

Failure Investigation Report

Final report on the Nov. 22, 2009 Failure of Piping at
Encana Swan Wellsite A5-7-77-14 L W6M

November 2010



About the BC Oil and Gas Commission

The BC Oil and Gas Commission (Commission) is an independent, single-window regulatory agency with responsibilities for overseeing oil and gas operations in British Columbia, including exploration, development, pipeline transportation and reclamation.

The Commission's core roles include reviewing and assessing applications for industry activity, consulting with First Nations, ensuring industry complies with provincial legislation and cooperating with partner agencies. The public interest is protected through the objectives of ensuring public safety, protecting the environment, conserving petroleum resources and ensuring equitable participation in production.

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1. Incident Summary

On Nov. 22, 2009 at 8:38 a.m., an A420 WPL-6 60.3 mm outside diameter (OD) x 11.07 mm wall thickness (WT) double extra strong (XXS) tee failed suddenly at an Encana wellsite situated at LSD 5 of Section 7 Township 77 Range 14 west of the 6th Meridian near Pouce Coupe, British Columbia. Residents near the wellsite reported smelling “sewer-like” odours from as early as approximately 2:30 a.m. and hearing a “jet-like” noise beginning as early as approximately 4 a.m. These reports indicate that a leak may have occurred prior to the sudden failure at 8:38 a.m. Figure 1 provides a spatial view of the incident location and surrounding roads.

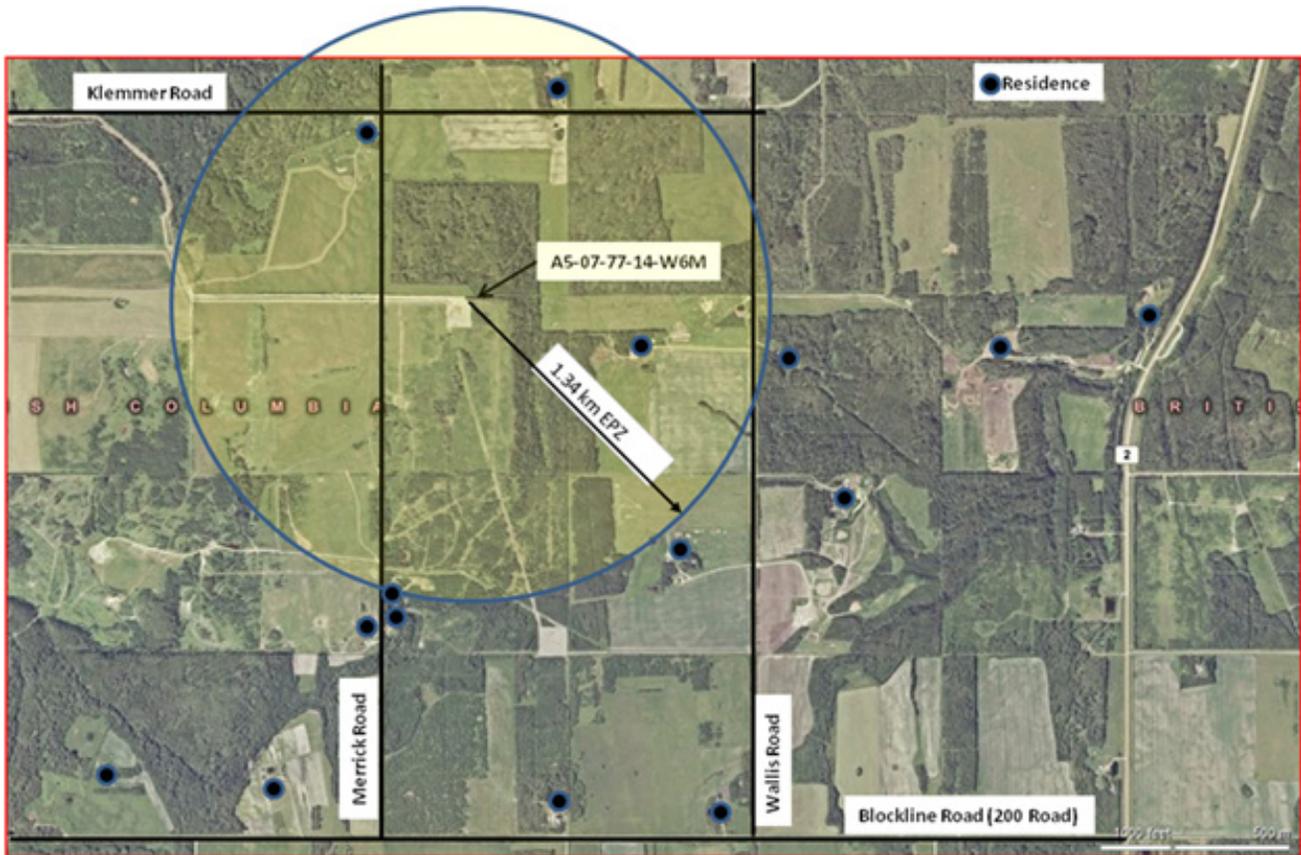


Figure 1 – Incident Location

At 9:05 a.m., approximately 27 minutes after the sudden failure, the emergency shutdown (ESD) valve at the well closed automatically but was unable to stop the flow of gas from the failed tee because the ESD was downstream of the failure point. The closure was recorded at the Encana control room located in Hythe, Alta. Five minutes later at 9:10 a.m., the control room received an H₂S alarm and notification of ESD closure at an adjacent well located on the same well pad approximately 25 metres from the leaking well. Encana began its response to the incident at that time.

Encana staff arrived near the site at approximately 10:02 a.m. Two Encana operators donned personal protective equipment (PPE) and self-contained breathing apparatus (SCBA) and manually closed the wellhead valves upstream of the failed tee. The well was shut in at approximately 10:45 a.m.

Approximately 30,000 cubic metres of natural gas containing approximately 6,200 parts per million (ppm) of H₂S was released between 8:38 a.m. and 10:45 a.m. Ambient H₂S was measured at 12.82 ppm at the wellsite. Encana reports the highest concentration of H₂S measured away from the wellsite was approximately one ppm. The tee failed due to internal erosion resulting from abrasion caused by fracture sand suspended in the high velocity gas stream.

