

2016 Straits of Mackinac Pipeline Inspections and Maintenance Project

Enbridge Energy
Superior, WI

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Prepared By:
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Re: 2016 Straits of Mackinac Pipeline Inspection & Maintenance Project

Dear Mr. Lawson,

Attached you will find the job overview report. This report will contain detailed information from the Enbridge Energy, Limited Partnership (Enbridge Energy) Straits of Mackinac pipeline inspection and maintenance project and is designed to meet the requirements of ¶68(e) of the proposed Consent Decree with the U.S. Government to which Enbridge Energy is a party. Included with this report is an excel spreadsheet detailing the current span information and anchor locations based on the 2016 inspection and maintenance work.

Autonomous Underwater Vehicle (AUV) data collection services took place between June 3, 2016 and June 11, 2016. Remotely Operated Vehicle (ROV) and video inspection services took place June 13, 2016 – June 14, 2016. Initial data review and submittal of the current span information was provided on July 22, 2016. Diving remediation & maintenance services began with the mobilization of dive equipment on August 23, 2016 with a tentative planned start date for anchor installation of August 29, 2016. After mobilization was completed on August 28, 2016, dive operations were put on standby pending permits until October 29, 2016. Upon receiving the permits, the barge was pushed to the Mackinaw State Dock to begin Anchor installation operations which took place on November 3, 2016 and November 5, 2016. The barge was then pushed back to Cheboygan for Demobilization on November 6, 2016
Thank you for allowing Ballard Marine Construction, Inc. (BMC) to perform the services stated above. If there are any questions, please don't hesitate to contact me by which means you deem necessary.

Sincerely,

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Project Overview

BMC was retained by Enbridge Energy Inc. to inspect and maintain the east and west, 20 inch diameter, steel pipelines which cross the Straits of Mackinac near Mackinaw City, Michigan. These two pipelines, located in water depths that range from 0 to 260 Feet of Fresh Water (FFW), run parallel to each other and are separated by approximately 1200 feet along the 4.6-mile length of the crossing. Both lines are buried from the shoreline extending out to water depths between 66 and 69 ft.



The focus of this project was to inspect, identify existing conditions and remediate any conditions which may not meet the easement requirements of the Straits of Mackinac crossing or could potentially compromise the safety of the pipelines. Examples of these conditions could include but are not limited to; uncovered or unsupported areas of pipeline, items such as fish traps or cable lying on or next to the pipeline or other items that may be of concern. Past surveys and historical data have showed that intermittent areas of uncovered pipeline have become unsupported along the crossing.

AUV inspection services mobilized to Mackinaw City on June 1, 2016, while ROV inspection services mobilized on June 12, 2016 and diving services mobilized on August 23, 2016. All services were de-mobilized from the project by November 6, 2016. Inspection services were conducted with a combination AUV, ROV method that included Multi-beam and Side-Scan survey systems, acoustical tracking system and video recording devices. After an initial review of the data, four spans were identified as having exceeded 75 ft. in length, and an additional 18 anchor locations were identified for preventative maintenance with a permit initially sought for all these locations. As such, BMC initially was requested to install mechanical supports at these 22 anchor locations. Issues of permitting reduced the scope to only the four spans which were identified as having exceeded 75 ft. in length. The attached spreadsheet contains updated results completed after BMC's initial review. It is BMC's understanding that Enbridge Energy will be renewing its request in 2017 for permits allowing for installation of additional anchors. BMC is prepared to install additional anchors as directed once final locations have been selected.

Operations

BMC completed mobilization of the AUV and ROV inspection vessel at the Mackinaw City Dock. From the Mackinaw City dock, the inspection vessel would mobilize to the work site where BMC went through a series of equipment calibration procedures to insure accurate data collection.

AUV inspections and data collection began on June 3, 2016 and were completed on June 11, 2016. ROV inspections and data collection began on June 13, 2016 and were completed on June 14, 2016. After data review, BMC supplied Enbridge with a spreadsheet outlining current span information on July 22, 2016. Diving operations barge and equipment began mobilization at Durocher Marine's yard in Cheboygan on August 23, 2016 and then put on standby pending permitting. On October 30, 2016, mobilization of the primary tug and diving operations barge to the Mackinaw City dock occurred, where the vessels would dock for the project. From Mackinaw City, the diving operations barge, equipment and personnel would mobilize to address the spans longer than 75 feet along Enbridge Energy's east and west crude oil pipelines crossing the Straits of Mackinac. BMC provided the navigation, positioning and diving operations while Durocher Marine provided the tug boats, inspection and diving barges, anchors and a crane.

