DOT	US Department of Transportation
PHMSA	Pipelines and Hazardous Materials Safety Administration
OPS	Office of Pipeline Safety
	Central Region

Principal Investigator	Darren Lemmerman/Brian Pierzina
Senior Accident Investigator	Karen Butler
Region Director	Ivan Huntoon/Allan Beshore
Date of Report	07/30/2015
Subject	Failure Investigation Report – Enbridge Energy, Limited Partnership – Material Failure – Longitudinal Seam

Operator, Location, & Consequences

Date of Failure	01/08/2010
Commodity Released	Crude Oil
City/County & State	Neche / Pembina, ND
OpID & Operator Name	11169 Enbridge Energy, Limited Partnership
Unit # & Unit Name	16123 North Dakota
SMART Activity #	128315
Milepost / Location	MP 774.18
Type of Failure	Rupture, Longitudinal Seam Fatigue Crack
Fatalities	0
Injuries	0
Description of area impacted	Agricultural field, non-HCA
Total Costs	$4,194,715

Executive Summary

On Jan. 8, 2010, at approximately 11:38 p.m. CST[1], Enbridge Energy, Limited Partnership's (Enbridge) 26-inch diameter Line 2 ruptured at Milepost (MP) 774.18, in Pembina County, near Neche, ND. The failure location was 2.2 miles downstream of Enbridge's Gretna, Manitoba pumping station, near the North Dakota/Canadian border. The failure resulted in the release of approximately 3,784 barrels (bbl) of light sweet crude oil into a flat agricultural field, which was covered in approximately 8 inches of snow. The release had minimal impact beyond the pipeline right-of-way, and did not impact any waterways or high consequence areas (HCAs). Approximately 4,760 cubic yards of contaminated soil were removed from the failure location. Total reported costs associated with the accident are $4,194,715.

The repair was made using 44 feet of pre-tested pipe, and the failed pipe specimen was submitted for metallurgical analysis by an independent testing laboratory. The results of metallurgical analysis "indicate that the rupture occurred as a result of a fatigue crack that grew to a critical size. The fatigue crack initiated at the ID weld toe of the seam weld. Misalignment and peaking at the seam weld likely contributed to the failure."[2] Pipeline integrity for this segment of Line 2 had most recently been assessed for crack-like defects using ultrasonic crack detection (USCD) in-line inspection (ILI) technology on Aug. 18, 2009. The failure defect was not reported by the ILI vendor in the final report/features list provided to Enbridge in December of 2009. Post-accident failure investigation revealed that the defect had been identified by the USCD ILI tool, but the feature was misclassified during the data analysis process, and was not reported to Enbridge prior to the failure.

As a result of the rupture, PHMSA issued a Corrective Action Order (CAO), CPF #3-2010-5001H, on Jan. 19, 2010. The CAO specified numerous requirements concerning investigation, repair, return to service at a reduced operating pressure, and integrity verification.

System Details

Line 2 is part of Enbridge's Lakehead Pipeline system, which is one of the primary transporters of crude oil from Western Canada into the United States. The U.S. segment of the Lakehead Pipeline system consists of over 4300 miles of pipeline ranging in diameter from 18 to 48 inches. At the location of the failure there are currently 7 parallel pipelines operated by Enbridge. The 26-inch Line 2 was constructed in 1956 using .281-inch wall thickness, API 5L X-52 line pipe manufactured by A.O. Smith with an electric flash welded (EFW) longitudinal seam, and coal tar coating. The maximum operating pressure (MOP) is 809 pounds per square inch gauge (psig), corresponding to 72% of specified minimum yield strength (SMYS). The pipeline was most recently hydrostatically tested in 1994 to a pressure of 1,127 psig (100% SMYS). The estimated pressure at the failure location at the time of failure was 725 psig.

Events Leading up to the Failure

On Jan. 8, 2010, at 11:38 p.m., a low-suction pressure alarm at the Gretna pumping station on Line 2 initiated an emergency station cascade shutdown, which automatically shut down any Line 2 pumps that were in operation at the Gretna pumping station. The sudden pressure drop caused by the rupture was recognized immediately at Enbridge's Edmonton Control Center (CCO), and prompt actions were taken to shutdown and isolate the entire pipeline. By 11:49 p.m., Line 2 was fully isolated between the Gretna, Manitoba (upstream) and Donaldson, MN (downstream) pumping stations. Enbridge personnel were dispatched to investigate the suspected leak and located the release at M.P. 774.18, at 2:20 a.m.

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[1] All times are Central Standard Time (CST) unless otherwise noted.

[2] Det Norske Veritas (DNV) – Final Report – Metallurgical Analysis of Rupture on 26-Inch Gretna to Clearbrook Line 2 at M.P. 774.2.

on Jan. 9, 2010. Enbridge notified the National Response Center (NRC) at 3:21 a.m. on Jan. 9, 2010 (NRC Report #928066).

Emergency Response

Enbridge personnel implemented company emergency response procedures to ensure containment of the released product as well as employee safety. The release did not impact any building structures, roads or bodies of water. The Incident Command System (ICS) was established per Enbridge procedure. In response to the NRC notification, PHMSA initiated an investigation and dispatched an investigator to the failure location. The PHMSA investigator arrived on site at approximately 5:00 p.m. on Jan. 9, 2010.

The release was confined to an approximately 40-foot-by-600-foot area within a sugar beet field. Product migration was limited in part by a spoil pile remaining from new construction of an adjacent pipeline. Investigation and repair activities were slowed in part due to cold weather and logistics associated with transporting recovered product across the U.S.-Canadian border. Response activities and status were shared with several external agencies including the National Transportation Safety Board (NTSB), U.S. Department of State, U.S. Department of Energy, the National Energy Board (NEB) of Canada, and the Minnesota Office of Pipeline Safety (MNOPS).

Summary of Return-to-Service

In response to the accident, PHMSA issued a Corrective Action Order (CAO), CPF 3-2010-5001H, which, among other requirements, implemented pressure restrictions based on pre-failure operating conditions, and required a comprehensive integrity verification and remedial work program. The CAO requirements applied to the entire U.S. portion of Line 2, from the Canadian border to Superior, WI (approximately 325 miles). Line 2 was returned to service on Jan. 13, 2010, in accordance with a written restart plan approved by the PHMSA Central Region Director, at pressures limited to 80% of pre-failure operating conditions.

Additional safety measures included a metallurgical evaluation of the failed piping, investigation into the USCD ILI inspection results for additional features requiring investigation, and implementation of a comprehensive excavation and repair program. The proposed integrity verification and remedial work program (IVP) required by the CAO is currently ongoing. Thus far, the IVP has included ILI of the entire U.S. portion of Line 2 using multiple inspection technologies, with hundreds of excavations to investigate reported anomalies and perform necessary repairs. Currently, Enbridge is preparing for a hydrostatic pressure test of Line 2 to confirm the integrity of the pipeline.

