PIPELINE OCCURRENCE REPORT

NATURAL GAS PIPELINE RUPTURE

WESTCOAST ENERGY INC.
MONIAS PIPELINE, MILE POST 20
NEAR FORT ST. JOHN, BRITISH COLUMBIA
30 APRIL 1997

REPORT NUMBER P97H0024

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Summary

At 0755 Pacific daylight time on 30 April 1997, a rupture occurred on the Westcoast Energy Inc. 219.1-millimetre (8-inch) outside diameter Monias pipeline at Mile Post 20 near Fort St. John, British Columbia. Approximately 85,000 cubic metres of sour natural gas was released and ignited.

Ce rapport est également disponible en français.

Other Factual Information

At 0755 Pacific daylight time (PDT), the Fort St. John Gas Control received a call from the local fire department which had been notified by a landowner that there was a pipeline rupture and fire in the Old Fort St. John area. At the same time, alarms were received by the Supervisory Control and Data Acquisition (SCADA) system at Fort St. John Gas Control indicating that the Monias receiving line break valve was closing due to low pressure. Westcoast Energy Inc. (WEI) personnel were dispatched to the site. A landowner also called the local police at 0758 to indicate that there was a pipeline rupture and fire. The police responded immediately and set up road blocks. WEI personnel took over site security when they arrived at 0835.

At 0755 and 0805, Fort St. John Gas Control asked the producers to shut in all production to the Monias pipeline. Producers cannot shut in their production remotely; it must be done at the well head. A producer's facilities can also be isolated from the WEI facilities by closing the valve at the location where the producer's gathering line ties in to the WEI pipeline. At 0845, a WEI crew arrived by helicopter at one of the two tie-in locations and closed that valve, thereby isolating this producer's facilities from the Monias pipeline. The crew continued upstream and, at 0900, closed the block valve at the Monias Booster Station, the location of the other tie-in to the Monias pipeline, thereby completing the isolation of the line. Neither the block valve nor the tie-in valve can be remotely operated.

The Monias pipeline line was acquired by WEI in 1985. It was originally constructed in 1978 by Czar Resources and followed the route of a pipeline constructed in the 1960s. The Monias pipeline crossed the Peace River one kilometre (km) downstream of the Old Fort St. John area. After the crossing, the pipeline turned west and followed the toe of the north slope of the river valley for about 0.5 km. At this point, the pipeline turned and ran diagonally in a north-easterly direction to the crest of the slope. This portion of the pipeline route was over pre-existing landslide terrain. On 30 April 1997, this portion of the north valley slope underwent a movement of at least seven metres (m) laterally. A buckle occurred in the pipeline at the sidebend where the pipeline began to run diagonally upslope. The pipeline split along the longitudinal weld in the vicinity of the buckle. A metallurgical examination of the weld was conducted, but no significant flaws were detected.

For several years, WEI has been implementing a geotechnical monitoring and mitigation program. The program consists of geotechnical inspections, remedial measures and monitoring. Geotechnical inspections include annual aerial patrols, focussed aerial patrols following periods of heavy rainfall or run-off, and routine ground patrols incidental with other right-of-way work. The following would be looked for during aerial patrols: changes in topography, open tension cracks, erosion, subsidence or sloughing. Indications of significant ground movement would be followed by a ground reconnaissance to assess the extent of the ground movement and risk to the pipeline. Remedial measures would be taken as required. Remedial measures could include: filling tension cracks with native clay or bentonite powder, surface grading to reduce water infiltration, sub-surface water control, daylighting the pipe to relieve pipe-to-soil stresses (temporary measure only) or replacing the affected section of line by a skid-mounted surface line. Geotechnical monitoring instrumentation has been used at certain locations along WEI's pipeline system when a risk assessment indicates that monitoring of a potentially deep-seated slide would be enhanced by such instrumentation.

There are a number of large slide blocks along the north and south valley walls of the Peace River in the general vicinity of the Monias pipeline route, some of which have had recent slide activity. However, the slide

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[1] All times are PDT (Coordinated Universal Time (UTC) minus seven hours) unless otherwise stated.

block which failed on 30 April 1997 had had no significant movement in the history of the pipeline. A recent WEI Northern District Geotechnical Report had not identified the Peace River crossing of the Monias pipeline as an area of concern. In addition, WEI had not identified any potential slide blocks along the Monias pipeline as requiring geotechnical monitoring instrumentation.

