



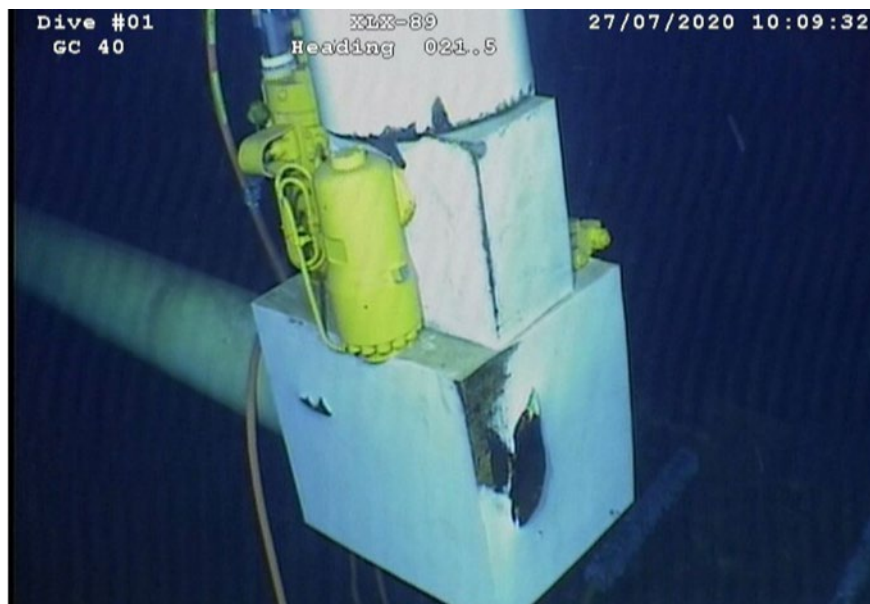
Safety Alert No. 458

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Investigation of Subsea Leak Identifies the Use of Materials Susceptible to Hydrogen Embrittlement



Subsea Jumper Connection Failure Picture

In July 2020, approximately 479 barrels of oil released into the Gulf of Mexico (GOM) from a subsea jumper. A BSEE investigation identified the incident resulted from a failed flange connection on the jumper, between the multiphase flowmeter (MPFM) and Blind Tee (see Figure).

The investigation found that the failure was due to the fracture of four of the eight fasteners (studs) at the flange connection, which was attributable to hydrogen embrittlement (HE). The fractured studs were composed of the corrosion-resistant nickel-based alloy (Inconel 718) which is not alloy steel. Inconel 718 fasteners installed in subsea environments with cathodic protection are susceptible to HE and should comply with the following American Petroleum Institute (API) standards to mitigate the embrittlement risks:

- API STD 6ACRA, 1st Edition, August 2015 - Age-hardened Nickel-based Alloys for Oil and Gas Drilling and Production Equipment.
- API SPEC 20F, 2nd Edition, May 2018 - Corrosion-resistant Bolting for Use in the Petroleum and Natural Gas Industries.

The investigation identified the following causes of the incident:

- Failure to install *API 6ACRA* compliant studs in the jumper flange connection.
- Engineering documentation used for procurement did not specify *API 6ACRA* compliance for subsea flange fasteners (studs and nuts).
- Gap in the quality assurance/quality control (QA/QC) process allowed for non-*API 6ACRA*-compliant subsea flange fastener installation.
- Management of change (MOC) process was not followed.

Therefore, BSEE recommends that operators and contractors consider the following:

- Review [BSEE GC40 Panel Report](#).
- Utilize an industry-knowledgeable metallurgist to evaluate all current and future subsea fasteners to verify fasteners are fit for service and not prone to Hydrogen Embrittlement (HE) or any other environmental cracking failures. For future installations, ensure the metallurgical evaluation is performed during the engineering technical review phase before releasing the engineering design for construction.
- Share Subsea Leak Detection (SSLD) system learnings with industry.
- Emphasize that company, contract, and sub-contract personnel enact MOC when there are modifications associated with equipment, operating procedures, personnel changes, materials, and operating conditions.
- Validate and document flange fastener make-up torque values.
- Ensure SSLD notification system alarms are appropriately set with effective alerts and properly monitored during shut-in, transient and steady state production operating conditions.
- Consider the subsea leak potential while investigating significant subsea flowline pressure drops even when the pressure trends are above the ambient pressure of the sea.

The Panel encourages industry to develop a standard means for determining shear and torsional capacities of API flange connections.

– BSEE –

A **Safety Alert** is a tool used by BSEE to inform the offshore oil and gas industry of the circumstances surrounding a potential safety issue. It also contains recommendations that could assist avoiding potential incidents on the Outer Continental Shelf.

Category: Spill/Pollution