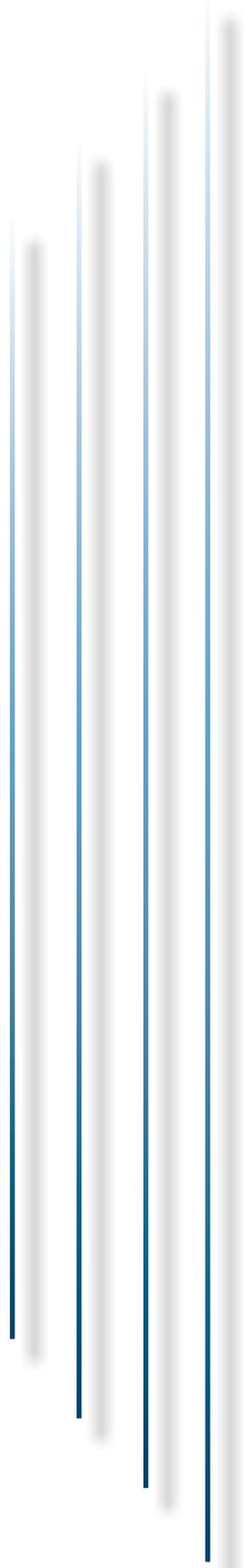




# Failure Investigation Report

22 November 2009 Failure of Piping at  
EnCana Swan Wellsite A5-7-77-14 L W6M

February 4, 2010





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## Incident Summary

On the morning of Sunday, November 22, at 8:38 am, 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 6<sup>th</sup> Meridian near Pouce Coupe, British Columbia. Residents near the wellsite reported smelling sewer like odours from as early as approximately 2:30 am and hearing a “jet-like” noise beginning from as early as approximately 4:00 am. These reports indicate that the tee probably developed a leak before the sudden failure at 8:38 am. Figure 1 provides a spatial view of the incident location and surrounding roads.