During the last three years, annual precipitation levels in the Fort St. John region had been close to record levels. On 01 April 1997, snow depth had been near the recorded high for the area. All the snow had melted by 30 April 1997. Snow had arrived early in the fall of 1996, resulting in little frost in the ground. Since conditions in the Fort St. John area were such that slope movements could have been triggered, WEI had completed its aerial patrol of the Monias pipeline on 29 April 1997, earlier than anticipated. No significant slope movements were noted during this patrol although active deep-seated instability had been identified on the north approach slope to the Peace River approximately 6 km downstream of the pipeline crossing. In addition, although unrelated to the aerial patrol, a cleaning pig had been run successfully in this section of the line on 29 April 1997, indicating that the pipeline had not buckled before that run.

A geotechnical assessment of the area following the failure indicated that the block that failed was part of a larger deep-seated pre-existing landslide complex. This landslide complex was formed from movements in Cretaceous shale bedrock and may be undergoing slow, small-scale creep movements along pre-existing deep-seated shear planes. The slide surface of the block that failed was along a weak clay layer within the shale bedrock below the upper part of the slope.

Analysis

The reactivation of the slide block within the larger pre-existing landslide complex was probably due to high ground water levels which had resulted from high precipitation levels over a three-year period and high snow pack combined with minimal ground frost. Slightly increased slope movements may have opened up existing tension cracks which then filled with water. Since the surficial clays in this area tend to be self-healing, the tension cracks would have probably closed up, trapping the excess water as well as preventing observation of the crack. The trapped water would have caused increased pressures, triggering additional rapid movement. Although WEI had a monitoring program for the Monias pipeline, this type of rapid movement could not have been predicted by the program.

A buckle was formed in the pipeline due to the longitudinal compression caused by the pipe-to-soil interaction created by the sudden, rapid movement of the pre-existing slide block. The pipeline split as a result of being stressed beyond its design limits and not as a result of metallurgical flaws.

Isolation of the rupture site took more than one hour from the time the rupture was first identified. The one low-pressure shut-off valve on the Monias pipeline closed automatically as intended but the tie-in valve and the block valve needed to complete the isolation of the rupture site from the producers' facilities had to be closed manually. Since the Peace River valley slopes are known to be composed of slide blocks and the Peace River crossing of the Monias pipeline was near an existing community, it would have been prudent to have located additional low-pressure shut-off valves near the unstable area to limit the size of a sour gas cloud in the event of a rupture due to a slope movement.

Findings

1. High precipitation levels over a three-year period and high snow pack combined with minimal ground frost probably triggered the sudden rapid movement of a portion of a pre-existing landslide complex on the north slope to the Peace River.

2. The Monias pipeline was compressed longitudinally in the downslope direction as a result of pipe-to-soil interaction forming a buckle in the pipeline.

3. The pipeline ruptured as a result of being stressed beyond its design limits and not as a result of metallurgical flaws.

4. WEI's geotechnical monitoring program for the Monias pipeline could not have provided advance warning for this type of sudden rapid slope movement.

5. Isolation of the rupture site would have been faster if the valves needed to isolate the rupture site could have been remotely operated or if there had been additional low-pressure shut-off valves located near the unstable area.

Causes and Contributing Factors

The pipeline ruptured as a result of being stressed beyond its design limits due to pipe-to-soil interaction caused by the sudden rapid movement of an existing slide block.

Safety Action

Action Taken

Subsequent to this occurrence, WEI took the following measures regarding the Monias pipeline:

i. construction of a temporary skid-mounted surface line to replace the failed section of line;

ii. installation of slope indicators at the upstream and downstream ends of the temporary surface line, coinciding with the crest and the toe of the slope;

iii. installation of a slope indicator approximately mid-way through the slide area; and

iv. installation of three low-pressure shut-off valves in the vicinity of the Peace River crossing to limit plume size at the Old Fort St. John area in the event of a pipeline rupture.

In addition, WEI has made the following changes to its geotechnical monitoring program for its pipeline system:

i. increased aerial monitoring of known slide areas;

ii. installed geotechnical monitoring instrumentation at certain locations; and

iii. installed additional geotechnical monitoring instrumentation at certain existing locations.

WEI has also indicated that it would be examining the need to limit plume size in the event of a line rupture in geotechnically unstable areas for those portions of its sour gas gathering system located close to populated areas.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 13 August 1998.