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November 7, 2017

Honorable Bill Schuette
Attorney General
State of Michigan
Department of Attorney General
G. Mennen Williams Building, 7th Floor
525 W. Ottawa Street
Lansing, Michigan 48909

Ms. C. Heidi Grether
Director
Michigan Department of Environmental Quality
Constitution Hall
525 West Allegan Street
Lansing, MI 48933

Mr. Keith Creagh
Director
Michigan Department of Natural Resources
Executive Division
525 West Allegan Street
Lansing, MI 48933

Re: Line 5 Dual Pipelines at the Straits of Mackinac and Enbridge Submittal of Hydrotest Report

Dear Attorney General Schuette, Director Grether and Director Creagh:

This letter is in response to the State's request to receive copies of final reports that are issued relating to certain information regarding the operation and maintenance of the Line 5 dual pipelines at the Straits of Mackinac.

Please find enclosed the redacted version of the Hydrotest Report for the hydrotests performed on the East and West legs of the 20 inch portions of Line 5 crossing the Straits of Mackinac.

If you have any questions about this submittal, please do not hesitate to contact me.

Sincerely,

ENBRIDGE ENERGY, LIMITED PARTNERSHIP
By Enbridge Pipelines (Lakehead) L.L.C.
Its General Partner

Bradley F. Shamla
Vice President, U.S. Operations

cc: Valerie Brader, Executive Director, Michigan Agency for Energy

Enclosure

REDACTED SUBMITTAL -- PUBLIC COPY

LAKE SUPERIOR CONSULTING

Final Report: Enbridge Line 5 - East Straits of Mackinac Hydrostatic Test

Prepared for:
Enbridge Energy, Limited Partnership
AFE: 20007132
Hydrostatic Test #: 5-17-153

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SIGNATURE PAGE

WRITTEN BY:

MEGAN HALVER



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AUGUST 28, 2017

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INTEGRITY ENGINEER

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GARY ZUNKEL, PE



SIGNATURE

AUGUST 28, 2017

DATE

SENIOR DIRECTOR OF INTEGRITY MANAGEMENT

DULUTH, MN

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KORY JOHNSON, PE



SIGNATURE

AUGUST 28, 2017

DATE

PIPELINE ENGINEER

DULUTH, MN

LAKE SUPERIOR CONSULTING, LLC

1 EXECUTIVE SUMMARY

The purpose of this report is to summarize and document the results from Test # 5-17-153, the East segment of the Line 5 Straits of Mackinac Hydrostatic Pressure Test for Enbridge US Special Projects. The test was conducted by Milbar who was subcontracted through UPI, the general contractor. Site Engineers Megan Halver and Kory Johnson observed the test. Gary Zunkel monitored the test remotely. The Line 5 Straits of Mackinac Hydrostatic Pressure Test fulfills Enbridge's requirements per Paragraph 25.f and 71.b of the Consent Decree for U.S. vs. Enbridge Energy, Limited Partnership, et. Al., (Civil Action No: 1:16-cv-914).

An 8-hour continuous pressure test was conducted. The Strength Test was completed with pressure held above 1200 psi at all locations on the pipe segment for a duration greater than 4.25 hours. The leak test was completed with the pressure held above 660 psi at all locations on the pipe segment for a duration greater than 4.25 hours.

2 TEST SPECIFICS

2.1 TEST SECTION DESCRIPTION

This hydrostatic test was comprised of the following elements:

- Test #: 5-17-153
- Test Segment: East Segment of Line 5 across the Straits of Mackinac
  - Trap 1475.68-5.1-ST-2 *(STA 19936+01)* to Trap 1479.55-5.1-ST-1 *(STA 20141+22)*
  - *Note: Stationing and Milepost Values are from trap to trap based on 2016 Geopig Data*
- Length: 4.09 Miles
- Test Site Location: North Straits Pipe Yard @ MP 1475.68, STA 19936+01
- Mainline Pipe Summary: 20" OD x 0.812" WT x Grade A seamless pipe
  - *Note: Additional Facility piping, valves, flanges, and fittings were also tested. A full list of all materials has been included in the Pressure Test Plans in Appendix 1.*

2.2 TEST MEDIUM

Line 5 East Straits Test # 5-17-153 was tested with water on 6/16/2017. Additional details on fill, stabilization, dewatering, and water quality are outlined in Appendix 4.

2.3 TEST PRESSURE RANGES

All components were tested to 1200 psi (minimum) for 4.25 hours, followed by 660 psi (minimum) for 4.25 hours. Hydrostatic test pressures were established based on the following elevation profiles and are outlined in the Project Hydrotest Plan, located in Appendix 3.

2.4 ELEVATION PROFILE

The elevation at the test site was 586.4 feet at the North Straits Pipe Yard. This is the same elevation as the Deadweight in the test trailer. Minimum elevation of the pipeline segment is 339.4 feet and maximum elevation is 651.7 feet.

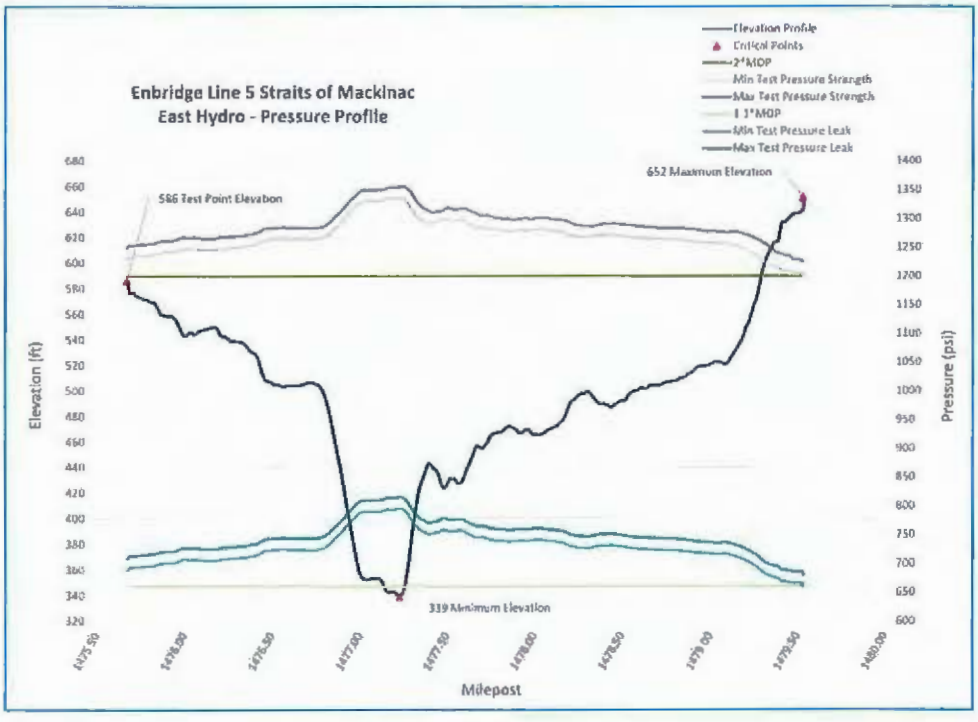


Figure 1. Test Pressure Profile

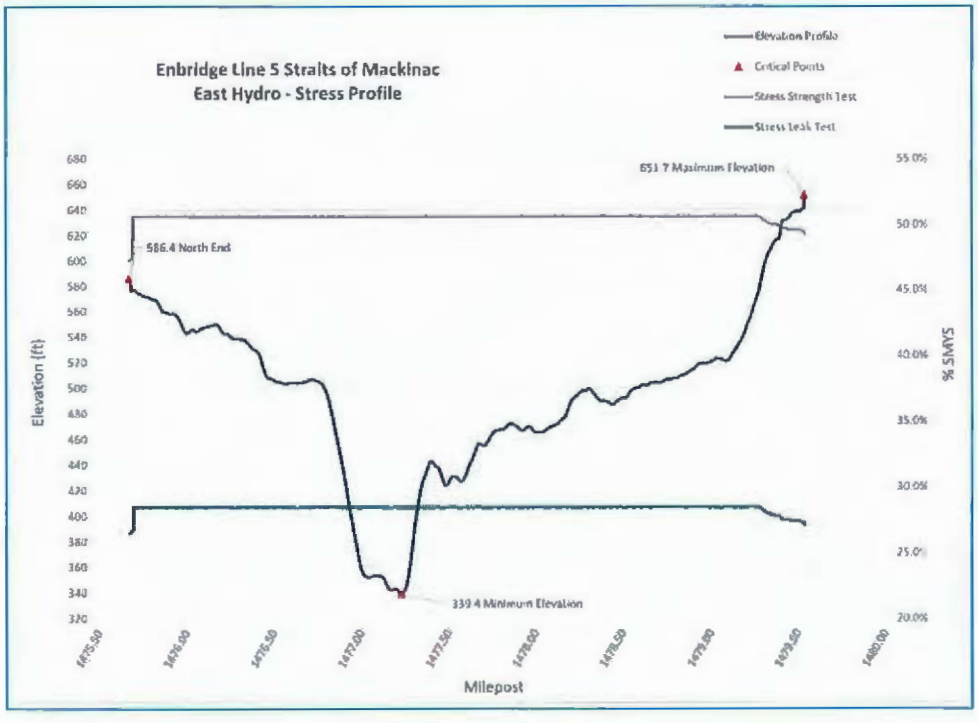


Figure 2. Test Stress Profile

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2.5 EQUIPMENT SETUP

Milbar conducted the test using Test Trailer 25. The equipment set-up by Milbar included:

