

**STATE OF ALASKA
ALASKA OIL AND GAS CONSERVATION COMMISSION
333 West Seventh Avenue
Anchorage, Alaska 99501**

Re: Mechanical Integrity of Prudhoe Bay Wells) Other Order 149
) Docket Number: OTH-18-064
)
) Prudhoe Bay Field
)
) February 28, 2019

IT APPEARING THAT:

In the last 18 months, BP Exploration Alaska, Inc. (BPXA), operator of the Prudhoe Bay Field, experienced sudden well head rise on two Drillsite 2 wells – DS 02-03B (April 2017) and DS02-02A (December 2018). Each incident resulted in permanent damage to surface casing and the flow tree assembly when the wellhead rose abruptly and impacted the well house. In a third incident on March 30, 2017, an injection well, L5-13, failed during a mechanical integrity test resulting in permanent damage to the casing strings. In all three incidents well bore fluids were released at the surface.

Because these three events raised concerns about the mechanical integrity of wells at Prudhoe Bay Field relating to permafrost subsidence, on its own motion the Alaska Oil and Gas Conservation Commission (AOGCC) noticed a public hearing for February 7, 2019 at 10:00 a.m. Due to unforeseen circumstances, AOGCC did not have a quorum of commissioners to conduct the hearing and it was continued until February 13, 2019 at 10:00 a.m.

At the February 13, 2019 hearing, BPXA presented evidence regarding the failures and how it intended to proceed in order to assure there are no additional failures. In advance of the hearing, guidance was provided to BPXA in the form of questions and specific topics AOGCC wanted BPXA to address. BPXA answered the questions posed before the hearing. During BPXA's presentation, additional questions arose. As a result, at the close of the hearing, the record was left open until February 26, 2019 to allow BPXA to provide the information requested. BPXA provided the information on February 26, 2019.

FACTUAL BACKGROUND:

1. BPXA discussed the findings of the investigation of the well integrity failure of injection well L5-13, a 2-casing-string well that failed during a routine, scheduled mechanical integrity test (pressure test on the tubing-casing annulus). Analysis by a forensic metallurgy company was summarized in BPXA's February 6, 2019 pre-hearing response to AOGCC. That study led BPXA to a conclusion that L5-13 likely failed as a result of annular ice plugs which deformed the inner casing and the surface casing rather than as a result of permafrost subsidence.

2. The L5-13 metallurgical examination report leaves several unanswered questions with implications for other Prudhoe Bay Field injectors.
3. DS 02-03B failed April 14, 2017 causing a sudden rise of the wellhead which impacted the roof of the well house resulting in leaks in the production tree. Well 02-03B was flowing at the time of failure.
4. In its investigation of the Prudhoe Bay 02-03B well failure, BPXA produced a model for Prudhoe Bay Field 3-casing-string wells to describe a scenario where the subsidence of 20” casing into the permafrost could produce compressive loading into the inner strings of pipe.
5. BPXA provided AOGCC a summary report of its investigation dated June 14, 2017 noting that Well 02-03B’s sudden wellhead rise was attributed to permafrost subsidence loading effects on the surface casing string. BPXA further noted that this type of failure at Prudhoe Bay is limited to wells with a 3-casing-string design with the base of the surface casing set within the permafrost zone. BPXA relied on inquiries, well history research, physical and digital evidence, interviews with subject matter experts, and modeling to investigate potential causal and contributory factors for DS 02-03B’s failure.
6. BPXA identified 23 3-casing-string design wells out of approximately 1700 wells at Prudhoe Bay, and made 8 risk-based recommendations to address the DS 02-03B investigation findings.
7. AOGCC ordered a North-Slope-wide assessment of all wells and found no other wells with similar 3-string casing design.
8. On December 6, 2018, DS 02-02A suffered the same failure as DS 02-03B: a sudden rise of the wellhead which resulted in the loss of primary containment in the production tree. At the time, DS 02-02A had been shut in for over twelve years. DS 02-02A was one of the listed 3-casing-string-design wells to be suspended and risk-assessed to determine the appropriate response in light of each well’s integrity.