The selection of the spans for installing anchor supports was determined by Enbridge based on the inspection results supplied by BMC. The BMC supplied inspection results were based on a review of the AUV and ROV survey and video data collected prior to diving operations. After this review it was determined that four unsupported spans of pipeline, that exceeded 75' in length, would be targeted for anchor support installation.

The four spans where anchor supports were installed in November 2016 are as follows; W-69, W-53A, W-5 & E-39. The installation of all four anchor supports was performed while crude oil was flowing in the pipelines.

After the initial review, four anchor supports and another additional 18 anchor supports were targeted for installation. These additional supports were to be installed as a preventative measure. Preventative anchor supports were determined through discussions between BMC and Enbridge and by use of the following criteria as a guideline;

- Span length in excess of 65'
- Span length history indicating that a span had previously been in excess of 75'
- Span length history showing significant growth when compared against the previous inspection
- Limited amount of length in a touchdown point between two spans, i.e. less than five feet such that if this touchdown support area were to be removed the result would be the merger of two smaller spans becoming one larger span
- Grout bags (previous repair) being used as touchdown point
- Anchors also to be added at a pre-existing engineering bend in one of the pipelines

Survey/Inspections Summary of Methods / Equipment Limitations

Autonomous Underwater Vehicle –Kongsberg "Munin" & Remotely Operated Vehicle – SeaBotix "vLBV 950"

The Kongsberg Munin Autonomous Underwater Vehicle (AUV) was utilized to collect Multi-Beam and Side-Scan Survey Data. The technicians are able to preprogram mission topside for the AUV to carry out underwater after it is deployed. Through these missions the technicians are able to communicate with the vehicle to insure proper operations. Once a mission is complete the technicians are able to download the collected data of the AUV before redeployment for the next mission. Because the AUV is a free flying vehicle, weather constraints are minimal. In addition, because the AUV can collect multi-beam data within a couple of meters of the pipeline, these factors make this a more versatile and useful data collection system than traditional topside survey data collection methods.

For the AUV inspection, the vehicle was equipped with a multi-bean system, side-scan system and internal positioning systems that included Global Positioning System (GPS), Inertial Navigation System (INS) and Doppler Velocity Logger (DVL) systems. AUV technicians were then able to deploy the vehicle for data collection of the pipeline, recover the vehicle to collect data and then redeploy for additional data collection. Two separate missions were run on each pipeline to insure accurate and ample data collection. The limitations for this equipment are minimal. This is what makes this vehicle such a beneficial tool. Because the AUV is free flying and not dependent on top side support during operations weather is not a large factor.

The "vLBV 950" is a Remotely Operated Vehicle (ROV) system and is an extremely versatile ROV system. It can be employed to carry out a variety of tasks including surveying, searching and inspections. A pilot on the surface controls the vehicle remotely by sending commands to the vehicle tether. The vehicle can be moved in any direction, or by using the autopilot facility, remain accurately on course and depth to provide a stable platform. The pilot can also control the vehicle's video system, lighting and any other equipment fitted to the unit.

For the ROV inspection, the vehicle was fitted with a Linkquest USBL tracking system in concert with an RTK GPS system and Hypack software. In operations, the ROV was fitted with a Linkquest acoustic transponder, which sends out a sound signal to be picked up by a hydrophone mounted on the side of the surface support vessel. The offsets of the vehicle as calculated by Hypack, is fed to the navigation computer that plots a corresponding XY position based on Real Time Kinematics (RTK) information from the GPS. Video from the on-board camera is recorded in a digital format, with the surveyor following position information from the Hypack navigational software.