Investigation Details

The PHMSA on-site investigation included photo documentation and observations of cleanup and repair activities. Free product from the release was recovered with vacuum equipment and contaminated soil was removed for remediation. Enbridge reported that 1,547 bbl of oil were recovered, and 4,760 cubic yards of contaminated soil was removed. The rupture opening was located at the seam weld, oriented at the 10:30 clock position (looking downstream). The rupture opening was 4.15 feet in length, between 36.18 and 40.33 feet from the upstream girth weld. The maximum distance between the opposing fracture surfaces was 5.5 inches and was located 38.28 feet from the upstream girth weld.

A 44-foot section of pipe including the ruptured portion was replaced with pretested pipe. The failed pipe was transported to an independent laboratory for metallurgical evaluation. The results of the metallurgical analysis indicate the failure was caused by a crack approximately 5.5 inches long which initiated at the toe of the longitudinal seam from the inside of the pipe, and grew in service (through cyclic fatigue) until failure. The peak depth of the crack at the time of failure was approximately 75% of the pipe wall thickness. The longitudinal seam exhibited peaking/misalignment in the area of the defect from original manufacturing, which contributed to the failure. The chemical composition and metallurgical properties of the pipe material were consistent with the minimum specifications for API 5L X-52 in place at the time of manufacture.

Enbridge had most recently inspected the pipeline for crack-like defects in 2009 using the GE USCD ILI tool. The failure defect was identified during the inspection, but the ultrasonic response was misinterpreted during the data analysis phase, and the defect was ultimately classified as a geometry feature (weld inhomogeneity), which was not reported to Enbridge prior to the failure. A post-accident analysis of the ILI data and the failure defect indicate the shape of the internal surface (peaking/misalignment) caused high amplitude reflections at the ultrasonic signal entry point, which led to the improper classification of the defect. In addition, there were internal grinding marks on the inside of the pipe in the area of the defect from original manufacturing, which also affected the ultrasonic signal response.

Findings and Contributing Factors

As a result of the findings from the metallurgical analysis and ILI review, a comprehensive investigation program was implemented to evaluate additional features reported by the ILI tool and make any necessary repairs. As stated previously, these and other integrity verification and remedial work activities are ongoing.

Appendices

A Map and Photographs

B NRC Report

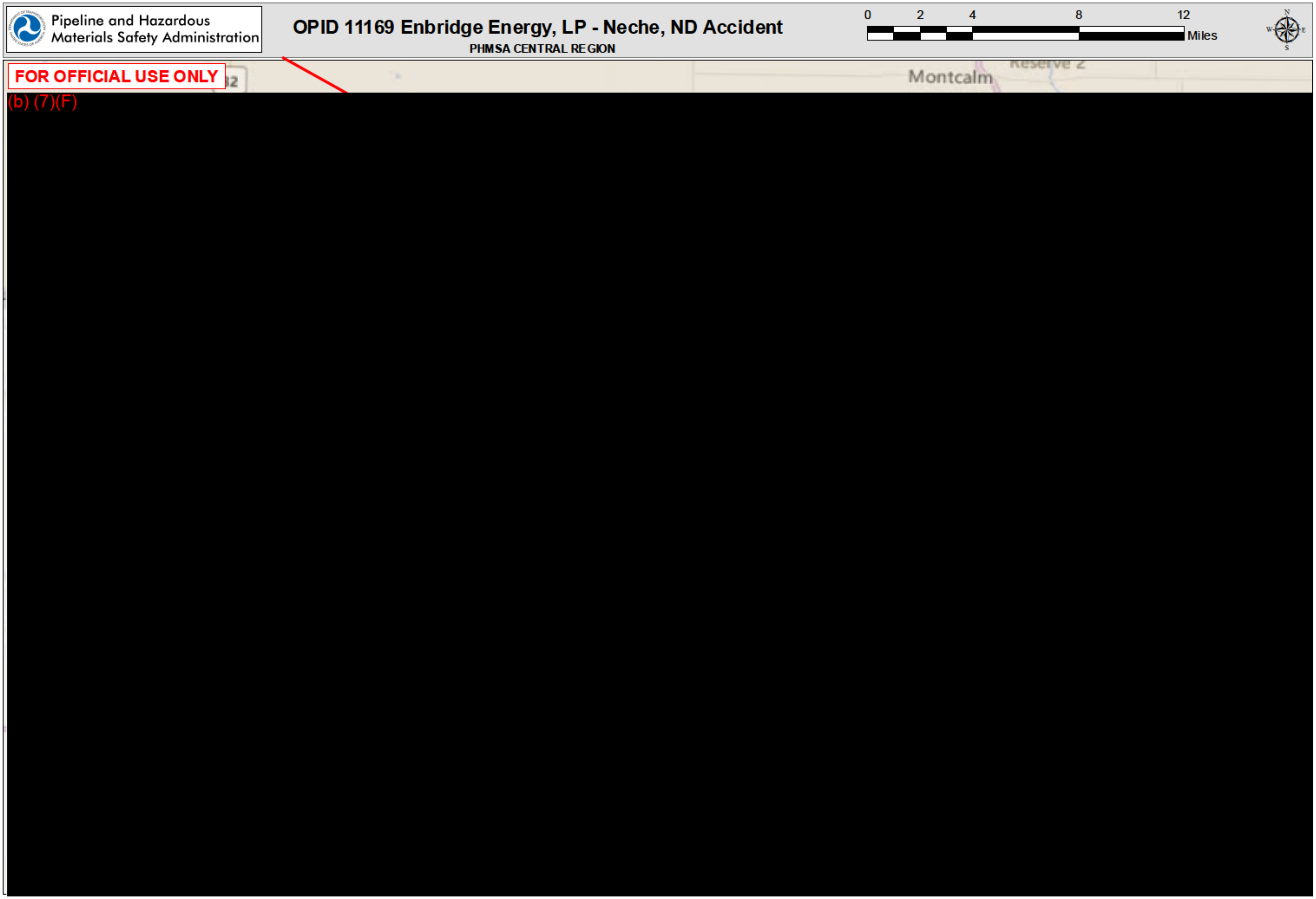
C Operator's Report

D Metallurgical Analysis

Pipeline and Hazardous Materials Safety Administration

OPID 11169 Enbridge Energy, LP - Neche, ND Accident

PHMSA CENTRAL REGION



[redacted]

