Safety Alert 005 - ANP/SSM

Well Barrier Elements Failure

The Operational Safety and Environment Superintendence is issuing this safety alert to notify the oil and gas industry and other stakeholders about the occurrence of well integrity loss due to structural failure.

What happened?

Throughout an offshore 1454 m water depth non-natural flow well abandonment intervention in Campos Basin, an oil leak around subsea equipment was observed while a DHSV test was attempted. The through tubing operation with slick line/wireline to drift the tubing using lead impression block, down hole video (DHV) and caliper multifinger proved a tubing collapsed above DHSV region, characterizing failure in the well barrier envelope.

During a hydrate dissociation operation, the pack-off disconnected leading to pressure communication between annuluses, causing chain collapse reaction of 16" surface casing, 13 3/8" production casing and tubing, resulting in loss of well integrity. The facts corroborating this hypothesis are: (i) the sudden temperature drop recorded in PDG (Permanent Downhole Gauge), (ii) the pressure indicated by the PT-A sensor was equivalent to the estimated external pressure.

Due to the lack of direct well access to carry out abandonment operations, the Operator created an ERT (Emergency Response Team) aiming to establish the permanent well barrier elements – WBEs - for well abandonment by constructing an interception well.

Figure 1 – Lead impression block with lateral mark

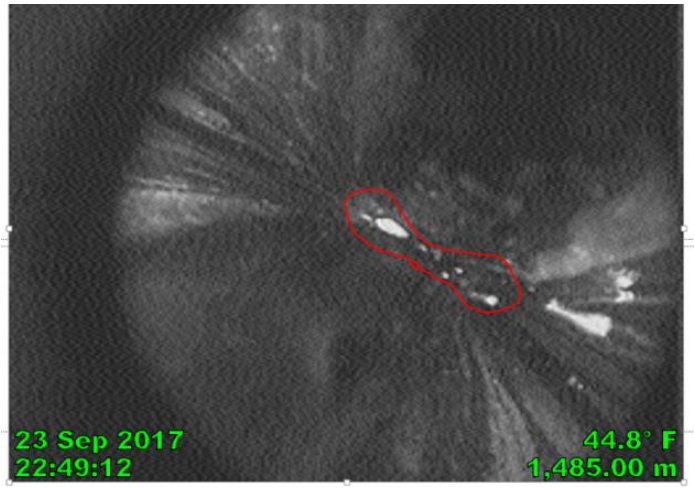


Figure 2 – DHV image

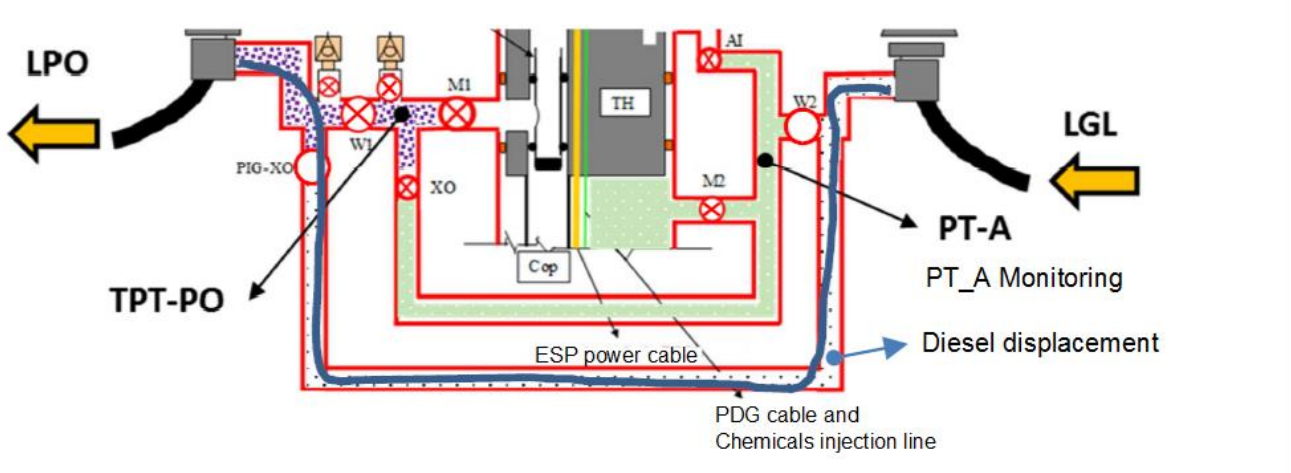
Potential Consequences

Considering the hypothesis of natural-flow well, the WBEs failure could result in an uncontrolled inflow of formation fluids to seabed, with consequent major environmental damage.