- North Straits Pipe Yard, Test Site (Milepost 1475.68)
  - 1 Deadweights, *for strength test* (S/N: 26747)
  - 1 Deadweights, *for leak test* (S/N: 883)
  - 1 Pressure Gauge (S/N: 218170D0023)
  - 1 Pressure Recorder (S/N: 102111-2)
  - 1 Back-up Pressure Recorder (S/N: 1215152)
  - 1 Pressure & Temperature Recorder *(Ambient, Pipe, and Ground)* (S/N: 1000225)
  - 1 Above Grade Pipe Temperature Recorder (S/N: 14342077)
  - 1 Back-up Above Grade Pipe Temperature Chart (S/N: 0807137)
- Northeast Temp Probe (Milepost 1475.74) REDACTED
  - 1 Pipe & Ground Temperature Recorder (S/N: 14342071)
- Southeast Temp Probe (Milepost 1479.38) REDACTED
  - 1 Pipe & Ground Temperature Recorder (S/N: 15015179)
- South Mackinaw Station, End Site (Milepost 1479.54)
  - 1 Back-up Pressure Recorder (S/N: 202E-52081)
  - 1 Pressure Gauge (S/N: 218170D0020)
  - 1 Above Grade Pipe Temperature Recorder (S/N: 06215056)

Details and photos of all equipment locations and certifications are outlined in Appendix 2.

3 TEST OVERVIEW

3.1 SUMMARY OF TEST

The East segment of Line 5, Test # 5-17-153, began at 7:15 AM on 6/16/2017 and concluded at 5:30 PM on 6/16/2017. The test included a 4.25-hour strength test where pressure on all points in the test segment were maintained above 1200 psi followed by a 4.25-hour leak test where pressure on all points in the test segment were maintained above 660 psi.

All times included in this report and on all documentation are in Eastern Daylight Time (EDT).

Official signed test plans, logs, and charts can be found in Appendix 1.

3.2 PRESSURIZATION AND PV PLOT

A 0% hold on all charts began at 4:00 AM on 6/16/2017 and was completed at 4:30 AM. Once the 0% hold was complete, line pressure of 562 psi was reintroduced to the recorders. Pressurization began at 5:07 AM, starting at a pressure of 562 psi.

At 5:14 AM, a 50% pressure of 620 psi was reached. A 15-minute hold was commenced at the 50% pressure. At 5:31 AM, pressurization began to 75% with a starting pressure of 621 psi. A PV plot was completed during pressurization from 50% to 75%. This PV plot resulted in an average of 49.9 strokes per 10 psi, using a 0.258 gal/stroke pump, with a maximum of 52 and minimum of 46. Pressurization rate did not exceed the outlined maximum of 10 psi/minute.

At 6:05 AM, a 75% pressure of 930 psi was reached. A 15-minute hold was commenced at the 75% pressure. At 6:31 AM, pressurization began to strength test pressure with a starting pressure of 930 psi. A PV plot was completed during pressurization from 75% to strength test pressure. The PV plot from 75% to strength test pressure resulted in an average of 49.7 strokes per 10 psi with a maximum of 53 and minimum of 46. Pressurization rate did not exceed the outlined maximum of 10 psi/minute.

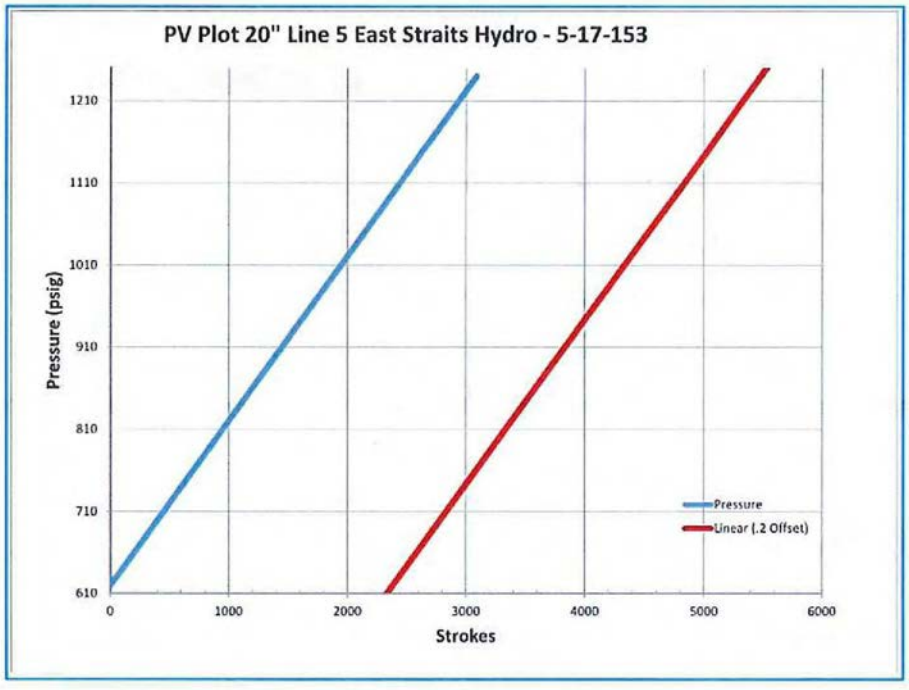


Figure 3. Pressure vs Volume Plot

3.3 STRENGTH TEST

At 7:05 AM, the strength test pressure of 1240 psi was reached. The start of the strength test began at 7:15 AM with a pressure of 1240 psi. The pressure remained at 1240 psi until the strength test was completed at 11:30 AM.

Location	Elevation	Actual Min. Pressure	Actual Max. Pressure
Deadweight	586.4'	1240 psi	1240 psi
Maximum Elevation	651.7'	1212 psi	1212 psi
Minimum Elevation	339.4'	1347 psi	1347 psi

Table 1. Resulting Minimum and Maximum Strength Test Pressures

Depressurization following the strength test began at 11:38 AM. At 12:14 PM, a 75% pressure of 930 psi was reached. A 15-minute hold was commenced at 75% pressure. At 12:30 PM, depressurization to leak test pressure began with a starting pressure of 931 psi. Depressurization did not exceed the outlined maximum of 10 psi/minute.

3.4 LEAK TEST

At 12:57 PM, the leak test pressure of 701 psi was reached. The start of the leak test began at 1:15 PM with a pressure of 701 psi. At 1:45 PM, deadweight pressure increased to 702 psi. At 4:45 PM, deadweight pressure increased to 703 psi. The pressure remained at 703 psi until the leak test was completed at 5:30 PM.

Location	Elevation	Actual Min. Pressure	Actual Max. Pressure
Deadweight	586.4'	701 psi	703 psi
Maximum Elevation	651.7'	673 psi	675 psi
Minimum Elevation	339.4'	808 psi	810 psi

Table 2. Resulting Minimum and Maximum Leak Test Pressures

Depressurization following the leak test began at 5:32 PM. At 5:39 PM, a 50% pressure of 620 psi was reached. A 15-minute hold was commenced at 50% pressure. At 6:01 PM, depressurization began with a starting pressure of 620 psi. At 6:55 PM, a pressure of 100 psi was reached. Upon reaching 50 psi, pressure recorders were bled to 0 psi for a 15-minute 0% hold. Depressurization rate did not exceed the outlined maximum of 90 psi/minute.

3.5 WEATHER CONDITIONS

The average temperature for 6/16/2017 was 72°F with a high of 84°F and low of 58°F seen during the hydrostatic test. It was sunny with winds from 0-10 MPH during the hydrostatic test.

3.6 TEMPERATURE SUMMARY

A summary table of temperature data throughout the test is provided in Appendix 5. A memo explaining temperature vs. pressure correlation calculations and methods can be found in Appendix 3.