View Looking Northwest

View Looking Northeast

View Looking South

Failed Pipe Section Being Removed

NATIONAL RESPONSE CENTER 1-800-424-8802
***** For Public Use *****
Information released to a third party shall comply with any applicable federal and/or state Freedom of Information and Privacy Laws

Incident Report # 928066

INCIDENT DESCRIPTION

*Report taken at 04:21 on 09-JAN-10
Incident Type: PIPELINE
Incident Cause: EQUIPMENT FAILURE
Affected Area:
The incident occurred on 08-JAN-10 at 23:38 local time.
Affected Medium: SOIL

SUSPECTED RESPONSIBLE PARTY

Organization: ENBRIDGE
SUPERIOR, WI 54880

Type of Organization: PUBLIC UTILITY

INCIDENT LOCATION

County: PEMBINA
City: NECHE State: ND
Distance from City:
Direction from City: E

CLOSET ROAD IS 109 ST NE

RELEASED MATERIAL(S)

CHRIS Code: OIL Official Material Name: OIL: CRUDE
Also Known As:
Qty Released: 3000 BARREL(S)

DESCRIPTION OF INCIDENT

DISCHARGE OF MATERIAL FROM A PIPELINE DUE TO A LEAK. A PRESSURE DROP WAS DISCOVERED AT 2338 CST ON 08 JANUARY 2010, BUT THE LOCATION OF THE OIL WAS CONFIRMED AT APPROXIMATELY 0245 CST ON 09 JANUARY 2010.

INCIDENT DETAILS

Pipeline Type: TRANSMISSION
DOT Regulated: YES
Pipeline Above/Below Ground: BELOW
Exposed or Under Water: NO
Pipeline Covered: UNKNOWN

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN

INJURIES:	NO	Hospitalized:	Empl/Crew:	Passenger:
FATALITIES:	NO	Empl/Crew:	Passenger:	Occupant:
EVACUATIONS:	NO	Who Evacuated:	Radius/Area:	
Damages:	NO			

Closure Type		Description of Closure	Length of Closure	Direction of Closure	
Air:	N				
Road:	N				Major Artery: N
Waterway:	N				

Track: N

Passengers Transferred: NO
Environmental Impact: NO

Media Interest: NONE Community Impact due to Material:

REMEDIAL ACTIONS

VAC TRUCK USED, MOBILIZING TANKER TRUCKS FOR CLEAN UP, CONTRACTOR HAS BEEN HIRED

Release Secured: YES
Release Rate:
Estimated Release Duration:

WEATHER

Weather: CLEAR, -17ºF   Wind direction: S

ADDITIONAL AGENCIES NOTIFIED

Federal: NONE

State/Local: NONE

State/Local On Scene: NONE
State Agency Number:

NOTIFICATIONS BY NRC

USCG ICC (ICC ONI)
09-JAN-10 04:52

DHS PROTECTIVE SECURITY ADVISOR (PSA DESK)
09-JAN-10 04:52

DOT CRISIS MANAGEMENT CENTER (MAIN OFFICE)
09-JAN-10 04:52

U.S. EPA VIII (MAIN OFFICE)
09-JAN-10 05:03

NTL ENVMTL EMERG CENTRE CANADA (MAIN OFFICE)
09-JAN-10 04:52

NATIONAL INFRASTRUCTURE COORD CTR (MAIN OFFICE)
09-JAN-10 04:52

NOAA RPTS FOR ND (MAIN OFFICE)
09-JAN-10 04:52

PIPELINE & HAZMAT SAFETY ADMIN (OFFICE OF PIPELINE SAFETY (AUTO))
09-JAN-10 04:52

PACIFIC STRIKE TEAM (MAIN OFFICE)
09-JAN-10 04:53

ND EMERGENCY RESPONSE COMMISSION (MAIN OFFICE)
09-JAN-10 04:52

DOI/OEPC DENVER (MAIN OFFICE)
09-JAN-10 04:52

ADDITIONAL INFORMATION

NO ADDITIONAL INFORMATION.

***** END INCIDENT REPORT # 928066 *****

NOTICE: This report is required by 49 CFR Part 195. Failure to report can result in a civil penalty not to exceed $100,000 for each violation for each day that such violation persists except that the maximum civil penalty shall not exceed $1,000,000 as provided in 49 USC 60122.	OMB NO: 2137-0047 EXPIRATION DATE: 01/31/2013

U.S Department of Transportation Pipeline and Hazardous Materials Safety Administration	**Report Date:**	04/02/2010
	No.	20100021 - 17161 -------------------------- (DOT Use Only)

ACCIDENT REPORT - HAZARDOUS LIQUID PIPELINE SYSTEMS

A federal agency may not conduct or sponsor, and a person is not required to respond to, nor shall a person be subject to a penalty for failure to comply with a collection of information subject to the requirements of the Paperwork Reduction Act unless that collection of information displays a current valid OMB Control Number. The OMB Control Number for this information collection is 2137-0047. Public reporting for this collection of information is estimated to be approximately 10 hours per response (5 hours for a small release), including the time for reviewing instructions, gathering the data needed, and completing and reviewing the collection of information. All responses to this collection of information are mandatory. Send comments regarding this burden estimate or any other aspect of this collec ion of information, including suggestions for reducing this burden to: Information Collec ion Clearance Officer, PHMSA, Office of Pipeline Safety (PHP-30) 1200 New Jersey Avenue, SE, Washington, D.C. 20590.

INSTRUCTIONS

Important: *Please read the separate instructions for completing this form before you begin. They clarify the information requested and provide specific examples. If you do not have a copy of the instructions, you can obtain one from the PHMSA Pipeline Safety Community Web Page at http://www.phmsa.dot.gov/pipeline.*

PART A - KEY REPORT INFORMATION

Report Type: *(select all that apply)*	**Original:**	**Supplemental:**	**Final:**
		Yes	**Yes**

