Incident description: gas leak 2016

In connection with starting up water injection after maintenance work, a water hammer occurred in the facility. This resulted in three rupture discs bursting in the seawater system to the flare. That created communication between the seawater side of the cooler and the flare system. Flare gas from production flaring was thereby transported into the seawater system. As a result of automatic shutdown and a new water hammer in the seawater system, the rupture disc burst towards an open drain. When the seawater system came to be reset, ESD valves were opened manually before it became clear that communication existed between the flare and seawater systems and before it was realised that a connection to the open drain existed. Because the rupture discs had burst, seawater drained to the open drain and gas was released to the open air via that route. The gas was distributed between a total of eight drain outlets on two decks. The initial emission rate was put at 3.44kg/s, with a total estimated quantity of 7.17kg.

The oxygen scavenging system is intended to remove this gas from seawater to be used for injection. This prevents corrosion of downhole equipment as well as biological growth in both equipment and reservoir. With optimum regulation of the process, the dump valve can be completely closed so that dumping of water to the seawater return line is avoided. A "zero dump" return pump is used to dump water. This pumps deoxygenated water from the outlet of the second-stage separator to the inlet of the first-stage separator. The purpose is to avoid discharging chemically treated water to the sea. Start-up of the above-mentioned system does not function automatically. Experience has shown that start-up must be done manually in order to maintain the correct fluid level in the first- and second-stage separators. Running up and stabilising the system takes about 30 minutes, and requires the close involvement of the central control room (CCR) technician. The plant is regarded as demanding to operate for the CCR technicians, and a number of them hesitate to perform this operation.

When the zero dump system started up, fluctuations occurred in the fluid level in the first-stage degasser. Alarms were received, but were not acted on in time because of the high level of activity in the CCR. That halted the flow of seawater to the oxygen scavenging system and caused a pressure rise in the seawater system which propagated to automatic shutdown and flaring as well as bursting rupture discs in several places

Several ESD valves were opened with the intention of resetting. However, this caused flare gas to enter the seawater system because rupture discs burst. The rupture disc towards the open drain also burst, allowing flare gas to enter the open drain and vent to the open air via outlets.

Causes

<u>Direct causes</u>

- Fluctuations in the fluid level in the first-stage degasser when the zero dump system started.
- Water hammer in the seawater system.
- Burst rupture discs in several places as a result of a water hammer.
- Manual opening of ESD valves in connection with resetting.

<u>Underlying causes</u>

- Start-up of the zero dump system does not function automatically, and must therefore be done manually.
- Unfortunate design in that the rupture discs burst when the ESD valve closes.
- High level of activity and large number of enquiries from CCR personnel, together with a large number of alarms, could have led to inadequate/erroneous responses to alarms and other signals.
- No routines exist in today's maintenance system for checking rupture disc status.

- Certain rupture discs have burst without design pressure being reached, with material fatigue over time considered to be the probable explanation.

Lessons and recommendations

- Initiate routines for preventive maintenance of rupture discs.
- Improve the design (improve the automatic start-up sequence, make changes to avoid excessive pressure on rupture discs when shutting ESD valves, and a pop-up window in the process control system when relevant ESD valves are opened).
- Improve CCR routines (strengthen communication with the CCR, clarification/prioritisation of alarms and use of time out).