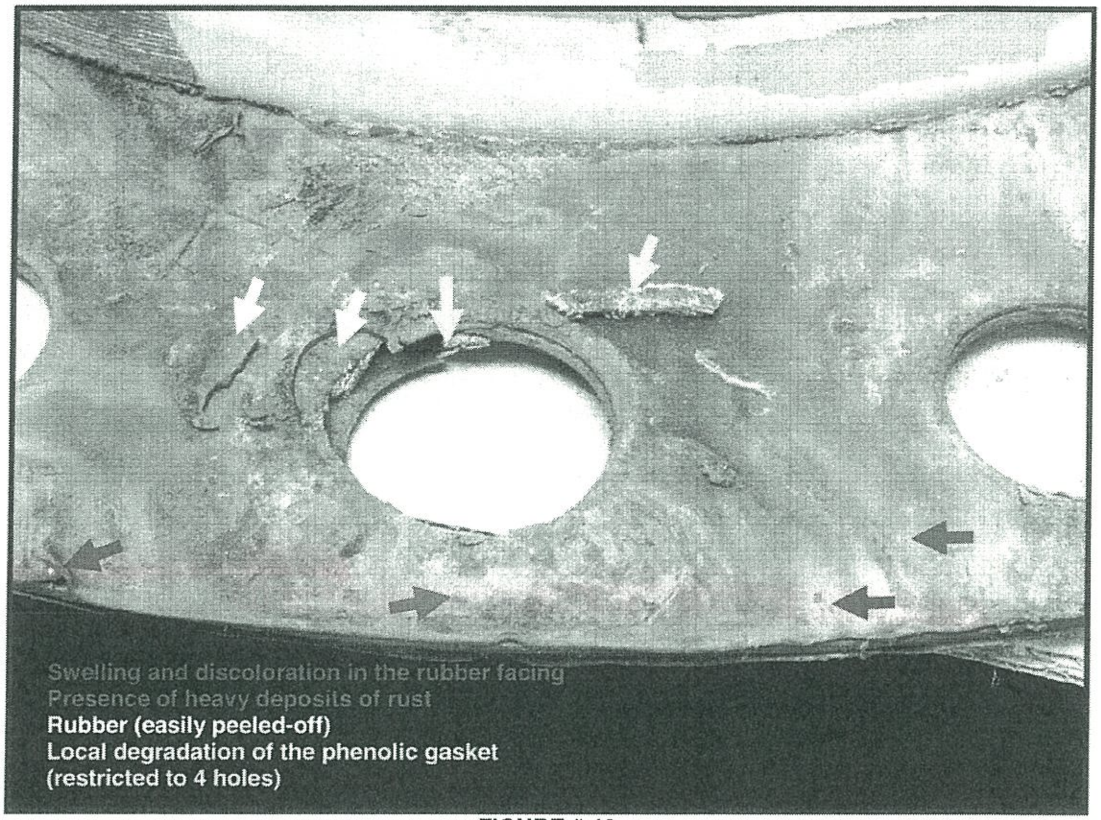


FIGURE # 12
Portions of rubber facing torn apart during dismantling.

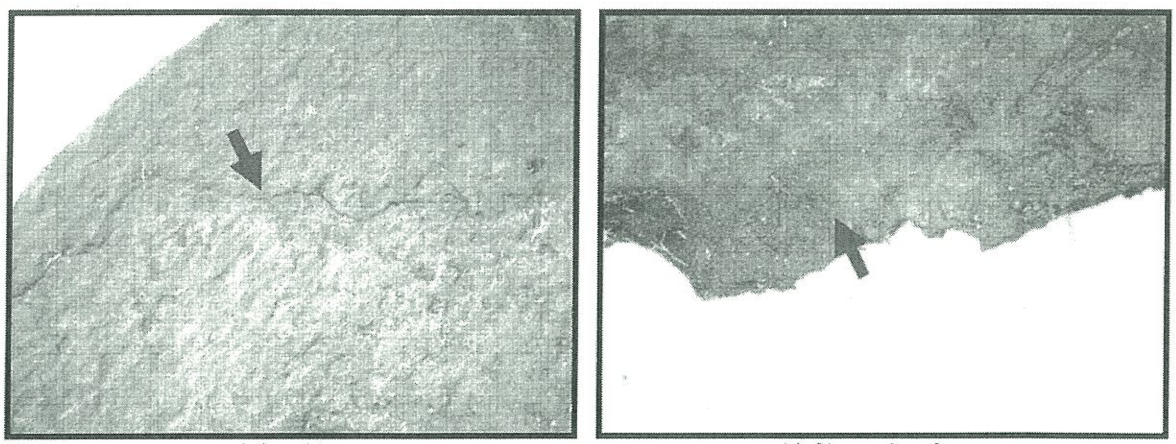
All indications previously described are significant at the bottom side of the gasket, i.e. the bottom side of the flange connection, and in the remaining of the compression area. In the upper side, the rubber facing degradation is less intense (Figure #10). More, in this area, no swelling was revealed although near the edges the rubber can be easily torn. Some yellowish deposits were present at the holes' edges (Figure #10).

Overall, the particular location of the most degraded area, that is, at the bottom side of the flange connection, is consistent with the presence of corrosion in progress in metallic parts (faces of flanges), which suggests that these two phenomena are related. This hypothesis will be verified during further analysis.

3.2 Low-Magnification Examination

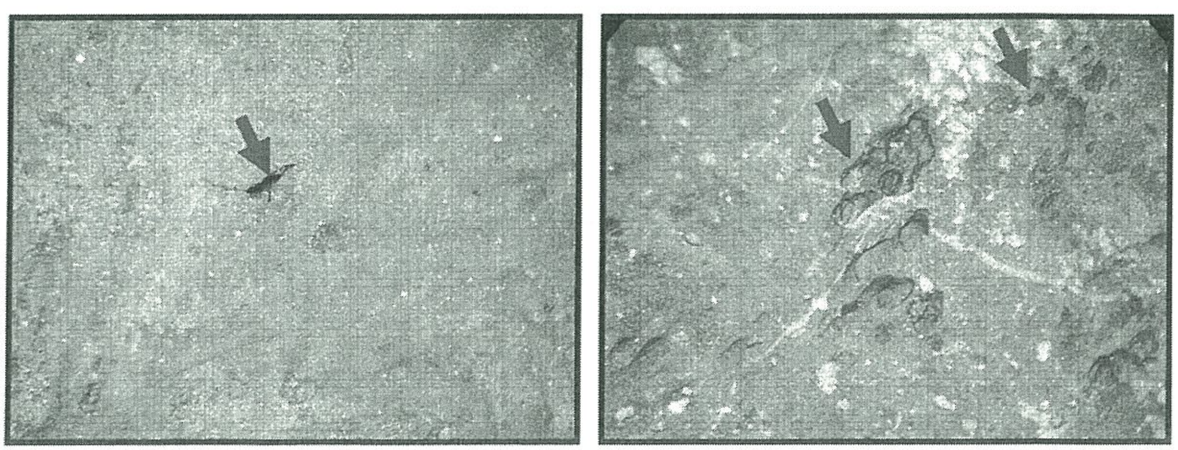
Low-magnification examination was conducted on sections of rubber facing detached from the bottom side of the gasket, and from the compression area between the raised faces of the flanges, to assess the degradation at microscale. At about 63 X magnification, it was found that the rubber surface presents charring, cracking, perforations and indentations. All these features, equally present the compression area, are illustrated in Figures #13 and #14.

Besides these typical signs of deterioration, almost all rubber surfaces at the bottom area are covered in rust deposits adherent to the surface. Some white shiny particles were also noted, at the rubber surface, although their exact nature cannot be established.



a) Cracking. b) Charred surface.

FIGURES # 13
Close-up views of the rubber surface in the bottom area of the gasket, in the compression area between the raised faces of the flanges (63X).



a) Perforation. a) Indentations.

FIGURES # 14
Close-up views of the rubber surface in the bottom area of the gasket, in the compression area between the raised faces of the flanges (63X).

3.3 Scanning Electron Microscopy (SEM)

Usually, an EDX (Electron Dispersion X-Ray Spectrometry) analysis that uses SEM techniques is performed in order to evaluate the presence of chemical elements in the degraded areas and in deposits coming from the bottom area of the gasket and from its compression face. This type of analysis provides a rather qualitative assessment of different compounds on a specified and very localized area. In the present case, the EDX analysis was conducted on deposits sampled in degraded areas of the rubber facing, in the bottom region. In this particular case, the EDX analysis aimed to determine whether chemical elements that could be considered aggressive for the rubber were present. Typical spectra of the analyzed deposits are presented in Figures #15 and #16. Presence of element gold (Au) must be disregarded as it was used to prepare the samples for analysis.

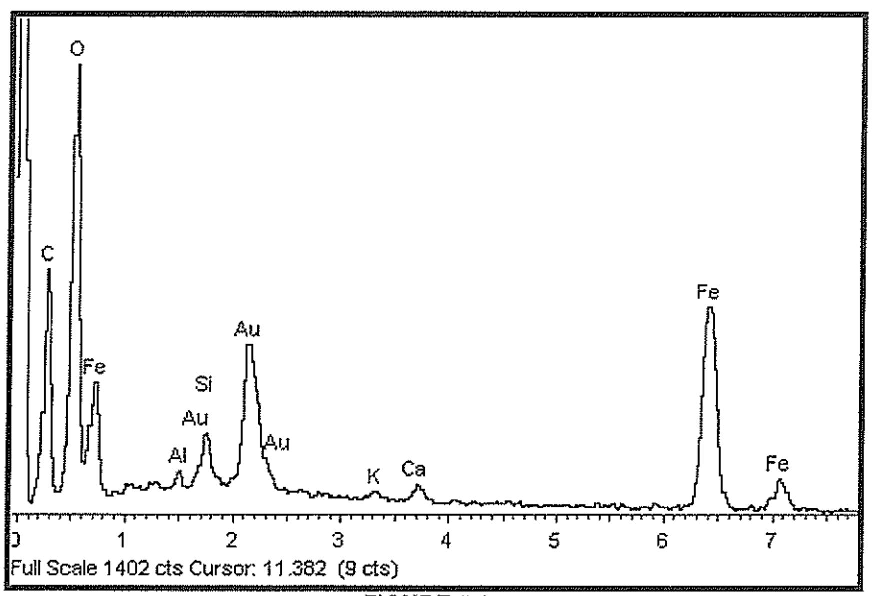


FIGURE # 15
EDX spectrum of the analyzed deposit.

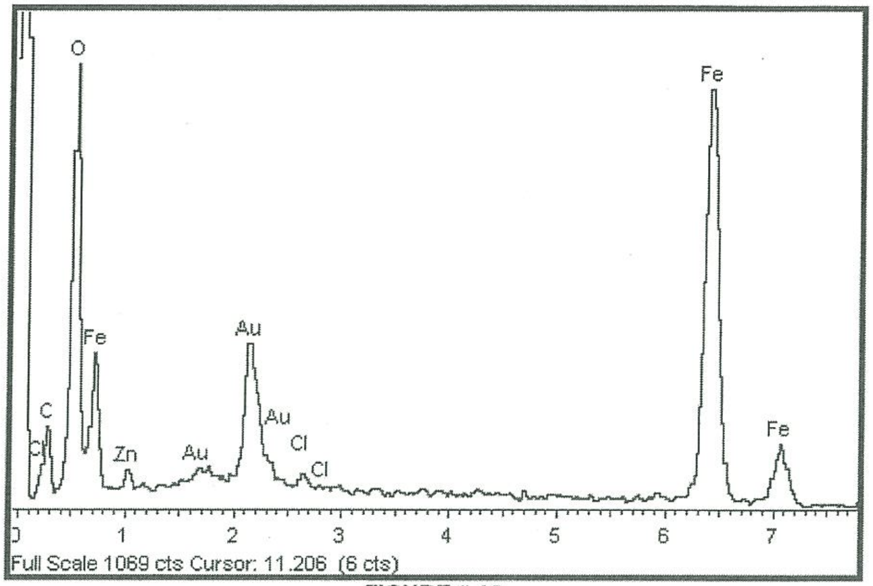


FIGURE # 16
EDX spectrum of the analyzed deposit.

As it can be observed on the EDX spectra, several chemical elements were found in the deposits present at the rubber facing surface. A significant amount of iron oxide was found, as well as carbon, calcium, potassium, zinc, and chlorine. Carbon and oxygen could come from the rubber degradation and from the gasoline transported by the piping system. Silicon could come from the sand and the earth nearby. Iron oxide, most likely in the form of rust, is a by-product of the corrosion process in the metallic parts. Zn could come from galvanizing in the metallic parts and could at the origin of the white particles previously noted at the rubber surface. Calcium, potassium and chlorine could be in form of salts and could be at the origin of the corrosion process in the metallic parts. Combined with water from condensation or from atmospheric humidity, these elements could form acids, such as HCl that can, at length, promote rubber degradation.

3.4 FTIR and DSC Analyses

Fourier Transform Infrared (FTIR) spectroscopy is an analysis that provides information about the chemical bonding or molecular structure of materials, whether organic or inorganic. The technique works on the fact that bonds and groups of bonds vibrate at characteristic frequencies. As such, a molecule exposed to infrared rays absorbs infrared energy at frequencies which are characteristic to that molecule.

Differential scanning calorimetry or DSC is a thermoanalytical technique in which the difference in the amount of heat required to increase the temperature of a sample and reference is measured as a function of temperature.

In the present case, FTIR and DSC analysis attempted to determine the type of polymer used for facing the gasket and thus to validate that this material is indeed neoprene. It was found that the said polymer is indeed of the elastomer type, but it is not a match for neoprene. The closest elastomer found in the machine library was shoe-rubber, but once again not a 100% match. This situation can be explained by three probable causes: (1) the degree of degradation and contamination in the polymer is too advanced and as such, the results are biased, (2) considering its age, the polymer could not be found in the machines' libraries, and (3) the polymer is closer to shoe rubber than to neoprene.

4.0 DISCUSSION/CONCLUSION

All findings of this investigation led to the conclusion that the most probable cause of the leak produced in the flange connection of the check valve is pronounced degradation of the rubber facing of the gasket used in the flange connection. Rubber facing degradation significantly diminished the sealing properties of the gasket. Most likely this degradation was the result of natural aging of the rubber accelerated or facilitated by the corrosion in progress in the adjacent metallic components, i.e. the flanges. It is our opinion that the cracking in the gasket phenolic body was entirely produced during valve removal and as such had no role in the gasket failure.

Corrosion in the flanges was the result of humidity and condensation phenomena inside the vault, undoubtedly promoted by the fact that the connection was no longer protected by the pipeline cathodic protection system. Chemical elements in the deposits found at the rubber surface could have combined with water from condensation and atmospheric humidity to form strong acids, harmful for both metal and rubber.

Our attempts to validate if the right elastomer was used, i.e. neoprene, were unsuccessful, as already explained. Any of the hypotheses formulated could be possible. The degradation and contamination itself could bias the results and as such, the data obtained are not matches for a known product. On the other hand, if the polymer is not a neoprene but a shoe-rubber, this could explain its low resistance to degradation. Finally, it can be possible that the polymer at hand is not available in the machine library, i.e. it was not a registered trade mark.

5.0 RECOMMANDATIONS

Regardless the true nature of the elastomer used for the gasket facing, it is obvious that the corrosion installed in the adjacent metallic parts played a role in its degradation. Corrosion was the direct result of the fact that the connection was now exposed to air in the vault and no longer protected by the pipeline cathodic protection system. It would be recommended that visual inspection be conducted on similar flange connections (installed in vaults) to determine if corrosion in progress is present in the metallic components. Inspection of gaskets, and particularly of their rubber facings, should be done in connections in which corrosion is detected. Gaskets in which rubber facing degradation is observed should be replaced to prevent the loss of sealing.