Last Revision Date:	01/16/2013
1. Operator's OPS-issued Operator Identification Number (OPID):	11169
2. Name of Operator	ENBRIDGE ENERGY, LIMITED PARTNERSHIP
3. Address of Operator:	
3a. Street Address	1100 LOUISIANA, SUITE 3300
3b. City	HOUSTON
3c. State	Texas
3d. Zip Code	77002
4. Local time *(24-hr clock)* and date of the Accident:	01/08/2010 23:38
5. Location of Accident:	
Latitude:	48.99555
Longitude:	-97.52554
6. National Response Center Report Number (if applicable):	928066
7. Local time *(24-hr clock)* and date of initial telephonic report to the National Response Center (if applicable):	01/09/2010 03:21
8. Commodity released: *(select only one, based on predominant volume released)*	Crude Oil
- Specify Commodity Subtype:	
- If "Other" Subtype, Descr be:	
- If Biofuel/Alternative Fuel and Commodity Subtype is Ethanol Blend, then % Ethanol Blend: %:	
- If Biofuel/Alternative Fuel and Commodity Subtype is Biodiesel, then Biodiesel Blend (e.g. B2, B20, B100): B	
9. Estimated volume of commodity released unintentionally (Barrels):	3,784.00
10. Estimated volume of intentional and/or controlled release/blowdown (Barrels):	
11. Estimated volume of commodity recovered (Barrels):	1,547.00
12. Were there fatalities?	No
- If Yes, specify the number in each category:	
12a. Operator employees	
12b. Contractor employees working for the Operator	
12c. Non-Operator emergency responders	
12d. Workers working on the right-of-way, but NOT associated with this Operator	
12e. General public	
12f. Total fatalities (sum of above)	
13. Were there injuries requiring inpatient hospitalization?	No
- If Yes, specify the number in each category:	
13a. Operator employees	
13b. Contractor employees working for the Operator	
13c. Non-Operator emergency responders	
13d. Workers working on the right-of-way, but NOT	

associated with this Operator	
13e. General public	
13f. Total injuries (sum of above)	
14. Was the pipeline/facility shut down due to the Accident?	Yes
- If No, Explain:	
- If Yes, complete Questions 14a and 14b: *(use local time, 24-hr clock)*	
14a. Local time and date of shutdown:	01/08/2010 23:41
14b. Local time pipeline/facility restarted:	01/13/2010 09:17
- Still shut down? (* Supplemental Report Required)	
15. Did the commodity ignite?	No
16. Did the commodity explode?	No
17. Number of general public evacuated:	0
18. Time sequence *(use local time, 24-hour clock)*:	
18a. Local time Operator identified Accident:	01/08/2010 23:38
18b. Local time Operator resources arrived on site:	01/09/2010 02:20
PART B - ADDITIONAL LOCATION INFORMATION	
1. Was the origin of Accident onshore?	Yes
If Yes, Complete Questions (2-12)	
If No, Complete Questions (13-15)	
- If Onshore:	
2. State:	North Dakota
3. Zip Code:	58265
4. City	NECHE
5. County or Parish	PEMBINA
6. Operator-designated location:	Milepost/Valve Station
Specify:	MP 774.18
7. Pipeline/Facility name:	
8. Segment name/ID:	LINE 2 MP 774.18
9. Was Accident on Federal land, other than the Outer Continental Shelf (OCS)?	No
10. Location of Accident:	Pipeline Right-of-way
11. Area of Accident (as found):	Underground
Specify:	Under soil
- If Other, Descr be:	
Depth-of-Cover (in):	42
12. Did Accident occur in a crossing?	No
- If Yes, specify below:	
- If Bridge crossing –	
Cased/ Uncased:	
- If Railroad crossing –	
Cased/ Uncased/ Bored/drilled	
- If Road crossing –	
Cased/ Uncased/ Bored/drilled	
- If Water crossing –	
Cased/ Uncased	
- Name of body of water, if commonly known:	
- Approx. water depth (ft) at the point of the Accident:	
- Select:	
- If Offshore:	
13. Approximate water depth (ft) at the point of the Accident:	
14. Origin of Accident:	
- In State waters - Specify:	
- State:	
- Area:	
- Block/Tract #:	
- Nearest County/Parish:	
- On the Outer Continental Shelf (OCS) - Specify:	
- Area:	
- Block #:	
15. Area of Accident:	
PART C - ADDITIONAL FACILITY INFORMATION	
1. Is the pipeline or facility:	Interstate
2. Part of system involved in Accident:	Onshore Pipeline, Including Valve Sites
- If Onshore Breakout Tank or Storage Vessel, Including Attached Appurtenances, specify:	
3. Item involved in Accident:	Pipe
- If Pipe, specify:	Pipe Seam

3a. Nominal diameter of pipe (in):	26
3b. Wall thickness (in):	.281
3c. SMYS (Specified Minimum Yield Strength) of pipe (psi):	52,000
3d. Pipe specification:	API 5L
3e. Pipe Seam , specify:	Flash Welded
- If Other, Descr be:	
3f. Pipe manufacturer:	A.O. SMITH
3g. Year of manufacture:	1954
3h. Pipeline coating type at point of Accident, specify:	Coal Tar
- If Other, Descr be:	
- If Weld, including heat-affected zone, specify:	
- If Other, Descr be:	
- If Valve, specify:	
- If Mainline, specify:	
- If Other, Descr be:	
3i. Manufactured by:	
3j. Year of manufacture:	
- If Tank/Vessel, specify:	
- If Other - Descr be:	
- If Other, descr be:	
4. Year item involved in Accident was installed:	1956
5. Material involved in Accident:	Carbon Steel
- If Material other than Carbon Steel, specify:	
6. Type of Accident Involved:	Rupture
- If Mechanical Puncture – Specify Approx. size:	
in. (axial) by	
in. (circumferential)	
- If Leak - Select Type:	
- If Other, Descr be:	
- If Rupture - Select Orientation:	Longitudinal
- If Other, Describe:	
Approx. size: in. (widest opening) by	5.5
in. (length circumferentially or axially)	50
- If Other – Describe:	

PART D - ADDITIONAL CONSEQUENCE INFORMATION

1. Wildlife impact:	No
1a. If Yes, specify all that apply:	
- Fish/aquatic	
- Birds	
- Terrestrial	
2. Soil contamination:	Yes
3. Long term impact assessment performed or planned:	Yes
4. Anticipated remediation:	Yes
4a. If Yes, specify all that apply:	
- Surface water	
- Groundwater	
- Soil	Yes
- Vegetation	
- Wildlife	
5. Water contamination:	No
5a. If Yes, specify all that apply:	
- Ocean/Seawater	
- Surface	
- Groundwater	
- Drinking water: *(Select one or both)*	
- Private Well	
- Public Water Intake	
5b. Estimated amount released in or reaching water (Barrels):	
5c. Name of body of water, if commonly known:	
6. At the location of this Accident, had the pipeline segment or facility been identified as one that "could affect" a High Consequence Area (HCA) as determined in the Operator's Integrity Management Program?	No
7. Did the released commodity reach or occur in one or more High Consequence Area (HCA)?	No
7a. If Yes, specify HCA type(s): *(Select all that apply)*	
- Commercially Navigable Waterway:	
Was this HCA identified in the "could affect" determination for this Accident site in the Operator's	