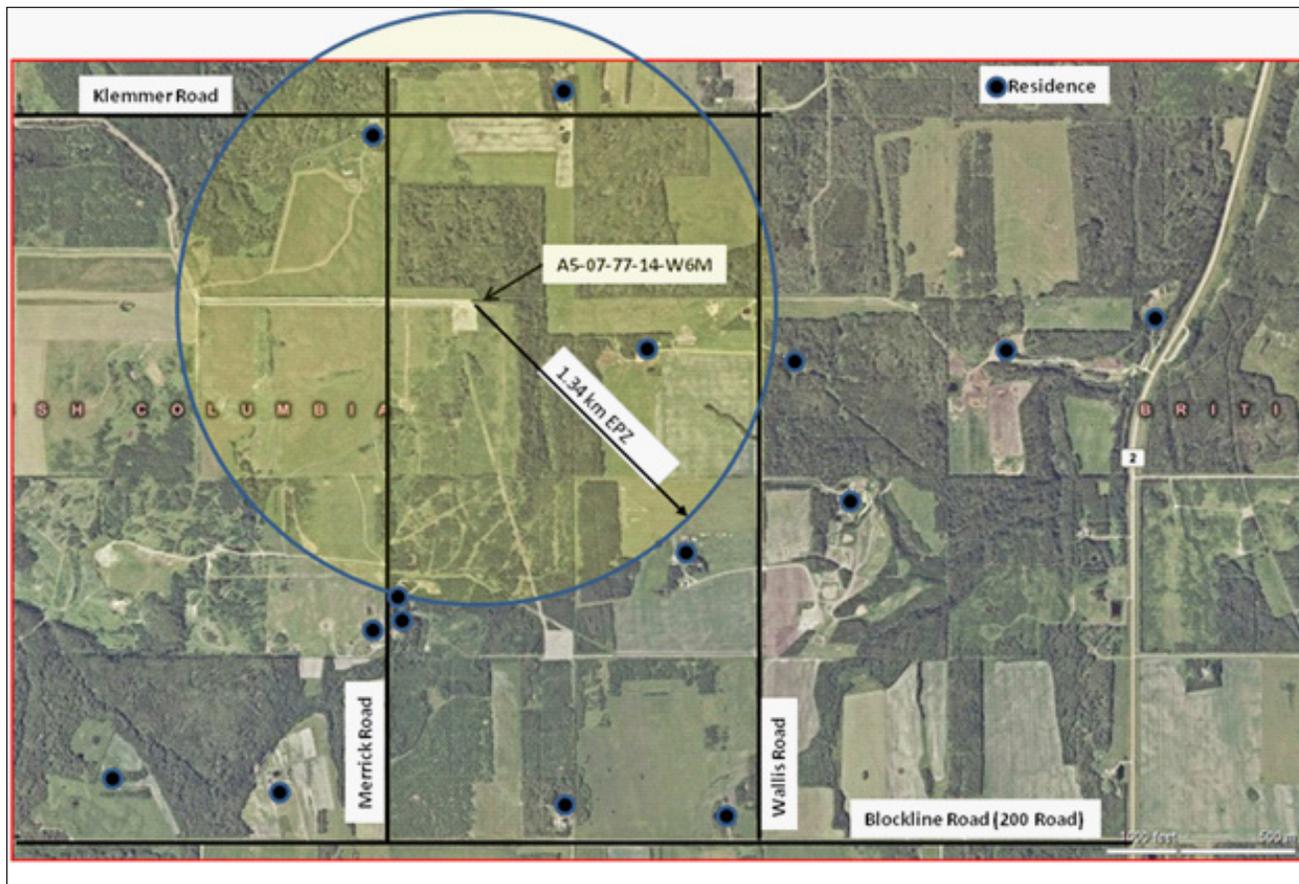


Figure 1 – Incident Location

At 9:05 am, approximately 22 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, Alberta. Five minutes later at 9:10 am, the control room received an H<sub>2</sub>S 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 their response to the incident at that time.

EnCana staff arrived near the site at approximately 10:02 am. Two EnCana operators donned personal

protective equipment (PPE) and self contained breathing apparatus (SCBA) and manually closed the well head valves upstream of the failed tee. The well was shut in at approximately 10:45 am. Approximately 30,000 cubic metres of natural gas containing approximately 6200 ppm of H<sub>2</sub>S was released between 8:38 am and 10:45 am. Ambient H<sub>2</sub>S was measured at 12.82 ppm at the wellsite. EnCana reports the highest concentration of H<sub>2</sub>S measured away from the wellsite was approximately 1 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 km radius emergency planning zone. A total of 18 residents evacuated the area during the release and mustered at the Tate Creek Community Centre.

## 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 British Columbia Oil and Gas Commission (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;
- Result or may have resulted in serious injury or death; and
- 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 will be 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.

