2017-E: Leak in pipe nozzle on condensate pump

While conducting an inspection round on the lower deck in the process module, the area technician observed a leak in a half-inch pipe nozzle on a condensate pump. After notifying the control room of the leak, he tried to close a manual block valve installed directly upstream from the leak point. In gaining access to the valve, the technician became exposed to the leaking fluid. A few minutes later, the control system activated an alarm for confirmed gas in the condensate pump area. This initiated emergency shutdown (ESD) level 2, followed by a general alarm and mustering. Deluge was activated.

In connection with ESD and pressure blowdown, it was observed that an ESD valve had failed to close. This is supposed to activate on receiving an ESD signal in order to limit the scope of a possible leak and thereby prevent an escalation of the incident. The valve was located upstream of the fracture, in the overlying area. Since the sectioning failed to function, the volume in the scrubber which the condensate pump was connected to became wholly or partly emptied through the fracture site.

Several unsuccessful attempts to close the ESD valve were made from the control room. The operators then decided to open a manual valve on the deck above, upstream from the leak site, which was connected to a closed drain. The piping and instrumentation diagram (P&ID) showed this line to be fitted with a closed spectacle blind, but it proved to have an open blind which made it possible to route the fluid feeding the leak to the closed drain and thereby reduce the leakage.

During the incident, it became clear that another ESD valve, this time for blowdown, had not opened to the flare as it was supposed to. That extended the time it took to blow down the process plant.

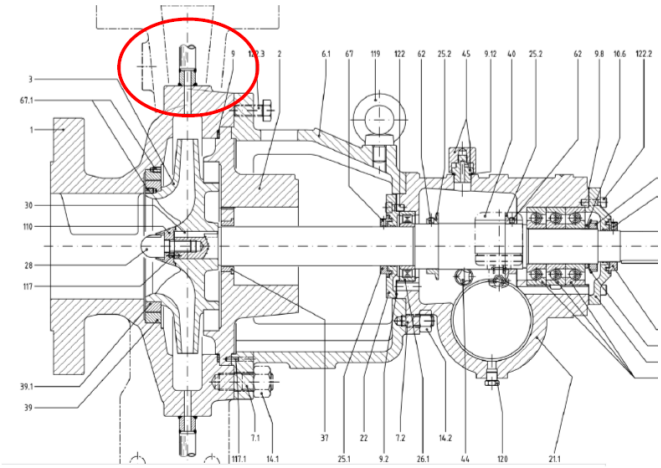

Figure 1 The leak point.

The pressure out of the condensate pump was about 26 bar. When the pump stopped because of the ESD, pressure in the leak was reduced to the static level in the fluid column upstream from the leakage. The leak is calculated at 1.25 m^3 of condensate with an initial rate of 1.06 kilograms per second and a duration of about 30 minutes.

Both the leaking condensate pump and another similar unit have a history of vibration and failure. They have been sent ashore for repair and modification several times. The faults with the two ESD valves arose because their actuators had suffered water intrusion and subsequent corrosion over a long period. Results from regular testing of the ESD valves shows that these problems have been known for a number of years.

Causes

Direct cause

- Fatigue failure in a weld on a half-inch pipe nozzle from the condensate pump as a result of vibration in the pump.

Underlying causes

- *Design:* Vibration in the pump caused fatigue stresses in a welded joint because of the 11.5-cm-long pipe nozzle with a 3.6-kg manual valve mounted on top. This created a torque with associated bending stresses.
- *Welding execution:* The weld was made with inadequate joint preparation and lack of penetration as well as some misalignment between the pipes welded together. The welding was done in connection with manufacturing the pump.
- *Follow-up of vibration in and failure of the condensate pumps:* The pumps have suffered major problems throughout their operating lives. Efforts to overcome these problems have been made several times. However, no trace can be found of assessments concerning the possible significance of the vibrations in terms of reduced operating life for the equipment or the piping.
- *Follow-up of safety-critical equipment and barriers:* Some ESD valves on the facility have a history of corrosion and water intrusion in their actuator. When valves have failed during function testing, personnel have carried out corrective maintenance with lubrication and repeated testing. The most recent measure was to change the test interval from 12 to three months. Planned maintenance of ESD valves was based solely on function testing, and did not include checks of water intrusion and other preventive aspects.
- *Organisation and handling of roles and responsibilities:*
    - Where an actuated valve is concerned, the actual valve falls under the mechanical discipline and the actuator under instrumentation, while the safety function to be performed by the valve is followed up by technical safety. However, instrumentation follows up closure times and tests.
    - The barrier panel used by the facility for risk control and monitoring did not show if parts of the ESD barrier were not functioning. That means supervisory and senior personnel on the facility and in the land organisation have been unaware of the weakening in the ESD system.
    - Information and measures related to any weakening of safety-critical equipment and barrier functions appear to have been communicated in an informal and unsystematic manner. In this case, where parts of a barrier were not functioning satisfactorily, none of the technical safety managers have taken ownership of or assessed the problem. The decision to change the test interval was made jointly by the maintenance supervisor and instrument technician. Nor has this been adequately communicated to the land organisation for registration and follow-up.

Lessons learnt and recommendations

- Process safety/operations
    - Evaluate/improve barrier strategy and panel
    - Evaluate support of small-bore tubing
    - Evaluate/improve plans for preventive maintenance of safety-critical equipment
    - Evaluate the spare parts regime for safety-critical equipment
    - Measures to ensure a robust and shared understanding of the testing regime for safety-critical equipment
    - Processes to ensure that management gives attention to work on safety-critical equipment
    - Evaluate/improve nonconformity system

    - Evaluate the interface between the engineer with system responsibility, the person responsible for equipment, and the person with offshore system responsibility
    - Other platform-specific measures
- Projects
    - Ensure that the welding standards set by equipment suppliers are reviewed, and that welds are subject to quality control
    - Secure valves and other mechanical equipment in line with the operational environment and the operating conditions where the equipment is to be used
    - Ensure that preventive maintenance plans are reviewed and updated before delivery to operations