Integrity Management Program?	
- High Population Area:	
Was this HCA identified in the "could affect" determination for this Accident site in the Operator's Integrity Management Program?	
- Other Populated Area	
Was this HCA identified in the "could affect" determination for this Accident site in the Operator's Integrity Management Program?	
- Unusually Sensitive Area (USA) - Drinking Water	
Was this HCA identified in the "could affect" determination for this Accident site in the Operator's Integrity Management Program?	
- Unusually Sensitive Area (USA) - Ecological	
Was this HCA identified in the "could affect" determination for this Accident site in the Operator's Integrity Management Program?	
8. Estimated Property Damage:	
8a. Estimated cost of public and non-Operator private property damage	$ 150,000
8b. Estimated cost of commodity lost	$ 167,775
8c. Estimated cost of Operator's property damage & repairs	$ 76,940
8d. Estimated cost of Operator's emergency response	$ 1,800,000
8e. Estimated cost of Operator's environmental remediation	$ 2,000,000
8f. Estimated other costs	$ 0
Descr be:	
8g. Total estimated property damage (sum of above)	$ 4,194,715

PART E - ADDITIONAL OPERATING INFORMATION

1. Estimated pressure at the point and time of the Accident (psig):	725.00
2. Maximum Operating Pressure (MOP) at the point and time of the Accident (psig):	809.00
3. Describe the pressure on the system or facility relating to the Accident (psig):	Pressure did not exceed MOP
4. Not including pressure reductions required by PHMSA regulations (such as for repairs and pipe movement), was the system or facility relating to the Accident operating under an established pressure restriction with pressure limits below those normally allowed by the MOP?	No
- If Yes, Complete 4.a and 4.b below:	
4a. Did the pressure exceed this established pressure restriction?	
4b. Was this pressure restriction mandated by PHMSA or the State?	
5. Was "Onshore Pipeline, Including Valve Sites" OR "Offshore Pipeline, Including Riser and Riser Bend" selected in PART C, Question 2?	Yes
- If Yes - (*Complete 5a. – 5f. below)*	
5a. Type of upstream valve used to initially isolate release source:	Remotely Controlled
5b. Type of downstream valve used to initially isolate release source:	Remotely Controlled
5c. Length of segment isolated between valves (ft):	220,862
5d. Is the pipeline configured to accommodate internal inspection tools?	Yes
- If No, Which physical features limit tool accommodation? (*select all that apply)*	
- Changes in line pipe diameter	
- Presence of unsuitable mainline valves	
- Tight or mitered pipe bends	
- Other passage restrictions (i.e. unbarred tee's, projecting instrumentation, etc.)	
- Extra thick pipe wall (applicable only for magnetic flux leakage internal inspection tools)	
- Other -	
- If Other, Descr be:	
5e. For this pipeline, are there operational factors which significantly complicate the execution of an internal inspection tool run?	No
- If Yes, Which operational factors complicate execution? (*select all that apply*)	
- Excessive debris or scale, wax, or other wall buildup	
- Low operating pressure(s)	

- Low flow or absence of flow	
- Incompatible commodity	
- Other -	
- If Other, Descr be:	
5f. Function of pipeline system:	> 20% SMYS Regulated Trunkline/Transmission
6. Was a Supervisory Control and Data Acquisition (SCADA)-based system in place on the pipeline or facility involved in the Accident?	Yes
If Yes -	
6a. Was it operating at the time of the Accident?	Yes
6b. Was it fully functional at the time of the Accident?	Yes
6c. Did SCADA-based information (such as alarm(s), alert(s), event(s), and/or volume calculations) assist with the detection of the Accident?	Yes
6d. Did SCADA-based information (such as alarm(s), alert(s), event(s), and/or volume calculations) assist with the confirmation of the Accident?	Yes
7. Was a CPM leak detection system in place on the pipeline or facility involved in the Accident?	Yes
- If Yes:	
7a. Was it operating at the time of the Accident?	Yes
7b. Was it fully functional at the time of the Accident?	Yes
7c. Did CPM leak detection system information (such as alarm(s), alert(s), event(s), and/or volume calculations) assist with the detection of the Accident?	No
7d. Did CPM leak detection system information (such as alarm(s), alert(s), event(s), and/or volume calculations) assist with the confirmation of the Accident?	Yes
8. How was the Accident initially identified for the Operator?	Controller
- If Other, Specify:	
8a. If "Controller", "Local Operating Personnel", including contractors", "Air Patrol", or "Guard Patrol by Operator or its contractor" is selected in Question 8, specify the following:	Operator employee
9. Was an investigation initiated into whether or not the controller(s) or control room issues were the cause of or a contributing factor to the Accident?	Yes, specify investigation result(s): (select all that apply)
- If No, the Operator did not find that an investigation of the controller(s) actions or control room issues was necessary due to: *(provide an explanation for why the operator did not investigate)*	
- If Yes, specify investigation result(s): *(select all that apply)*	
- Investigation reviewed work schedule rotations, continuous hours of service (while working for the Operator), and other factors associated with fatigue	Yes
- Investigation did NOT review work schedule rotations, continuous hours of service (while working for the Operator), and other factors associated with fatigue	
Provide an explanation for why not:	
- Investigation identified no control room issues	Yes
- Investigation identified no controller issues	Yes
- Investigation identified incorrect controller action or controller error	
- Investigation identified that fatigue may have affected the controller(s) involved or impacted the involved controller(s) response	
- Investigation identified incorrect procedures	
- Investigation identified incorrect control room equipment operation	
- Investigation identified maintenance activities that affected control room operations, procedures, and/or controller response	
- Investigation identified areas other than those above:	
Descr be:	

PART F - DRUG & ALCOHOL TESTING INFORMATION

1. As a result of this Accident, were any Operator employees tested under the post-accident drug and alcohol testing requirements of DOT's Drug & Alcohol Testing regulations?	No
- If Yes:	
1a. Specify how many were tested:	
1b. Specify how many failed:	

2. As a result of this Accident, were any Operator contractor employees tested under the post-accident drug and alcohol testing requirements of DOT's Drug & Alcohol Testing regulations?	No
- If Yes:	
2a. Specify how many were tested:	
2b. Specify how many failed:	

PART G – APPARENT CAUSE

Select only one box from PART G in shaded column on left representing the APPARENT Cause of the Accident, and answer the questions on the right. Describe secondary, contributing or root causes of the Accident in the narrative (PART H).