# Relevant Information

## Incident Chronology

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

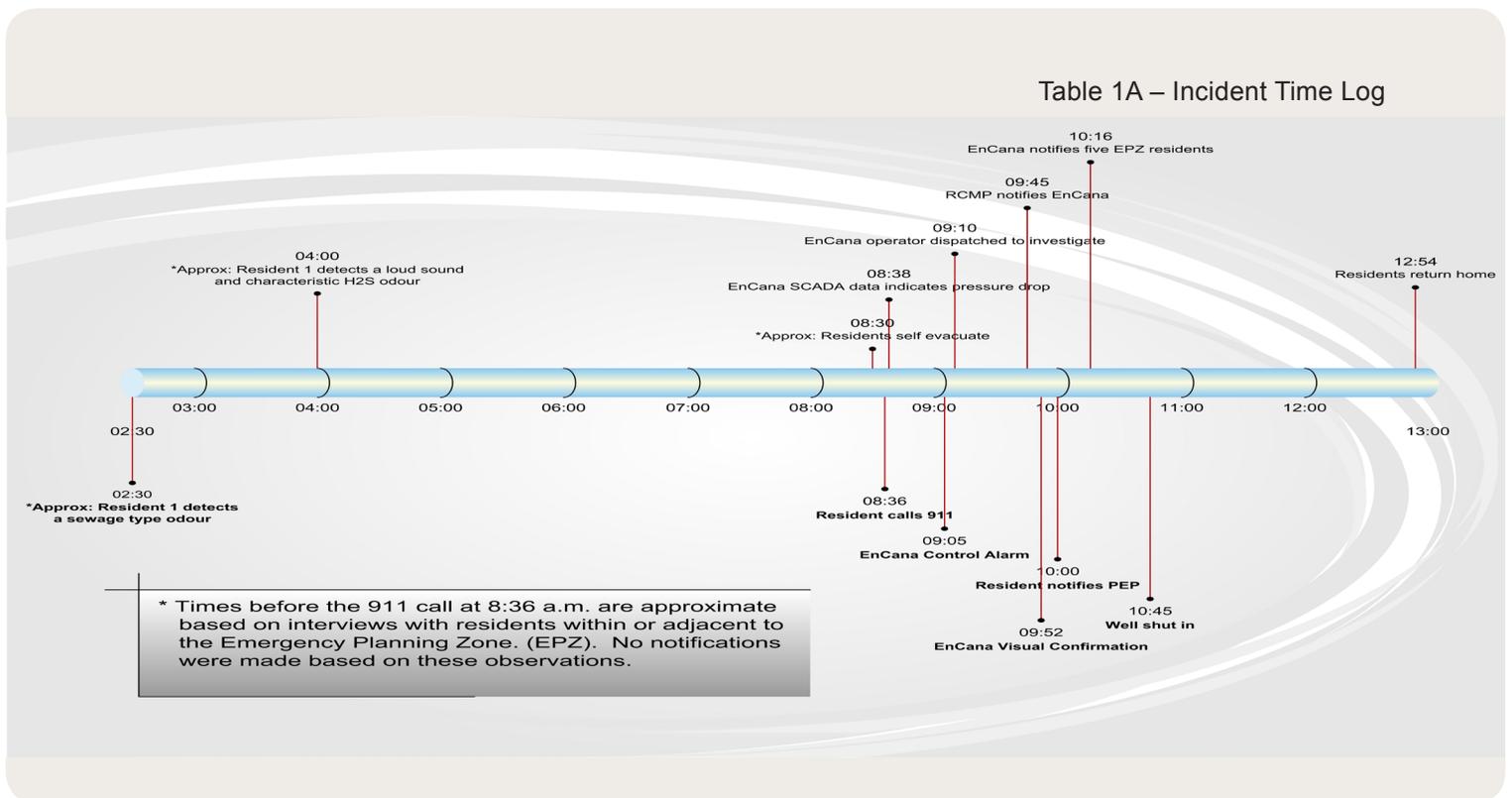


Table 1B – Incident Time Log

<b>Time</b>	<b>Detail</b>
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 3 times to determine source of the smell but was uncertain where the smell could be 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 over head. 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. 7:00 AM	A local resident (3) out hunting drives up Klemmer Road and can smell gas; assumes some work is being done. The resident does not make any notifications.
Approx. 8:00 AM	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.
Approx. 8:30 AM	Resident (3) returns to area via Klemmer Road and observes gas cloud and detects strong odours. 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 pick-up about 300 metres cross wind on Merrick Road.
8:36 AM	Resident (3) does not have any EnCana emergency numbers and decides to call 911 to report a gas release at an EnCana wellsite.
8:38 AM	Sudden failure of a 60.3 mm Tee at the wellsite (noted on SCADA data for well pressure and flowrate).

Approx. 8:45 AM	Resident (3) contacts wife at home and suggests she start calling all neighbours to evacuate their homes. Resident (3) makes additional notifications to local residents and passersby advising the area is unsafe and instructs Resident (1) to park her pick-up at the junction of Klemmer Road and Wallis Road to restrict access and warn local residents to not drive through that area. Resident (3) then drives to junction of Wallis Road and Blockline Road and parks vehicle to restrict access and wait for more information.
9:00 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 confirm they have received odour complaints from residents and are on the way.
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 <sub>2</sub> S detection of 12.82 PPM.
9:10 AM	EnCana dispatches operator to investigate (Operator 1).
9:15 AM	RCMP arrive; then proceed to set up road blocks at 2 separate locations. 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.
9:30 AM	Several residents gathered at the intersection of Wallis Road and Klemmer Road Dawson Creek evacuate including resident (1). Resident (1) states that gas odour was very strong at the highway near Gumbo Gulch Ranch.
9:38 AM	Local EnCana operator (Operator 2) receives a call from a local resident (4) informing him there is a leak.
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.
9:45 AM	RCMP makes first contact with EnCana stating several local residents have phoned in complaining of strong gas odours.

- 9:47 AM EnCana control room operator contacts EnCana Operator 3 and dispatches him to the incident.
- 
- 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<sub>2</sub>S.
- 
- 9:50 AM Operator 2 then proceeds to drive slowly down Klemmer Road with window open and gas detector on. No H<sub>2</sub>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.
- 
- 9:57 AM RCMP notifies EnCana that a resident (5) on Merrick Road has contacted the RCMP with an odour complaint.
- 
- 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 MOE 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 SCBA's 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 AM Operator 4 meets with residents gathered at the intersection of Wallis Road and Klemmer Road. Advises residents to proceed to 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 SCBA's. Operator 5 arrives at site.
- 
- 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, Minerals 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 Peace River Regional District notified, mayor of Dawson Creek notified.
- 
- 12:54 PM Residents advised they may return to their residences.