From: Luke Furmidge
Sent: Thursday, March 04, 2010 12:49 PM
To: PUTAWAY PUTAWAY
Subject: FW: Information Requested - TNPI flange Leak - Laval - Incident 2010-029
Attachments: Torque Procedures 2.pdf.DRF; Torque Procedures 1.pdf.DRF

-----Original Message-----
From: Chad Bunch
Sent: Tuesday, March 02, 2010 1:58 PM
To: Luke Furmidge
Subject: FW: Information Requested - TNPI flange Leak - Laval

For distribution.

Chad

19(1)
-----Original Message-----
From: [redacted] [mailto: [redacted] @tnpi.ca]
Sent: Tuesday, March 02, 2010 1:11 PM
To: Chad Bunch
Cc: [redacted] 19(1)
Subject: Information Requested - TNPI flange Leak - Laval

Chad, following up on your email request of Monday, March 1st, 3:34 p.m.:

As of Tuesday afternoon at 14:00 hrs we continue to drain down the segment of line downstream of the leak site in order to execute our investigation and repair. The leaking flange has not been broken yet.

Root Cause Determination

TNPI will make every effort to preserve the failed gasket in its entirety if possible. All components will be retained for examination by TNPI as to failure mechanism, and third party examination will be employed if necessary. Prior to disassembly, samples of any corrosion products will be taken from the subject flange and catalogued and retained for possible analysis.

Repair Plan

TNPI will fully remove the 16" check valve to allow inspection of all four flange faces. They will be cleaned, inspected and repaired as necessary before reassembly. The existing insulated flange kit on the upstream side of the valve will be replaced with a new 16" flexitallic gasket. New studs and nuts will be utilized in the reassembly and TNPI torquing procedures will be used to tighten the flanges. (The procedures are attached at the end of this note.)

TNPI has decided that the existing valve vault will be removed. This action is being taken primarily to gain access under the vault for the removal of contaminated soil and also to facilitate a safe work environment for personnel accessing the valve and flanges.

As a result of this decision, photographic record of the pre-disassembly conditions should also be facilitated. TNPI personnel will also take note of flange alignment and offset throughout the disassembly and assembly process.

In response to your question about the type, brand and model of the gasket, the gasket in place at the failed joint is a Maloney Flange Insulation ENDW with neoprene facing, 16", 600#, with polyethylene sleeves. It was purchased and installed in 1972 at the time of the installation of the 16" line. Its purpose as an insulated flange was to segment the line for cathodic protection.

While TNPI will respond with more detailed information in the future as per your request, I can give you the following information today:

1. No irregular operating characteristics have been identified from an initial review of our Line Control records during the period since our last vault inspection.
2. TNPI's normal inspection practice is to visit and inspect every vault location at a frequency of no greater than every 10 days.
3. The most recent vault inspection of the site in question was conducted 7 days prior to the identification of product in Ruisseau Lapiniere.
4. TNPI has reviewed the leak detection records for the period prior to the leak and no abnormalities have been identified.
5. TNPI's SCADA leak detection system is designed to detect any 13 m3 loss in a maximum 1-hour period. This incident is clearly below detection limits.
6. To be confirmed, but initial investigation suggests this flange has never been opened since original installation in 1972.

As I noted, further information and more detailed specifics will be forwarded to you within the prescribed 7-day period.

A copy of TNPI's torquing specification and procedure is attached to this file.

[redacted] **19(1)**

President & CEO
Trans-Northern Pipeline Inc.
Richmond Hill, Ontario.
L4B 3P6

[redacted] **19(1)**

11.5 Torquing Procedures

11.5.1 General: The objective of applying torque to nuts and bolt heads is to effect a seal along mating surfaces of flanges and closures. That is to say that the work of torque is transfered to a restraining pressure. Torque is defined as the twisting moment around a point created by the application a force on a moment arm at a given distance from the point. Therefore, torque can be changed by altering the applied force or the length of the arm.

In most of TNPI's applications, there are four critical components in the system:

1) nuts, 2) studs, 3) gaskets, 4) flanges.

There may be minor variations of the basic categories such as the nut and stud being replaced by a hex head bolt and flanges being replaced by a removable cover and fixed base (ie. filter vessels) and gaskets by O-rings. Regardless, the overlying principals are the same.

The seal is achieved by balancing out the competing interests of each of the components. Once the system is loosely assembled the process is as such:

a) As torque is applied to the nuts the nuts are forced by the thread to travel towards the joint to be sealed. This places the studs into tension.

b) The reactive force resulting from the bolt tension is the compressive force of the nut onto the flanges and in turn this is transmitted through to the gasket.

The competing interest mentioned above are the toque must be sufficient to effect enough compressive force to contain the systems internal pressure yet not exceed the tensile strength of the stud and its threads nor the compressive strength of the gasket nor the strength of the flanges (flange distortion is most likely to occur if initial line up is improper, ie. trying to pull flanges together across a large gap or uneven torquing). Given that the material properties are fixed for all the components the factor which is under our control is the torque applied.

The single most important factor in application of the correct torque is the lubrication of the threads. Surface irregularities will cause wide variations in the resultant stud tension for the same torque applied stud to stud. Lubrication is the only means of developing a consistent set of conditions for the nuts and studs. There is also the obvious benefit of ease of installation.

11.5.2 Procedure: a) Ensure all materials are available and of proper rating:
- flanges meet design pressure requirement (Figure 1 and Table 1, 2, and 3).

- studs and nuts are proper size and type for flanges (Table 1, 2, and 3). All studs shall be ASTM-A-193 Grade B7; all nuts shall be ASTM-A-194 Class 2H (Table 4).
  - gaskets are suitable for contained product, size, function (ie. insulating gaskets) (Table 5, 6, and 7).
  - appropriate lubricant
  - all materials are free from defect

  Spare consumable materials (ie. gaskets, nuts, and studs) should be included on materials estimates and on hand at the job site to allow for defective pieces and damage on site. A good rule of thumb is to allow for 5% above the minimum requirement. Joints which must be uncoupled after hydrostatic testing require duplicate gaskets.

b) Throughly clean threads, nut faces and flange where nut face bears. Use new washers if old washers are fouled with paint and dirt which can not be removed. If roughness or irregularity is present, dress it out to as near a perfect surface as possible.

c) Apply lubricant evenly to studs and nut threads. Torque Tables 8, 9, and 10 are based upon application of Threadease or equivalent spray type petroleum based lubricants.

d) Flange bolt holes should line up precisely. Gap between flange faces should be just enough to accommodate gasket. Flanges faces should be parallel. Piping design should take into account locations where line up is a chronic problem and allow for field fitting of components to avoid 'forcing' a fit. Inform the Supervisor and/or Project Co-ordinator if line up problems are anticipated or encountered.

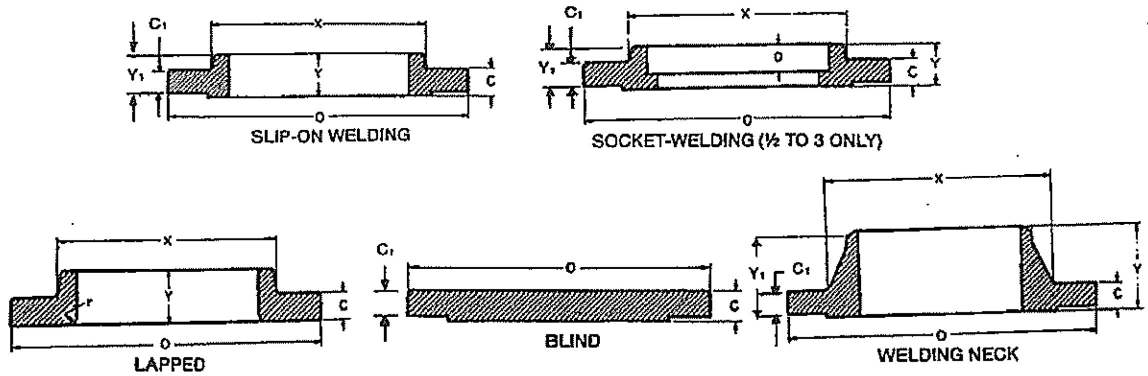
e) For horizontal piping runs, the bottom studs should be inserted first, then the gasket, then the remaining studs. This will allow the gasket to sit on the bottom studs to ensure gasket is centred. When disassembling flanges, the bottom bolts should be the last out. This will prevent the gasket from falling out and the flange can be quickly closed if required.

f) Tighten the nuts by hand in the order as shown in attached Figure 2. Begin the application of torque to the nuts in the same order. Avoid use of hammer wrenches if at all possible as it is impossible to control torque applied in this manner. Maximum specified torque should not be applied in one single pass. Flexitalic gaskets require no more than 30% of specified bolt stress be achieved on the initial set, the remainder on subsequent pass(es). 3L Filters recommend three passes of 60, 80 and 100% desired torque.

g) It is good practice to check the torque on connections within two weeks of installation. Steel has a property known as creep which will tend to deform the steel over time after the initial deformation due to an applied load.

ANSI B16.5 FLANGES

FIGURE 1



NOTES:

1. Dimensions in the following six tables are in inches.
2. For slip-on, socket-welded, and lapped flanges, the bore corresponds to the O.D. of B36.10 pipe plus a small tolerance.
3. For weld neck flanges, the bore will be determined by the I.D. of the pipe to be attached. The supplier should be consulted for availability.
4. Lengths of stud bolts do not include the height of the unthreaded points.

DIMENSIONS OF ANSI B16.5 CLASS 150 FLANGES AND FLANGE BOLTS

TABLE 1

Nominal Pipe Size	Outside Diameter of Flange	Thickness of Flange Min.	Diameter of Hub	Length Through Hub: Slip-on Socket Welding	Length Through Hub: Lapped	Length Through Hub: Welding Neck	Depth of Socket	Diameter of Bolt Circle	Diameter of Bolt Holes	Number & Diameter of Bolts	Length of Bolts: Stud Bolts: 0.06-In. Raised Face	Length of Bolts: Stud Bolts: Ring Joint	Length of Bolts: Machine Bolts: 0.06-In. Raised Face
	O	C	X	Y	Y	Y	D						
1/2	3.50	0.44	1.19	0.62	0.62	1.88	0.38	2.38	0.62	4 1/2	2.50	—	2.00
3/4	3.88	0.50	1.50	0.62	0.62	2.06	0.44	2.75	0.62	4 1/2	2.50	—	2.25
1	4.25	0.56	1.94	0.69	0.69	2.19	0.50	3.12	0.62	4 1/2	2.75	3.25	2.25
1 1/4	4.62	0.62	2.31	0.81	0.81	2.25	0.56	3.50	0.62	4 1/2	2.75	3.25	2.50
1 1/2	5.00	0.69	2.56	0.88	0.88	2.44	0.62	3.88	0.62	4 1/2	3.00	3.50	2.50
2	6.00	0.75	3.06	1.00	1.00	2.50	0.69	4.75	0.75	4 5/8	3.25	3.75	2.75
2 1/2	7.00	0.88	3.56	1.12	1.12	2.75	0.75	5.50	0.75	4 5/8	3.50	4.00	3.00
3	7.50	0.94	4.25	1.19	1.19	2.75	0.81	6.00	0.75	4 5/8	3.75	4.25	3.25
3 1/2	8.50	0.94	4.81	1.25	1.25	2.81	—	7.00	0.75	8 5/8	3.75	4.25	3.25
4	9.00	0.94	5.31	1.31	1.31	3.00	—	7.50	0.75	8 5/8	3.75	4.25	3.25
5	10.00	0.94	6.44	1.44	1.44	3.50	—	8.50	0.88	8 3/4	4.00	4.50	3.25
6	11.00	1.00	7.56	1.56	1.56	3.50	—	9.50	0.88	8 3/4	4.00	4.50	3.50
8	13.50	1.12	9.69	1.75	1.75	4.00	—	11.75	0.88	8 3/4	4.25	4.75	3.75
10	16.00	1.19	12.00	1.94	1.94	4.00	—	14.25	1.00	12 7/8	4.75	5.25	4.00
12	19.00	1.25	14.38	2.19	2.19	4.50	—	17.00	1.00	12 7/8	4.75	5.25	4.25
14	21.00	1.38	15.75	2.25	3.12	5.00	—	18.75	1.12	12 1	5.25	5.75	4.50
16	23.50	1.44	18.00	2.50	3.44	5.00	—	21.25	1.12	16 1	5.50	6.00	4.75
18	25.00	1.56	19.88	2.69	3.81	5.50	—	22.75	1.25	16 1 1/8	6.00	6.50	5.00
20	27.50	1.69	22.00	2.88	4.06	5.69	—	25.00	1.25	20 1 1/8	6.25	6.75	5.50
24	32.00	1.88	26.12	3.25	4.38	6.00	—	29.50	1.38	20 1 1/4	7.00	7.50	6.00

DIMENSIONS OF ANSI B16.5 CLASS 300 FLANGES AND FLANGE BOLTS

TABLE 2

Nominal Pipe Size	Outside Diameter of Flange	Thickness of Flange Min.	Diameter of Hub	Length Through Hub: Slip-on Socket Welding	Length Through Hub: Lapped	Length Through Hub: Welding Neck	Depth of Socket	Diameter of Bolt Circle	Diameter of Bolt Holes	Number & Diameter of Bolts	Length of Bolts: Stud Bolts: 0.06-In. Raised Face	Length of Bolts: Stud Bolts: Ring Joint	Length of Bolts: Machine Bolts: 0.06-In. Raised Face
	O	C	X	Y	Y	Y	D						
1/2	3.75	0.56	1.50	0.88	0.88	2.06	0.38	2.62	0.62	4 1/2	2.75	3.00	2.25
3/4	4.62	0.62	1.88	1.00	1.00	2.25	0.44	3.25	0.75	4 5/8	3.00	3.50	2.50
1	4.88	0.69	2.12	1.06	1.06	2.44	0.50	3.50	0.75	4 5/8	3.25	3.75	2.75
1 1/4	5.25	0.75	2.50	1.06	1.06	2.56	0.56	3.88	0.75	4 5/8	3.25	3.75	2.75
1 1/2	6.12	0.81	2.75	1.19	1.19	2.69	0.62	4.50	0.88	4 3/4	3.75	4.25	3.00
2	6.50	0.88	3.31	1.31	1.31	2.75	0.69	5.00	0.75	8 5/8	3.50	4.25	3.00
2 1/2	7.50	1.00	3.94	1.50	1.50	3.00	0.75	5.88	0.88	8 3/4	4.00	4.75	3.50
3	8.25	1.12	4.62	1.69	1.69	3.12	0.81	6.62	0.88	8 3/4	4.25	5.00	3.75
3 1/2	9.00	1.19	5.25	1.75	1.75	3.19	—	7.25	0.88	8 3/4	4.50	5.25	3.75
4	10.00	1.25	5.75	1.88	1.88	3.38	—	7.88	0.88	8 3/4	4.50	5.25	4.00
5	11.00	1.38	7.00	2.00	2.00	3.88	—	9.25	0.88	8 3/4	4.75	5.50	4.25
6	12.50	1.44	8.12	2.06	2.06	3.88	—	10.62	0.88	12 3/4	5.00	5.75	4.25
8	15.00	1.62	10.25	2.44	2.44	4.38	—	13.00	1.00	12 7/8	5.50	6.25	4.75
10	17.50	1.88	12.62	2.62	3.75	4.62	—	15.25	1.12	16 1	6.25	7.00	5.50
12	20.50	2.00	14.75	2.88	4.00	5.12	—	17.75	1.25	16 1 1/8	6.75	7.50	6.00
14	23.00	2.12	16.75	3.00	4.38	5.62	—	20.25	1.25	20 1 1/8	7.00	7.75	6.25
16	25.50	2.25	19.00	3.25	4.75	5.75	—	22.50	1.38	20 1 1/4	7.50	8.25	6.50
18	28.00	2.38	21.00	3.50	5.12	6.25	—	24.75	1.38	24 1 1/4	7.75	8.50	6.75
20	30.50	2.50	23.12	3.75	5.50	6.38	—	27.00	1.38	24 1 1/4	8.25	9.00	7.25
24	36.00	2.75	27.62	4.19	6.00	6.62	—	32.00	1.62	24 1 1/2	9.25	10.25	8.00