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4 TEST ACCEPTANCE

4.1 STRENGTH TEST

Pressure maintained constant at 1240 psi during the 4.25-hour Strength Test. Pressure within an isolated test segment is influenced by the temperature of the water within that segment, and the gross amount of pressure change across the segment depends on the length of pipe exposed to each heating/cooling influence, as shown further in Appendix 3, 3. Temperature vs Pressure Correlation. During the strength test, the following influences were present:

- Fluctuations in temperature were observed in the above grade pipe temperature and below grade pipe temperature. A slight decrease of less than 1°F was observed in the below grade pipe temperature. An increase in above grade pipe temperature of approximately 2°F was observed throughout the Strength Test. The length of below grade pipe is significantly greater than the above grade pipe so any change in temperature of below grade pipe will influence pressure much more than temperature changes in the above grade pipe. The net change in pressure resulting from the temperature change in above grade and below grade pipe results in less than a 0.5 psi decrease in pressure.
- The effect of the lake water on the submerged portion of the pipe has the most significant effect on changes in pressure. The lake water temperature recordings fluctuated approximately ~0.3°F from the beginning to the end of the strength test. If this temperature change had transferred directly to the water inside the pipe, the resulting pressure change would have been a 2 psi fluctuation.

The minimal change in lake water temperature in combination with the above and below grade pipe temperatures result in a zero-net pressure effect on the pipeline. A 0 psi pressure change during the Strength Test is within the resolution of the instrumentation and within the calculated response due to the observed temperature changes.

Strength Test pressure was held at a 1240 psi for a duration of 4 hours and 15 minutes. Pressures remained within the allowable Strength Test range of 1229 psi – 1249 psi, and a minimum of a 4.25-hour hold was completed.

4.2 LEAK TEST

Pressure increased 2 psi during the 4.25-hour Leak Test. As with the strength test, pressure fluctuations were influenced by corresponding fluctuations in temperature during the leak test. During the leak test, the following influences were present:

- An average of 0.5°F decrease was observed on the below grade pipe during the 4.25-hour Leak Test, which corresponds to a 0.5 psi decrease in pressure.
- The above grade pipe temperature increased on average approximately 3°F, which corresponds to a 0.6 psi increase in pressure.

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- The lake water temperature recordings fluctuated approximately ~0.4°F throughout the Leak Test with an upward trend. If this temperature change had transferred directly to the water inside the pipe, the result would have been a 3 psi increase.

The net effect of minimal temperature fluctuations throughout the Leak Test had a slight upward trend resulting from the slight increase in observed water temperature recordings. The pressure increase of 2 psi during the Leak Test is within the resolution of the instrumentation and within the calculated response due to the observed temperature changes.

Leak Test pressure held at a minimum of 701 psi and a maximum of 703 psi for a duration of 4 hours and 15 minutes. Pressures remained within the allowable Leak test range of 689 psi – 709 psi, and a minimum of a 4.25-hour hold was completed.

4.3 Test Criteria Confirmation

4.3.1 Test Period

The test was conducted by completing the Strength Test and Leak Test consecutively over a continuous 8-hour period.

1. The Strength Test was conducted with test pressure maintained at 2 X MOP (>1200 psi) for 4 hours 15 minutes at all locations of the test segment.
2. Upon completion of the Strength Test, the Leak Test was conducted with the test pressure maintained at 1.1 X MOP (>660 psi) for 4 hours 15 minutes at all locations of the test segment.
3. No water was added to or withdrawn from any line segment during the test period.

4.3.2 Line Failure

No line failures or evidence of leaks occurred during the hydrostatic pressure test.

APPENDIX 1 – TEST RECORDS

1 PRESSURE TEST PLAN – NORTH STRAITS SITE

Accepted Pressure Test Plan with all materials associated with the North Straits Site.

2 PRESSURE TEST PLAN – MACKINAW STATION SITE

Accepted Pressure Test Plan with all materials associated with the Mackinaw Station Site.

3 701 PRESSURE TEST REPORT

Signed copy of the 701 Pressure Test Report form.

4 702 PRESSURE TEST DATA SHEET

Signed copy of the 702 Pressure Test Data Sheets.

5 PV PLOT

Copy of the PV Plot graph and PV Plot data sheet.

6 CHARTS

Signed copy of all test charts.

7 TEMPERATURE PROBE GRAPHS

Signed copy of all temperature probe graphs.

8 704 PRESSURE TEST CHECKLIST

Copy of the 704 Pressure Test Checklist form.

9 705 PRESSURE TEST REQUIREMENTS CHECKLIST

Copy of the 705 Pressure Test Requirements Checklist form.

APPENDIX 2 – TEST EQUIPMENT & OPERATOR QUALIFICATIONS

1 TEST SCHEMATIC

Drawing D-3.04-1783-E-165 – EAST with overview of all equipment locations and serial numbers.

2 PHOTO REPORT

Photo report of all test equipment outlined in above schematic.

3 EQUIPMENT CERTIFICATIONS

Equipment certifications for all test equipment. All equipment certifications were verified as being within the calibration data and accuracy range outlined in the Project Hydrotest Plan (Appendix 3).

4 HYDROTEST OPERATOR QUALIFICATIONS

Copy of Milbar personnel operator qualifications.

APPENDIX 3 – PROJECT SPECIFIC HYDROTEST PLANS

1 PROJECT HYDROTEST PLAN

Version No. 2.3 of the official Project Hydrotest Plan.

2 HYDROTEST PLAN SUBMITTED TO EPA

Version No. 2 (4/25/2017) of the official Line 5 Straits of Mackinac Hydrostatic Pressure Test Plan.

3 TEMPERATURE VS. PRESSURE CORRELATION

Document outlining how the temperature pressure calculations were completed.

APPENDIX 4 – TEST MEDIUM

1 WATER ACQUISITION

Water was acquired from the City of St. Ignace, MI from a fire hydrant at (45°51'12.37" N, 84°46'13.91" W). A report of the initial quality of water from the City of St Ignace is included below. Water was then trucked to the North Straits Pipeyard and unloaded into an Above Ground Storage tank (AST). The AST was 73ft in diameter and had a capacity of 9000BBLS.

2 LINE FILL

Line fill of the East Segment of the Line 5 Straits Hydrotest began on 6/13/2017 at 8:50 PM. Line fill was completed behind a pig to ensure a solid water column from trap to trap during line fill, and ensure all air was purged from the pipeline. Enbridge operations set up temporary venting locations on the 2" valves to bleed air out of the station piping. Once venting was completed the line was packed out to 260 psi by the fill pumps. Line Fill was complete on 6/14/2017 at 4:58 AM.

The calculated volume of water required for line fill was 305,900 gallons. A total of 305,200 gallons were used to complete pipe fill, station piping fill, and initial pack out of the segment, according to the flow meter on the fill pump. The initial height of the water in the AST was 11ft 1" and a final height of 22" was observed resulting in a total of 299,600 gallons used. An additional 10,000 gallons was added to the AST prior to line fill resulting in a total volume of 309,600 gallons. The additional volume was used to flood the line fill piping.

During line fill, Praxair "Seeper Trace" tracer gas was injected in the first 20,000 gallons of water and the last 28,000 gallons of water at a concentration of 7 PPM. This was designed to have gas entrained in all above lake level piping. Also during line fill Milbar injected a fluorescein dye into the entire water column at a concentration of 1GAL/1000BBLS. The "Seeper Trace" and dye were injected into the pipeline in preparation of a leak event, but were not utilized on this hydrotest since no leaks were observed.

3 STABILIZATION

Water was injected into the pipeline at approximately 65°F to fill the pipeline. The ground temperature at the below grade temperature sites was approximately 57°F. Line fill was completed at 4:58 AM, 6/14/2017, pressure was increased to 600 psi to allow beginning of stabilization at 7:36 AM, 6/14/2017. Pressure declined steadily at an average rate of less than 2 psi per hour until 7:30 AM, 6/15/2017. At 7:30 AM, 6/15/2017 pressure was 565 psi, over the next 21 hours a decline of only 3 psi was observed. Referring to the below grade pipe and ground temperature data, the pipe temperature was seen to be nearly equal to the ground temperature.

The minimal decrease in pressure (3 psi) in 21 hours preceding the start of test at 5:00 AM, 6/16/2017 combined with the minimal difference in pipe/ground temperature data indicated the water in the test segment had stabilized with its environment. A total of 45 hours stabilization occurred from initial pressurization to 600 psi (7:36 AM, 6/14/2017) to beginning of test sequence (5:00 AM, 6/16/2017).