## Information Requests

On 2 December 2009, Commission employees met with EnCana and reviewed a formal request for information (Information Requests or IR's) pertaining to the incident.

The IR's were separated into two areas:

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

## Failure Analysis

The site was secured immediately after the flow of gas from the failed tee was stopped. Commission investigators visited the site on 22 November and again on 23 November 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 09 December 2009 and concluded that the cause of failure of the tee was erosion due to sand in the production flow path.

## Analysis

### 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 (see figure 2 on next page) 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 clean-up flow for the A5 well was 4.6 days – the average time for clean-up flow for similar EnCana wells is 9 days;
- EnCana determines a well to be clean when the sand concentration produced over a 24 hour period is 0.5% or less by volume – the A5 well clean-up did not achieve this result;
- The fracture program for the A5 well anticipated the use of 7 sand plugs to achieve 8 fractures. Due to complications during fracture operations, an additional 6 sand plugs were required for a total of 13 sand plugs during fracturing operations;

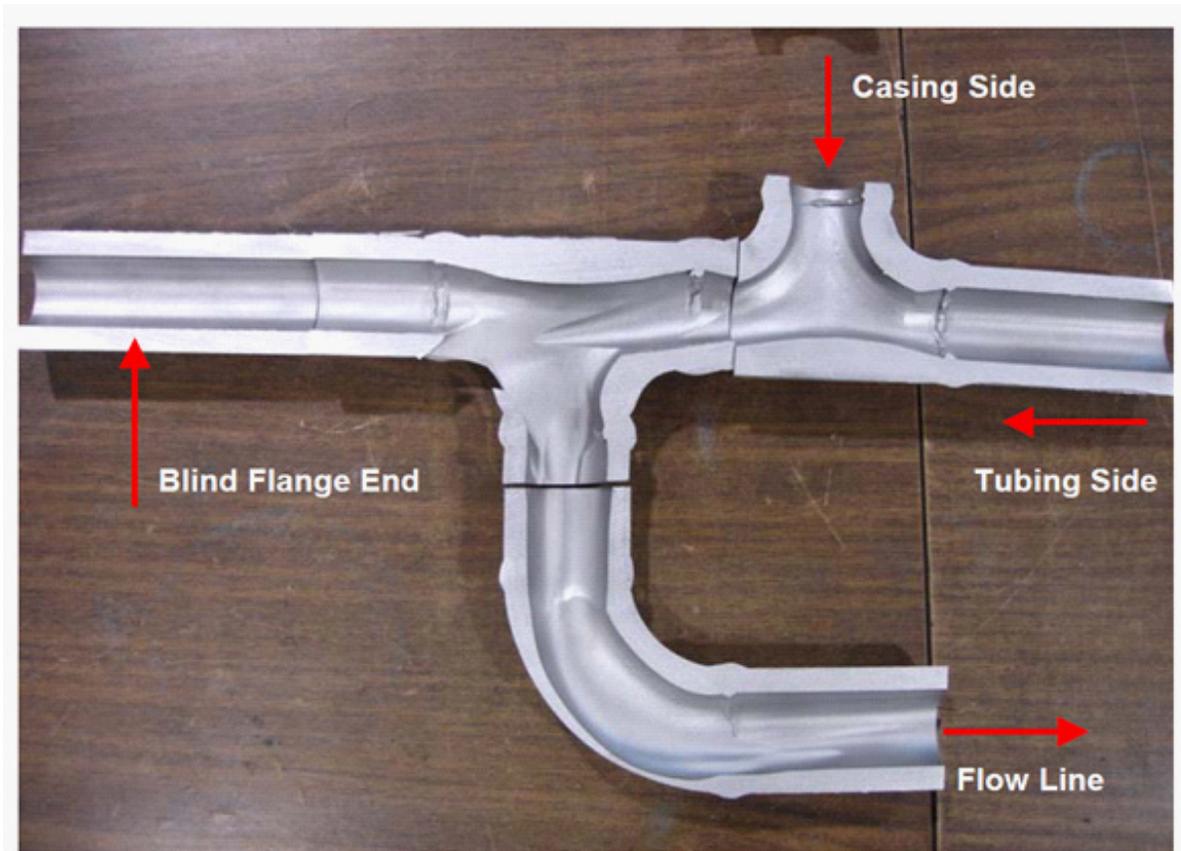


Figure 2 – Photograph of Eroded Tee

- H<sub>2</sub>S detection at the A5 well, located on the well choke and on the meter skid, was set to alarm at 5 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 AM 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 21 November 2008 and drilled to a total vertical depth of 4,148.3 metres;
- The well was placed in production on 30 March 2009 with a tested H<sub>2</sub>S concentration of 8300 ppm, at the time of failure the concentration measured 6200 ppm. Flow through the permanent meter run began on 15 October 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 6200 ppm H<sub>2</sub>S 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 which occurred the morning of 22 November 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 clean-up 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 am – 27 minutes after the sudden failure of the tee at 8:38 AM. The flow and pressure data used to determine the approximate 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.

## 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:

- At least three separate residents in the immediate vicinity of the site suspected there was a problem based on observations between 2:30 AM and 8:36 AM;
- Residents began self evacuation at approximately 8:30 AM;
- RCMP were dispatched following the 911 notification made by a resident at 8:36 AM – EnCana was not immediately notified;
- EnCana received first alarm at 9:05 AM and dispatched operator to investigate at 9:10 AM;
- EnCana operator visually confirms leak at 9:52 AM;
- EnCana evacuation notifications were initiated at 10:16 AM, 24 minutes after visual confirmation of the gas leak and 71 minutes after H<sub>2</sub>S triggered the alarms;
- The PEP was alerted by a resident at 10:00 AM and the event was classified as a Level 1 emergency; PEP was notified by EnCana at 10:49 AM;
- The response time from alarm notification at 9:05 AM to visual confirmation of the leak by EnCana personnel at 9:52 AM was 47 minutes;
- Initial attempts to shut in the well at 10:10 AM 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 AM notification to MEMPR;

- Incident was classified as Level 1; however, some elements of Level 2 emergency action plan were initiated;