FINDINGS FROM THE HEARING:

1. In response to the DS 02-02A failure the AOGCC instructed BPXA to begin the process of abandonment for 14 3-casing-string wells with shoes set in the permafrost. Applications for Sundry Approval to abandon 13 of the 14 3-casing string wells identified as similar to DS 02-02A were granted from January 9, 2019 to February 8, 2019.
2. During the drilling of the original Prudhoe Bay wells conductors were surveyed primarily in the X-Y plane but highly accurate wellhead elevations surveys were not conducted, as subsidence was not considered a concern. In response to awareness of the risks posed by subsidence, in 2011 BPXA initiated an annual wellhead elevation survey for all BPXA-operated wells.
3. Wells identified by BPXA with significant vertical displacement may require additional intervention measurements to determine if the well is undergoing deformation to the point where well integrity could be at risk.
4. BPXA believes the permafrost soil types and ice contents are so highly irregular and localized that broad application of subsidence models may provide limited guidance. BPXA is engaged in ongoing studies to determine permafrost thaw behavior on its existing pads. BPXA also testified that it plans to undertake an independent geotechnical study for Prudhoe Bay Drillsite

2 to gain additional understanding of the permafrost loading across casing strings. That study has not yet begun.

CONCLUSIONS:

1. The two failures of the 3-casing string design demonstrate the inner strings of casing could be displaced into compression and result in the 20" casing being loaded in tension to the point where the 20" casing fails. The remaining intact strings of tubing and casing would have enough stored energy from the compression that when the surface casing fails, the sudden release of stored energy would displace the wellhead and flow tree upward with significant force into the ceiling of the wellhouse. If the tubing or annuli are in communication with the Prudhoe Bay reservoir, the result could be an uncontrolled release of produced fluids at the surface.
2. For wells with 2-casing-string designs in the Prudhoe Bay Field, BPXA does not currently have evidence to suggest that the permafrost subsidence loading and resulting displacement of the surface casings will impart enough unidentified loads on the surface casing to result in sudden catastrophic failure. Of greater significance, BPXA also has no evidence that permafrost subsidence will not result in sudden catastrophic failure. Given the lack of evidence, BPXA's current well integrity management methods may not be sufficient to identify 2-casing-string wells that develop subsidence risk.
3. For the failed well DS 02-03B, the BPXA model for loads imparted by the downward movement of surface casing shows these loads to be in the margin of error for the surface casing tensile failure and resulting upward wellhead movement observed in that well. However, BPXA acknowledges that untested hypotheses and unevaluated potential impacts are the bases for the assumptions used to formulate its conclusions about the cause of failure for the 3-casing-string wells and to prioritize well actions to prevent recurrence of permafrost subsidence events. Areas of uncertainty include the implications of surface casing placement relative to the depth of permafrost, the comparison of subsidence loads on the 20" surface casing versus that on the 18-5/8" casing, and the likely importance of the high degree of variability in rock properties of the geologic strata occurring in the permafrost zone. These unquantified impacts and their resultant assumptions lend substantial uncertainty to BPXA's 3-casing-string model.
4. The inadequacy of BPXA's model is demonstrated by BPXA's model-based assessment that shut in wells are less likely to fail followed by the failure of DS 02-02A, which had been shut in for over 12 years when it failed.
5. BPXA's understanding of the DS 02-02A surface casing failure and 5-1/2" tubing connection failure is incomplete. This problem is exacerbated by the fact that BPXA's current plans for abandoning well 02-02A with plugs and cement will prevent the opportunity to gather information that may assist in understanding of the failure mechanism for this well.
6. BPXA does not have good engineering records from the original PBU operator to understand the movement or the mechanical strength of the 3 or 4 slip joints placed in the 20" surface casing for the two failed DS2 wells. The purpose for these, as stated in the DS 02-03B

investigation summary, was to compensate against buckling for an unknown level of subsidence arising from the thaw bulb around a well.

