Transportation Safety Board of Canada | Bureau de la sécurité des transports du Canada

Pipeline Transportation Safety Investigation Report P18H0034

RELEASE OF CRUDE OIL

Trans Mountain Pipeline ULC
Darfield Pump Station
Darfield, British Columbia
27 May 2018

About the investigation

The Transportation Safety Board of Canada (TSB) conducted a limited-scope, fact-gathering investigation into this occurrence to advance transportation safety through greater awareness of potential safety issues. It is not the function of the Board to assign fault or determine civil or criminal liability.

The occurrence

On 27 May 2018, at approximately 0013,[1] a release of crude oil occurred from an above-ground pipe section in Trans Mountain Pipeline ULC's[2] (Trans Mountain) Darfield Pump Station in Darfield, British Columbia (Figure 1).

There were no injuries and no evacuation was required.

[1] All times are Mountain Standard Time.

[2] Effective 31 August 2018, Trans Mountain Pipeline ULC was purchased by the federal government and became Trans Mountain Corporation, a Crown corporation.

Canada

Figure 1. Location of the occurrence (Source: Google Maps, with TSB annotations)

Site examination

The crude oil had released from a ¾-inch pipe nipple that was threaded into a 16-inch flow meter downstream of the main pumps at the Darfield Pump Station. The flow meter is located on a section of above-ground piping adjacent to the building that houses the pumping equipment (pump building). Approximately 4.8 m^3 of product was released. Some of the released product had sprayed onto the west side of the pump building (Figure 2) and a small amount of product was found on vegetation outside the station property.

During site cleanup, about 3 m^3 of product was recovered.

Figure 2. Oil spray on the side of the pump building (Source: Trans Mountain)

The Trans Mountain pipeline

The Trans Mountain pipeline, which is regulated by the National Energy Board (NEB), transports petroleum crude oil and refined petroleum products from Edmonton, Alberta, to refineries and terminals in British Columbia and the state of Washington, United States.

There are 23 pumping stations at various intervals along the pipeline. At the time of the occurrence, the pipeline, which was operating within prescribed limits, was transporting light crude oil at a flow rate of 2048 m^3/h. The Darfield Pump Station's discharge pressure was 5338 kPa.

Notification of the occurrence and Trans Mountain's response to the occurrence

At 0013, Trans Mountain's control centre operator (CCO) received a low flow alarm at the Darfield Pump Station. At 0023, after confirming and reviewing the alarm, the CCO contacted an on-call field employee located near Darfield to investigate the alarm further.

At approximately 0040, a Trans Mountain security contractor who was posted at the Darfield Pump Station called Trans Mountain to report that there was a hydrocarbon odour at the station and that a mist of crude oil had sprayed on one side of the station's pump building.

At 0046, after confirming the product release with the security contractor, the CCO initiated a controlled shutdown of the Trans Mountain pipeline, which included a shutdown of the Darfield Pump Station.

The pipeline was out of service for about 15 hours.

Site remediation

Site remediation started later that day. Surficial soils and all accessible saturated subsoil affected by the released product were excavated and disposed of at an appropriate disposal facility. The affected vegetation off company property was cut and disposed of appropriately.

Soil samples from the adjacent property in the area where vegetation had been affected were collected for testing. The soil test results met the applicable regulatory criteria, confirming that no offsite impacts remained.

Starting in June 2018 and throughout the rest of the year, the remaining on-site subsoil that was inaccessible owing to the site's infrastructure was treated in place using bio-remediation, that is, nutrients are injected into the sub-surface to help hydrocarbons to degrade. Monitoring of this subsoil will continue for the next several years. Additional groundwater monitoring wells were installed to monitor for potential impacts to the groundwater resulting from the release.

Flow meter

The flow meter is of the wedge type and operates by creating a pressure differential across a restricting element (wedge).[3] Small-diameter pressure taps are located upstream and downstream of the wedge at approximately 90° relative to the top of the meter.[4] These taps are used to measure the

[3] This type of flow meter is generally used in heavy oil or dirty service, as the turbulence created by the wedge encourages any particulates to drop to the bottom of the pipe. This allows the fluid entering the pressure instrumentation to be relatively clean, ensuring a more reliable and accurate reading.

[4] At the nine-o'clock position when looking downstream.

pressures in order to calculate the flow. The ¾-inch pipe nipple that failed had been installed in 2009. It was threaded into the pressure tap component of the flow meter that was upstream.

Metallurgical analysis of pipe nipple

The spool piece,[5] including the ¾-inch pipe nipple from which the oil was leaking, was removed and sent by Trans Mountain to a laboratory for detailed examination (Figure 3). Ratchet and beach marks were present on the fracture surfaces of the threaded portion of the nipple. It was determined that the threaded fitting had cracked due to fatigue (Figure 4).