DIMENSIONS OF ANSI B16.5 CLASS 600 FLANGES AND FLANGE BOLTS

TABLE 3

Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange, Min. C_1	Diameter of Hub X	Length Through Hub: Slip-on Socket Welding Y_1	Length Through Hub: Lapped Y_1	Length Through Hub: Welding Neck Y_1	Depth of Socket D	Diameter of Bolt Circle	Diameter of Bolt Holes	Number & Diameter of Bolts	Length of Stud Bolts: 0.25 In. Raised Face	Length of Stud Bolts: Male & Female also Tongue & Groove	Length of Stud Bolts: Ring Joint
1/2	3.75	0.56	1.50	0.88	0.88	2.06	0.38	2.62	0.62	4 1/2	3.25	3.00	3.00
3/4	4.62	0.62	1.88	1.00	1.00	2.25	0.44	3.25	0.75	4 5/8	3.50	3.25	3.50
1	4.88	0.69	2.12	1.06	1.06	2.44	0.50	3.50	0.75	4 5/8	3.75	3.50	3.75
1 1/4	5.25	0.81	2.50	1.12	1.12	2.62	0.56	3.88	0.75	4 5/8	4.00	3.75	4.00
1 1/2	6.12	0.88	2.75	1.25	1.25	2.75	0.62	4.50	0.88	4 3/4	4.25	4.00	4.25
2	6.50	1.00	3.31	1.44	1.44	2.88	0.69	5.00	0.75	8 5/8	4.25	4.00	4.50
2 1/2	7.50	1.12	3.94	1.62	1.62	3.12	0.75	5.88	0.88	8 3/4	4.75	4.50	5.00
3	8.25	1.25	4.62	1.81	1.81	3.25	0.81	6.62	0.88	8 3/4	5.00	4.75	5.25
3 1/2	9.00	1.38	5.25	1.94	1.94	3.38	—	7.25	1.00	8 7/8	5.50	5.25	5.75
4	10.75	1.50	6.00	2.12	2.12	4.00	—	8.50	1.00	8 7/8	5.75	5.50	6.00
5	13.00	1.75	7.44	2.38	2.38	4.50	—	10.50	1.12	8 1	6.50	6.25	6.75
6	14.00	1.88	8.75	2.62	2.62	4.62	—	11.50	1.12	12 1	6.75	6.50	7.00
8	16.50	2.19	10.75	3.00	3.00	5.25	—	13.75	1.25	12 1 1/8	7.75	7.50	7.75
10	20.00	2.50	13.50	3.38	4.38	6.00	—	17.00	1.38	16 1 1/4	8.50	8.25	8.75
12	22.00	2.62	15.75	3.62	4.62	6.12	—	19.25	1.38	20 1 1/4	8.75	8.50	9.00
14	23.75	2.75	17.00	3.69	5.00	6.50	—	20.75	1.50	20 1 3/8	9.25	9.00	9.50
16	27.00	3.00	19.50	4.19	5.50	7.00	—	23.75	1.62	20 1 1/2	10.00	9.75	10.25
18	29.25	3.25	21.50	4.62	6.00	7.25	—	25.75	1.75	20 1 5/8	10.75	10.50	11.00
20	32.00	3.50	24.00	5.00	6.50	7.50	—	28.50	1.75	24 1 5/8	11.50	11.25	11.75
24	37.00	4.00	28.25	5.50	7.25	8.00	—	33.00	2.00	24 1 7/8	13.00	12.75	13.25

GASKET DIMENSIONS FOR ANSI B16.5 Class 150

Flanges and Flanged Fittings

TABLE 5

Nominal Pipe Size*	Gasket I.D.	Flat Ring O.D.	Full Face Gasket O.D.	Full Face Gasket No. of Holes	Full Face Gasket Hole Diameter	Full Face Gasket Bolt Circle Diameter	Large Male and Female O.D.	Large Tongue and Groove I.D.	Large Tongue and Groove O.D.
½	0.84	1.88	3.50	4	0.62	2.38	1.38	1.00	1.38
¾	1.06	2.25	3.88	4	0.62	2.76	1.69	1.31	1.69
1	1.31	2.62	4.25	4	0.62	3.12	2.00	1.50	2.00
1¼	1.66	3.00	4.63	4	0.62	3.50	2.50	1.88	2.50
1½	1.91	3.38	5.00	4	0.62	3.88	2.88	2.12	2.88
2	2.38	4.12	6.00	4	0.75	4.75	3.62	2.88	3.62
2½	2.88	4.88	7.00	4	0.75	5.50	4.12	3.38	4.12
3	3.50	5.38	7.50	4	0.75	6.00	5.00	4.25	5.00
3½	4.00	6.38	8.50	8	0.75	7.00	5.50	4.75	5.50
4	4.50	6.88	9.00	8	0.75	7.50	6.19	5.19	6.19
5	5.56	7.75	10.00	8	0.88	8.50	7.31	6.31	7.31
6	6.62	8.75	11.00	8	0.88	9.50	8.50	7.50	8.50
8	8.62	11.00	13.50	8	0.88	11.75	10.62	9.33	10.62
10	10.75	13.38	16.00	12	1.00	14.25	12.75	11.25	12.75
12	12.75	16.13	19.00	12	1.00	17.00	15.00	13.50	15.00
14	14.00	17.75	21.00	12	1.12	18.75	16.25	14.75	16.25
16	16.00	20.25	23.50	16	1.12	21.25	18.50	16.75	18.50
18	18.00	21.62	25.00	16	1.25	22.75	21.00	19.25	21.00
20	20.00	23.88	27.50	20	1.25	26.00	23.00	21.00	23.00
24	24.00	28.25	32.00	20	1.38	29.50	27.25	25.25	27.25

Dimensions are in inches

GASKET DIMENSIONS FOR ANSI B16.5 CLASS 300

Flanges and Flanged Fittings

TABLE 6

Nominal Pipe Size	Gasket I.D.	Flat Ring O.D.	Large Male and Female O.D.	Large Tongue and Groove I.D.	Large Tongue and Groove O.D.
½	0.84	2.12	1.38	1.00	1.38
¾	1.06	2.62	1.69	1.31	1.69
1	1.31	2.88	2.00	1.50	2.00
1¼	1.66	3.25	2.50	1.88	2.50
1½	1.91	3.75	2.88	2.12	2.88
2	2.38	4.38	3.62	2.88	3.62
2½	2.88	5.12	4.12	3.38	4.12
3	3.50	5.88	5.00	4.25	5.00
3½	4.00	6.50	5.50	4.75	5.50
4	4.50	7.12	6.19	5.19	6.19
5	5.56	8.50	7.31	6.31	7.31
6	6.62	9.88	8.50	7.50	8.50
8	8.62	12.12	10.62	9.38	10.62
10	10.76	14.25	12.75	11.25	12.75
12	12.75	16.62	15.00	13.50	15.00
14	14.00	19.12	16.25	14.75	16.25
16	16.00	21.25	18.50	16.75	18.50
18	18.00	23.50	21.00	19.25	21.00
20	20.00	25.75	23.00	21.00	23.00
24	24.00	30.50	27.25	25.25	27.25

Dimensions are in inches

TABLE 4

1/2

Mechanical Requirements

Grade	Diameter, in. [mm]	Minimum Tempering Temperature, °F [°C]	Tensile Strength, min, ksi [MPa]	Yield Strength, min, 0.2 % offset, ksi [MPa]	Elongation in 4 D, min, %	Reduction of Area, min, %	Hardness, max
Ferritic Steels							
B5 4 to 6 % chromium	up to 4 [100], incl	1100 [593]	100 [690]	80 [550]	16	50	...
B6 13 % chromium	up to 4 [100], incl	1100 [593]	110 [760]	85 [585]	15	50	...
B6X 13 % chromium	up to 4 [100], incl	1100 [593]	90 [620]	70 [485]	16	50	26 HRC
B7 Chromium-molybdenum	2½ [65] and under	1100 [593]	125 [860]	105 [720]	16	50	...
	over 2½ to 4 [65 to 100]	1100 [593]	115 [795]	95 [655]	16	50	...
	over 4 to 7 [100 to 180]	1100 [593]	100 [690]	75 [515]	18	50	...
B7M[A] Chromium-molybdenum	2½ [65] and under	1150 [620]	100 [690]	80 [550]	18	50	235 HB or 99 HRB
	4 [101.6] and under	1150 [620]	100 [690]	80 [550]	18	50	235 BHN or 99 R/B
	over 4 to 7 [101.6 to 117.8]	1150 [620]	100 [690]	75 [515]	18	50	235 BHN or 99 R/B
B16 Chromium-molybdenum-vanadium	2½ [65] and under	1200 [650]	125 [860]	105 [725]	18	50	...
	over 2½ to 4 [65 to 100]	1200 [650]	110 [760]	95 [655]	17	45	...
	over 4 to 7 [100 to 180]	1200 [650]	100 [690]	85 [585]	16	45	...

Class and Grade, Diameter, in. [mm]	Heat Treatment[B]	Tensile Strength, min, ksi [MPa]	Yield Strength, min, 0.2 % offset, ksi [MPa]	Elongation in 4 D, min, %	Reduction of Area, min %	Hardness, max
Austenitic Steels						
Classes 1 and 1D: B8, B8C, B8M, B8P, B8T, B8LN, B8MLN, all diameters	carbide solution treated	75 [515]	30 [205]	30	50	223 HB[C] or 96 HRB
Class 1A: B8A, B8CA, B8MA, B8PA, B8TA, B8LNA, B8MLNA, B8NA, B8MNA, all diameters	carbide solution treated in the finished condition	75 [515]	30 [205]	30	50	192 HB or 90 HRB
Classes 1B and 1D: B8N, B8MN, and B8MLCuN all diameters	carbide solution treated	80 [550]	35 [240]	30	40	223 HB[C] or 96 HRB
Classes 1C and 1D: B8R, all diameters	carbide solution treated	100 [690]	55 [380]	35	55	271 HB or 28 HRC
B8RA, all diameters	carbide solution treated in the finished condition	100 [690]	55 [380]	35	55	271 HB or 28 HRC
B8S, all diameters	carbide solution treated	95 [655]	50 [345]	35	55	271 HB or 28 HRC
B8SA, all diameters	carbide solution treated in the finished condition	95 [655]	50 [345]	35	55	271 HB or 28 HRC
Class 2: B8, B8C, B8P, B8T, B8N, and B8MLCuN, ¾ [20] and under	carbide solution treated and strain hardened	125 [860]	100 [690]	12	35	321 HB or 35 HRC
over ¾ to 1, [20 to 25] incl		115 [795]	80 [550]	15	35	321 HB or 35 HRC
over 1 to 1¼ [25.4 to 31.6] incl		105 [725]	65 [450]	20	35	321 HB or 35 HRC
over 1¼ to 1½ [32 to 40] incl		100 [690]	50 [345]	28	45	321 HB or 35 HRC
Class 2: B8M, B8MN, B8MLCuN[D] ¾ [19.05] and under	carbide solution treated and strain hardened	110 [760]	95 [665]	15	45	321 HB or 35 HRC
over ¾ to 1 [19.05 to 25.4] incl		100 [690]	80 [550]	20	45	321 HB or 35 HRC
over 1 to 1¼ [25.4 to 31.6] incl		95 [655]	65 [450]	25	45	321 HB or 35 HRC
over 1¼ to 1½ [31.6 to 37.9] incl		90 [620]	50 [345]	30	45	321 HB or 35 HRC

(Continued)

TABLE 4

2/2

Hardness Requirements

Grade and Type	Completed Nuts			Sample Nut after Treatment as in 7.1.5.2	
	Brinell Hardness	Rockwell Hardness		Brinell Hardness, min	Rockwell Hardness B Scale, min
		C Scale	B Scale		
1	121 min	...	70 min	121	70
2	159 to 352	...	84 min	159	84
2H	248 to 352	24 to 38	...	179	89
To 1½ in. [38.1 mm], incl	248 to 352	24 to 38	...	179	89
Over 1½ in. [38.1 mm]	212 to 352	38 max	95 min	147	79
2HM and 7M	159 to 237	22 max	...	159	84
3, 4, and 7	248 to 352	24 to 38	...	201	94
6 and 6F	228 to 271	20 to 28	...	...	...
8, 8C, 8M, 8T, 8F, 8P, 8N,	126 to 300	...	60 to 105	...	...
8MN, 8LN, 8MLN, and 8MLCuN	126 to 300	...	60 to 105	...	...
8A, 8CA, 8MA, 8TA,	126 to 192	...	60 to 90	...	...
8FA, 8PA, 8NA, 8MNA,	126 to 192	...	60 to 90	...	...
8LNA, 8MLNA, and 8MLCuNa	126 to 192	...	60 to 90	...	...
8R, 8RA, 8S, and 8SA	183 to 271	B 88 to C 25	...	...	...

Proof Load Using Threaded Mandrel

Note—Proof loads are not design loads.

