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## Incompatible Materials Cause Downtime

### Description of Issue

A stack pull in 2009 was required when the Schrader nitrogen charging valve for a 15-gallon accumulator on the LMRP (lower marine riser package) began leaking. The EDS (emergency disconnect sequence) timing could not be verified as there was only one isolation valve for the *entire* accumulator circuit (4 racks containing 28 15-gallon bottles) and the leaking accumulator could not be isolated. Had each rack had its own isolation valve, the rack with the leaking accumulator could have been isolated. Calculations indicated that there was enough usable fluid to perform an EDS with one rack isolated. Such single point failures present safety hazards and can cause massive amounts of downtime if the failure point is not addressed prior to running the stack.

Once the BOP was on the surface, the system was bled down and repairs commenced. The failed valve was found to be in a severely corroded state, as were six other charge valves on the LMRP accumulator circuit and one charge valve on the BOP circuit (Figure 1). Three of the valves removed from the LMRP accumulators were in such a deteriorated state that after removal they literally fell apart.



**Figure 1:** Schrader valve showing severe corrosion.

The valves in question were made of 303 stainless steel (SS) and were found to contain 410 SS retaining pins. Both of these steel types are unsuitable for subsea applications, and are also prone to galvanic corrosion when placed in contact with each other in the presence of an electrolyte, such as seawater or control fluid. In this case, the 410 SS is more anodic and will preferentially corrode. In fact, the rig suffered a near-miss accident during an attempt to check the pre-charge on a bottle when a retaining pin failed and ejected the stem and trash cover. Considering that even 303 SS has a very short incubation time when exposed to a chloride environment, both of these materials should be avoided for subsea applications. This prompted the contractor to replace all 60 stack nitrogen charge valves.

It was decided to change the charge valves to a 316 SS design (ordered from the same manufacturer) that offered substantially better corrosion resistance in a subsea environment. However, the change-out proved unsatisfactory as the valves suffered a 50% failure rate when pre-charging 20 accumulators to 4000 psi (Figure 2). An investigation revealed that the valve design utilized a concave metal surface on the internal stem to seal against a polymer seat. It was discovered from the manufacturer that the maximum allowable make-up torque on the swivel nut was only 5 ft-lbs; more than this and the stem could easily tear or puncture the polymer seat and prevent the valve from achieving a seal. Such a valve design was deemed unfit for use on subsea accumulators. This problem could easily have been avoided if the contractor had been more specific when discussing application requirements with the

valve manufacturer. The application of the actual valve was not discussed, only that the valve needed to be 316 SS. The valve manufacturer sent what was available in 316 SS, a polymer sealing valve intended to provide a robust seal in a high vibratory environment.

As excessive vibration was not an issue with the rig, it was decided to again change out the valves. Due to time constraints, the contractor decided that reinstalling 303 SS valves, similar to those used in the initial accumulator application, was an acceptable risk, and had all 60 accumulator valves replaced. This type of valve, though 303 SS, used a metal to metal stem seal design instead of an elastomeric one, allowing for a greater tolerance for make-up torque. Future plans include “hybrid” valves that offer a metal-to-metal stem seal and are made entirely of 316 SS.



**Figure 2.** Leaking Charge Valve.

## Conclusion

Many factors contributed to the massive downtime the rig experienced while trying to remedy a problem that originally began with one leaking nitrogen charge valve. Not having an isolation valve on each accumulator rack caused all the accumulators to be taken off-line and the BOP to be pulled when the leak was noticed.

The root cause of the problem turned out to be the use of two materials that were not meant to be used subsea, a problem made worse by different galvanic potentials. A valve change-out failed to fix the problem because the replacement valves were of the wrong design, leading to the reinstallation of a 303 SS valve due to time constraints.

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