In operation, the vessel is positioned over the pipeline using a live boat operation for the survey. With evidence of a strong fixed RTK lock as well as a solid return from the vehicle tracking system, the vehicle is launched from the surface to begin its descent to the bottom. Once on bottom, the operator utilizes the navigation system to guide the vehicle to the pipeline. With the pilot free to fly the vehicle, the survey supervisor takes notes with further direction given by the client representative on site. Different from years past, the ROV inspection services were used only to obtain video of the pipelines to look for visual anomalies, coating delamination, obstructions or items endangering the pipeline and inspections of previously installed anchors. 2014 was the first year that an AUV was used to collect all position information on the pipeline

The main limitations for ROV operations are typically related to water clarity (visibility), water current, surface weather and wave conditions. In highly turbid water conditions, an acceptable video record is impossible to generate. Fortunately water clarity for this project was exceptional, allowing for a very clear video record. Water velocities (currents) can sometimes pose difficulties in keeping the vehicle on station, or even getting it to the target. At times stronger currents (2-3ft/sec) hampered dive operations but never became a problem during survey operations

The most prevalent limitation of this equipment is imposed by weather conditions. High winds/waves make for difficulties in launch and recovery of the equipment. Throughout the survey period weather was ideal, however during dive operations weather played a large role and weather downtime was incurred.

ENBDNR0000692

Equipment Overview (Inspection Operations)

BMC mobilized the AUV, ROV, Hydrographic survey vessel and additional equipment from at the Mackinaw City, MI State Dock for the inspection. This package consisted of the following:

- Kongsberg Munin – Autonomous Underwater Vehicle with all associated equipment
  - EM 204 Multi-beam system
  - EdgeTech Side-Scan Sonar System
  - Doppler Velocity Logger (DVL)
  - Inertial Navigation System (INS)
  - Global Positioning System (GPS)
  - Forward Looking Sonar System
  - Depth Sensor
  - Long Base Line (LBL) acoustic tracking system
- ROV LARS – Launch and Recovery System
- vLBV 950 - Remotely Operated Vehicle with all associated equipment
  - 2- Camera (1 Black and White and 1 Color)
  - Tilt Unit
  - Lighting
  - Compass
  - Depth Sensor
- Comprehensive field spares kit
- Linkquest tracking, Ultra short base line acoustic tracking system
- Trimble SPS 461 Heading
- Motion Reference Unit (MRU)
- Trimble R5-R6 GPS System - Real Time Kinematics (RTK) (centimeter accuracy)
- Computer navigation system
- Computerized and digital video recording equipment
- Offshore safety package
- Hydrographic Survey Vessel (Miss Geodesy)
- Hypack Hydrographic Survey Software

Diving Operation and Equipment

The project manager is in contact with immediate personnel on treatment gas stores, equipment and equipment start-up. In turn, the tug boat captain is in contact with the USCG for shipping traffic concerns, weather reports and will report this information to the project manager. At this point, the project manager and client representative will make the determination of that day's project location and a decision to sail.

Span coordinates identified from the 2016 AUV survey were used to plot anchor supports and mooring anchor locations. The barge was then positioned over anchor locations identified by the Hypack navigation system. The Hypack navigation program, located on the barge, brings in information provided from the RTK GPS, Heading Sensor, Motion Reference Unit (MRU) and Link-quest tracking system, which is then relayed to a monitor on the tug for the tug captain to follow. The mooring anchors are then dropped approximately 750' from the pipeline and anywhere between 1,000'-2,200' apart. Once both anchors are in position (2 anchor spread off the stern of the barge) the barge was towed into position and held in place with a constant speed and heading from the tugboat.

The vLBV 950 ROV was launched and the span is again inspected so that the final anchor support location can be determined. Locations were selected based on their proximity to the center of the span or as discussed with Enbridge's on site representative, type of bottom encountered (smooth or irregular, hardness) and span height.

The dive bell was then lowered to the work site, guided by the ROV. Adjustments were then made for barge positioning. When positioning of the barge was finished, guided by the remotely operated vehicle, the hydraulic drilling tool was then lowered to the work area and held by the crane. When the barge position was stable, the crane operator, by use of the live video supplied by the ROV, would begin lowering the tool into position and capture the pipeline. Next, the dive supervisor would begin the drilling process via controls located topside. Once drilling was complete a diver would enter the water to detach the tool from the anchor assemble and complete final installation.