Figure 3. Crack in the ¾-inch threaded portion of the nipple (Source: Trans Mountain, with TSB annotations)

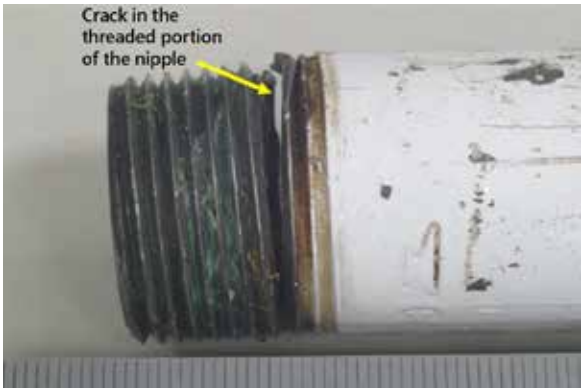

Figure 4. Fracture surface of the threaded portion of the nipple (Source: Trans Mountain)

The crack had started at the last engaged thread of the nipple, a location known to have a high stress concentration. The location of the pressure taps on each side of the flow meter would have subjected the pipe nipple to additional bending forces. The high stress concentration on the threads combined with the additional bending forces likely led to the vibration-induced fatigue failure of the nipple.

Facility Integrity Management Program

Trans Mountain's Facility Integrity Management Program[6] includes provisions to identify, assess, document, and address hazards within each facility. As part of this program, a risk assessment is conducted annually and a qualitative risk assessment (QRA) is conducted every 3 years.

The annual risk assessment, which is conducted in accordance with the company's Integrated Safety and Loss Management System, includes a review of all known facility integrity hazards and any recently identified facility integrity hazards. This assessment takes into account all identified control measures to determine the risk associated with each identified hazard. The most recent risk assessment had been conducted in November 2017.

The QRA includes the assessment of each hazard to determine whether adequate preventive and mitigating control measures are in place to manage the risks. Trans Mountain requires that each control measure be properly implemented, maintained, and documented. The 2 most recent QRAs had been conducted in 2013 and 2016.

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[5] A pipeline spool piece is a short piece of pipe, typically between 2 flanges, that can be removed for maintenance or replacement.

[6] The Facility Integrity Management Program is 1 component of Trans Mountain's overall Integrity Management Program.

At the Darfield Pump Station, the hazards associated with pumps, sump tanks, and facility piping (including small-diameter piping) had been identified. With respect to small-diameter piping, the potential hazards related to vibration affecting threaded connections were documented in the QRA. The applicable control measures (engineering and/or procedural) had been implemented to address fatigue failure. However, the specific effect of additional external loads and stresses on small-diameter pipe components, such as bending stresses when such components are installed at a 90° angle, had not been considered.

Regulatory requirements for managing hazards and risks

The NEB requires the pipeline companies it regulates to anticipate, prevent, mitigate, and manage any hazards and risks associated with their operations. The NEB uses audits and inspections as key tools to verify whether companies under its jurisdiction are complying with the applicable regulatory provisions. A risk-based model is used to assess regulated companies and their facilities to determine the appropriate activities for verifying compliance.

The NEB had conducted a management program audit at Trans Mountain in February 2009. This included a comprehensive review of the company's integrity, damage prevention, health, safety, and environmental protection programs. Its final report, issued in March 2010, noted a number of instances of non-compliance with Trans Mountain's system-wide proactive approach to identifying hazards. Trans Mountain later submitted a corrective action plan, which the NEB approved. In February 2014, the NEB accepted the corrective actions that had been implemented and closed the audit.

In May 2015, the NEB conducted an inspection at the Darfield Pump Station. This inspection did not find any non-compliance issues related to Trans Mountain's Integrity Management Program.

Actions taken by Trans Mountain

Following the occurrence, Trans Mountain developed a revised configuration design for piping associated with flow meters. This revised configuration is intended to reduce the effects of bending loads that can contribute to vibration-induced fatigue at small-diameter threaded connections. The revised configuration was applied at the Darfield Pump Station.

Trans Mountain conducted inspections of all wedge flow meters and associated piping nipples across the Trans Mountain pipeline. From these inspections, Trans Mountain identified nipples at 4 other pump stations that had a similar configuration to that of the Darfield Pump Station at the time of the occurrence. These nipples were replaced using the revised configuration design. Also, Trans Mountain initiated a system-wide inspection at other installations to identify and address situations where threaded connections are subjected to bending loads and vibrations.

Safety message

In order to manage the risk of vibration-induced fatigue failures effectively, a pipeline company's integrity management program must identify and mitigate hazards related to vibration, including additional external loads and stresses, particularly for small-diameter threaded connections.

This concludes the TSB's limited-scope investigation into this occurrence. The Board authorized the release of this investigation report on 30 January 2019. It was officially released on 14 February 2019.

Transportation Safety Board of Canada
Place du Centre
200 Promenade du Portage, 4th floor
Gatineau QC K1A 1K8
819-994-3741
1-800-387-3557
www.tsb.gc.ca
communications@tsb.gc.ca

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Le présent rapport est également disponible en français.