Charts and graphs for stabilization are in Appendix 4 Attachments.

4 DEWATER AND TREATMENT

Once the East segment hydrotest was complete the south station piping was drained up using a vac truck. The segment was then dewatered by pushing the water out of the pipeline with a pig, being pushed by nitrogen from Mackinaw Station towards the North Straits Pipe Yard. Water flowed through temporary piping at the North Straits Pipe Yard into 2 frac tanks. After the frac tanks water was treated by ProAct who was subcontracted through UPI, the general contractor. ProAct used a carbon filtration system to remove any remaining hydrocarbons and the fluorescent dye from the water before discharging into the Above Ground Storage tank (AST). Water was then transported to the St. Ignace wastewater treatment facility for disposal. A report of the final quality of water after filtration is included below.

5 PHOTO REPORT

Photo report of all test medium equipment.

APPENDIX 5 –SYSTEM ISOLATION AND VALVE POSITIONS

1 SYSTEM ISOLATION

The East Segment of Line 5 across the Straits of Mackinac was isolated on the north end by removing flanged valve 5.1-V-1 and installing blind flanges. It was isolated on the south end by removing flanged check valve 5.1-CV-1 and installing blind flanges. All 2" auxiliary connections on the traps and station piping were removed and isolated with blind flanges or plugs.



Figure 7: North Straits Pipeyard Isolation



Figure 5: North Straits Pipeyard Isolation



Figure 6: Mackinaw Station Isolation



Figure 4: Mackinaw Station Isolation

2 VALVE POSITIONS

All valve positions were confirmed to be in the partially open position by Enbridge Operations to Kory Johnson (Test Engineer) prior to the start of test. Valves were set in the partially open position to include the body of the valve in the hydrotest.

APPENDIX 6 –TEMPERATURE SUMMARY

1 TEMPERATURE DATA SUMMARY TABLES

1.1 STRENGTH TEST

Recorder Location	Serial Number	Beginning of Test	Low	High	End of Test
Ambient	Chessell 1000225	57.2°F	57.1°F	71.1°F	70.1°F
North Straits Pipeyard Piping (A/G)	Dickson 14342077	59.5°F	59.5°F	62.1°F	62.1°F
NE Temp Probe Pipe (B/G)	Chessell 1000225	59.3°F	59.1°F	59.4°F	59.2°F
NE Temp Probe Ground (B/G)	Chessell 1000225	60.1°F	60.0°F	60.2°F	60.1°F
NE Temp Probe Pipe (B/G)	Dickson 14342071	57.2°F	57.1°F	58.0°F	57.9°F
NE Temp Probe Ground (B/G)	Dickson 14342071	58.1°F	57.4°F	58.3°F	57.7°F
SE Temp Probe Pipe (B/G)	Dickson 15015179	55.4°F	54.5°F	56.4°F	56.2°F
SE Temp Probe Ground (B/G)	Dickson 15015179	57.5°F	56.7°F	57.9°F	57.7°F
Mackinaw Station Piping (A/G)	Dickson 06215056	58.2°F	58.2°F	60.4°F	60.4°F

(A/G) = Above Grade Piping (B/G) = Below Grade Piping

1.2 LEAK TEST

Recorder Location	Serial Number	Beginning of Test	Low	High	End of Test
Ambient	Chessell 1000225	77.5°F	76°F	84.6°F	76.0°F
North Straits Pipeyard Piping (A/G)	Dickson 14342077	60.8°F	60.8°F	65.4°F	65.4°F
NE Temp Probe Pipe (B/G)	Chessell 1000225	59.1°F	58.9°F	59.2°F	59.0°F
NE Temp Probe Ground (B/G)	Chessell 1000225	60.1°F	60.0°F	60.1°F	60.0°F
NE Temp Probe Pipe (B/G)	Dickson 14342071	58.1°F	58.0°F	58.6°F	58.6°F
NE Temp Probe Ground (B/G)	Dickson 14342071	57.3°F	57.2°F	58.3°F	58.1°F
SE Temp Probe Pipe (B/G)	Dickson 15015179	57.2°F	54.9°F	57.2°F	55.2°F
SE Temp Probe Ground (B/G)	Dickson 15015179	58.2°F	56. °F	58.2°F	56.8°F
Mackinaw Station Piping (A/G)	Dickson 06215056	60.9°F	60.9°F	65.6°F	63.9°F

(A/G) = Above Grade Piping (B/G) = Below Grade Piping

APPENDIX 7 – MICHIGAN TECHNOLOGICAL UNIVERSITY WATER TEMPERATURE MEASUREMENTS

1 WATER TEMPERATURE OVERVIEW

The majority of the L5 Pipeline crossing the Straits of Mackinac is underwater so it was determined that reference water temperature data would be beneficial in order to correlate trends in lake water temperature versus trends in pressure throughout the duration of the hydrotest.

Michigan Technological University was brought on to the project to collect this data. The data was gathered approximately every 15 minutes from a boat which was located at a location 50ft off of the pipeline. The location was chosen to represent the average elevation of the below water piping. Data was gathered by using a CastAway®-CTD instrument for gathering the temperature. Data was gathered during the daytime on the day prior to the test (stabilization period) and during the hydrotest duration.

Note: Data was gathered only during times when weather conditions allowed.

2 DATA SUMMARY TABLE

Below is a table provided by Michigan Technological University, from 6/16/2017, summarizing the data gathered during the hydrotest.

Cast #	Cast Time (local)	Depth (m)	Temperature (C)	Depth (ft, derived)	Temperature (F, derived)	Latitude (dd)	Longitude (dd)	Note
1	615	34.99	9.32	114.78	48.73	REDACTED		
2	631	34.81	9.29	114.22	48.73			
3	645	35.23	9.31	115.59	48.75			
4	700	34.98	9.39	114.76	48.90			
5	717	37.91	9.81	124.38	49.66			Moved to "west" waypt - depth (sonar) 124' - depths varying drastically as we drift at 1.0kt
6	717	36.87	9.87	120.96	49.76			"slice" of water col at 114.5ft
7	730	35.03	9.98	114.94	49.97			"slice" of water col - next cast will attempt to stop fall at 114.5ft
8	745	34.86	9.95	114.37	49.91			cast dropped to ~114.5 feet and recovered
9	759	35.00	9.93	114.82	49.87			
10	816	34.84	9.84	114.30	49.72			
11	830	35.10	9.81	115.16	49.65			CastAway batteries depleated - replaced w/ Lithiums
12	845	35.03	9.77	114.92	49.58			
13	901	34.66	9.78	113.70	49.60			
14	916	35.25	9.80	115.63	49.64			Error closing transfer message logged
15	929	34.75	9.82	114.00	49.68			
16	945	35.05	9.79	114.98	49.62			
17	1000	34.79	9.81	114.15	49.66			
18	1017	35.00	9.80	114.81	49.63			
19	1030	34.24	9.85	112.33	49.74			
20	1045	35.09	9.82	115.11	49.68			
21	1100	34.64	9.84	113.63	49.71			
22	1115	34.93	9.86	114.58	49.74			
23	1129	34.88	9.85	114.44	49.73			
24	1145	34.92	9.88	114.56	49.79			Waves < 1 foot
25	1200	35.13	9.93	115.27	49.87			
26	1215	34.84	10.12	114.32	50.21			
27	1230	34.89	10.25	114.46	50.45			
28	1245	34.89	10.05	114.47	50.09			
29	1300	35.13	10.10	115.24	50.18			
30	1315	34.98	9.97	114.78	49.94			
31	1331	34.88	9.94	114.45	49.89			
32	1345	34.77	9.89	114.09	49.81			
33	1400	34.94	9.88	114.65	49.78			
34	1416	34.96	9.95	114.70	49.91			
35	1430	34.79	9.92	114.13	49.86			
36	1445	34.98	9.90	114.75	49.82			
37	1501	34.55	10.01	113.35	50.02			
38	1516	34.97	10.03	114.73	50.05			
39	1532	34.86	10.24	114.37	50.43			
40	1546	34.75	10.28	114.00	50.51			
41	1600	34.91	10.13	114.54	50.24			
42	1615	34.95	10.29	114.66	50.52			
43	1630	34.66	10.19	113.73	50.34			
44	1645	34.90	10.10	114.49	50.18			
45	1700	34.84	10.06	114.32	50.11			
46	1715	35.01	9.99	114.87	49.98			
47	1730	34.67	10.00	113.76	50.00			
48	1746	34.90	10.12	114.51	50.22			
49	1800	34.69	10.23	113.80	50.41			

ENBDNR0003092

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LAKE SUPERIOR CONSULTING

Final Report: Enbridge Line 5 - West Straits of Mackinac Hydrostatic Test

Prepared for:
Enbridge Energy, Limited Partnership
AFE: 20007132
Hydrostatic Test #: 5-17-154

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ENBDNR0003096

SIGNATURE PAGE

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1 EXECUTIVE SUMMARY

The purpose of this report is to summarize and document the results from Test # 5-17-154, the West segment of the Line 5 Straits of Mackinac Hydrostatic Pressure Test for Enbridge US Special Projects. The test was conducted by Milbar who was subcontracted through UPI, the general contractor. Site Engineers Megan Halver and Kory Johnson observed the test on site. Gary Zunkel monitored the test remotely. The Line 5 Straits of Mackinac Hydrostatic Pressure Test fulfills Enbridge's requirements per Paragraphs 25.f and 71.b of the Consent Decree for U.S. vs. Enbridge Energy, Limited Partnership, et. Al., (Civil Action No: 1:16-cv-914).