- 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 Emergency Response Plan. 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 AM - 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 Regulations 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. This may be a contributing factor in the delay in reporting a suspected incident to authorities.

EnCana did not review the emergency planning zone to identify residents who may require contact until after visually confirming the leak at 9:52 AM and did not begin resident notifications until 10:16 AM – 71 minutes after the first alarm at 9:05 AM. Communication took place between the EnCana and the residents gathered at the intersection of Wallis Road and Klemmer Road at 10:15 AM. The Commission notes that it would be impractical 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 AM visual confirmation of the leak.

During the management of the event, some local residents indicated they were uncertain as to who was representing EnCana at the intersection of Klemmer Road and Wallis Road. Residents have stated that EnCana trucks responding to the incident were unmarked.

## Findings as to Cause and Contributing Factors

1. The 22 November 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 clean-up 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 suspected a release was occurring (through odour detection or noise) as early as 2:30 AM but did not make any notification to EnCana until 9:38 AM. The Public Information Package is intended to get residents to call EnCana immediately if they think they smell H<sub>2</sub>S.
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 AM. Gas flowed uncontrolled from the well head for approximately 27 minutes before the first alarm was detected at 9:05 AM – 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 BC Government was made prior to 10:42 AM.
6. There was no coordination between the RCMP and EnCana prior to the RCMP's odour notification to EnCana at 9:45 AM. The first call to 911 was made at 8:36 AM by a resident.
7. 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.

## Preliminary Directions and Recommendations

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 30 May 2010.
2. On or before 31 March 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 22 November incident.
3. On or before 30 May 2010, EnCana will submit to the Commission a report on all wellsites within British Columbia where well control and isolation is dependent on ambient H<sub>2</sub>S 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 31 March 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 31 March 2010 to 31 December 2012. The first review of the incident report with EnCana staff shall take place on or before 31 March 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; and
- 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 clean-ups performed in British Columbia from January 01, 2009 to the present and shall identify any wells where clean-up criteria established under Direction 12 were not met. EnCana shall submit to the Commission by 30 April 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 22 November incident to include H<sub>2</sub>S and emergency contact procedures awareness.
8. EnCana will report in written form on a quarterly basis beginning 31 March 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.
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 clean-up procedures and sand recovery criterion and shall present to the Commission their procedures and criteria on 31 March 2010.

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