Apparent Cause:	G5 - Material Failure of Pipe or Weld
G1 - Corrosion Failure - only one **sub-cause** can be picked from shaded left-hand column	
External Corrosion:	
Internal Corrosion:	
- If External Corrosion:	
1. Results of visual examination:	
- If Other, Describe:	
2. Type of corrosion: *(select all that apply)*	
- Galvanic	
- Atmospheric	
- Stray Current	
- Microbiological	
- Selective Seam	
- Other:	
- If Other, Describe:	
3. The type(s) of corrosion selected in Question 2 is based on the following: *(select all that apply)*	
- Field examination	
- Determined by metallurgical analysis	
- Other:	
- If Other, Describe:	
4. Was the failed item buried under the ground?	
- If Yes :	
4a. Was failed item considered to be under cathodic protection at the time of the Accident?	
If Yes - Year protection started:	
4b. Was shielding, tenting, or disbonding of coating evident at the point of the Accident?	
4c. Has one or more Cathodic Protection Survey been conducted at the point of the Accident?	
If "Yes, CP Annual Survey" – Most recent year conducted:	
If "Yes, Close Interval Survey" – Most recent year conducted:	
If "Yes, Other CP Survey" – Most recent year conducted:	
- If No:	
4d. Was the failed item externally coated or painted?	
5. Was there observable damage to the coating or paint in the vicinity of the corrosion?	
- If Internal Corrosion:	
6. Results of visual examination:	
- Other:	
7. Type of corrosion *(select all that apply)*: -	
- Corrosive Commodity	
- Water drop-out/Acid	
- Microbiological	
- Erosion	
- Other:	
- If Other, Describe:	
8. The cause(s) of corrosion selected in Question 7 is based on the following *(select all that apply)*: -	
- Field examination	
- Determined by metallurgical analysis	
- Other:	
- If Other, Describe:	
9. Location of corrosion *(select all that apply)*: -	
- Low point in pipe	
- Elbow	
- Other:	

- If Other, Descr be:	
10. Was the commodity treated with corrosion inhibitors or biocides?	
11. Was the interior coated or lined with protective coating?	
12. Were cleaning/dewatering pigs (or other operations) routinely utilized?	
13. Were corrosion coupons routinely utilized?	
Complete the following if any Corrosion Failure sub-cause is selected AND the "Item Involved in Accident" (from PART C, Question 3) is Tank/Vessel.	
14. List the year of the most recent inspections:	
14a. API Std 653 Out-of-Service Inspection	
- No Out-of-Service Inspection completed	
14b. API Std 653 In-Service Inspection	
- No In-Service Inspection completed	
Complete the following if any Corrosion Failure sub-cause is selected AND the "Item Involved in Accident" (from PART C, Question 3) is Pipe or Weld.	
15. Has one or more internal inspection tool collected data at the point of the Accident?	
15a. If Yes, for each tool used, select type of internal inspection tool and indicate most recent year run: -	
- Magnetic Flux Leakage Tool	
Most recent year:	
- Ultrasonic	
Most recent year:	
- Geometry	
Most recent year:	
- Caliper	
Most recent year:	
- Crack	
Most recent year:	
- Hard Spot	
Most recent year:	
- Combination Tool	
Most recent year:	
- Transverse Field/Triaxial	
Most recent year:	
- Other	
Most recent year:	
Descr be:	
16. Has one or more hydrotest or other pressure test been conducted since original construction at the point of the Accident?	
If Yes -	
Most recent year tested:	
Test pressure:	
17. Has one or more Direct Assessment been conducted on this segment?	
- If Yes, and an investigative dig was conducted at the point of the Accident::	
Most recent year conducted:	
- If Yes, but the point of the Accident was not identified as a dig site:	
Most recent year conducted:	
18. Has one or more non-destructive examination been conducted at the point of the Accident since January 1, 2002?	
18a. If Yes, for each examination conducted since January 1, 2002, select type of non-destructive examination and indicate most recent year the examination was conducted:	
- Radiography	
Most recent year conducted:	
- Guided Wave Ultrasonic	
Most recent year conducted:	
- Handheld Ultrasonic Tool	
Most recent year conducted:	
- Wet Magnetic Particle Test	
Most recent year conducted:	
- Dry Magnetic Particle Test	
Most recent year conducted:	
- Other	
Most recent year conducted:	
Descr be:	
G2 - Natural Force Damage - only one **sub-cause** can be picked from shaded left-handed column	
Natural Force Damage – Sub-Cause:	
- If Earth Movement, NOT due to Heavy Rains/Floods:	
1. Specify:	

- If Other, Descr be:	
- If Heavy Rains/Floods:	
2. Specify:	
- If Other, Descr be:	
- If Lightning:	
3. Specify:	
- If Temperature:	
4. Specify:	
- If Other, Descr be:	
- If High Winds:	
- If Other Natural Force Damage:	
5. Describe:	
Complete the following if any Natural Force Damage sub-cause is selected.	
6. Were the natural forces causing the Accident generated in conjunction with an extreme weather event?	
6a. If Yes, specify: *(select all that apply)*	
- Hurricane	
- Tropical Storm	
- Tornado	
- Other	
- If Other, Descr be:	
G3 - Excavation Damage - only one **sub-cause** can be picked from shaded left-hand column	
Excavation Damage – Sub-Cause:	
- If Excavation Damage by Operator (First Party):	
- If Excavation Damage by Operator's Contractor (Second Party):	
- If Excavation Damage by Third Party:	
- If Previous Damage due to Excavation Activity:	
Complete Questions 1-5 ONLY IF the "Item Involved in Accident" (from PART C, Question 3) is Pipe or Weld.	
1. Has one or more internal inspection tool collected data at the point of the Accident?	
1a. If Yes, for each tool used, select type of internal inspection tool and indicate most recent year run: -	
- Magnetic Flux Leakage	
Most recent year conducted:	
- Ultrasonic	
Most recent year conducted:	
- Geometry	
Most recent year conducted:	
- Caliper	
Most recent year conducted:	
- Crack	
Most recent year conducted:	
- Hard Spot	
Most recent year conducted:	
- Combination Tool	
Most recent year conducted:	
- Transverse Field/Triaxial	
Most recent year conducted:	
- Other	
Most recent year conducted:	
Descr be:	
2. Do you have reason to believe that the internal inspection was completed BEFORE the damage was sustained?	
3. Has one or more hydrotest or other pressure test been conducted since original construction at the point of the Accident?	
- If Yes:	
Most recent year tested:	
Test pressure (psig):	
4. Has one or more Direct Assessment been conducted on the pipeline segment?	
- If Yes, and an investigative dig was conducted at the point of the Accident:	
Most recent year conducted:	
- If Yes, but the point of the Accident was not identified as a dig site:	
Most recent year conducted:	