The screw anchor and saddle support, which is a prefabricated design, is designed to drill along both sides of the pipeline simultaneously. Extensions can be added, for adjustment with sub-bottom material or span height. When drilling anchor supports into the sub-bottom, a minimum torque value must be met. At that time, the upper and lower saddle supports were installed. Placing the support over and under the pipeline and then all-thread bolts bring all the support saddles together.

Dive operation begins and bottom time starts when the diver leaves the surface. Once on bottom, the diver removes the 3-pin assembly thus disconnecting the hydraulic tool from the anchor assembly. The tool is then lifted off the screw assembly and safely placed off the East Side of the pipeline to prevent dragging back into the pipe. The diver then assembles the anchor and saddle into place until installation is completed.

The final inspection and position of the pipeline anchor supports were recorded from the ROV and the diver is brought to the surface for decompression if needed.

Equipment Overview (Diving Operations)

The following equipment was mobilized to Durocher Marine's yard in Cheboygan, MI for setup on barges:

- Mixed gas control Trailer
- 3 – 54" deck decompression chambers
- 4 – Hot water machines
- 3 – Quincy 5120 diver's air compressors
- 150kw Multi-quip generator
- 2 - Class 2 diving bell and Man Rated Handling system
- Hydraulic drilling tool
- 2 – Hydraulic hose reels
- 2 – Underwater video and lighting systems
- vLBV 950 - Remotely Operated Vehicle with all equipment and spares (Inspection Class)
- Link Quest tracking Plus tracking system with 4 beacons
- 2 - Hypack navigation computers
- Trimble R5/R6 RTK GPS
- Trimble SPS 461Heading
- 2 – 600' Diver's umbilical's
- Mixed gas stores
    - 100% Oxygen (Decompression gas)
    - 8416 HeO2 (Bottom mix)
    - 8614 HeO2 (Bottom mix, emergency gas)
    - 6040 HeO2 (Decompression gas)
    - 6040 Nitrox (Treatment gas)
- Miscellaneous diving and construction equipment (hoses, extension cords, tools, etc.)
- Helical Screw Anchors and Supports

- Due to space and weather considerations, the above equipment was setup in storage containers and sea fastened to the barge. The Hypack navigation equipment was centralized in the dive container, tracking the barge heading and position, ROV position, bell position and anchor drilling tool position. With the primary navigation being controlled from the dive container, a monitor was installed in the tug boat for navigation.

Findings

Data obtained during the 2016 AUV and ROV survey inspection were found to be similar to past findings, including the data obtained during the 2014 survey and inspection. Both the east and west pipelines show intermittent suspension over their entire length of uncovered pipeline. Four spans were determined to have exceeded the 75' span length requiring mitigation. Grout bags that were previously used (pre-anchor support design) for span repair were noted on the east and west lines, and at most of these locations the pipeline no longer rested on top of these grout bags. Currently only three grout bag locations still made contact with the bottom of the pipeline and were still considered to be touchdown points. These 3 locations were included in the 18 locations for which permits were sought. Mechanical anchor supports installed during previous mitigation programs were found to be stable and in good condition. A few instances of a small amount of coating delamination were observed. Additionally, areas of small debris encroachment were noted but nothing of concern was observed.

The enclosed spreadsheet identifying requested span information is also included within this report. This spreadsheet identifies span identifiers, location of all spans, current span lengths, span touchdown point information including depth and bottom type.

Conclusions

Upon the completion of the AUV and ROV inspection and data review process, Enbridge Energy, with support from Ballard Marine Construction, made the determination that four spans exceeded the 75' length and required anchor supports. In addition, another 18 preventative anchor supports would also be installed. The timing for install of the anchors will be such to ensure that the pipeline will have crude flowing through the line during anchor installation which is consistent with the 2014 remediation program.

Enbridge Energy received the permits required to install the four anchor supports required to eliminate spans exceeding 75 feet, and these supports were installed during the 2016 mitigation campaign. As a result of the installation of these four anchor supports, BMC has concluded (as of November 5th, 2016) that there are no longer spans exceeding 75' in length for either the east or west legs of Enbridge Energy's line 5 crossing the Straits of Mackinac. Furthermore, the ROV video inspection and AUV data collection shows that the pipeline currently appears to be in stable condition with minimal coating delamination or nearby obstruction concerns.

Lastly and subject to permitting, BMC understands that additional preventative anchor supports will be installed in 2017.