Nominal Size, in. [mm]	Threads per Inch [25.4 mm]	Stress Area, in.², [mm²]	Proof Load, lbf [kN][A]					
			Grade 1		Grades 2, 2HM, 6 6F, 7M		Grades 2H, 3, 4, 7	
			Heavy Hex[B]	Hex[C]	Heavy Hex[D]	Hex[E]	Heavy Hex[F]	Hex[G]
¼ [6.4]	20	0.0316 [20.4]	4 130 [18.4]	3 820 [17.0]	4 770 [21.2]	4 300 [19.1]	5 570 [24.8]	4 770 [21.2]
5/16 [7.9]	18	0.0524 [33.8]	6 810 [30.3]	6 290 [28.0]	7 860 [35.0]	7 070 [31.4]	9 170 [40.8]	7 860 [35.0]
⅜ [9.5]	16	0.0774 [49.9]	10 080 [44.8]	9 300 [41.4]	11 620 [51.7]	10 460 [46.5]	13 560 [60.3]	11 620 [51.7]
7/16 [11.1]	14	0.1063 [68.6]	13 820 [61.5]	12 760 [56.8]	15 940 [70.9]	14 350 [63.8]	18 600 [82.7]	15 940 [70.9]
½ [12.7]	13	0.1419 [91.5]	18 450 [82.1]	17 030 [75.8]	21 280 [94.6]	19 160 [85.2]	24 830 [110]	21 280 [94.6]
9/16 [14.2]	12	0.182 [117]	23 660 [105]	21 840 [97.1]	27 300 [121]	24 570 [109]	31 850 [142]	27 300 [121]
⅝ [15.9]	11	0.226 [146]	29 380 [131]	27 120 [121]	33 900 [151]	30 510 [136]	39 550 [176]	33 900 [151]
¾ [19]	10	0.334 [215]	43 420 [193]	40 080 [178]	50 100 [223]	45 090 [200]	58 450 [260]	50 100 [223]
⅞ [22.2]	9	0.462 [298]	60 060 [267]	55 440 [247]	69 300 [308]	62 370 [277]	80 850 [360]	69 300 [308]
1 [25.4]	8	0.606 [391]	78 780 [350]	72 720 [323]	90 900 [404]	81 810 [364]	106 000 [472]	90 900 [404]
1⅛ [28.6]	8	0.790 [510]	102 700 [457]	94 800 [422]	118 500 [527]	106 700 [475]	138 200 [615]	118 500 [527]
1¼ [31.8]	8	1.000 [645]	130 000 [578]	120 000 [534]	150 000 [667]	135 000 [600]	175 000 [778]	150 000 [667]
1⅜ [34.9]	8	1.233 [795]	160 200 [713]	148 000 [658]	185 000 [823]	166 500 [741]	215 800 [960]	185 000 [823]
1½ [38.1]	8	1.492 [962]	194 000 [863]	170 040 [756]	223 800 [996]	201 400 [896]	261 100 [1161]	223 800 [996]

Nominal Size, in. [mm]	Threads per Inch [25.4 mm]	Stress Area, in.², [mm²]	All Types of Grade 8		Grade 8M (Strain-Hardened)		All Other Types of Grade 8 (Strain-Hardened)	
			Heavy Hex[H]	Hex[I]	Heavy Hex[J]	Hex[K]	Heavy Hex[L]	Hex[J]
¼ [6.4]	20	0.0316 [20.4]	2 540 [11.3]	2 380 [10.6]	3 480 [15.5]	3 160 [14.0]	3 950 [17.6]	3 480 [15.5]
5/16 [7.9]	18	0.0524 [33.8]	4 190 [18.6]	3 930 [17.5]	5 760 [25.6]	5 240 [23.3]	6 550 [29.1]	5 760 [25.6]
⅜ [9.5]	16	0.0774 [49.9]	6 200 [27.6]	5 810 [25.8]	8 510 [37.8]	7 740 [34.4]	9 675 [43.0]	8 510 [37.8]
7/16 [11.1]	14	0.1063 [68.6]	8 500 [37.8]	7 970 [35.4]	11 690 [52.0]	10 630 [47.3]	13 290 [59.1]	11 690 [52.0]
½ [12.7]	13	0.1419 [91.5]	11 350 [50.5]	10 640 [49.8]	15 610 [69.4]	14 190 [63.1]	17 740 [78.9]	15 610 [69.4]
9/16 [14.2]	12	0.182 [117]	14 560 [64.8]	13 650 [60.7]	20 020 [89.0]	18 200 [80.9]	22 750 [101]	20 020 [89.0]
⅝ [15.9]	11	0.226 [146]	18 080 [80.4]	16 950 [75.4]	24 860 [110]	22 600 [100]	28 250 [126]	24 860 [110]
¾ [19]	10	0.334 [215]	26 720 [119]	25 050 [111]	36 740 [163]	33 400 [148]	41 750 [186]	36 740 [163]
⅞ [22.2]	9	0.462 [298]	36 960 [164]	34 650 [154]	46 200 [206]	41 580 [185]	53 130 [236]	46 200 [206]
1 [25.4]	8	0.606 [391]	48 480 [216]	45 450 [202]	60 600 [270]	54 540 [243]	69 690 [310]	60 600 [270]
1⅛ [28.6]	8	0.790 [510]	63 200 [281]	59 250 [264]	75 050 [334]	67 150 [299]	82 950 [369]	75 050 [334]
1¼ [31.8]	8	1.000 [645]	80 000 [356]	75 000 [334]	95 000 [422]	85 000 [378]	105 000 [467]	95 000 [422]
1⅜ [34.9]	8	1.233 [795]	98 640 [439]	92 450 [411]	110 970 [494]	98 640 [439]	123 300 [548]	110 970 [494]
1½ [38.1]	8	1.492 [962]	119 360 [531]	111 900 [498]	134 280 [597]	119 360 [531]	149 200 [664]	134 280 [597]

[A] See limit for proof load test in 7.2.2.1. The proof load for jam nuts shall be 46 % of the tabulated load.
[B] Based on proof stress of 130 000 psi [895 MPa].
[C] Based on proof stress of 120 000 psi [825 MPa].
[D] Based on proof stress of 150 000 psi [1035 MPa].
[E] Based on proof stress of 135 000 psi [930 MPa].
[F] Based on proof stress of 175 000 psi [1205 MPa].
[G] Based on proof stress of 150 000 psi [1035 MPa].
[H] Based on proof stress of 80 000 psi [550 MPa].
[I] Based on proof stress of 75 000 psi [515 MPa].
[J] Based on proof stress of 110 000 psi [760 MPa] up to ¾ in. [19 mm]; 100 000 psi [690 MPa] ⅞ to 1 in. [22.2 to 25.4 mm]; 95 000 psi [655 MPa] 1⅛ to 1¼ in. [28 to 31.8 mm]; 90 000 psi [620 MPa] 1⅜ to 1½ in. [34.9 to 38.1 mm].
[K] Based on proof stress of 100 000 psi [690 MPa] up to ¾ in. [19 mm]; 90 000 psi [620 MPa] ⅞ to 1 in. [22.2 to 25.4 mm]; 85 000 psi [585 MPa] 1⅛ to 1¼ in. [28 to 31.8 mm]; 80 000 psi [550 MPa] 1⅜ to 1½ in. [34.9 to 38.1 mm].
[L] Based on proof stress of 125 000 psi [860 MPa] up to ¾ in. [19 mm]; 115 000 psi [795 MPa] ⅞ to 1 in. [22.2 to 25.4 mm]; 105 000 psi [725 MPa] 1⅛ to 1¼ i [28.6 to 31.8 mm]; 100 000 psi [690 MPa] 1⅜ to 1½ in. [34.9 to 38.1 mm].

GASKET DIMENSIONS FOR ANSI B16.5 CLASS 600

Flanges and Flanged Fittings

TABLE 7

Nominal Pipe Size	Gasket I.D.	Flat Ring O.D.	Large Male and Female O.D.	Large Tongue and Groove	
				I.D.	O.D.
½	0.84	2.12	1.38	1.00	1.38
¾	1.06	2.62	1.69	1.31	1.69
1	1.31	2.88	2.00	1.50	2.00
1¼	1.66	3.25	2.50	1.88	2.50
1½	1.91	3.75	2.88	2.12	2.88
2	2.38	4.38	3.62	2.88	3.62
2½	2.88	5.12	4.12	3.38	4.12
3	3.50	5.88	5.00	4.25	5.00
3½	4.00	6.38	5.50	4.75	5.50
4	4.50	7.62	6.19	5.19	6.19
5	5.56	9.50	7.31	6.31	7.31
6	6.62	10.50	8.50	7.50	8.50
8	8.62	12.62	10.62	9.38	10.62
10	10.75	15.75	12.75	11.25	12.75
12	12.75	18.00	15.00	13.50	15.00
14	14.00	19.38	16.25	14.75	16.25
16	16.00	22.25	18.50	16.75	18.50
18	18.00	24.12	21.00	19.25	21.00
20	20.00	26.88	23.00	21.00	23.00
24	24.00	31.12	27.25	25.25	27.25

Dimensions are in inches

TABLE 8

Recommended Torquing Limits and Resultant Compressive Force on Insulated Gaskets

150 Series ANSI Flanges

Flange Size	Stud Diameter	No. of Studs	Raised Face Surface Area	Recommended Torque (2)	Compressive/ Stud	Resultant Compressive Force on Gasket
2" Ø	5/8"	4	6.94 in^2	90 ft.lbs.	9090 psi	5239 psi
4" Ø	5/8"	8	17.25 in^2	90	9090	4216
6" Ø	3/4"	8	27.76 in^2	150	13590	3916
8" Ø	3/4"	8	38.61 in^2	150	13590	2816
10" Ø	7/8"	12	48.92 in^2	240	18855	4625
12" Ø	7/8"	12	63.62 in^2	240	18855	3556
16" Ø	1"	16	86.02 in^2	368	24795	4612

Notes:

1) Based on 150 ANSI Flange Series.
2) Based on applied stress of 50% yield strength of Alloy Steel Stud Bolts (90,000 SMYS).
3) Indicated Torque assumes that a lubricant is applied to the threads and the nut face.

GCR/83-07-08

TABLE 9

300 Series ANSI Flanges

Recommended Torquing Limits and Resultant Compressive Force on Insulated Gaskets

Flange Size	Stud Diameter	No. of Studs	Raised Face Surface Area	Recommended Torque (2)	Compression/ Stud	Resultant Compressive Force on Gasket
2" Ø	5/8"	8	6.91 in^2	90 ft.lbs.	9090 psi	10524 psi
4" Ø	3/4"	8	17.28 in^2	150	13590	6292
6" Ø	3/4"	12	27.81 in^2	150	13590	5864
8" Ø	7/8"	12	38.61 in^2	240	18855	5860
10" Ø	1"	16	48.82 in^2	368	24795	8126
12" Ø	1/2 ;"	16	63.62 in^2	533	32760	8239
16" Ø	1 1/4"	20	86.03 in^2	750	41805	9719

Notes:

1) Based on 300 ANSI Falnge Series.
2) Based on applied stress of 50% yield strength on Alloy Steel Stud Bolts (90,000 SMYS).
3) Indicated Torque assumes that a lubricant is applied to the threads and the nut face.

GCR/83-07-08

TABLE 10

600 Series ANSI Flanges

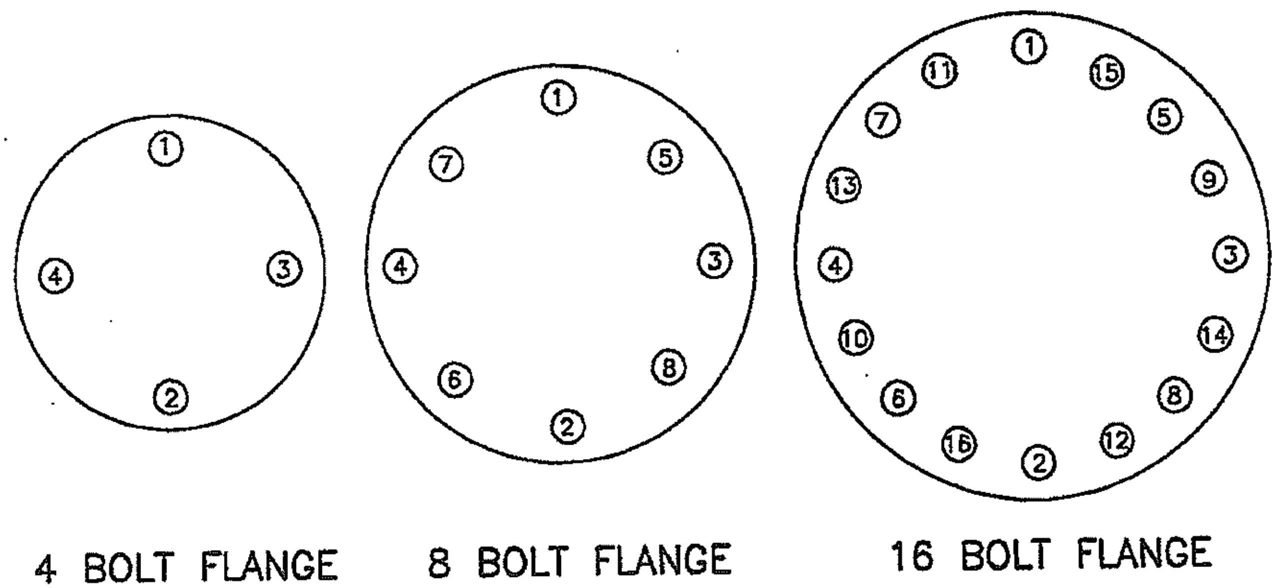
Recommended Torquing Limits and Resultant Compressive Force on Insulated Gaskets

Flange Size	Stud Diameter	No. of Studs	Raised Face Surface Area	Recommended Torque (2)	Compression/ Stud	Resultant Compressive Force on Gasket
2" Ø	5/8"	8	7.37 in^2	90 ft.lbs.	9090 psi	9867 psi
4" Ø	7/8"	8	18.55 in^2	240	18855	8131
6" Ø	1"	12	30.69 in^2	368	24795	9695
8" Ø	1 1/8"	12	42.94 in^2	533	32760	9155
10" Ø	1 1/4"	16	53.02 in^2	750	41805	12615
12" Ø	1 1/4"	20	68.28 in^2	750	41805	12245
16" Ø	1 1/2"	20	81.61 in^2	1200	63225	15494
20" Ø	1 5/8"	24	118.73 in^2	1650	75600	15282

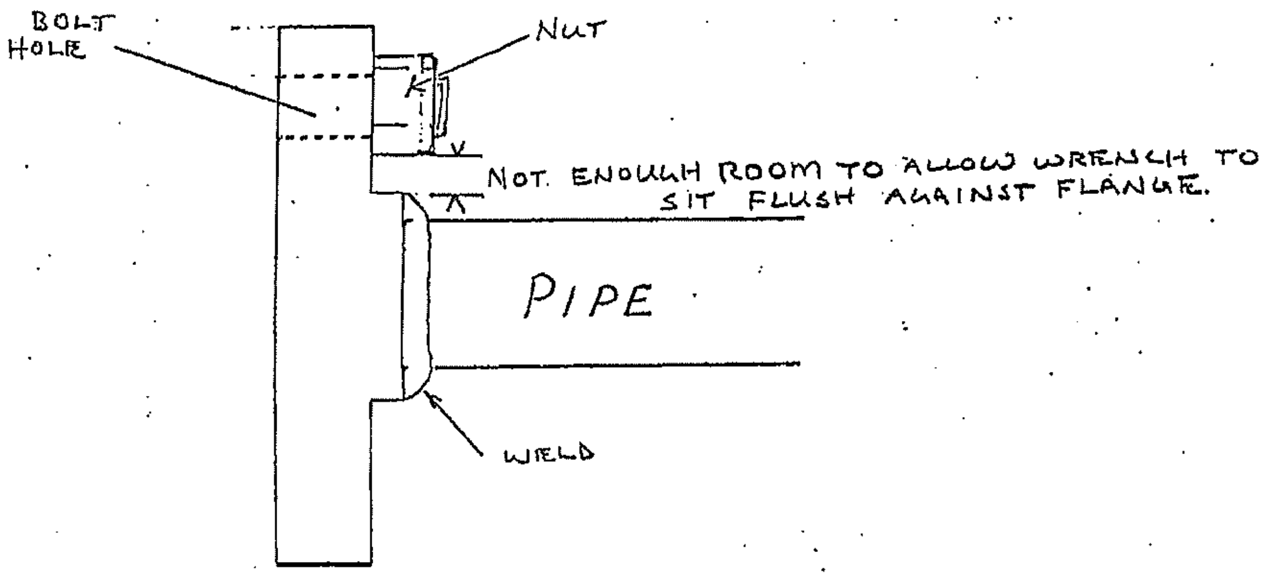
Notes:
1) Based on 600 ANSI Flange Series
2) Based on applied stress of 50% yield strength of Alloy Steel Stud Bolts (90,000 SMYS)
3) Indicated Torque assumes that a lubricant is applied to the threads and the nut face