Five residences were located within a 1.34 kilometre (km) radius emergency planning zone. A total of 18 residents evacuated the area during the release and mustered at the Tate Creek Community Centre.

2. Investigation Procedures

All companies engaged in oil and gas activities in British Columbia are required to report incidents where the safety of persons or the quality of the environment has been placed at risk. The Commission receives and reviews these reports and provides regulatory oversight of the follow-up response and mitigation by the company.

Certain incidents may prompt a more detailed investigation by the Commission. As a general rule, the Commission may launch an Engineering/Technical Investigation into an incident when the incident:

- Results in significant impacts to the public or other stakeholders.
- May stem from a systemic issue within the company's management systems.
- May identify deficiencies in current practices and procedures within industry.
- May identify opportunities for improvement of processes and procedures within the Commission or within industry.
- Results or may have resulted in serious injury or death.
- Attracts significant public attention.

The Commission's goals in conducting an Engineering/Technical Investigation are to identify the incident cause and contributing factors. The results of these investigations are summarized in a publicly accessible report available from the Commission website. By sharing the results and findings of these investigations, the Commission reduces the likelihood of similar events occurring. Enforcement actions may arise during the course of an investigation but are not the primary purpose.

3. Relevant Information

3.1 Incident Chronology

The timing of events and the emergency response to the incident is provided in Table 1A and 1B. All events took place on Nov. 22, 2009. The tables represent an amalgamation of incident data from multiple sources and do not represent the complete incident log.