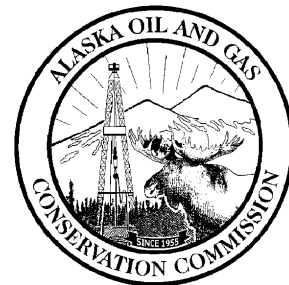
7. Because quantitative historical subsidence measurements of Prudhoe Bay wells are only known from 2011 on, early subsidence could have been significant (and possibly non-linear with time) and may now have imparted unquantifiable stored energy into the casing strings for Prudhoe Bay wells.
8. BPXA does not have any casing recovery plans to identify and analyze casing deformations within the 20" annuli of any of the current well stock with three-string casing designs that have the surface casing shoes set in the permafrost.

NOW, THEREFORE IT IS ORDERED THAT:

1. Rig interventions are required in 2019 to recover production tubing, production casing, outer casing, surface casing, and conductor on at least two of the 3-casing-string wells with 20" surface casing set in permafrost, one of which must be DS 02-02A. The remaining well or wells will be determined by AOGCC in consultation with BPXA.
2. Sundry approval applications for the rig interventions to decomplate the 3-string wells must include the specifics of data acquisition and analysis that will be performed.
3. Not later than March 15, 2019 BPXA must provide all reports for the Prudhoe Bay 02-02A failure.
4. BPXA must provide the geotechnical review report upon its completion.
5. Rig interventions will be required on at least two separate wells with 2-casing-string designs within the Prudhoe Bay Field to understand effects of wellbore surface casing subsidence. These wells will be selected by AOGCC in consultation with BPXA for inclusion in either the 2019 or 2020 P&A schedule.
6. Sundry approval applications for the rig interventions to decomplate the 2-casing-string wells must include specifics of data acquisition and analysis that will be performed.
7. BPXA must provide all reports for the 2-casing-string design rig interventions within 3 months of completing those interventions.
8. Previously approved sundries for the 14 wells identified with risk of failure of the surface casing on the 3-casing-string wells are rescinded. All 14 wells must be secured with tested downhole plugs and kill weight brine to isolate the reservoir. AOGCC must be afforded the opportunity to witness these downhole plugs and reports are required upon completion of the plugging operations on each well. Additional abandonment operations will be considered after reviewing the above required decompletions of 2- and 3-casing-string design wells.

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Cathy P. Foerster
Commissioner

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Daniel T. Seamount, Jr.
Commissioner



RECONSIDERATION AND APPEAL NOTICE

As provided in AS 31.05.080(a), within **20** days after written notice of the entry of this order or decision, or such further time as the AOGCC grants for good cause shown, a person affected by it may file with the AOGCC an application for reconsideration of the matter determined by it. If the notice was mailed, then the period of time shall be **23** days. An application for reconsideration must set out the respect in which the order or decision is believed to be erroneous.

The AOGCC shall grant or refuse the application for reconsideration in whole or in part within 10 days after it is filed. Failure to act on it within 10-days is a denial of reconsideration. If the AOGCC denies reconsideration, upon denial, this order or decision and the denial of reconsideration are **FINAL** and may be appealed to superior court. The appeal **MUST** be filed within **33** days after the date on which the AOGCC mails, **OR 30** days if the AOGCC otherwise distributes, the order or decision denying reconsideration, **UNLESS** the denial is by inaction, in which case the appeal **MUST** be filed within **40** days after the date on which the application for reconsideration was filed.

If the AOGCC grants an application for reconsideration, this order or decision does not become final. Rather, the order or decision on reconsideration will be the **FINAL** order or decision of the AOGCC, and it may be appealed to superior court. That appeal **MUST** be filed within **33** days after the date on which the AOGCC mails, **OR 30** days if the AOGCC otherwise distributes, the order or decision on reconsideration.

In computing a period of time above, the date of the event or default after which the designated period begins to run is not included in the period; the last day of the period is included, unless it falls on a weekend or state holiday, in which event the period runs until 5:00 p.m. on the next day that does not fall on a weekend or state holiday.