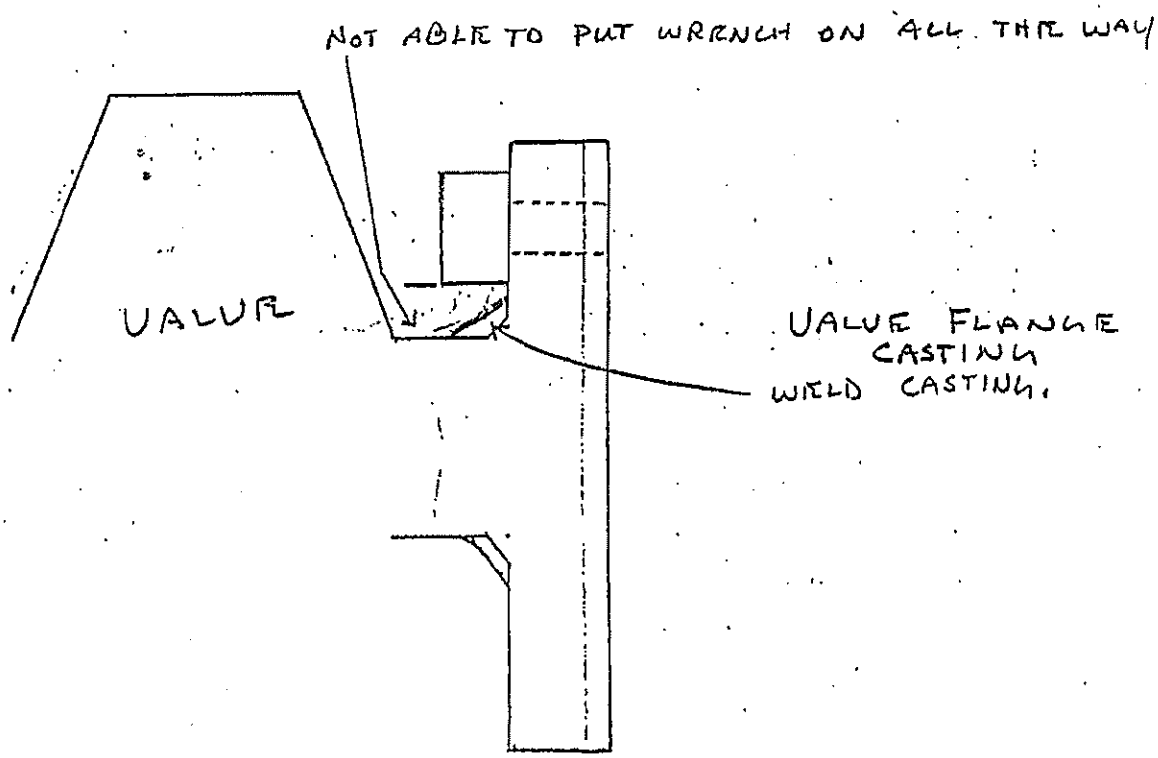
GCR/83-05-04

IGURE 2



BOLTING-UP SEQUENCE





SOME VALVES THERE IS NO ROOM TO PUT WRENCH ON PERIOD

HAMMER WRENCH PROCEDURE

FORWARD

The "Hammer" or "Striking" Wrench is routinely used to tighten flange studs in areas where fittings are located close together preventing the use of air impact wrenches (or similar electrical tools). Any future manifold or piping design should provide sufficient space to permit the use of these automatic tools and eliminate the need for the Hammer Wrench.

The use of a Hammer wrench requires two men, the "Holder" and the "Striker". The "Holder" is the one in charge of the operation and gives all commands.

THE HOLDER

1. Tighten all studs by hand using the "Diagonal Clock" order (see diagram 1).

2. Using the same order, tighten each stud in the following manner. Position the wrench on the stud ensuring its face is flush against the outside face of the flange. If the wrench will not sit flush, use the other end of the stud to continue the process. (see diagram 2). Stabilize the wrench using the palm of an open hand ensuring no slack exists between the drive face of the wrench socket and outside stud face. It is imperative that the hand remain flat open and all potential pinch areas be identified and avoided before striking. Square the Striker's position so that his swing of the hammer will be in direct line with the contact surface on the wrench (see diagram 3) It must be emphasized that positioning of the Striker is the responsibility of the Holder.

3. When prepared to begin tightening (#1 & 2 above) indicate the signal word (usually "Strike") and proceed. NOTE that only the Holder issues commands, using the same siganl consistently throughout the operation. This avoids confusion.

4. Repeat for each stud, at a safe speed DO NOT RUSH OR HURRY THE PROCEDURE.

THE STRIKER

1. Before using the hammer, test swing against a wooden test piece to ensure the hammer head is tight. If the head is found to be loose DO NOT USE THE HAMMER IN THE TIGHTENING PROCEDURE.

THE STRIKER CONT'D.....

2. After being positioned by the Holder, stand with feet shoulder width apart so that the path centre line of the hammer passes between the legs.

3. Hand protection must be dry and oil free to prevent slippage.

4. After receiving the Holder's command, strike the wrench contact surface (see diagram 3) sqaurely. Repeat as required ONLY AFTER RECEIVING THE "STRIKE" COMMAND FROM THE HOLDER.

PROTECTIVE EQUIPMENT:

Both parties must wear eye, head and hand protection when using the hammer wrench.

COMMUNICATION:

Good communications between the Holder and the Striker are essential in the safe implementation of this procedure. Reviewing the above steps at the job site before commencing will reduce the risk of injury.

CW/MGM

86-03-10.

CW, MGM/ch

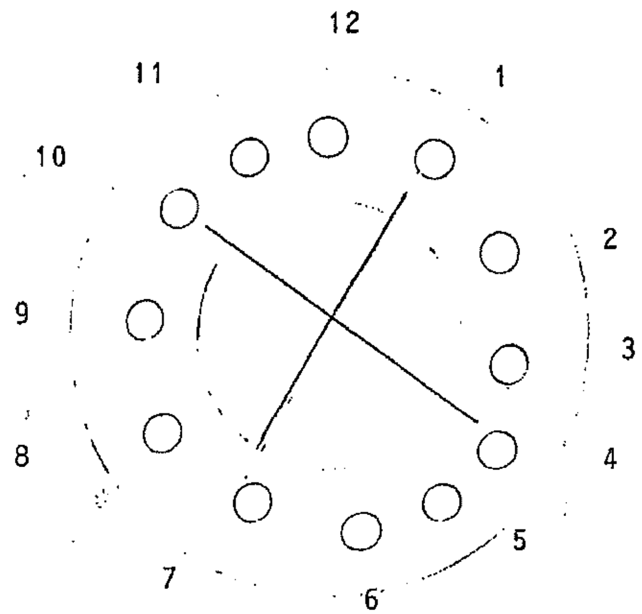
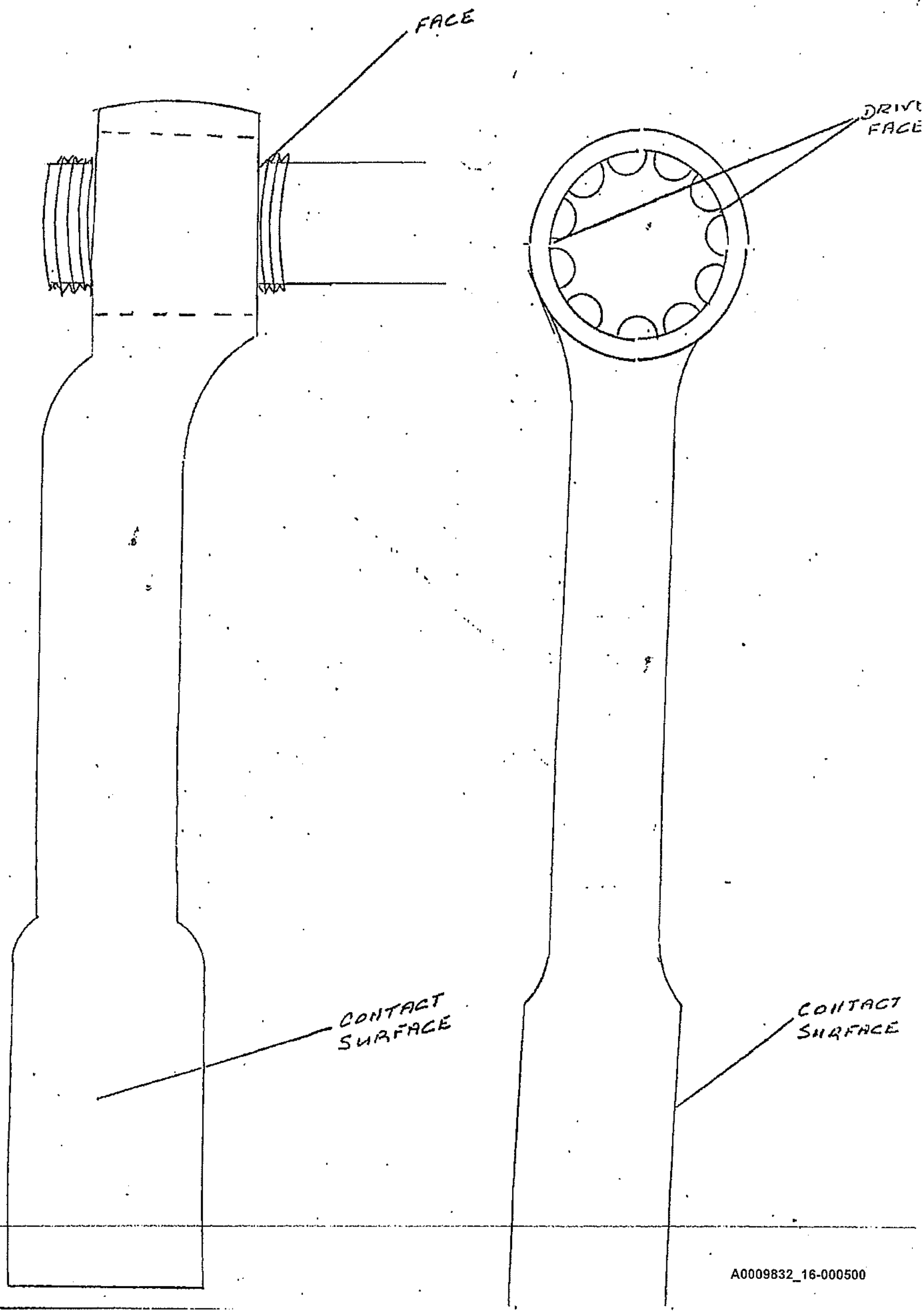


DIAGRAM 1

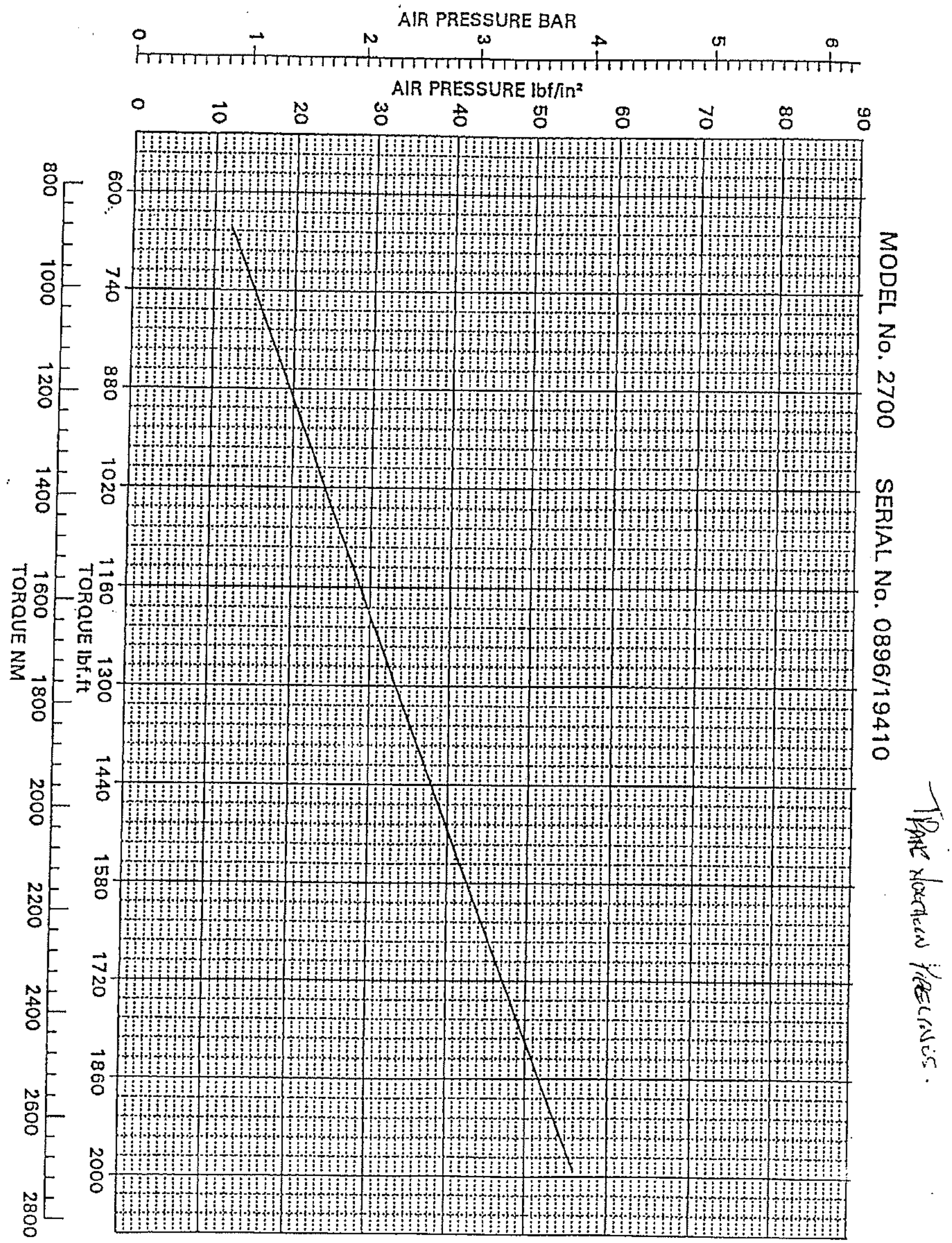
TIGHTEN STUDS 1-7-4-10. WHEN THESE ARE COMPLETE AND FLANGES ARE TIGHT, CONTINUE WITH REMAINING STUDS, IN A CLOCKWISE ORDER.


FACE
DRIVE FACE
CONTACT SURFACE
CONTACT SURFACE

COLOUR CODING FOR BLIND FLANGE IDENTIFICATION

(and mainline repair fittings)

DIAMETER	COLOUR	STENCIL/LABELLING			
16"	BLACK	600#			WHITE LETTERING
12"	RED	600#			
10"	WHITE	600#	300#	150#	BLACK LETTERING
8"	YELLOW	600#	300#	150#	
6"	GREEN	600#	300#	150#	WHITE LETTERING
4"	BLUE	600#	300#	150#	


AIR PRESSURE BAR
0
1
2
3
4
5
6
AIR PRESSURE lbf/in²
0
10
20
30
40
50
60
70
80
90
MODEL No. 2700 SERIAL No. 0896/19410
TORQUE lbf.ft
600
740
880
1020
1160
1300
1440
1580
1720
1860
2000
TORQUE NM
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

PNEUTORQUE WRENCHES

OPERATORS HANDBOOK (PART NO. 34068)

Total No. of pages - 40.

CE

PNEUTORQUE WRENCHES

OPERATORS HANDBOOK (PART NO. 34068)

Sound Level at Operator's Position: 85 dB

Method Of Sound Level Measurement: CEN/TC 255 N 184

Vibration Level at handle: Does not exceed 2.5 m/s^2

IMPORTANT: DO NOT OPERATE THE TOOL BEFORE READING THESE INSTRUCTIONS.