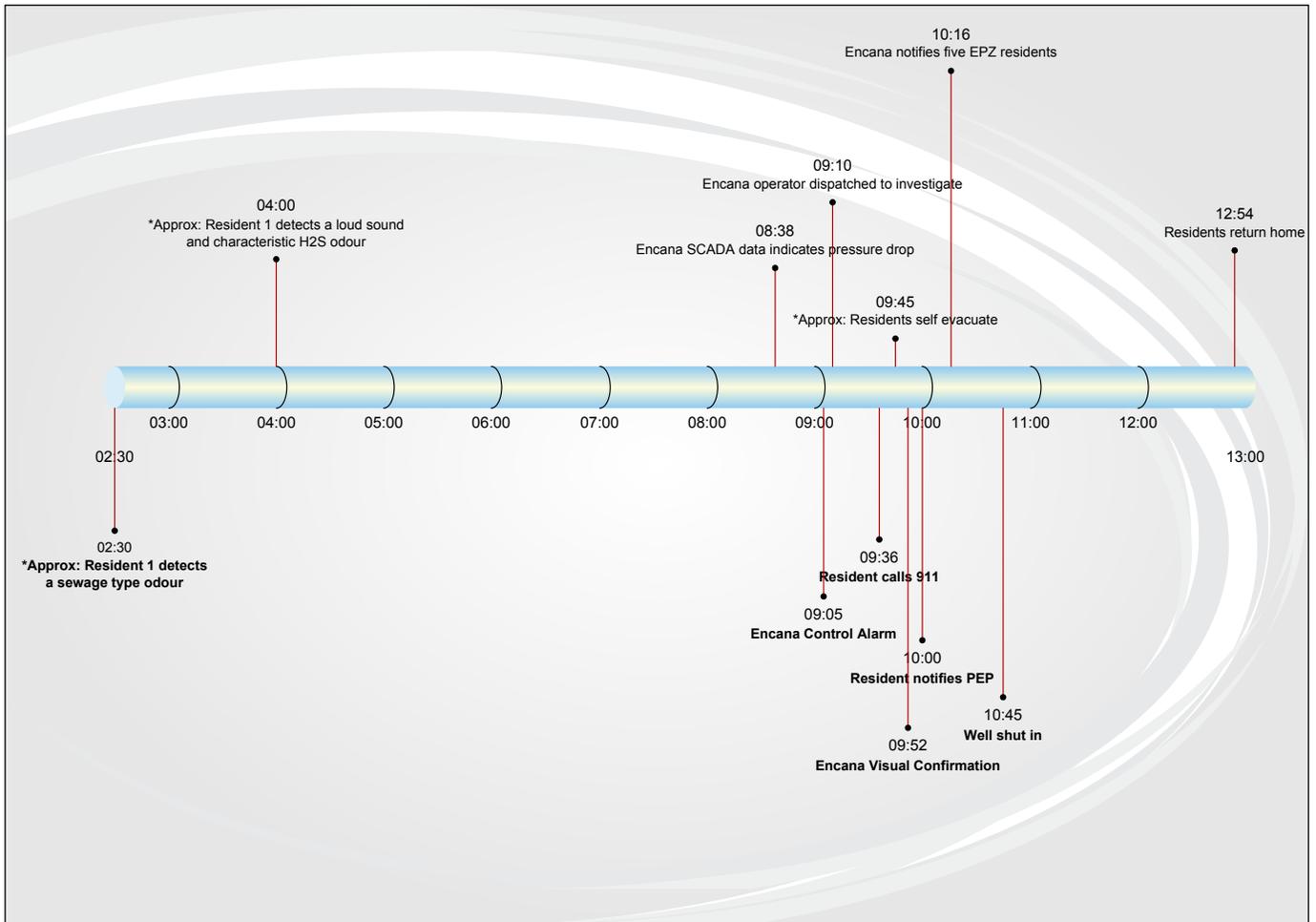


Table 1A – Incident Timeline Graphic

Table 1B – Incident Time Log

| Time | Detail |
|--------------------|--|
| Approx. 2:30 AM | A local resident (1) smells what they thought was sewage. The resident did not make any notifications. |
| Approx. 3:30 AM | Resident (1) went outside three times to determine the source of the smell but was uncertain where the smell was coming from. The resident did not make any notifications. |
| Approx. 4:00 AM | Resident (1) hears a loud roaring sound from inside the house sounding like a jet flying overhead. The resident did not make any notifications. |
| Approx. 5:00 AM | Another local resident (2) outside checking on livestock hears a loud roar but does not detect any odours. The resident does not make any notifications. |
| Approx. 8:00 AM | A local resident (3) out hunting drives up Klemmer Road and can smell gas, and assumes some work is being done. The resident does not make any notifications. At the same time, resident (2) goes back outside and detects a pungent rotten egg smell and hears a roaring sound, but assumes a company is doing some work. The resident does not make any notifications. |
| 8:38 AM | Sudden failure of a 60.3 mm Tee at the wellsite (noted on Supervisory Control and Data Acquisition [SCADA] data for well pressure and flowrate). |
| 9:05 AM | Encana control room receives alarm showing the ESD valve at A5 has closed. |
| 9:10 AM | Encana control room receives high alarm from adjacent well (A6) confirming ESD at A6 has closed due to H ₂ S detection of 12.82 PPM. |
| 9:10 AM | Encana dispatches operator to investigate (Operator 1). |
| 9:30 AM | Resident (3) returns to area via Klemmer Road and observes a gas cloud and detects strong odours, and advises inhabitants at nearby residence to evacuate. Resident (3) drives through the gas cloud and heads east on Merrick Road and sees the gas coming off the wellsite and parks his pickup truck about 300 metres crosswind on Merrick Road. Resident (3) calls 911. |
| 9:36 AM | Resident (3) provides update to 911 and confirms the event is a gas leak. |
| 9:38 AM | Local Encana operator (Operator 2) receives a call from a local resident (4) informing of a leak. |
| Approx. 9:45 AM | Resident (3) contacts wife at home and suggests she calls neighbours to evacuate their homes. Resident (3) makes notifications to local residents and passersby advising the area is unsafe and instructs resident (1) to park her pickup truck at the junction of Klemmer Road and Wallis Road to restrict access and warn local residents to not drive through. Resident (3) then drives to junction of Wallis Road and Blockline Road and parks vehicle to restrict access and wait for more information. |
| 9:45 AM | Operator 2 notifies Encana control room of call. At the same time another local resident (5) arrives at Operator 2's residence to inform him of the leak. |
| 9:47 AM | Encana control room operator contacts Encana Operator 3 and dispatches him to the incident. |

| Time | Detail |
|-------------------|---|
| 9:48 AM | Encana Community Relations Advisor receives a call from local resident from SE 18-77-14-W6M and is informed by the resident he is evacuating to Pouce Coupe. |
| 9:50 AM | Operator 2 arrives at the junction of Wallis Road and Klemmer Road and meets an Encana construction foreman there. Operator tests ambient atmosphere with gas monitor and detects no H ₂ S. |
| 9:50 AM | Operator 2 then proceeds to drive slowly down Klemmer Road with window open and gas detector on. No H ₂ S detected. |
| 9:52 AM | Operator 1 requests assistance from another operator (Operator 4). Operator 3 observes gas plume from A5 well at this time. |
| 9:53 AM | Operator 3 confirms leak and proceeds to nearby compressor station to get an ignition kit. |
| 10:00 AM | Resident (1) dials 911 to advise RCMP of a gas release and is transferred to fire service dispatch; resident is instructed to stay at present location until told otherwise. RCMP arrive and proceed to set up road blocks at two separate locations. |
| 10:00 AM | Operator 1 reports the leak is visible from Blockline Road. He requests that the wells and the 05-07 Block Valve be shut in. |
| 10:00 AM | Local resident (6) phones Provincial Emergency Program (PEP) to report gas leak. PEP classifies as Level 1 and assigns incident #902235. |
| 10:00 AM | Encana Community Relations Advisor reports leak to Encana control room. Encana senior management notified. |
| 10:02 AM | Operators 1, 2 and 4 arrive near the incident but cannot approach due to ongoing gas release. |
| 10:05 AM | PEP places call to Commission emergency officer and Ministry of Environment codes incident as a Code 1 Provincial. |
| 10:06 AM | Operator 4 advised by local resident (3) that residents north of the incident site have evacuated and gathered at the intersection of Wallis Road and Klemmer Road. |
| 10:06 AM | Operators 1, 2 and 3 determine a need to physically enter the site using SCBAs to stop the flow of gas. Operators 1 and 3 will enter the site under observation from Operator 2. |
| 10:07 AM | Encana classifies incident as a Level 1 Emergency. |
| 10:10 AM | Operators 1 and 3 attempt to shut in the A5 well. They get within 25 metres and can see that the tee has failed upstream of the ESD. |
| 10:15 to 10:30 AM | An industry medic truck arrives at Klemmer Road and Wallis Road and assembles with several others at intersection to await further instructions. Several others arrive at the intersection including a work crew and grader operator. |

| Time | Detail |
|----------------------|--|
| 10:15 AM | Operator 4 meets with residents gathered at the intersection of Wallis Road and Klemmer Road and advises residents to proceed to the Tomslake hall. Encana personnel man the roadblock at this location. |
| 10:16 AM | Encana identifies five residences within the 1.34 km emergency planning zone (EPZ) and initiates contact with all residents advising them that they may evacuate voluntarily to the Tomslake hall. |
| 10:20 AM | Operator 1 and 3 evacuate the site due to problems with one of the SCBAs. Operator 5 arrives at site. |
| 10:30 AM | Several residents gathered at the intersection of Wallis Road and Klemmer Road evacuate to Dawson Creek, including resident (1). Resident (1) states that gas odour was very strong at the highway near Gumbo Gulch Ranch. |
| 10:30 AM | Encana provides a situation update to the RCMP. |
| 10:35 AM | Operator 4 drives to the five residences within the EPZ to confirm evacuation. |
| 10:42 AM | Encana notifies Ministry of Energy, Mines and Petroleum Resources (MEMPR) of incident. |
| 10:45 AM | Operators 3 and 5 successfully shut in well. |
| 10:45 AM | Evacuation reception centre opened at Tate Creek Community Centre in Tomslake. |
| 10:49 AM | Encana notifies PEP to report incident. |
| 10:55 AM | Encana provides a situation update to the RCMP. |
| 11:00 AM | Commission inspector contacts Encana to receive additional information. |
| 11:13 AM | Encana provides an e-mail situation update to senior MEMPR officials. |
| 12:30 to 12:33 PM | Encana classifies incident as a Level 1 Emergency. |
| 12:54 PM | Residents advised they may return to their residences. |

3.2 Information Requests

On Dec. 2, 2009 Commission employees met with Encana and reviewed a formal request for information (Information Request or IR) pertaining to the incident.