An 8-hour continuous pressure test was conducted. The Strength Test was completed with pressure held above 1200 psi at all locations on the pipe segment for a duration greater than 4.25 hours. The leak test was completed with the pressure held above 660 psi at all locations on the pipe segment for a duration greater than 4.25 hours.

2 TEST SPECIFICS

2.1 TEST SECTION DESCRIPTION

This hydrostatic test was comprised of the following elements:

- Test #: 5-17-154
- Test Segment: West Segment of Line 5 across the Straits of Mackinac
  - Trap 1475.68-5.2-ST-2 *(STA 19935+77)* to Trap 1479.55-5.2-ST-1 *(STA 20141+07)*
  - *Note: Stationing and Milepost Values are from trap to trap based on 2016 Geopig Data*
- Length: 4.09 Miles
- Test Site Location: North Straits Pipe Yard @ MP 1475.67, STA 19935+77
- Mainline Pipe Summary: 20" OD x 0.812" WT x Grade A seamless pipe
  - *Note: Additional Facility piping, valves, flanges, and fittings were also tested. A full list of all materials has been included in the Pressure Test Plans in Appendix 1.*

2.2 TEST MEDIUM

Line 5 West Straits Test # 5-17-154 was tested with water on 6/10/2017. Additional details on fill, stabilization, dewatering, and water quality are outlined in Appendix 4.

2.3 TEST PRESSURE RANGES

All components were tested to 1200 psi (minimum) for 4.25 hours, followed by 660 psi (minimum) for 4.25 hours. Hydrostatic test pressures were established based on the following elevation profiles and are outlined in the Project Hydrotest Plan, located in Appendix 3.

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2.4 ELEVATION PROFILE

The elevation at the test site was 586.8 feet at the North Straits Pipe Yard. This is the same elevation as the Deadweight in the test trailer. Minimum elevation of the pipeline segment is 330.7 feet and maximum elevation is 651.5 feet.

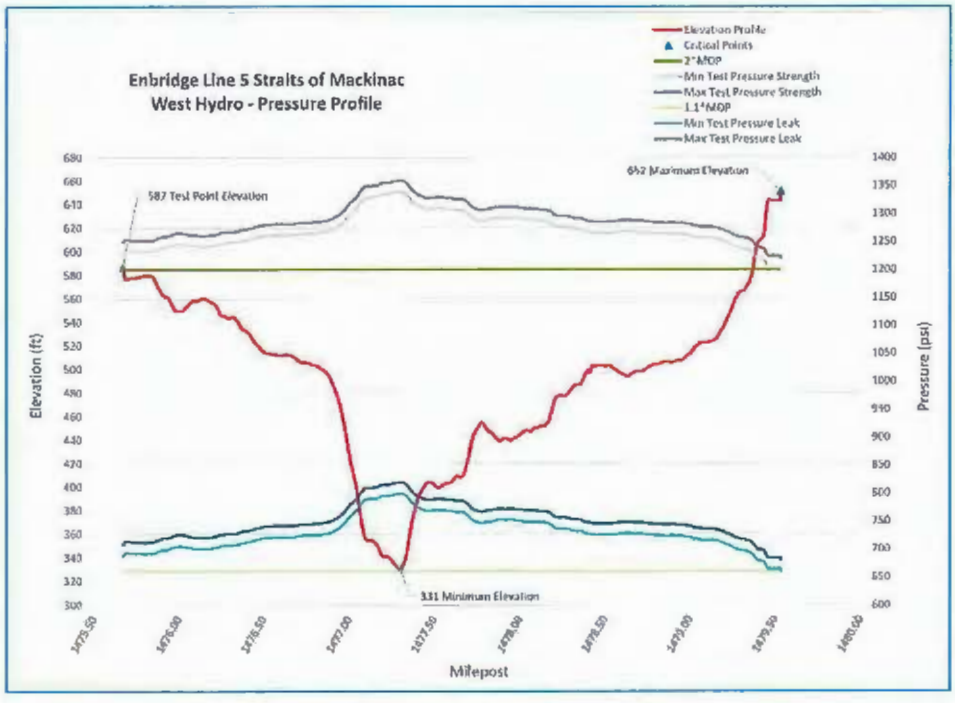


Figure 1. Test Pressure Profile

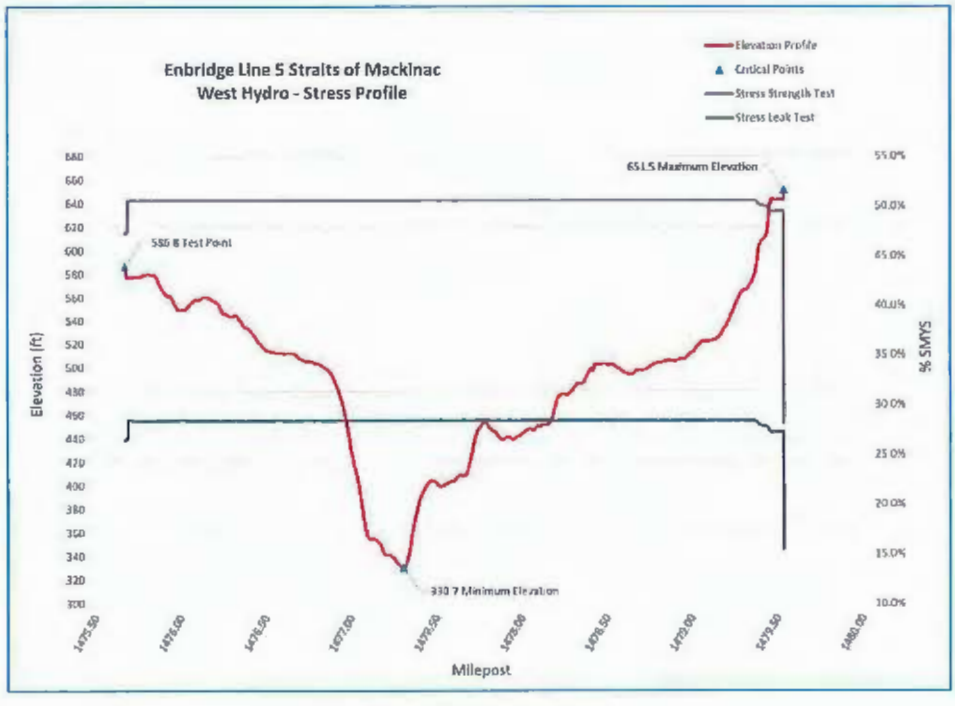


Figure 2. Test Stress Profile

2.5 EQUIPMENT SETUP

Milbar conducted the test using Test Trailer 25. The equipment set-up by Milbar included:

- North Straits Pipe Yard, Test Site (Milepost 1475.67)
  - 1 Deadweights, *for strength test* (S/N: 26747)
  - 1 Deadweights, *for leak test* (S/N: 883)
  - 1 Pressure Gauge (S/N: 218170D0023)
  - 1 Pressure Recorder (S/N: 1215152)
  - 1 Back-up Pressure Recorder (S/N: 102111-2)
  - 1 Pressure & Temperature Recorder *(Ambient, Pipe, and Ground)* (S/N: 1000225)
  - 1 Above Grade Pipe Temperature Recorder (S/N: 06215056)
  - 1 Back-up Above Grade Pipe Temperature Chart (S/N: 0807137)
- Northwest Temp Probe (Milepost 1475.82) REDACTED
  - 1 Pipe & Ground Temperature Recorder (S/N: 14342077)
- Southwest Temp Probe (Milepost 1479.42) REDACTED)
  - 1 Pipe & Ground Temperature Recorder (S/N: 15015179)
- South Mackinaw Station, End Site (Milepost 1479.54)
  - 1 Back-up Pressure Recorder (S/N: 202E-52081)
  - 1 Pressure Gauge (S/N: 218170D0020)
  - 1 Above Grade Pipe Temperature Recorder (S/N: 14342071)

Details and photos of all equipment locations and certifications are outlined in Appendix 2.