Pneutorque Wrenches are reversible, non impacting, torque controlled tools for threaded fasteners, and must always be operated with the following:-

- Clean dry air supply with a minimum flow of 19 litres/sec (40 CFM)
- Lubro Control Unit or similar Filter, Regulator & Lubricator Unit 1/2" Bore (12mm)
- Impact or machine Quality Sockets
- Reaction Plate

Where the intended usage is not with threaded fasteners, the safety of operation must be evaluated and appropriate precautions taken. Your distributor will be pleased to advise you.

These tools contain grease, which may cause an explosion hazard in the presence of pure oxygen. These tools contain aluminium alloy components which may cause a hazard in certain explosive environments. Please contact your distributor for details of solutions to these hazards.

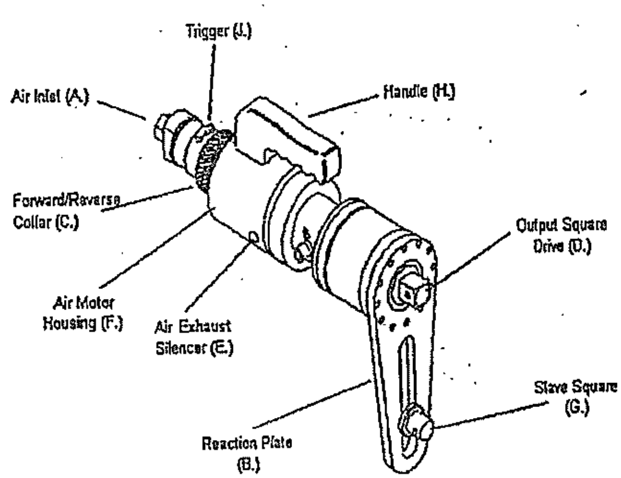


FIG 1

ASSEMBLY

1. Blow out all hoses before connecting.
2. Connect the wrench Air Inlet (A.) to the outlet side of the Lubro Control Unit using the 3 metre hose provided, observing the air flow direction arrows.
3. Connect air supply to the inlet side of the Lubro Control Unit using a minimum hose size of 1/2" bore (12mm). Avoid using 1/2" bore hoses of longer than 5 metres from the supply to the Lubro Control Unit as this will reduce the performance of the wrench.
4. Check oil level in lubricator and fill to correct level if required. (see "LUBRICATION")
5. a) If PT1 to 14, The bolts holding the reaction plate to the gearbox have a torque setting which is stamped onto the plate. The torque should be checked periodically.

   b) If PT 2700 or PT 5500, Remove the circlip from the spline, slide on the reaction plate, replace the circlip.

WARNING: TO AVOID HAZARD FROM WHIPPING AIR HOSES MAKE ALL CONNECTIONS TO THE TOOL BEFORE TURNING ON THE AIR SUPPLY.

TORQUE REACTION

When the Pneutorque is in operation the Reaction Plate (B.) rotates in the opposite direction to the Output Square Drive (D.) and must be allowed to rest squarely against a solid object or surface adjacent to the bolt to be tightened. (see figure 2).

WARNING: ALWAYS KEEP HANDS CLEAR OF THE REACTION PLATE WHEN THE TOOL IS IN USE OR SERIOUS INJURY MAY RESULT.

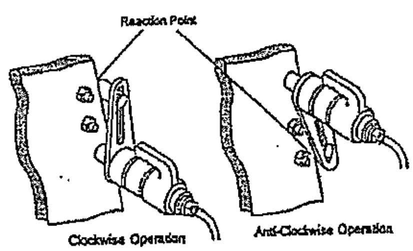


FIG 2

WARNING: CARE MUST BE TAKEN TO ENSURE THAT THE REACTION PLATE IS ONLY USED WITHIN THE LIMITATIONS SHOWN IN FIGURE 3.

For special applications or where extra deep sockets must be used the standard plate may be extended but only within the limitations shown in Figure 3.

WARNING: FAILURE TO OBSERVE THE LIMITATIONS SHOWN IN FIGURE 3 WHEN MODIFYING STANDARD REACTION PLATES MAY RESULT IN PREMATURE WEAR OR DAMAGE TO THE WRENCH.

Standard square drive extensions MUST NOT be used as these will cause serious damage to the wrench output drive. A range of nose extensions is available for applications where access is restricted and these are designed to support the final drive correctly.

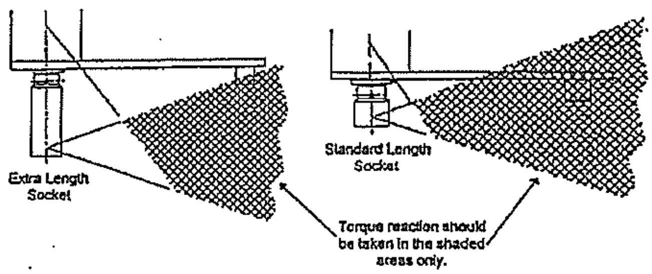


FIG 3

SETTING TORQUE FOR BOLT TIGHTENING

Every Pneutorque Wrench is supplied with an Air Pressure Graph which relates torque output to air pressure. Set the torque output as follows:-

1. Establish the air pressure required using the Air Pressure Graph.
2. Turn collar (C.) to set the tool direction, then squeeze and hold the trigger (J.).
3. Adjust the Lubro Control Unit pressure regulator until the correct pressure is shown on the gauge.

IMPORTANT: THE WRENCH MUST BE FREE RUNNING WHILE ADJUSTING THE AIR PRESSURE TO GIVE THE CORRECT SETTING.

WHILE THE WRENCH IS FREE RUNNING CHECK THAT LUBRO CONTROL UNIT IS SUPPLYING APPROXIMATELY SIX DROPS OF OIL PER MINUTE.

SETTING TORQUE FOR BOLT LOOSENING

1. Establish maximum air pressure from Air Pressure Graph or tool label and set air pressure as for bolt tightening.
2. Ensure that the collar is set to the 'REV' (reverse) position for right hand threads.

WARNING: EXCEEDING THE MAXIMUM AIR PRESSURE WILL OVER-LOAD THE WRENCH AND MAY CAUSE SERIOUS DAMAGE.

OPERATING THE WRENCH

1. Fit the wrench with the correct size impact or machine quality socket to suit the bolt to be tightened.
2. Fit the tool onto the bolt to be tightened with the Reaction Plate adjacent to the reaction point. See figure 2.
3. Slowly bring the Reaction Plate into contact with the reaction point by operating the wrench in short bursts.

WARNING: KEEP HANDS CLEAR OF REACTION ARM.

WARNING: IN USE, THIS TOOL MUST BE SUPPORTED AT ALL TIMES IN ORDER TO PREVENT UNEXPECTED RELEASE IN THE EVENT OF FASTENER OR COMPONENT FAILURE.

4. Keep the 'trigger' squeezed to its open position and collar turned fully until wrench stalls. If the 'trigger' is released or collar is turned back to the 'OFF' position before the wrench stalls, full torque will not be applied to the bolt.
5. Release the 'trigger' and turn Collar to 'off' and remove tool from bolt.
6. If the tool will not release from the bolt, turn collar to the opposite direction and squeeze the trigger for a fraction of a second.

TWO SPEED AUTOMATIC GEARBOX

Automatic gearboxes, where fitted, will 'run down' the nut at five times normal operating speed. No operator intervention is required. The wrench will automatically select low gear (ie. low speed, high torque) to apply final torque. Set the wrench exactly as described above.

TWO SPEED MANUAL GEARBOX

1. Set the air pressure as described above.
2. Set the gear selector to it's 'high' position and then follow the procedure 'Operating the Wrench'.
3. Where there are several bolts in the joint, eg. a flange, it is desirable to tighten all of the bolts with the tool in 'high' gear.
4. Set the gear selector to 'low' and apply final torque.

MAINTENANCE

To maintain optimum performance and safety, the following maintenance should be carried out:

1. Check that the bolts fastening reaction plate are tightened to the torque stamped onto the reaction plate.
   Frequency: Weekly
2. Replace the silencer material in the tool handle.
   Frequency: Every six months.

LUBRICATION

Air Lubricator and Air Motor:-

Shell Tellus 15, BP Energol H.P.L. 40, or equivalent good quality hydraulic oil.

Gearbox:-

The gearbox contains BP energrease LS-EP1. Under normal operating conditions it is not necessary to re-grease the gearbox.

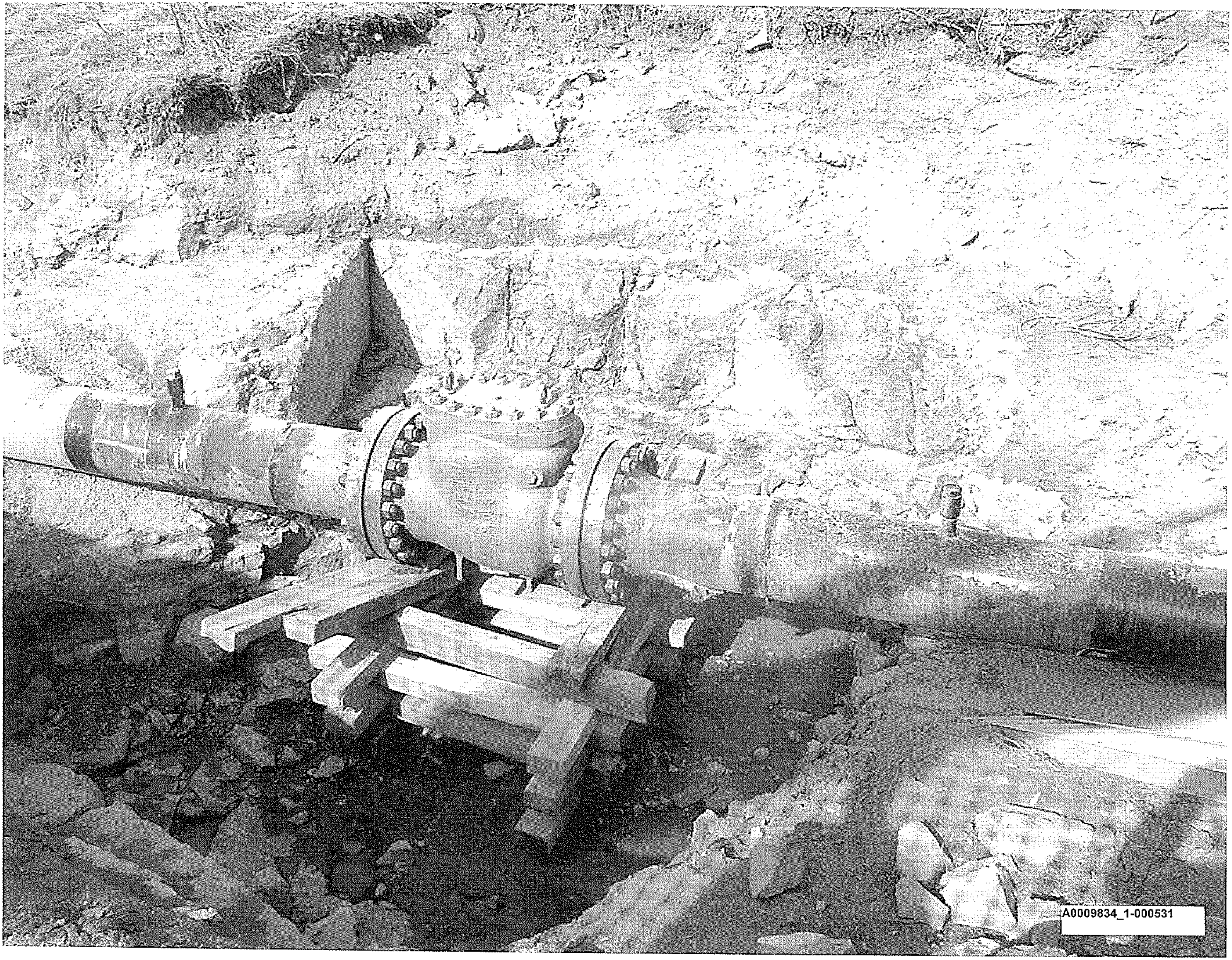
Manufacturer's Name and Address:

Norbar Torque Tools Ltd
Beaumont Road
Banbury, Oxon
OX16 7XJ
United Kingdom
Tel: ** 44 (0) 1295 270333
Fax: ** 44 (0) 1295 269864

For Service Contact:

Pages 508 to 530

are duplicates



Trans-Northern Pipelines Inc.

Report of Leak
from TNPI's 16" Diameter Valve Flange
St. Vincent de Paul
Ville de Laval
Province of Quebec.
February 27, 2010

Executive Summary:

Around noon hour (11:48 am) on February 27th, TNPI Line Control received a telephone call from TNPI's Quebec emergency service call centre that a representative from Environment Canada had called to report the presence of gasoline escaping from the TNPI pipeline near 6175 Levesque Boulevard East in Laval, Quebec. Although system hydraulics did not indicate any anomalous conditions, Line Control shut down both operating pipelines through Montreal and after confirming the address location provided, closed upstream and downstream valves. TNPI's emergency response team contacted the initial caller to confirm the location. TNPI was advised that emergency services had been working at this site since Friday afternoon (February 26th) in response to a brown coloured liquid in the creek. Environment Quebec and Environment Canada officials believed the source of the liquid was from an upstream industrial plant. On the following morning, February 27, someone observed product escaping the vault containing TNPI's valve. Within an hour of the initial call to TNPI, TNPI personnel were on site and confirmed that fuel was escaping from a vault containing a 16" check valve on the north shore of the Rivieres des Prairies, adjacent to Lapiniere Creek. Additional TNPI emergency responders and contractors were dispatched to the scene.

Although the pipeline was fully depressurized, the flange leak itself could not be stopped completely until the valve was removed and re-inserted between the pipeline flanges with new replacement gaskets. During this time, leaking product was continuously collected on site by TNPI personnel. Final repairs were completed on March 3, 2010 and the pipeline was returned to service.

Based on the observed leakage at the time of notification, TNPI has calculated that the maximum amount of product that could have leaked from the pipeline since the last vault inspection (February 19) was 14 m3. The volume of product recovered from the vault was approximately 7

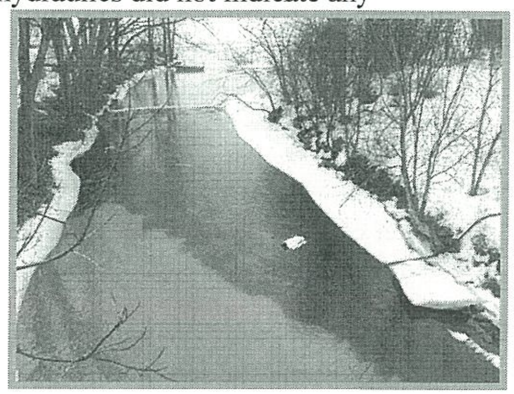
m3, therefore the maximum amount of product released to the environment is estimated to be 7 m3.

The escaped fuel soaked into the ground around the vault and seeped through the soil and rock to enter Lapiniere Creek to the north and the Riviere de Prairies to the south.

Contractor work crews focused on the environmental response and continue to work at the time of the submission of this report to capture as much of the escaped fuel as possible. TNPI's environmental consultant has been on site continuously to direct the environmental response and to develop TNPI's remediation plan.

Leak Response and Repair:

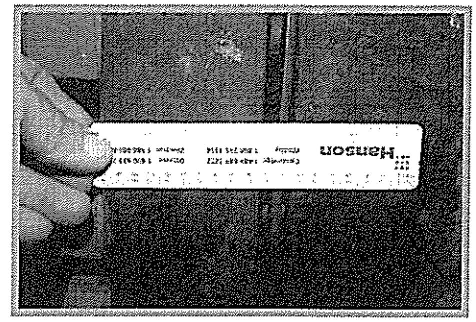
Around noon hour (11:48 am) on February 27th, TNPI Line Control received a telephone call from TNPI's Quebec emergency service call centre that a representative from Environment Canada had called to report the presence of gasoline escaping from the TNPI pipeline near 6175 Levesque Boulevard East in Laval, Quebec. Although system hydraulics did not indicate any anomalous conditions, Line Control shut down both operating pipelines through Montreal and after confirming the address location provided closed upstream and downstream block valves.