The IRs were separated into two areas:

- Failure analysis in order to determine the root cause of the failure as well as the contributing factors.
- Emergency management and response in order to assess the adequacy and effectiveness of Encana's emergency preparedness and response.

3.3 Failure Analysis

The site was secured immediately after the flow of gas from the failed tee was stopped. Commission investigators visited the site on Nov. 22 and again on Nov. 23 to obtain evidence and gather information pertinent to the investigation of the failure cause and contributing factors. The failed piping was removed from the site and sent to CORRMAT (C&M Engineering Limited) for analysis.

The failure report from CORRMAT was completed on Dec. 9, 2009 and concluded that the cause of failure of the tee was erosion due to sand in the production flow path.

4. Relevant Information

4.1 Failure Cause and Contributing Factors

The following observations and statements are based on a review of the evidence:

- The failed piping consisting of the failed tee (60.3 mm x 11.07 mm XXS A420-WPL6 tee) and the downstream elbow (Figure 2) exhibited significant internal erosion.
- A significant amount of sand was recovered from the failed piping and determined to be sand injected into the gas-producing formation during fracture operations at this location.
- The primary flow of produced gas at A5 is from the production tubing with secondary production flow from the well casing.
- The cleanup flow for the A5 well was 4.6 days – the average time for cleanup flow for similar Encana wells is nine days.
- Encana determines a well to be clean when the sand concentration produced over a 24-hour period is 0.5 per cent or less by volume – the A5 well cleanup did not achieve this result.
- The fracture program for the A5 well anticipated the use of seven sand plugs to achieve eight fractures. Due to complications during fracture operations, an additional six sand plugs were required for a total of 13 sand plugs during fracturing operations.
- H₂S detection at the A5 well, located on the well choke and on the meter skid, was set to alarm at five ppm and to activate the ESD at 10 ppm.
- The pressure and flow data for the A5 well immediately prior to the sudden failure of the tee at 8:38 a.m.

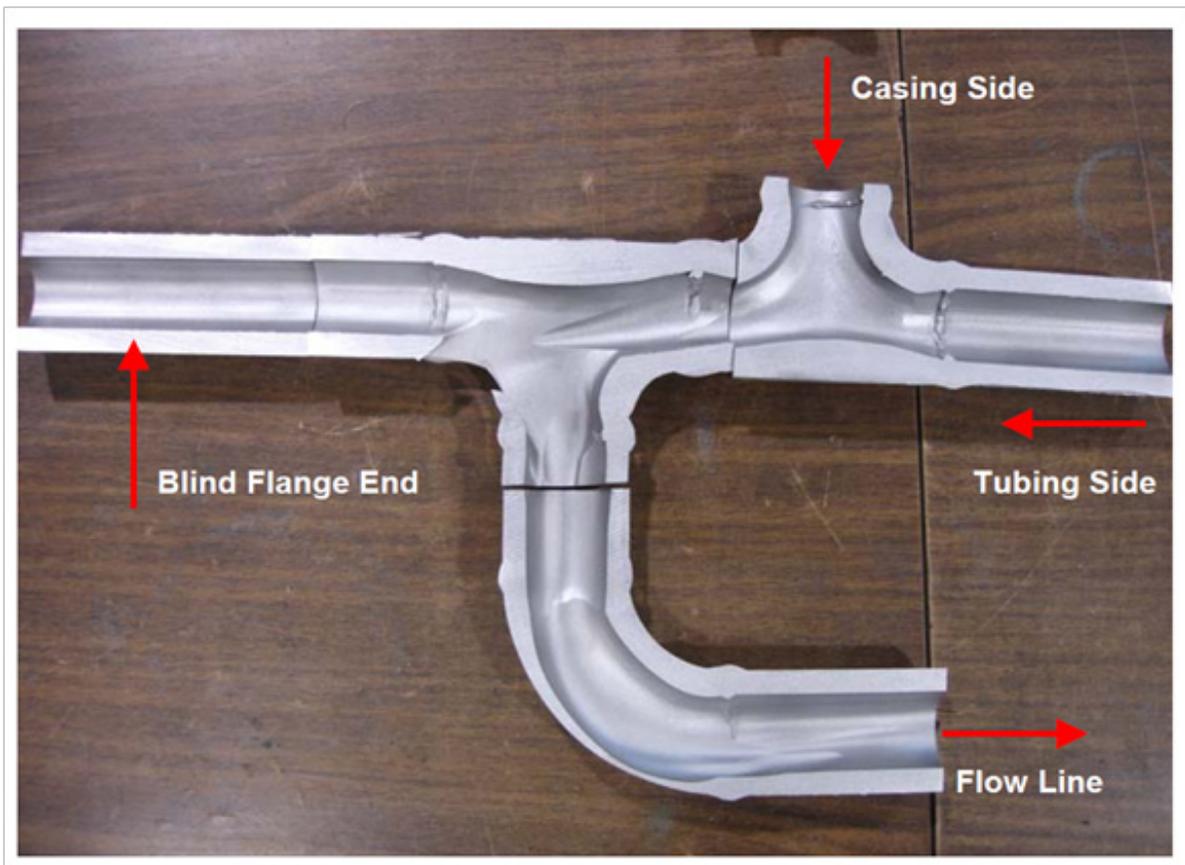


Figure 2 – Photograph of Eroded Tee

shows a steady decline in casing pressure, tubing pressure and flow rate – a comparison of flow data from this location to similar wells shows similarities in flow characteristics.