3 TEST OVERVIEW

3.1 SUMMARY OF TEST

The West segment of Line 5, Test # 5-17-154, began at 8:30 AM on 6/10/2017 and concluded at 7:15 PM on 6/10/2017. The test included a 4.25-hour strength test where pressure on all points in the test segment were maintained above 1200 psi followed by a 4.25-hour leak test where pressure on all points in the test segment were maintained above 660 psi.

All times included in this report and on all documentation are in Eastern Daylight Time (EDT).

Official signed test plans, logs, and charts can be found in Appendix 1.

3.2 PRESSURIZATION AND PV PLOT

A 0% hold on all charts began at 4:15 AM on 6/10/2017 and was completed at 4:30 AM. Once 0% hold was complete, line pressure of 582 psi was reintroduced to the recorders. Pressurization began at 5:56 AM, starting at a pressure of 580 PSI.

At 5:59 AM, a 50% pressure of 620 psi was reached. A 15-minute hold was commenced at the 50% pressure. At 6:21 AM, pressurization began to 75% with a starting pressure of 619 psi. A PV plot was completed during pressurization from 50% to 75%. This PV plot resulted in an average of 49.6 strokes per 10 psi, using a 0.258 gal/stroke pump, with a maximum of 57 and minimum of 44. Pressurization did not exceed the outlined maximum of 10 psi/minute.

At 7:00 AM, a 75% pressure of 930 psi was reached. A 15-minute hold was commenced at the 75% pressure. At 7:40 AM, pressurization began to strength test pressure with a starting pressure of 930 psi. A PV plot was completed during pressurization from 75% to strength test pressure. The PV plot from 75% to strength test pressure resulted in an average of 49.7 strokes per 10 psi with a maximum of 55 and minimum of 46. Pressurization did not exceed the outlined maximum of 10 psi/minute.

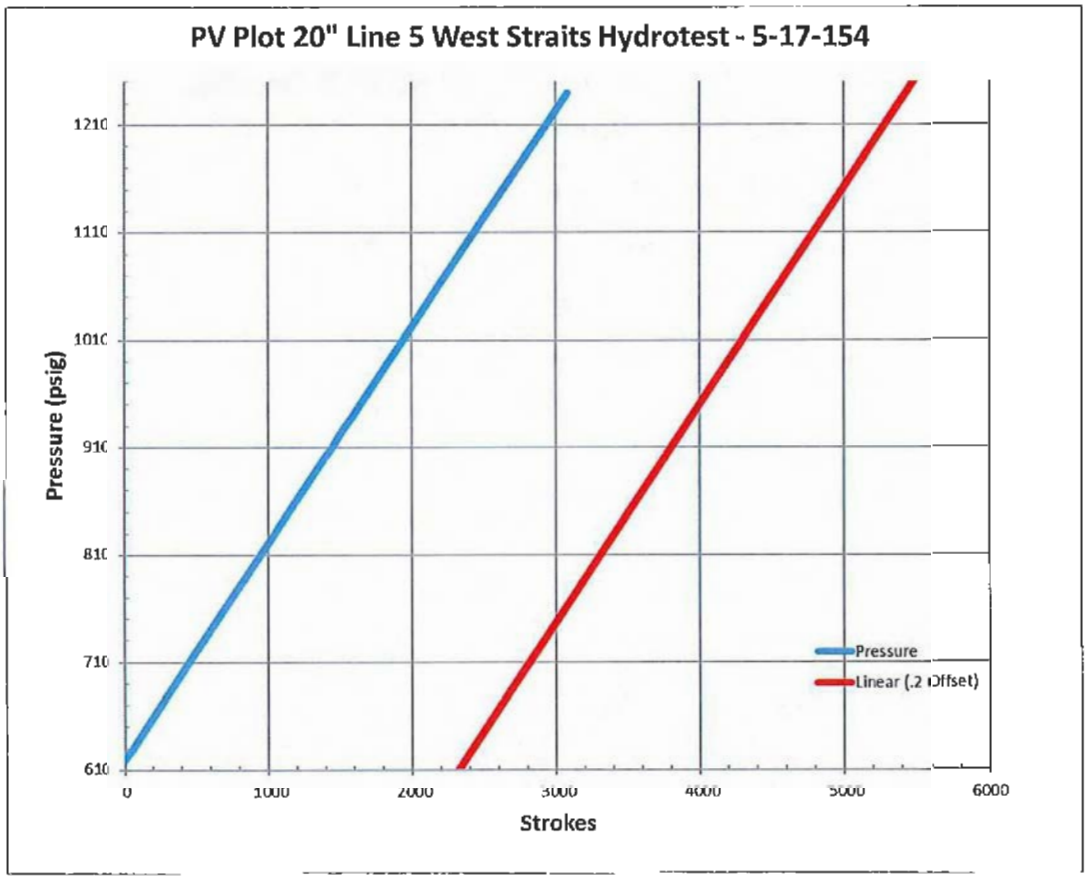


Figure 3. Pressure vs Volume Plot

3.3 STRENGTH TEST

At 8:18 AM, the strength test pressure of 1240 psi was reached. The start of the strength test began at 8:30 AM with a pressure of 1240 psi. At 11:15 AM, deadweight pressure dropped to 1239 psi. The pressure remained at 1239 psi until the strength test was completed at 12:45 PM.

Location	Elevation	Actual Min. Pressure	Actual Max. Pressure
Deadweight	586.8'	1239 psi	1240 psi
Maximum Elevation	651.5'	1211 psi	1212 psi
Minimum Elevation	330.7'	1350 psi	1351 psi

Table 1. Resulting Minimum and Maximum Strength Test Pressures

Depressurization following the strength test began at 1:05 PM. At 1:57 PM, a 75% pressure of 930 psi was reached. A 15-minute hold was commenced at 75% pressure. At 2:15 PM, depressurization to leak test pressure began with a starting pressure of 931 psi. Depressurization did not exceed the outlined maximum of 10 psi/minute.

3.4 LEAK TEST

At 2:43 PM, the leak test pressure of 705 psi was reached. The start of the leak test began at 3:00 PM with a pressure of 705 psi. At 3:45 PM, deadweight pressure increased to 706 psi. At 5:30 PM, deadweight pressure increased to 707 psi. The pressure remained at 707 psi until the leak test was completed at 7:15 PM.

Location	Elevation	Actual Min. Pressure	Actual Max. Pressure
Deadweight	586.8'	705 psi	707 psi
Maximum Elevation	651.5'	677 psi	679 psi
Minimum Elevation	330.7'	816 psi	818 psi

Table 2. Resulting Minimum and Maximum Leak Test Pressures

Depressurization following the leak test began at 7:17 PM. At 7:32 PM, a 50% pressure of 620 psi was reached. A 15-minute hold was commenced at 50% pressure. At 7:50 PM, depressurization began with a starting pressure of 620 psi. At 8:52 PM, a pressure of 50 psi was reached. Upon reaching 50 psi, pressure recorders were bled to 0 psi for a 15-minute 0% hold. Depressurization did not exceed the outlined maximum of 90 psi/minute.

3.5 WEATHER CONDITIONS

The average temperature for 6/10/2017 was 72°F with a high of 81°F and low of 63°F seen during the hydrostatic test. It was mostly sunny with winds from 0-10 MPH during the Strength Test and winds from 10-20 MPH during the Leak Test.

3.6 TEMPERATURE SUMMARY

A summary table of temperature data throughout the test is provided in Appendix 5. A memo explaining temperature vs. pressure correlation calculations and methods can be found in Appendix 3.

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4 TEST ACCEPTANCE

4.1 STRENGTH TEST

Pressure decreased 1 psi during the 4.25-hour Strength Test. This minimal change is within the resolution of all instrumentation used to measure pressure, including the deadweights. Pressure within an isolated test segment is influenced by the temperature of the water within that segment, and the gross amount of pressure change across the segment depends on the length of pipe exposed to each heating/cooling influence, as shown further in Appendix 3, 3. Temperature vs Pressure Correlation. During the strength test, the following influences were present:

- The below grade pipe temperature increased an average of <0.5°F, which corresponds to a 0.6 psi increase in pressure.
- The above grade pipe temperature increased on average approximately 3°F, which corresponds to a 0.6 psi increase in pressure. Note the above grade temperature probe was influenced by exposure to direct sunlight until it was insulated at 2:00 PM. The Mackinaw Station above grade temperature is used as a representative measure of pipe temperature for this evaluation. This temperature measurement is not a direct measure of the water temperature inside the pipe.
- The effect of the lake water on the submerged portion of the test segment has the most significant effect on changes in pressure, due to the relative length of that portion of the test segment. The lake water temperature recordings decreased 0.2°F from 10:00 AM until 11:29 AM, which corresponds to a 2 psi decrease in pressure.