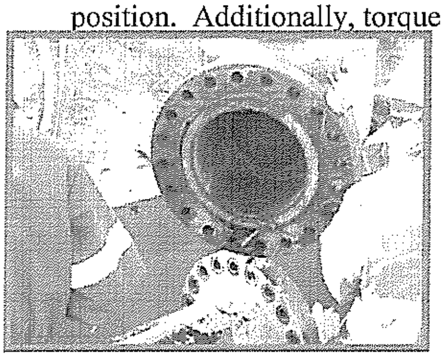
TNPI's emergency response team contacted the initial caller to confirm the location. Within an hour of the initial call to TNPI, TNPI personnel were on site and confirmed that fuel was escaping from a vault containing a 16" check valve. Additional TNPI emergency responders and contractors were dispatched to the scene.

TNPI was advised that emergency services had been working at this site since Friday afternoon (February 26th) in response to a brown coloured liquid in the creek. Environment Quebec and Environment Canada officials originally believed the source of the liquid was from an upstream industrial plant. On February 26th, Ville de Laval officials had installed a boom across Lapiniere Creek and were recovering the accumulated brown coloured liquid to keep it from entering the Riviere des Prairies.

At 11:40 am on February 27th, Environment Canada officials investigating the response discovered the previous day discovered product escaping the vault containing TNPI's valve. An Environment Canada employee measured the leak rate at 1 litre per minute, at which time TNPI's pipeline was operating at 392 psi. This information was later used to determine the maximum with multiple layers of adsorbent pads and wrapped with plastic sheeting to contain any residual escaping product. The area immediately outside of the vault was covered with plastic sheeting and then covered with sand to ensure there were no hazardous vapours around the vault and continuous monitoring was maintained. Remnants of the vault around the circumference of the pipeline were removed using torches. The work to allow unencumbered access to the pipeline was completed around midnight on March 2. However the drain down was not complete so removal of the valve could not commence until the following morning. Removal of the top portion of the vault allowed subsequent work at the leak site to be no longer classified as work in a confined space.



On March 3rd, prior to removing the valve, photographs were taken of both flanges at the 12:00, 03:00 and 09:00 positions. Photos at the 06:00 position were not possible due to the proximity of the vault base. The top of the gasket was marked with a "V" notch to indicate its original position. Additionally, torque testing of the bolts was conducted before attempting to undo any of the bolts from the flanges. All nuts were determined tighter than the specified 1200 fps. This was determined by hydraulic torque gauge.



All of the nuts and studs that were removed were in good shape with no evidence of corrosion or deterioration. The valve was easily removed without the need to spread the flanges indicating good alignment of the pipe segments. On removal the gasket was photographed and preserved in a plastic bag for future examination.

The pipe and valve flange faces were examined and deemed to be acceptable for re-insertion into the pipeline. This was performed without difficulty. The flange faces and bolt holes lined-up without the need for adjustment. New gaskets, studs and nuts were installed in both pipeline flanges. The insulating gasket was replaced with a standard flexitallic gasket since there was no need for isolation with the current cathodic protection system. After the valve was installed and the studs were torqued to specification the pipeline was re-filled with product from Montreal Pump Station.

The fillet welds of the two 2" tapping connections were inspected by NDE methods two days after welding, as these connections have now become permanent features on the 16" pipeline.

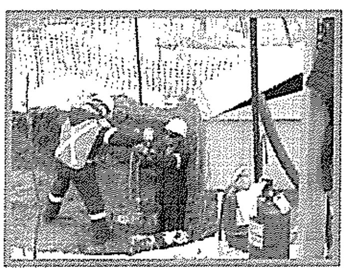
The repair was completed about 15:40 hours on March 3rd. After the pipeline was refilled with product, the pipeline section was pressurized to 800 psi and held for an hour so that the flange connections could be checked for leakage. None was evident. Operation of the pipeline was resumed at 20:42 hours on March 3, 2010. The pipeline had been out of service for 104 hours 52 amount of leakage that could have escaped the pipeline and valve vault.

Fuel which overflowed the vault soaked into the ground around the vault and seeped through the soil and rock to enter Lapiniere Creek to the north and the Riviere de Prairies to the south.

Equipment deployed on the previous day by the Ville de Laval was maintained and used by TNPI until it was replaced by TNPI's response contractor.

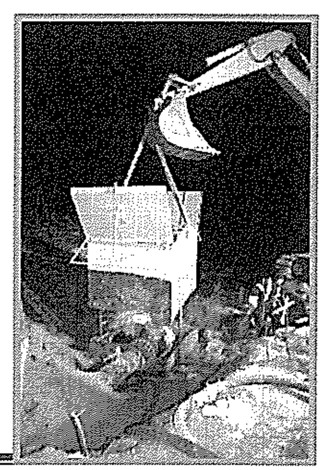
In compliance to established protocols, on confirmation of the leak, TNPI notified the Transportation Safety Board of Canada of the incident at 13:25 hours even though TNPI did not have detailed information about the leak itself.

The source of the leak was ultimately determined to be at an insulated gasket on the upstream side of the Riviere des Prairies check valve on the 16" pipeline. Emergency response contractors removed the accumulated water and product from the vault by vacuum truck. This action stopped the product from escaping the steel vault into the natural environment, but could not prevent the product from escaping the flange. Though the pipeline was shut down and isolated, the head pressure between St. Rose Junction and the valve was sufficient enough for the leak to persist until the pipeline could be drained.



Continuous vacuum truck extraction was necessary to prevent product from accumulating in the vault. A tub was placed under the leaking flange to concentrate the liquid for vacuum truck recovery. Once the leak was reduced to a safe level, safety precautions including flushing the vault with water to reduce hazardous vapours was performed. TNPI personnel entered the vault to assess and to confirm the source of the leak and to assess the type of repair required. It was determined that the pipeline would have to be drained of product to remove the valve and replace the gasket.

The pipeline was exposed on each side of the valve vault so that 2" tapping connections could be welded onto the pipeline. After the welding was completed, the pipeline was tapped and product removal began. Approximately 400 cubic metres of product was removed from the pipeline over a two day period using vacuum trucks and eventually air driven pumps.

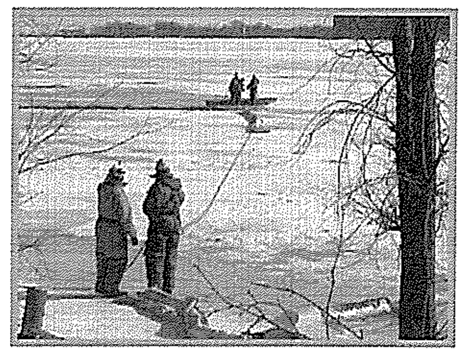


Throughout the entire ordeal the air was monitored with hazardous atmosphere detectors. To remove the valve from the pipeline, the top portion of the vault was first removed for worker safety and to allow easy access to the flange bolts with air and hydraulic wrenches, and to allow for eventual product recovery underneath the vault base.

A contractor was brought in to cut through the steel vault with an electric saw to create a safe work environment. The leaking flange was wrapped minutes. The flanges have been repeatedly checked and no further leakage has been observed.

Site Safety:

Throughout the entire emergency response, including the pipeline drain down and valve removal and reinstallation TNPI maintained a Safety Watch. TNPI's Safety Watch ensured that personnel were wearing the appropriate personal protective equipment and following proper work procedures. Hazardous atmosphere detectors were employed in the vault, in the excavation and around the site to monitor for explosive atmospheres and oxygen levels. At no time was there any indication of unsafe atmosphere exposure to personnel with the exception of inside the vault. During hot work, when removing the vault from around the valve, fire extinguishers were deployed in the event of fire.



All vacuum trucks were grounded when handling product from either the pipeline drain down or when pumping contaminated water or fuel from excavation pits or along the shorelines. Bonds were installed around the valve to ensure the potential of the pipe south of the insulated flanges was equal to the potential of the pipe north of the insulated flange. The closest rectifier on the pipeline was turned off to ensure there was no potential for electrical discharge when the valve was being removed.

CSRS/SIMEC was the prime contractor working on the surface of the ice and near the shorelines. Additional site rules were enforced to ensure that personnel were not exposed to hazardous conditions related to water and hypothermia. Personal flotation devices were mandatory for anyone working on the ice or water or within 10 feet of the shoreline. Workers used aluminium boats to travel over the ice surface. Travel lines were also used so that workers could be retrieved from shore in the event of ice failure. Workers also worked in pairs connected by lanyards. Whenever booms were winched or pulled by powered equipment, a wide berth was given in the event of rope failure and lash back. On two separate occasions, personnel fell through the ice and into the water. In both cases the water depth was shallow enough that the individuals were not fully immersed in cold water. Following the second event, personnel worked exclusively from aluminium boats when working on the ice.

Tailgate meetings were held regularly with crews as new personnel arrived on site and when work conditions were about to change. Temperature conditions changed daily, giving rise to varying hazardous walking hazards. In the morning when the ground surface was frozen, walking conditions changed from hard uneven surfaces to slippery, soft and wet conditions. In the late afternoon, conditions changed back to hard uneven ground. Walking conditions during darkness away from light plants was difficult across the hard uneven ground. On March 11th, an equipment operator walking up the excavation and slipped on the uneven surface striking his left hand on the embankment. The next day he was diagnosed with a broken ring finger.

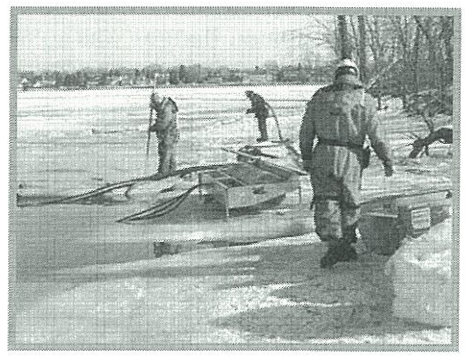
As spring daytime weather conditions improved there were more people walking by the site. Accordingly, a security fence was erected along the limit of Boulevard Levesque and the western perimeter of the site to prevent inadvertent intrusion. A secondary snow fence was erected around open excavations within the site.

During the evening hours security was posted at the site to prevent access and to prevent theft. Despite this security, one evening when the security guard was asleep in his vehicle, persons unknown stole a generator.

Wildlife Watch:

Early into the emergency response, one dead black duck was found by Environment Canada in Lapiniere Creek. Another oil laden duck was later captured on March 2nd and sent to a veterinary clinic for care. This duck died in the clinic March 17th. Two dead salamanders were found along the bank of Lapiniere Creek reportedly by Environment Canada.

On March 2nd a wildlife watch was established to monitor the site upstream of the valve vault for nesting birds and other animals and to monitor the shoreline and banks for product sheen. Twice each day, personnel would walk about 1000 feet upstream along Lapiniere Creek. This continued until March 11th after which the wildlife was conducted once each day until late March when the wildlife watch was suspended.



Shoreline Spill Response and Site Clean-up:

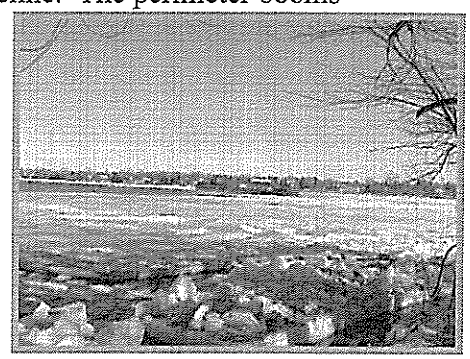
Immediately on responding to the site, a marine spill response contractor (CSRS/SIMEC) was retained by TNPI to assist with the spill response and initiate site clean-up. These activities went on for approximately three weeks until it was evident that the volume of product being recovered had declined substantially and became more manageable.

Upon arrival at the site the contractor installed booms in open water at the mouth of Lapiniere Creek and the Riviere des Prairies to capture and contain as much fuel as possible. Adsorbent booms and pad were also deployed. Oil skimmers were used to collect product within the booms and several vacuum trucks were also used to skim product off the surface of the water.

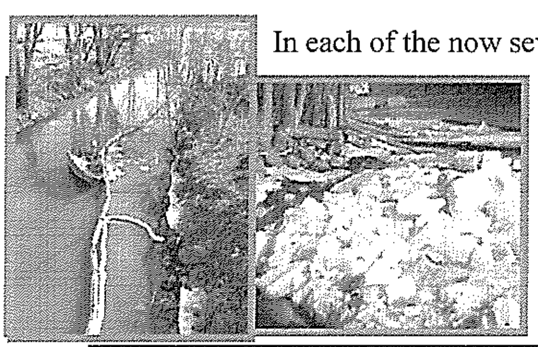
Oil recovery along the shore line was challenged by cold overnight temperatures and warm afternoon sun. The presence of ice and snow concealed the presence of oil and melting water spread the sheen over a broad area. The ice in Riviere des Prairies was slotted and booms were installed beyond the perimeter of the known sheen. At peak there was 1900 feet of booms installed across Lapiniere Creek and along Riviere des Prairies.

Product recovery along the shoreline required the additional slotting of ice to release the oil for recovery by vacuum truck and collection by adsorbent pads. Water deluge hoses were deployed along the shoreline to aid in melting the shoreline ice and to release additional product that had accumulated along the shoreline and under the ice. To avoid releasing large amounts of trapped fuel ice slotting and water deluge was performed in three (3) divisions that were encircled by booms. Hand shovels, rakes and pike poles were used to move sheen towards vacuum skimmers.

As the water flows in the Riviere des Prairies fluctuated and as the ice thickness deteriorated a floating backhoe was brought to the site on March 6th to break the river ice in order to establish a tighter perimeter but careful not to break the ice clinging to the shoreline. The perimeter booms installed along the Riviere des Prairies were removed and re-deployed closer to shore. During this process it was discovered that the oil had migrated upstream along the bank of Riviere des Prairies to a distance of 450 feet from the pipeline. This new division was bordered by additional floating boom. The total boom deployed in all divisions by the end of the day was 1650 feet. Shore line cleanup in this division continued by water deluge to melt the snow and ice and to displace the trapped oil onto the water surface where it was then collected by adsorbent pads, booms and by vacuum truck.



On March 11th, a Canadian Coast Guard hovercraft made several passes upstream and downstream on the Riviere des Prairies to break-up the ice sheet in the river as a flood control measure. During these passes, waves moved blocks of ice into the booms deployed along the shoreline. Some of the boom was destroyed by ice action. Other portions were displaced. The waves lapped the shoreline well above the static water level and initiated the release of more product and more sheen. It took work crews two days to re-establish the boom divisions that were disturbed by this action. In addition a change of wind direction forced the broken ice flows into the booms parallel to the river shoreline. When the wind direction changed two days later the broken ice flows eventually drifted downstream and the booms were re-secured.



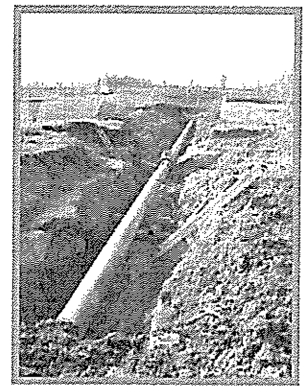
In each of the now seven (7) boom divisions, vegetative debris, leaves and other matter that had adsorbed oil sheen was collected and disposed of in plastic bags. When all evidence of sheen and product weeping in each boom division had disappeared most of the booms were removed from upstream towards the downstream direction along the river shoreline.