5. Has one or more non-destructive examination been conducted at the point of the Accident since January 1, 2002?	
5a. If Yes, for each examination, conducted since January 1, 2002, select type of non-destructive examination and indicate most recent year the examination was conducted:	
- Radiography	
Most recent year conducted:	
- Guided Wave Ultrasonic	
Most recent year conducted:	
- Handheld Ultrasonic Tool	
Most recent year conducted:	
- Wet Magnetic Particle Test	
Most recent year conducted:	
- Dry Magnetic Particle Test	
Most recent year conducted:	
- Other	
Most recent year conducted:	
Descr be:	
Complete the following if Excavation Damage by Third Party is selected as the sub-cause.	
6. Did the operator get prior notification of the excavation activity?	
6a. If Yes, Notification received from: *(select all that apply)* -	
- One-Call System	
- Excavator	
- Contractor	
- Landowner	
Complete the following mandatory CGA-DIRT Program questions if any Excavation Damage sub-cause is selected.	
7. Do you want PHMSA to upload the following information to CGA-DIRT (www.cga-dirt.com)?	
8. Right-of-Way where event occurred: *(select all that apply)* -	
- Public	
- If "Public", Specify:	
- Private	
- If "Private", Specify:	
- Pipeline Property/Easement	
- Power/Transmission Line	
- Railroad	
- Dedicated Public Utility Easement	
- Federal Land	
- Data not collected	
- Unknown/Other	
9. Type of excavator:	
10. Type of excavation equipment:	
11. Type of work performed:	
12. Was the One-Call Center notified?	
12a. If Yes, specify ticket number:	
12b. If this is a State where more than a single One-Call Center exists, list the name of the One-Call Center notified:	
13. Type of Locator:	
14. Were facility locate marks vis ble in the area of excavation?	
15. Were facilities marked correctly?	
16. Did the damage cause an interruption in service?	
16a. If Yes, specify duration of the interruption (hours)	
17. Description of the CGA-DIRT Root Cause *(select only the one predominant first level CGA-DIRT Root Cause and then, where available as a choice, the one predominant second level CGA-DIRT Root Cause as well):*	
Root Cause:	
- If One-Call Notification Practices Not Sufficient, specify:	
- If Locating Practices Not Sufficient, specify:	
- If Excavation Practices Not Sufficient, specify:	
- If Other/None of the Above, explain:	
G4 - Other Outside Force Damage - *only one **sub-cause** can be selected from the shaded left-hand column*	
Other Outside Force Damage – Sub-Cause:	
- If Nearby Industrial, Man-made, or Other Fire/Explosion as Primary Cause of Incident:	
- If Damage by Car, Truck, or Other Motorized Vehicle/Equipment NOT Engaged in Excavation:	
1. Vehicle/Equipment operated by:	
- If Damage by Boats, Barges, Drilling Rigs, or Other Maritime Equipment or Vessels Set Adrift or Which Have Otherwise Lost Their Mooring:	

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2. Select one or more of the following IF an extreme weather event was a factor:	
- Hurricane	
- Tropical Storm	
- Tornado	
- Heavy Rains/Flood	
- Other	
- If Other, Descr be:	
- If Routine or Normal Fishing or Other Maritime Activity NOT Engaged in Excavation:	
- If Electrical Arcing from Other Equipment or Facility:	
- If Previous Mechanical Damage NOT Related to Excavation:	
Complete Questions 3-7 ONLY IF the "Item Involved in Accident" (from PART C, Question 3) is Pipe or Weld.	
3. Has one or more internal inspection tool collected data at the point of the Accident?	
3a. If Yes, for each tool used, select type of internal inspection tool and indicate most recent year run:	
- Magnetic Flux Leakage	
Most recent year conducted:	
- Ultrasonic	
Most recent year conducted:	
- Geometry	
Most recent year conducted:	
- Caliper	
Most recent year conducted:	
- Crack	
Most recent year conducted:	
- Hard Spot	
Most recent year conducted:	
- Combination Tool	
Most recent year conducted:	
- Transverse Field/Triaxial	
Most recent year conducted:	
- Other	
Most recent year conducted:	
Descr be:	
4. Do you have reason to believe that the internal inspection was completed BEFORE the damage was sustained?	
5. Has one or more hydrotest or other pressure test been conducted since original construction at the point of the Accident?	
- If Yes:	
Most recent year tested:	
Test pressure (psig):	
6. Has one or more Direct Assessment been conducted on the pipeline segment?	
- If Yes, and an investigative dig was conducted at the point of the Accident:	
Most recent year conducted:	
- If Yes, but the point of the Accident was not identified as a dig site:	
Most recent year conducted:	
7. Has one or more non-destructive examination been conducted at the point of the Accident since January 1, 2002?	
7a. If Yes, for each examination conducted since January 1, 2002, select type of non-destructive examination and indicate most recent year the examination was conducted:	
- Radiography	
Most recent year conducted:	
- Guided Wave Ultrasonic	
Most recent year conducted:	
- Handheld Ultrasonic Tool	
Most recent year conducted:	
- Wet Magnetic Particle Test	
Most recent year conducted:	
- Dry Magnetic Particle Test	
Most recent year conducted:	
- Other	
Most recent year conducted:	
Descr be:	
- If Intentional Damage:	
8. Specify:	
- If Other, Descr be:	
- If Other Outside Force Damage:	
9. Describe:	

G5 - Material Failure of Pipe or Weld - only one **sub-cause** can be selected from the shaded left-hand column	
Use this section to report material failures ONLY IF the "Item Involved in Accident" (from PART C, Question 3) is "Pipe" or "Weld."	
Material Failure of Pipe or Weld – Sub-Cause:	Original Manufacturing-related (NOT girth weld or other welds formed in the field)
1. The sub-cause selected below is based on the following: *(select all that apply)*	
- Field Examination	
- Determined by Metallurgical Analysis	Yes
- Other Analysis	
- If "Other Analysis", Descr be:	
- Sub-cause is Tentative or Suspected; Still Under Investigation (Supplemental Report required)	
- If Construction, Installation, or Fabrication-related:	
2. List contr buting factors: *(select all that apply)*	
- Fatigue or Vibration-related	
Specify:	
- If Other, Descr be:	
- Mechanical Stress:	
- Other	
- If Other, Descr be:	
- If Original Manufacturing-related (NOT girth weld or other welds formed in the field):	
2. List contr buting factors: *(select all that apply)*	
- Fatigue or Vibration-related:	Yes
Specify:	Pressure-related
- If Other, Descr be:	
- Mechanical Stress:	
- Other	
- If Other, Descr be:	
- If Environmental Cracking-related:	
3. Specify:	
- Other - Describe:	
Complete the following if any Material Failure of Pipe or Weld sub-cause is selected.	
4. Additional factors: (*select all that apply*):	
- Dent	
- Gouge	
- Pipe Bend	
- Arc Burn	
- Crack	Yes
- Lack of Fusion	
- Lamination	
- Buckle	
- Wrinkle	
- Misalignment	Yes
- Burnt Steel	
- Other:	Yes
- If Other, Descr be:	Peaking
5. Has one or more internal inspection tool collected data at the point of the Accident?	Yes
5a. If Yes, for each tool used, select type of internal inspection tool and indicate most recent year run:	
- Magnetic Flux Leakage	Yes
Most recent year run:	2007
- Ultrasonic	
Most recent year run:	
- Geometry	
Most recent year run:	
- Caliper	Yes
Most recent year run:	2009
- Crack	Yes
Most recent year run:	2009
- Hard Spot	
Most recent year run:	
- Combination Tool	
Most recent year run:	
- Transverse Field/Triaxial	
Most recent year run:	
- Other	
Most recent year run:	