- The well was started on Nov. 21, 2008 and drilled to a total vertical depth of 4,148.3 metres.
- The well was placed in production on Mar. 30, 2009 with a tested H₂S concentration of 8,300 ppm; at the time of failure the concentration measured 6,200 ppm. Flow through the permanent meter run began on Oct. 15, 2009.
- 119 wells operated by Encana were shut in following the failure pending ultrasonic evaluation of piping to confirm suitability for continued operation in light of potential internal erosion.
- Approximately 30,000 cubic metres of natural gas containing approximately 6,200 ppm H₂S was released to atmosphere during the incident.
- The ESD at the wellsite failed to control the flow of gas at the failure point as it was situated downstream of the failed tee.

Based on the preceding observations and statements, the Commission has determined the root cause of the piping failure that occurred the morning of Nov. 22, 2009 at the Encana well A05-07-077-14-W6M was internal erosion of the wall of the 60.3 mm x 11.07 mm XXS tee caused by flowing fracture sand suspended in the gas stream.

Factors contributing to the failure at this location include the failure by Encana to follow established procedures for well cleanup monitoring of sand concentrations. In addition, Encana's monitoring equipment at the site did not provide any notification to the control operator until 9:05 a.m. – 27 minutes after the sudden failure of the tee at 8:38 a.m. The flow and pressure data used to determine the time of the sudden failure of the tee was not incorporated in Encana's leak detection system for this wellsite at the time of the failure. The location of the ESD downstream of the failure point did not enable remote or automated shut in of the failed piping.

The frequency of non-destructive inspection of wellsite piping did not address the hazards presented by internal erosion at this location. Production erosion assessments were to be conducted after erosion of the choke required maintenance under the direction of Encana's Facility Asset Management team.

4.2 Emergency Management

The following observations and statements have been made following a review of the incident logs and the responses to the information requests made by the Commission:

- Three residents in the immediate vicinity of the site reported hearing sounds and detecting H₂S-like odours prior to the 8:38 a.m. failure identified by the SCADA information.
- Residents began self-evacuation at approximately 9:30 a.m.
- Encana received the first alarm at 9:05 a.m. and dispatched an operator to investigate at 9:10 a.m.
- RCMP were dispatched following the 911 notification made by a resident at 9:30 a.m.
- Encana operator visually confirms leak at 9:52 a.m.
- Encana evacuation notifications were initiated at 10:16 a.m., 24 minutes after visual confirmation of the gas leak and 71 minutes after H₂S triggered the alarms.
- PEP was alerted by a resident at 10:00 a.m. and the event was classified as a Level 1 emergency and

notifications to the Commission and the Ministry of Environment were made.

- The response time from alarm notification at 9:05 a.m. to visual confirmation of the leak by Encana personnel at 9:52 a.m. was 47 minutes.
- Initial attempts to shut in the well at 10:10 a.m. were halted when the SCBA of one of the operators malfunctioned.
- Encana's incident log shows no external notifications were made to affected agencies or government departments prior to the 10:42 a.m. notification to MEMPR and the 10:49 a.m. notification to PEP.
- The Emergency Response Plan used by Encana was not updated with the current information for gas analyses data and EPZ calculations.

Based on the preceding observations and statements, the Commission has determined that Encana's response to this incident did not entirely conform to their ERP. Specifically, the Commission notes that the flow of information within Encana during the event was effective but delays in external notifications reduced the overall effectiveness of the response. Encana's notification to PEP took place at 10:49 a.m. – 57 minutes after visual confirmation of the leak. Notification of PEP and the Commission is the second step in Encana's Grande Prairie Area Emergency Response Plan. Subsection 38(2) of the Drilling and Production Regulations¹ requires companies to provide a verbal report to the Commission immediately when a well is flowing uncontrolled. Notification to PEP equates to notification to the Commission through established reporting protocols.

When interviewed by the Commission investigation team, residents in the immediate vicinity of the site indicated that they had little understanding of the contents of the Public Information Package provided to them by Encana.

Encana did not review the Emergency Planning Zone to identify residents who may require contact until after visually confirming the leak at 9:52 a.m. and did not begin resident notifications until 10:16 a.m. – 71 minutes after the first alarm at 9:05 a.m.

The Commission notes that it would be impractical and undesirable for Encana to notify residents or prepare for evacuation upon receipt of every alarm. However, in this instance there were indications of an active gas release available to Encana prior to the 9:52 a.m. visual confirmation of the leak – specifically the H₂S alarms from the site, the pressure and flow data available from the SCADA system following the 8:38 a.m. failure and the call from a resident received at 9:38 a.m.

¹ S. 38(2) of the Drilling and Production Regulation has been superseded by s. 39 of the new Drilling and Production Regulations promulgated under the Oil and Gas Activities Act, which came into force on Oct. 4, 2010.

5. Findings as to Cause and Contributing Factors

The findings as to cause and contributing factors are as follows:

1. The Nov. 22, 2009 failure of the A420 WPL-6 60.3 mm outside diameter (OD) x 11.07 mm wall thickness (WT) (XXS) tee at A5-7-77-14-W6M was caused by internal erosion of the wall resulting from flowing fracture sand suspended in the gas stream.
2. Encana's established criterion for sand recovery was not followed during the well cleanup at this location and did not effectively limit the amount of sand available for flow within the gas stream.
3. Encana's Public Information Package did not achieve the desired results regarding notification to Encana in the event of odour detection. Residents reported hearing sounds and detecting H₂S-like odours prior to the 8:38 a.m. failure. The first contact by residents to Encana occurred at 9:38 a.m. The Public Information Package informs residents that they should call Encana immediately if they think they smell H₂S.
4. Leak detection and emergency isolation at the site did not achieve timely detection of the leak or control of the escaping gas. SCADA information indicates a significant gas release occurred with the sudden failure of the tee at 8:38 a.m. Gas flowed uncontrolled from the wellhead for approximately 27 minutes before the first alarm was detected at 9:05 a.m. – the automated closure of the emergency shutdown valve at the A5 well.
5. Encana's response did not entirely conform to their Emergency Response Plan. No notification to the provincial government was made prior to 10:42 a.m.
6. Encana's Integrity Management Program did not effectively mitigate the hazard of internal erosion. Encana's procedure for internal erosion monitoring at this site was based on erosion of the choke. Piping inspection would be triggered by replacement of the choke. In this instance, the piping failed before any inspection of the piping was conducted.