When the booms were removed from the water they were winched to shore and laid out on rolls of adsorbent padding to ensure any clinging oil product would not be transferred to the ground.

By the end of March 17th 900 feet of boom remains at the site along the bank of Lapiniere Creek and along the shore line of Riviere des Prairies near the 16" pipeline. On March 18th, CSRS/ SIMEC demobilized their trailers from the site. CSRS/ SIMEC will return as needed to maintain shoreline boom and assist with shoreline cleanup. Shoreline cleanup will continue until the seeping of hydrocarbons from the rock ledges along Lapiniere Creek ends. Installation of the recovery system and well pumping is believed to be the solution to prevent further product migration into the water.

Pipeline Excavation:

During the initial stages of TNPIs' response, contaminated soil that was removed from around the vault and the pipeline was initially placed on tarps and covered with plastic sheeting until soil samples were analyzed. It quickly became evident that the fuel that escaped the vault soaked into the ground around the vault appeared to have seeped along the 16" pipeline trench to enter Lapiniere Creek to the north and the Riviere de Prairies to the south. Sand padding that surrounded the 16" pipeline provided a convenient subsurface pathway from the valve in both directions.



Test pits excavated near the bank of Lapiniere Creek and near the Riviere des Prairies, confirmed TNPI's beliefs. To prevent further migration along the pipeline, bentonite plugs were installed near these test pits. TNPI continued to excavate the 16" pipeline by backhoe and by vacuum excavation between the bentonite plugs and the valve site. As the excavation continued, contaminated soils were placed into lugger bins for easy removal from site. All soils were analyzed prior to disposal at a licensed landfill site.

After the pipeline was fully exposed, TNPI determined that the coating on the 16" pipeline (coal tar enamel) was unaffected by the fuel spill and therefore did not require repair. Minor coating holidays were repaired with Kema tape. Following excavation and cleaning of the pipeline trench base and sidewalls by vacuum excavation the pipeline was again padded and then backfilled with clean granular materials.

The parallel 10" pipeline situated 30 feet or so west of the 16" pipeline was excavated at four locations to determine if any fuel had found its way to the 10" trench. None of the test pits revealed product or contamination. The pipeline was marked with flagging. Heavy equipment was confined to gravel road crossings that were constructed over the 10" pipeline, which is marginally shallower than the 16" pipeline.

Spill Volume and Recovery Calculations:

The estimated loss of product from the leaking flange was estimated based on the observation made by an Environment Canada employee who measured the leak rate at 1 litre per minute, at which time TNPI's pipeline was operating at 392 psi. Utilizing this information, the equivalent leak rate at various operating pressures was determined and applied to all product movements between the time of discovery at 11:40 am on February 27th and the last vault inspection at noon on February 19th. The resultant product of this calculation is 14 m3. Given the total vault volume of 9 m3 and a resident volume of water in the base of the vault of 2 m3 (the volume of water that was in the vault at the time of the last vault inspection), the volume of product that overflowed the vault is approximately 7 m3.

Analytical information from the soil concentrations was used to determine that the soils contained 2380 litres of fuel. Similarly analytical information from a limited number of water concentrations was used to determine that the water contained 5845 litres. Overall, the total product recovered is approximately 8225 litres of fuel.

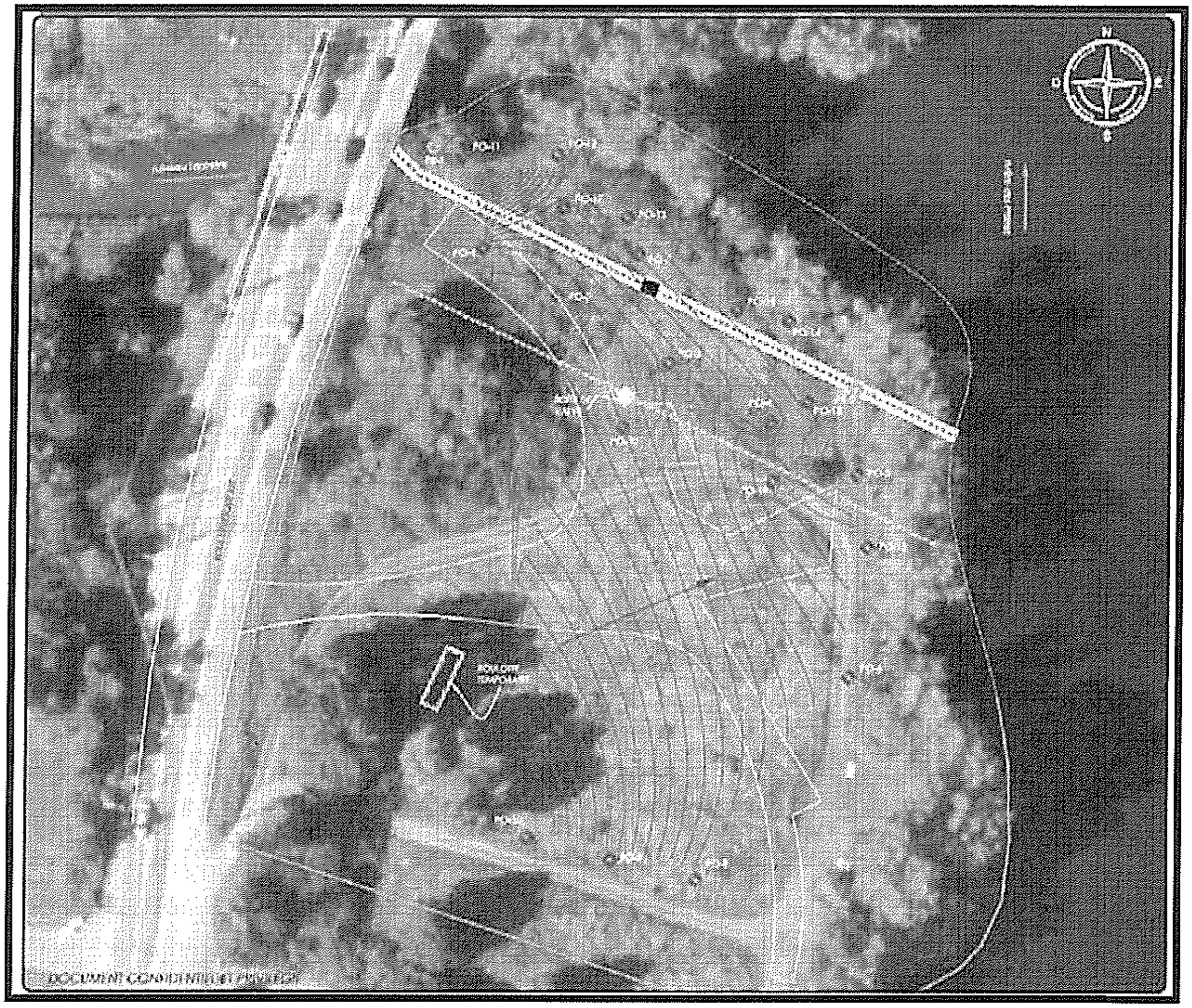
The difference between the amounts of product that theoretically escaped versus the amount that was theoretically recovered is due to the various assumptions that were made in both calculations. Variation of any of the assumptive values would alter the numbers themselves, but the two values corroborate closely.

Site Investigation and Remedial Action Plan:

TNPI's environmental consultant, Mission HGE assisted with characterization of soils and water quality. In addition to test pitting along the 10" pipeline, excavation of the 16" pipeline and sixteen (16) other test pits excavated on the site, nineteen (19) boreholes were drilled around the site to aid in delineation of subsurface contamination as shown on the attached site plan. Free product is being recovered from two wells using a Petrotrap. A detailed site remediation plan was submitted to authorities for a Certificate of Approval on April 12th.

In addition to Mission HGE, TNPI's insurance broker has retained the services of its own environmental consultant, Environmental Solutions Remediation Services (ESRS) to monitor site activities and to provide guidance. Both consultants continue to liaise with regulatory authorities to procure approval for the remediation plan.

Until the Certificate of Approval is issued, TNPI's consultants and contractor remain on scene to remove as much free product from the monitoring wells as possible. In addition, shoreline monitoring continues. Booms are re-positioned and adsorbent pads are changed as necessary.



Regulatory Notifications and On-site Representation:

TNPI notified the Transportation Safety Board of Canada (one window reporting protocol) on February 27th at 13:25 hours. TNPI was contacted by the National Energy Board at 13:50 hours. Representatives of the TSB (1)* and NEB (4) attended the site over the next two days. Other agencies that attended the site were: Corrections Canada (3), Environment Canada (2), Environment Quebec (2) and the Ville de Laval (1).

*(4) denotes the number of representatives that have attended the site at various times throughout the emergency response.

On-site Resources:

Throughout the emergency response and continuing to the date of this report, all parties have attended weekly meetings at the site. Minutes of the meetings have been circulated amongst all parties by e-mail. A construction trailer was acquired to facilitate on site coordination and to provide shelter for site workers.

Primary contractors on site were CSRS/SIMEC, Veolia vacuum services, Recubec vacuum services, Alary construction and Petrosol for contaminated soil disposal.

TNPI's environmental consultant is Mission HGE was retained early into the emergency response and continues to produce information relative to the remedial action plan.

Representatives from TNPI's insurance broker, Environmental Solutions (ESRS) were on site throughout the emergency response and for the development of the site remedial plan.

Public Notification and Media Attention:

The Ministry of Environment issued a press release on February 27th advising the public of the pipeline leak.

Early into TNPI's emergency response TNPI retained the services of Hill and Knowlton, communication consultant to provide information to the public and the media. On February 28th, the media consultant spoke to the media and any passersby at the site.

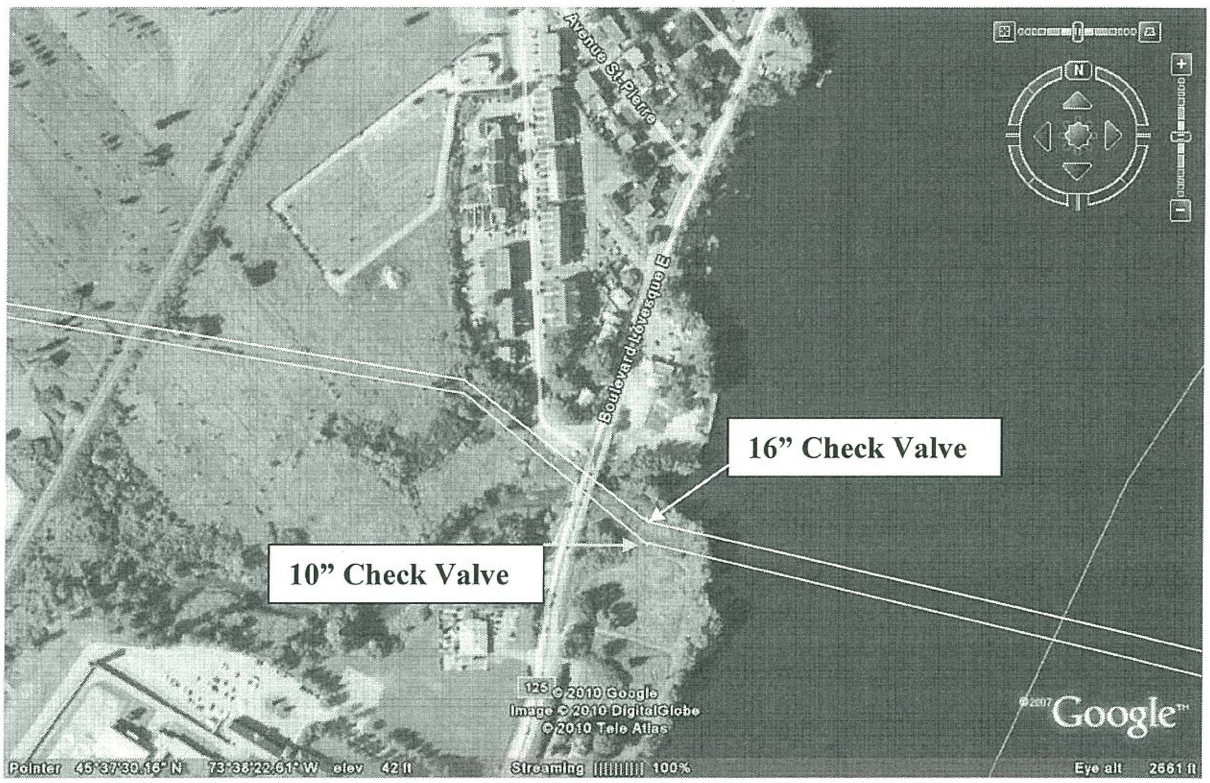
On March 1st, TNPI personnel knocked on the doors of the most immediate nearby residents and advised them of TNPI's activities at the leak site. On March 18, TNPI delivered 118 letters to residents in the community. No follow-up inquiries were received.

Though there have been a few reports in newspapers and some radio reports citing the emergency response, none of these was sufficient to draw attention to the site. One media reporter arranged for on-site interviews, but later declined to show-up.

Site Location Reference:

ML-7, R/W-2, Mile Post 6.4
Lot 323, St. Vincent de Paul
1,538,090 Cadastre du Quebec/Laval
Laval, Quebec

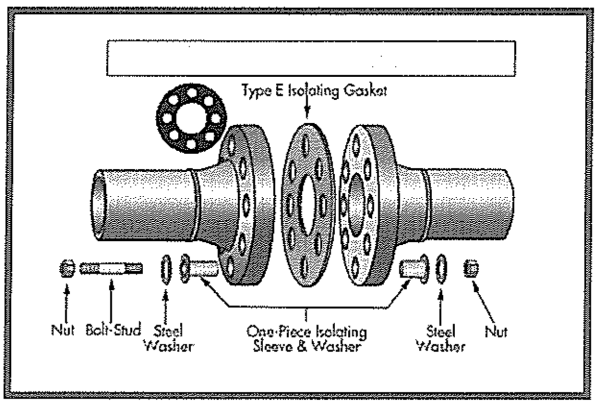
Property Owner: Corrections Service Canada



Summary of Pipeline Characteristics:

The 16" pipeline was constructed in 1972. The valve and gasket were installed at that time and included as part of the hydrostatic test for the pipeline.

- Pipeline 16.00" OD x 0.312" nominal wall, API 5LX Grade 52 line pipe
- Flanges are ANSI 600 class, with a 1440 WOG operating pressure ¼" raised face
- Check valve is Frankflo 16" ANSI 600 class, with viton soft goods kit
- Gasket is flexitalic 16" ANSI 600 class spiral wound
- Insulated gasket is F. H. Maloney, Type E neoprene faced phenolic



The steel vault was installed around the valve in 1994.

Operating Certificates:

The 16" pipeline was constructed in 1972 under order of the National Energy Board XO-3-72 and allowed to operate at 1411 psi pursuant to OPLO-2-17-72. Other orders in place for the pipeline are OPL-2-10-72 (ML-7) and AO-1-OP-239-72 (CR-267).

Information Requests and Orders:

TNPI has received three (3) e-mail information requests from the National Energy Board, dated March 2, 3 and 10, 2010.

In addition, TNPI has received several information requests, both e-mail and verbal from Environment Canada.

Failure Analysis:

TNPI has sent the failed insulated gasket to SGS Canada Inc., to determine the root cause of the gasket failure. The analysis is expected to be completed by May 28, 2010.

Underlying Cause(s):

To be determined.

Corrective Actions Taken or Planned by TNPI to Prevent Similar Incidents:

Full identification of correction actions will be determined when the root cause has been identified from the failure analysis report.

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2010-04-21