Descr be:	
6. Has one or more hydrotest or other pressure test been conducted since original construction at the point of the Accident?	Yes
- If Yes:	
Most recent year tested:	1994
Test pressure (psig):	1,124.00
7. Has one or more Direct Assessment been conducted on the pipeline segment?	No
- If Yes, and an investigative dig was conducted at the point of the Accident -	
Most recent year conducted:	
- If Yes, but the point of the Accident was not identified as a dig site -	
Most recent year conducted:	
8. Has one or more non-destructive examination(s) been conducted at the point of the Accident since January 1, 2002?	No
8a. If Yes, for each examination conducted since January 1, 2002, select type of non-destructive examination and indicate most recent year the examination was conducted: -	
- Radiography	
Most recent year conducted:	
- Guided Wave Ultrasonic	
Most recent year conducted:	
- Handheld Ultrasonic Tool	
Most recent year conducted:	
- Wet Magnetic Particle Test	
Most recent year conducted:	
- Dry Magnetic Particle Test	
Most recent year conducted:	
- Other	
Most recent year conducted:	
Descr be:	
G6 – Equipment Failure - only one **sub-cause** can be selected from the shaded left-hand column	
Equipment Failure – Sub-Cause:	
- If Malfunction of Control/Relief Equipment:	
1. Specify: *(select all that apply)* -	
- Control Valve	
- Instrumentation	
- SCADA	
- Communications	
- Block Valve	
- Check Valve	
- Relief Valve	
- Power Failure	
- Stopple/Control Fitting	
- ESD System Failure	
- Other	
- If Other – Descr be:	
- If Pump or Pump-related Equipment:	
2. Specify:	
- If Other – Descr be:	
- If Threaded Connection/Coupling Failure:	
3. Specify:	
- If Other – Descr be:	
- If Non-threaded Connection Failure:	
4. Specify:	
- If Other – Descr be:	
- If Defective or Loose Tubing or Fitting:	
- If Failure of Equipment Body (except Pump), Tank Plate, or other Material:	
- If Other Equipment Failure:	
5. Describe:	
Complete the following if any Equipment Failure sub-cause is selected.	
6. Additional factors that contributed to the equipment failure: *(select all that apply)*	
- Excessive vibration	
- Overpressurization	
- No support or loss of support	
- Manufacturing defect	

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- Loss of electricity	
- Improper installation	
- Mismatched items (different manufacturer for tubing and tubing fittings)	
- Dissimilar metals	
- Breakdown of soft goods due to compatibility issues with transported commodity	
- Valve vault or valve can contributed to the release	
- Alarm/status failure	
- Misalignment	
- Thermal stress	
- Other	
- If Other, Descr be:	

G7 - Incorrect Operation - only one **sub-cause** can be selected from the shaded left-hand column

Incorrect Operation – Sub-Cause:	
Damage by Operator or Operator's Contractor NOT Related to Excavation and NOT due to Motorized Vehicle/Equipment Damage	No
Tank, Vessel, or Sump/Separator Allowed or Caused to Overfill or Overflow	No
1. Specify:	
- If Other, Descr be:	
Valve Left or Placed in Wrong Position, but NOT Resulting in a Tank, Vessel, or Sump/Separator Overflow or Facility Overpressure	No
Pipeline or Equipment Overpressured	No
Equipment Not Installed Properly	No
Wrong Equipment Specified or Installed	No
Other Incorrect Operation	No
2. Describe:	
Complete the following if any Incorrect Operation sub-cause is selected.	
3. Was this Accident related to *(select all that apply)*: -	
- Inadequate procedure	
- No procedure established	
- Failure to follow procedure	
- Other:	
- If Other, Descr be:	
4. What category type was the activity that caused the Accident?	
5. Was the task(s) that led to the Accident identified as a covered task in your Operator Qualification Program?	
5a. If Yes, were the individuals performing the task(s) qualified for the task(s)?	

G8 - Other Accident Cause - only one **sub-cause** can be selected from the shaded left-hand column

Other Accident Cause – Sub-Cause:	
- If Miscellaneous:	
1. Describe:	
- If Unknown:	
2. Specify:	

PART H - NARRATIVE DESCRIPTION OF THE ACCIDENT

On January 8, 2010 at 23:38 local time, the Enbridge Control Centre noticed a sudden drop in pressure on line 2 and immediately shut the pipeline down. Enbridge Superior Region Operations and Central Region Operations (Canada) were notified and dispatched. Upon arrival, company personnel discovered a leak estimated at approximately 3,000 barrels contained primarily to the Company right-of-way. Additional Company resources were immediately dispatched to control and clean-up the released oil, investigate the cause of the release and to repair the pipeline for retum to service. The National Response Center and North Dakota State Incident Reporting Hotlines were contacted.

The preliminary cause of the pipeline rupture was a failure in a section of the longitudinal seam of the pipe. The affected pipe segment was removed during the repair and has been sent to a third-party metallurgical lab for analysis. The pipeline was repaired and was restarted on January 13, 2010 at approximately 09:17 local time. Site dean-up (soil excavation) is currently still being completed; however no long term remediation activities are expected.

A PHMSA representative was onsite during the emergency response and repair activi ies and was involved with the retum to service plan. Enbridge will be working withPHMSA during the investigation and will be sharing he results of the investigation/failure analysis.

Supplemental/Final Report (Update as of April 1,, 2011)

The metallurgical investigation that was conducted concluded that the failure was the result of a fatigue crack that ini iated at a location along the flash welded seam, from the inside pipe diameter. The investigation revealed no pre-exis ing welding or pipe body defects, or material property deficiencies hat could have contributed to crack initiation, crack growth, or final failure. Weld misalignment and peaking were observed at the initiation location. The crack grew in service under cyclic loads until it reached a critical size and ruptured.

Site clean up is completed and the leak site has officially been closed by the Environmental Health Section of the North Dakota Department of Health. Approximately 4760 cubic yards of contaminated soil were disposed of at an approved land fill.

File Full Name

PART I - PREPARER AND AUTHORIZED SIGNATURE

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Appendix D

Metallurgical Analysis

This document is on file at PHMSA