The net effect of minimal temperature fluctuations throughout the Strength Test did not establish an increasing or decreasing trend. The pressure decrease of 1 psi during the Strength Test is within the resolution of the instrumentation and within the calculated response due to the observed temperature changes.

Strength Test pressure was held at a minimum of 1239 psi and maximum of 1240 psi for a duration of 4 hours and 15 minutes. Pressures remained within the allowable Strength Test range of 1229 psi – 1249, and the minimum 4.25-hour hold was achieved.

4.2 LEAK TEST

Pressure increased 2 psi during the 4.25-hour Leak Test. As with the Strength Test, pressure fluctuations were influenced by corresponding fluctuations in temperature during the leak test. During the leak test, the following influences were present:

- An average of 1°F decrease was observed on the below grade pipe during the 4.25-hour Leak Test, which corresponds to a 1.2 psi decrease in pressure.
- The above grade pipe temperature increased on average approximately 4°F, which corresponds to a 0.8 psi increase in pressure.
- The lake water temperature recordings fluctuated approximately ~0.4°F throughout the Leak Test, with a slight trend upward corresponding to a 3 psi increase in pressure.

The net effect of minimal temperature fluctuations throughout the Leak Test had a minimal upward trend resulting from the slight increase in observed water temperature recordings. The pressure increase of 2 psi during the Leak Test is within the calculated response due to the observed temperature changes.

Leak Test pressure held at a minimum of 705 psi and a maximum of 707 PSI for a duration of 4.25 hours and 15 minutes. Pressures remained within the allowable Leak Test range of 689 psi – 709 psi, and the minimum 4.25-hour hold was achieved.

4.3 Test Criteria Confirmation

4.3.1 Test Period

The test was conducted by completing the Strength Test and Leak Test consecutively over a continuous 8-hour period.

1. The Strength Test was conducted with test pressure maintained at 2 X MOP (>1200 psi) for 4 hours 15 minutes at all locations of the test segment.
2. Upon completion of the Strength Test, the Leak Test was conducted with the test pressure maintained at 1.1 X MOP (>660 psi) for 4 hours 15 minutes at all locations of the test segment.
3. No water was added to or withdrawn from any line segment during the test period.

4.3.2 Line Failure

No line failures or leaks occurred during the hydrostatic pressure test.

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APPENDIX 1 – TEST RECORDS

1 PRESSURE TEST PLAN – NORTH STRAITS SITE

Accepted Pressure Test Plan with all materials associated with the North Straits Site.

2 PRESSURE TEST PLAN – MACKINAW STATION SITE

Accepted Pressure Test Plan with all materials associated with the Mackinaw Station Site.

3 701 PRESSURE TEST REPORT

Signed copy of the 701 Pressure Test Report form.

4 702 PRESSURE TEST DATA SHEET

Signed copy of the 702 Pressure Test Data Sheets.

5 PV PLOT

Copy of the PV Plot graph and PV Plot data sheet.

6 CHARTS

Signed copy of all test charts.

7 TEMPERATURE PROBE GRAPHS

Signed copy of all temperature probe graphs.

8 704 PRESSURE TEST CHECKLIST

Copy of the 704 Pressure Test Checklist form.

9 705 PRESSURE TEST REQUIREMENTS CHECKLIST

Copy of the 705 Pressure Test Requirements Checklist form.

APPENDIX 2 – TEST EQUIPMENT & OPERATOR QUALIFICATIONS

1 TEST SCHEMATIC

Drawing D-3.04-1783-E-165-WEST with overview of all equipment locations and serial numbers.

2 PHOTO REPORT

Photo report of all test equipment outlined in above schematic.

3 EQUIPMENT CERTIFICATIONS

Equipment certifications for all test equipment. All equipment certifications were verified as being within the calibration data and accuracy range outlined in the Project Hydrotest Plan (Appendix 3).

4 HYDROTEST OPERATOR QUALIFICATIONS

Copy of Milbar personnel operator qualifications.

APPENDIX 3 – PROJECT SPECIFIC HYDROTEST PLANS

1 PROJECT HYDROTEST PLAN

Version No. 2.3 of the Project Hydrotest Plan.

2 HYDROTEST PLAN SUBMITTED TO EPA

Version No. 2 (4/25/2017) of the Line 5 Straits of Mackinac Hydrostatic Pressure Test Plan.

3 TEMPERATURE VS. PRESSURE CORRELATION

Document outlining how the temperature pressure calculations were completed.

APPENDIX 4 – TEST MEDIUM

1 WATER ACQUISITION

Water was acquired from the city of St. Ignace, MI from a fire hydrant at (45°51'12.37" N, 84°46'13.91" W). A report of the initial quality of water from the City of St Ignace, MI is included below. Water was then trucked to the North Straits Pipe yard and unloaded into an Above Ground Storage tank (AST). The AST was 73ft in diameter and had a capacity of 9000 BBLS.

2 LINE FILL

Line fill of the West Segment of the Line 5 Straits Hydrotest began on 6/7/2017 at 08:30 AM. Line fill was completed behind a pig to ensure a solid water column from trap to trap during line fill, and ensure all air has been purged from the pipeline. Enbridge operations set up temporary venting locations on the 2" valves to bleed air out of the station piping. Once venting was completed the line was packed out to 246 psi by the fill pumps. Line Fill was complete on 6/8/2017 at 04:30 AM.

The calculated volume of water required for line fill was 305,469 gallons. A total of 307,320 gallons were used to complete pipe fill, station piping fill, and initial pack out of the segment, according to the flow meter on the fill pump. The initial water height in the AST was 11ft 4" and the final height was 17" resulting in a total of volume of 310,458 gallons of which 3,138 gallons were used to fill the temporary fill piping and purge the system of any air.

During line fill, Praxair "Seeper Trace" tracer gas was injected in the first 20,000 gallons of water and the last 28,000 gallons of water at a concentration of 7 PPM. This was designed to have gas entrained in all above lake level piping. Also during line fill Milbar injected a fluorescein dye into the entire water column at a concentration of 1GAL/1000 BBLS. The "Seeper Trace" and dye were intended for leak detection methods, but were not utilized on this hydrotest since no leaks were detected.

3 STABILIZATION

Water was injected into the pipeline at approximately 65°F to fill the pipeline. The ground temperature at the below grade temperature sites was approximately 57°F. Line fill was completed at 4:30 AM, 6/8/2017, pressure was increased to 600 psi to allow beginning of stabilization at 8:07 PM, 6/8/2017. Pressure declined steadily at a rate of approximately 1 psi per hour until 11:00 AM, 6/9/2017. At 5:00 AM, 6/10/2017 pressure was 581 psi, showing a decline of 6 psi over the previous 17 hours. Referring to the below grade pipe and ground temperature data, the pipe temperature was seen to be nearly equal to or below the ground temperature.

The decrease in pressure (5 psi) in 12 hours preceding the start of test preparation at 5:00 AM, 6/10/2017 combined with the difference in pipe/ground temperature data indicated the water in the test segment had stabilized with its environment. A total of 33 hours stabilization occurred from initial pressurization to 600 psi (8:07 PM, 6/8/2017) to beginning of test sequence (5:00 AM, 6/10/2017).

Charts and graphs for stabilization are in Appendix 4 Attachments.

4 DEWATER AND TREATMENT

Once the west segment hydrotest was complete, the south station piping was drained up using a vac truck. The segment was then dewatered by pushing the water out of the pipeline with a pig being pushed by nitrogen from Mackinaw Station towards the North Straits Pipe yard. Water flowed through temporary piping at the North Straits Pipe yard into 2 frac tanks. After the frac tanks water was treated by Proact, who was subcontracted through UPI, the general contractor, ProAct used a carbon filtration system to remove any residual hydrocarbons and the fluorescent dye from the water before discharging into the AST. Water was stored in the tank to be used for the East Segment hydrotest. A report of the final quality of water after filtration is included below.

5 PHOTO REPORT

Photo report of all test medium equipment.