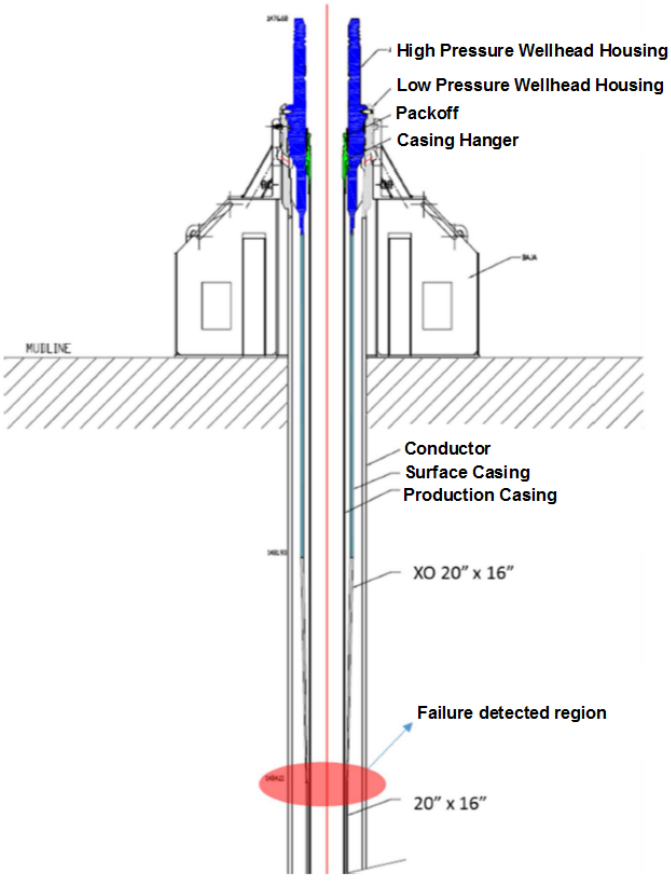
Identified causes

The immediate cause for the failure was a collapse chain reaction in the surface casing, production casing and tubing above DHSV, due to pack-off failure. The last was caused by Annulus A exposure to gas lift line pressure during a diesel displacement operation to prevent hydrates formation in the production line. For this displacement, it was necessary to open the W2 valve in the subsea christmas tree.

The figure below shows the **foreseen** scheme for diesel circulation, with M2 valve closed:



Due to an operational error, the W2 valve was opened without previous closing of M2 valve. Thus, there was unintended pressure connection between the gas lift line and Annulus A, which was depressurized. Subsequently, the pack-off that isolates the Annulus B and Annulus A failed, communicating the two annuluses, which equalized the pressures:



This pressure equalization led to casing collapse due to a loading that generated a stress level above the design limits.

The Operator incident investigation identified the following root causes (linked to management system):

- Use of inadequate design requirements, since the pack-off failure mode induced by heat loading was not analyzed during well construction (lack of additional locking); and

- Failure in the management of changes process, applied to changes in design requirements during the well production phase and, consequently, in the evaluation and update of the operational envelope.

No root causes were identified related to operational discipline, even though the sequence of valves maneuver was determinant for the accident. It was considered that the process was inadequate due to the lack of knowledge about the operational envelope. If the restriction for depressurization of Annulus A was known, the operational procedure would have considered specific safeguards to the impact of WBE loss in case of Annulus A depressurization, as well as it would emphasize the importance of correct operational sequence to WBE integrity assurance.

Additionally, the Operator did not point out the well handover as a cause, because even if they had done this procedure, the inputs still would be insufficient, since changes in design requirements were not extended to wells in the operational phase.

Lessons Learned

- Establish systematic loading analysis prior to well annulus-depressurizing operations, in order to verify pack-off stress.
- Use supplementary pack-off locking devices, in order to increase design reliability and robustness.

Regulatory Framework

The following items of Well Integrity Management System (WIMS) Technical Regulation, attached to ANP Resolution n. 46/2016, are related to the incident:

Item 10.1.2.3 of Management Practice 10 – Stages of Well Life Cycle: *"Ensure that each part and equipment that compose the well are sized to support design maximum loads, heat effects, chemical composition of reservoir fluids, wear to which they will be submitted as well as the combined effects, during all stages of the Well Life Cycle."*

Item 16.2.1.1: *"Ensure that the management of changes process comprises:*

i) Updating documents affected by change; and

j) Training and/or communicating to whole workforce impacted by changes".

Additionally, the following requirements must be observed:

Item 8.4.1 of Management Practice 8 – Information and Documentation Management: *"Operator must have, during all Stages of Well Life Cycle, updated Well Handover documentation (…)".*

Item 10.2.2.6 of Management Practice 10 – Well Life Cycle Stages: *"Operator must ensure that Well Handover documentation is updated and delivered to the responsible for the next stage of Well Life Cycle".*

Contact

For additional information regarding this safety alert, please contact ANP's Operational Safety and Environment Superintendency at incidentes@anp.gov.br.