6. Preliminary Directives and Recommendations

The preliminary directives and recommendations are as follows:

1. Encana shall place emergency shutdown (ESD) valves immediately adjacent to (within one metre of) the wellhead at all wellsites within British Columbia where internal abrasion from sand returns may present a hazard. At these locations, bends between the wellhead and the ESD valves are not permitted. Encana shall review the location of ESD valves at all existing wells within British Columbia and shall file with the Commission a plan for the necessary modifications. The plan shall be filed with the Commission for approval on or before May 30, 2010.
2. On or before Mar. 31, 2010 Encana shall provide the Commission with a detailed report summarizing the remedial actions and modifications made to facilities and piping based on their internal investigation of the Nov. 22 incident.
3. On or before May 30, 2010 Encana will submit to the Commission a report on all wellsites within British Columbia where well control and isolation is dependent on ambient H₂S measurement. The report shall include recommendations for additional controls and monitoring at all locations where a well is located within three

kilometres of a residence.

4. On or before Mar. 31, 2010 Encana will develop and file with the Commission internal requirements and standards for leak detection and isolation for all Encana wellsites within British Columbia.
5. Encana will include a review of this incident report in all emergency response training for Encana employees and contractors within British Columbia conducted during the period from Mar. 31, 2010 to Dec. 31, 2012. The first review of the incident report with Encana staff shall take place on or before Mar. 31, 2010. Encana shall inform the Commission of the date, time and location one week in advance of the review and shall provide time at the review for presentation by the Commission. The review shall include:
 - a. A review of the event log for the incident with specific focus on the time taken to detect and respond, external notifications, public information, evacuation and coordination with RCMP and other agencies.
 - b. A review and discussion on the findings and recommendations.
 - c. A review and discussion on these recommendations and directions and the current status of Encana's response.
6. Encana will provide to the Commission an evaluation of all well cleanups performed in British Columbia from Jan. 1, 2009 to the present and shall identify any wells where cleanup criteria established under Directive 12 were not met. Encana shall submit to the Commission by Apr. 30, 2010 a comprehensive plan for the evaluation and ongoing integrity management of those wellsites.
7. Encana will develop information for residents in the vicinity of the Nov. 22 incident to include H₂S and emergency contact procedures awareness.
8. Encana will report in written form on a quarterly basis beginning Mar. 31, 2010 to the Chief Engineer of the Commission on the status of Encana's implementation of these recommendations and directives. Such reporting shall continue subject to the discretion of the Chief Engineer.
9. Encana will review their public information program and shall make modifications as necessary to improve public understanding of the contents. In addition, Encana shall develop a methodology for the assessment of the effectiveness of their public information program and shall evaluate the effectiveness of the program on an annual basis. The results of the annual evaluation shall be shared with the Commission.
10. Encana shall modify all public communication documents to clearly identify the Commission's 24-hour emergency and complaint contact information. Such documents shall encourage residents to call PEP immediately if they suspect a leak.
11. Encana shall develop a regulatory training and awareness program for all employees, contractors and emergency response officials working for Encana within British Columbia. The program shall include a description of the Commission's role and regulatory authority as well as emergency contact information.
12. Encana will conduct a detailed review of their well cleanup procedures and sand recovery criterion and shall present to the Commission their procedures and criteria on Mar. 31, 2010.

7. Review of Encana Response to Directives and Recommendations

This section contains a summary of the directives provided to Encana and the Commission's response review.

Directive 1

Encana shall place emergency shutdown (ESD) valves immediately adjacent to (within one metre of) the wellhead at all wellsites within British Columbia where internal abrasion from sand returns may present a hazard. At these locations, bends between the wellhead and the ESD valves are not permitted. Encana shall review the location of ESD valves at all existing wells within British Columbia and shall file with the Commission a plan for the necessary modifications. The plan shall be filed with the Commission for approval on or before May 30, 2010.

Commission Review of Response:

- Encana has provided a satisfactory response to this directive.
- Encana filed a plan for modifications of susceptible wellsite piping on May 28, 2010.
- In response to the directive, Encana undertook a review of each of its 1,920 wells in British Columbia to determine where internal abrasion from sand returns may present a hazard. The criteria used for hazard assessment included:
 - Potential for internal sand erosion.
 - Placement of the ESD valve within one metre of the wellhead.
 - Piping bends between wellhead and ESD valve.
 - H₂S concentration.
 - Proximity to residences.
 - Other design and operations criteria.
- 257 of 1,920 Encana wells in British Columbia were completed using sand fracturing. Of these, 76 wells were identified where the possibility of sand erosion was considered a possible hazard. As of Sept. 1, 2010, modifications have been completed at all of these locations to mitigate the hazards associated with possible sand abrasion.
- In addition, Encana has taken steps to place additional controls at all sand fractured wellsites, including establishing limitations on fluid velocities and ultrasonic monitoring of pipe and component wall thicknesses.

Directive 2

On or before Mar. 31, 2010, Encana shall provide the Commission with a detailed report summarizing the remedial actions and modifications made to facilities and piping based on their internal investigation of the Nov. 22 incident.

Commission Review of Response:

- Encana has provided a satisfactory response to this directive.
- Encana provided a report to the Commission on remedial actions and modifications on Mar. 30, 2010.
- All changes to piping and facilities identified as necessary by Encana under the work conducted in response to Directive 1 have been approved by the Commission through the Notice of Intent process.
- In addition, Encana has taken a number of steps with respect to design and operational procedures to prevent a similar occurrence, including:
 - Resetting H₂S detection to lower shutdown and alarm points.
 - Completion of wellsite piping inspection using ultrasonic and x-ray technologies to determine remaining wall thickness and wall loss rate.
 - Increasing the sensitivity of leak detection systems based on pressure monitoring and detection.

- Implementing maximum flow velocity operating limits on wells with erosional risk and installing high velocity shutdown controls.
- Resizing flow piping to reduce flow velocity.
- Moving ESDs to within one metre of the wellhead and removing upstream piping bends where internal sand erosion was identified as a hazard.
- Installing H₂S and other gas detection at strategic locations and shutdown controls for all wells on a given pad.
- Continued monitoring of choke valve health for erosion.
- Evaluating alternative leak detection devices (including acoustic monitors and other technologies).