APPENDIX 5 –SYSTEM ISOLATION AND VALVE POSITIONS

1 SYSTEM ISOLATION

The west segment of Line 5 across the Straits of Mackinac was isolated on the north end by removing flanged valve 5.2-V-1 and installing blind flanges. It was isolated on the south end by removing flanged check valve 5.2-CV-1 and installing blind flanges. All 2" auxiliary connections on the traps and station piping were removed and isolated with blind flanges or plugs.



Figure 5: North Straits Pipe yard Isolation



Figure 4: North Straits Pipe yard Isolation



Figure 7: Mackinaw Station Isolation

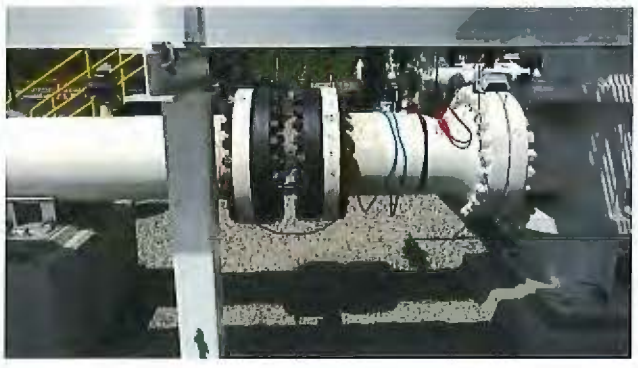


Figure 6: Mackinaw Station Isolation

2 VALVE POSITIONS

All valve positions were confirmed to be in the partially open position by Enbridge Operations to Kory Johnson (Test Engineer) prior to the start of test. Valves were set in the partially open position to include the body of the valve in the hydrotest.

APPENDIX 6 –TEMPERATURE SUMMARY

1 TEMPERATURE DATA SUMMARY TABLES

1.1 STRENGTH TEST

Recorder Location	Serial Number	Beginning of Test	Minimum	Maximum	End of Test
Ambient	Chessell 1000225	64.2°F	63.7°F	72.4°F	69.5°F
NW Above Grade Pipe Temp (A/G)*	Dickson 06215056	59.3°F	59.3°F	76.5°F*	75.9°F*
NW Pipe Temp (B/G)	Chessell 1000225	58.3°F	58.2°F	58.3°F	58.2°F
NW Ground Temp (B/G)	Chessell 1000225	57.6°F	57.6°F	57.7°F	57.7°F
NW Pipe Temp (B/G)	Dickson 14342077	58.4°F	58.2°F	58.8°F	58.7°F
NW Ground Temp (B/G)	Dickson 14342077	58.4°F	56.6°F	58.4°F	57.1°F
SW Pipe Temp (B/G)	Dickson 15015179	52.5°F	52.5°F	54.4°F	53.9°F
SW Ground Temp (B/G)	Dickson 15015179	52.8°F	51.7°F	53.2°F	52.3°F
SW Above Grade Pipe Temp (A/G)	Dickson 14342071	58.0°F	58.0°F	66.3°F	66.1°F

(A/G) = Above Grade Piping (B/G) = Below Grade Piping

*Note: Temperature data was observed to rise abnormally at 11:00 AM. The data recorder was found to be exposed to ambient conditions and sunlight. Insulation was placed over the recorder and temperature data was observed to stabilize at 3:00 PM. Data between these periods was not used for calculations.

At 12:30 PM an additional temperature recorder (S/N 0807137) was placed on the A/G pipe at the North Straits (Test Site) as a backup to monitor temperature of the A/G pipe.

1.2 LEAK TEST

Recorder Location	Serial Number	Beginning of Test	Low	High	End of Test
Ambient	Chessell 1000225	80.7°F	76.7°F	80.7°F	78.3°F
NW Above Grade Pipe Temp (A/G)	Dickson 06215056	61.7°F	61.7°F	68.0°F	67.9°F
NW Pipe Temp (B/G)	Chessell 1000225	58.2°F	57.9°F	58.2°F	57.9°F
NW Ground Temp (B/G)	Chessell 1000225	57.7°F	57.7°F	57.8°F	57.7°F
NW Pipe Temp (B/G)	Dickson 14342077	58.9°F	58.4°F	59.0°F	58.4°F
NW Ground Temp (B/G)	Dickson 14342077	57.4°F	57.3°F	58.4°F	58.1°F
SW Pipe Temp (B/G)	Dickson 15015179	55.4°F	52.8°F	56.6°F	53.4°F
SW Ground Temp (B/G)	Dickson 15015179	53.8°F	52.7°F	55.1°F	53.1°F
SW Above Grade Pipe Temp (A/G)	Dickson 14342071	69.0°F	68..8°F	70.6°F	70.5°F

(A/G) = Above Grade Piping (B/G) = Below Grade Piping

APPENDIX 7 – MICHIGAN TECHNOLOGICAL UNIVERSITY WATER TEMPERATURE MEASUREMENTS

1 WATER TEMPERATURE OVERVIEW

The majority of the Line 5 Pipeline crossing the Straits of Mackinac is underwater so it was determined that reference water temperature data would be beneficial in order to correlate trends in lake water temperature versus trends in pressure throughout the duration of the hydrotest.

Michigan Technological University was contracted to collect this data. The data was gathered from a boat which was located at a location 50 ft. from the pipeline. The depth of measurement was chosen to represent the average elevation of the below water piping. Data was gathered by using a CastAway®-CTD instrument for gathering the temperature. Data was gathered during the daytime on the day prior to the test (stabilization period) and during the hydrotest duration.

Note: Data was gathered only during times when weather conditions allowed.

2 DATA SUMMARY TABLE

Below is a table provided by Michigan Technological University, from 6/10/2017, summarizing the data gathered during the hydrotest.

Cast #	Cast Time (local)	Depth (m)	Temperature (C)	Depth (ft, derived)	Temp. (F, derived)	Latitude (dd)	Longitude (dd)	Note
1	600	41.92	7.33	137.54	45.19	REDACTED		Cast duration: 82.6s
2	615	40.82	7.30	133.92	45.13			Cast duration: 73.4s
3	630	40.72	7.31	133.59	45.16			
4	645	40.59	7.42	133.17	45.35			Summary KML from last four casts placed in folder.
5	700	40.76	7.40	133.74	45.32			Cast duration: 64.8s
6	714	63.12	7.12	207.09	44.81			Cast at ~200ft, listing multiple readings from single cast
7	714	**61.03**	**7.14**	**200.22**	**44.85**			
8	730	40.62	7.44	133.26	45.40			Returned to 133' station, cast duration: 61.6s
9	745	41.69	7.41	136.77	45.34			Cast duration: 67.8s, Summary KML from last five casts placed in folder. Raw Data folder updated.
10	800	40.84	7.42	133.97	45.35			Cast duration: 60.8s
11	815	40.84	7.42	133.98	45.35			rare "identical" sequential readings, increase decimal places displayed and they diverge
12	830	40.71	7.45	133.57	45.41			
13	845	40.68	7.49	133.46	45.49			Summary KML from last four casts placed in folder.
14	901	41.03	7.49	134.62	45.48			
15	915	41.80	7.50	137.15	45.50			
16	930	40.79	7.51	133.84	45.53			
17	945	40.53	7.57	132.96	45.62			Summary KML from last four casts placed in folder.
18	1000	40.81	7.53	133.88	45.55			
19	1014	40.92	7.51	134.24	45.52			
20	1030	41.82	7.51	137.19	45.52			
21	1045	40.89	7.51	134.16	45.52			Summary KML from last four casts placed in folder.
22	1100	41.80	7.45	137.15	45.42			
23	1114	39.88	7.43	130.84	45.38			
24	1129	40.69	7.41	133.49	45.33			
25	1145	39.79	7.43	130.53	45.38			Summary KML from last four casts placed in folder. Raw data folder updated.
26	1200	40.88	7.46	134.12	45.43			
27	1214	41.26	7.50	135.35	45.49			
28	1230	40.60	7.59	133.21	45.66			
29	1245	41.08	7.63	134.77	45.74			Summary KML from last four casts placed in folder.
30	1300	41.88	7.59	137.39	45.67			
31	1314	42.57	7.71	139.67	45.89			
32	1331	41.84	7.67	137.27	45.81			heading off station
33	1612	40.73	7.87	133.64	46.17			back on station
34	1628	30.67	8.05	100.61	46.49			
35	1645	39.56	7.93	129.78	46.28			
36	1659	37.02	7.87	121.44	46.16			
37	1714	42.23	7.80	138.56	46.04			
38	1729	40.48	7.75	132.80	45.95			
39	1744	39.07	7.76	128.19	45.96			
40	1759	39.80	7.80	130.59	46.04			
41	1814	41.43	7.82	135.91	46.07			last cast

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