Directive 3

On or before May 30, 2010, Encana will submit to the Commission a report on all wellsites within British Columbia where well control and isolation is dependent on ambient H₂S measurement. The report shall include recommendations for additional controls and monitoring at all locations where a well is located within three kilometres of a residence.

Commission Review of Response:

- Encana has provided a satisfactory response to this directive.
- The report filed by Encana on May 28, 2010 indicated that they had conducted an evaluation of all wells in British Columbia where well control and isolation is dependent on ambient H₂S measurement.
- Of the 1,920 wells in British Columbia, 192 have ambient H₂S measurement; 120 of these 192 wells are within three km of a residence.
- Additional controls and monitoring practices are in place at all 192 wells. These include but are not limited to:
 - Limiting fluid velocity below threshold.
 - Monitoring of fluid velocity with appropriate alarm and shutdown parameters in the event that velocity control limits are reached.
 - Monitoring for potential erosion on a scheduled basis, including comparison to pre-commissioning baseline through a wellsite integrity program.
 - Wellsite design practices.
- Many of the actions identified in Encana's response to Directive 1 are effective in mitigating the hazard associated with possible H₂S releases.
- In addition to Encana's actions, the Commission incorporated the findings from the Nov. 22 incident in the development of the new Drilling and Production Regulations which came into force on Oct. 4, 2010. Specifically, s. 39 of the regulations is designed to address the hazards presented by H₂S in the event of an incident (see Appendix 1).

Directive 4

On or before Mar. 31, 2010, Encana will develop and file with the Commission internal requirements and standards for leak detection and isolation for all Encana wellsites within British Columbia.

Commission Review of Response:

- Encana has provided a satisfactory response to this directive.
- In addition to Encana's actions, the Commission incorporated the findings from the Nov. 22 incident in the development of the new Drilling and Production Regulations which came into force on Oct. 4, 2010. Specifically, s. 39 of those regulations (see Appendix 1) is designed to establish where leak detection and isolation is required and under what circumstances

these systems should be automated.

Directive 5

Encana will include a review of this incident report in all emergency response training for Encana employees and contractors within British Columbia conducted during the period from Mar. 31, 2010 to Dec. 31, 2012. The first review of the incident report with Encana staff shall take place on or before Mar. 31, 2010. Encana shall inform the Commission of the date, time and location one week in advance of the review and shall provide time at the review for presentation by the Commission.

The review shall include:

- a. A review of the event log for the incident with specific focus on the time taken to detect and respond, external notifications, public information, evacuation and coordination with RCMP and other agencies.*
- b. A review and discussion on the findings and recommendations.*
- c. A review and discussion on these recommendations and directives and the current status of Encana's response.*

Commission Review of Response:

- Encana has provided a satisfactory response to this directive.
- The first review of this incident was held on Mar. 24, 2010. Attendees included:
 - VPs, Team Leads and Group Leads from all Canadian BUs + USA Division Engineering Team Lead.
 - Ken Paulson of the Commission.
- As of Sept. 22, 2010, 21 training sessions have been held with 258 persons attending.

Directive 6

Encana will provide to the Commission an evaluation of all well cleanups performed in British Columbia from Jan. 1, 2009 to the present and shall identify any wells where cleanup criteria established under Directive 12 were not met. Encana shall submit to the Commission by Apr. 30, 2010 a comprehensive plan for the evaluation and ongoing integrity management of those wellsites.

Commission Review of Response:

- Encana has provided a satisfactory response to this directive.
- Encana provided the Commission with their Well Site Integrity Management Program on Apr. 29, 2010.
- Encana performed an analysis of daily flow reports on all wells that were completed by Encana in British Columbia from January 2009 to Apr. 15, 2010.
- There were 59 wells in the database which had been fracture stimulated using proppants in the fracture treatments. The areas reviewed included:
 - Dawson Creek SBU
 - Cutbank Ridge SBU
 - Peace River Arch SBU
 - Ft. Nelson BU
- Encana's guideline, (as per Directive 12), is to flow a well to 1.0 per cent sand or less by volume, based on a daily average measurement prior to flowing into permanent facilities.
- The review identified one well which had an average daily sand measurement greater than 1.0 per cent by volume. The subject well was immediately examined for internal erosion (none was noted) and the well has since received all modifications required to mitigate the hazard of erosion damage and to provide for timely detection of leaks.

Directive 7

Encana will develop information for residents in the vicinity of the Nov. 22 incident to include H₂S and emergency contact procedures awareness.

Commission Review of Response:

- Encana has provided a satisfactory response to this directive.
- Encana held H₂S/ERP Community Awareness sessions in Pouce Coupe and Farmington as outlined below:
 - April 13-14, 2010: Pouce Coupe.
 - April 26-27, 2010: Farmington.
- Feedback from participants in these sessions was mixed. Encana has indicated a desire for continual improvement in this area and is planning additional sessions for Fall 2010 and ongoing in the future.

Directive 8

Encana will report in written form on a quarterly basis beginning Mar. 31, 2010 to the Chief Engineer of the Commission on the status of Encana's implementation of these recommendations and directions. Such reporting shall continue subject to the discretion of the Chief Engineer.

Commission Review of Response:

- Encana has met all submission deadlines to date and has been responsive to all Commission requests and inquiries for follow up and clarification. As of Oct. 22, 2010, quarterly reporting is continuing.

Directive 9

Encana will review their public information program and shall make modifications as necessary to improve public understanding of the contents. In addition, Encana shall develop a methodology for the assessment of the effectiveness of their public information program and shall evaluate the effectiveness of the program on an annual basis. The results of the annual evaluation shall be shared with the Commission.

Commission Review of Response:

- The Commission continues to monitor Encana's progress in meeting Directive 9.
- Encana is continuing efforts to communicate and engage the communities surrounding Dawson Creek.
- Some of the initiatives implemented and/or participated in throughout 2010 include (among other actions):
 - Information Sessions: H₂S/ERP Awareness sessions in April 2010.
 - Stakeholder Survey on communication in Spring (May/June) 2010.
 - Stakeholder Barbeque – WPCA event in Dawson Creek on Aug. 11, 2010.
- A key element of Directive 9 is the requirement to assess the effectiveness of the public information program. The Commission is aware that many residents in northeast British Columbia are fatigued by the volume of communications. As such, the Commission wants to find ways to ensure that essential messages around notifications and response are effectively communicated and commonly understood.
- Encana has indicated that their public information program and its effectiveness are currently being reviewed. This review includes the development of a methodology to evaluate the effectiveness of communications, including public meetings, consultation and surveys.

- Encana has indicated that the results of their initial review will be provided to the Commission by Dec. 31, 2010 and annually thereafter.
- The Commission hopes that the work performed by Encana in this regard can be used as the basis for industry-wide requirements to be implemented at a later date.

Directive 10

Encana shall modify all public communication documents to clearly identify the Commission's 24-hour emergency and complaint contact information. Such documents shall encourage residents to call PEP immediately if they suspect a leak.

Commission Review of Response:

- Encana has provided a satisfactory response to this directive.
- Encana has indicated that all public communication documents now distributed in British Columbia have been reviewed to ensure and confirm that they include Commission emergency contact information.

Directive 11

Encana shall develop a regulatory training and awareness program for all employees, contractors and emergency response officials working for Encana within British Columbia. The program shall include a description of the Commission's role and regulatory authority as well as emergency contact information.

Commission Review of Response:

- Encana has provided a satisfactory response to this directive.
- Encana has developed a training module that includes the regulatory role and emergency contact information for the Commission for employees and contractors working in British Columbia. In addition, Encana has ensured that regulatory awareness training is delivered concurrently with ERP training (Directive 5).

Directive 12

Encana will conduct a detailed review of their well cleanup procedures and sand recovery criterion and shall present to the Commission their procedures and criteria on Mar. 31 2010.

Commission Review of Response:

- Encana has provided a satisfactory response to this directive.
- On Mar. 30, 2010, Encana filed their Well Clean-up and Sand Recovery Criteria for British Columbia with the Commission.
- The document establishes a target sand flow cleanup criteria of 1.0 per cent sand by volume based on daily average measurement.
- The document further describes the steps and actions necessary to mitigate the hazard of sand erosion where the target criteria cannot be reasonably achieved.

Appendix 1. Drilling and Production Regulation Section 39

39 (1) In this section, “populated area” means an occupied dwelling, school, picnic ground or other place of public concourse.

(2) A permit holder of a completed well or facility must equip each well or facility with a system to detect and control leaks as quickly as practicable.

(3) A permit holder of a completed well or facility must install and maintain fencing or take other access control measures to prevent unauthorized access to the well or facility if

- (a) the well or facility is located within 800 m of a populated area, or
- (b) a populated area is within the emergency planning zone for the well or facility.

(4) Subject to subsection (10), if an uncontrolled flow of oil or gas from a completed well, other than a well suspended in accordance with section 25, could produce a hydrogen sulphide concentration greater than 100 ppm in atmosphere within 50 metres of the well, the permit holder of the well must install and maintain

- (a) an automated system to isolate the well in the event of an uncontrolled flow of oil or gas; and
- (b) if the well is located within 1,600 m of a populated area, a hydrogen sulphide detection alarm system that is continuously monitored and is capable of activating the automated system referred to in paragraph (a).

(5) Subject to subsection (10), if an uncontrolled flow of oil or gas from a facility could produce a hydrogen sulphide concentration greater than 100 ppm in atmosphere at the facility boundary, the permit holder of the facility must install and maintain

- (a) an automated system to isolate the facility in the event of an uncontrolled flow of oil or gas, and
- (b) if the facility is located within 1,600 m of a populated area, a hydrogen sulphide detection and alarm system which is continuously monitored and is capable of activating the automated system referred to in paragraph (a).

(6) The permit holder of a completed well or facility where the hydrogen sulphide content of the gas exceeds five mole per cent must do all of the following if a populated area or numbered highway is within the emergency planning zone for the well or facility:

- (a) for a completed well not produced by artificial lift,
 - (i) equip the well with two master valves,
 - (ii) install a production packer set as closely above the producing formation as is practicable and fill the annular space between the tubing and production casing with a suitable corrosion inhibiting liquid,
 - (iii) install wellhead equipment for which the working pressure rating is not less than the bottom-hole pressure of the producing formation, but with a minimum rating of 14,000 kPa,
 - (iv) if a hot oil circulating string is used inside the production casing of a well, install a check valve in the injection line and automatic shutoff valve on the return line,
 - (v) if a well is equipped with a production packer as required under subparagraph (ii), conduct annual segregation tests and, if the test fails, complete repairs without unreasonable delay, and
 - (vi) maintain a record of the tests and repairs referred to in subparagraph (v);

(b) for a flowing well that is located within 800 m of a populated area or within eight km of a city, town or village and that has the potential to produce more than 30,000 m³ of gas per day, install at least 30 m below the surface a downhole safety valve in the tubing that closes automatically in the event of an uncontrolled flow of oil or gas or a failure in the system which operates the valve.

(7) If a well completed after the date this regulation came into force is produced by artificial lift and the hydrogen sulphide content of the gas exceeds 100 ppm, the well permit holder must

(a) install on the stuffing box an automatic shutdown device that will shut down the pumping unit in the event of a stuffing box failure and effectively seal off the well in the event of a polish rod failure, and

(b) install an automatic vibration shutdown system that will safely shut down the pumping unit.

(8) A permit holder must ensure that buildings of wood construction do not house production equipment at a well or facility.

(9) For each well or facility, a permit holder must

(a) develop and maintain an adequate emergency response plan,

(b) submit the emergency response plan to the commission before beginning operations at the well or facility, and

(c) respond to an emergency at the well or facility in accordance with the emergency response plan.

(10) Subsections (4) and (5) do not apply to a well completed or a facility constructed before this regulation came into force.

(11) Subsection (10) is repealed on January 1, 2012.

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