This report describes a retrofit trim solution provided by Fisher Controls to a nuclear power plant experiencing valve body and trim erosion due to cavitation and flashing damage. The solution consisted of installing a Dirty Service Trim (DST) into the valves. While the application did not contain any entrained particulate, the large passage DST trim could address the cavitation and flashing concerns and allow the capacity demands to be met.

Retrofit trim addresses erosion and capacity issues for recirculation valves

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A nuclear power plant in New England, USA had experienced repeated issues with valve body and trim erosion due to cavitation and flashing damage and subsequent leakage in their feedwater recirculation valves. The 1385MW pressurized water reactor facility has one motor driven feedpump for startup and two turbine driven pumps for normal operation. All three valves were of similar construction, but the recirculation valves for the turbine driven pumps experienced less severe conditions. The originally installed 8" valves incorporated little protection against cavitation (the formation and subsequent collapse of vapor bubbles) that was present during initial operation. The recirculation valves for the turbine driven pumps had inlet pressures up to 1200psig while the recirculation valve for the motor driven pump experienced inlet pressures as high at 1750psig.

Cavitation and flashing

As the unit load rises during startup, temperature of the feedwater increases and when coupled with the fact that the recirculation lines run directly to the condenser, the damaging mechanism moves from cavitation to flashing. These two phenomena combined to cause extensive damage to the valve trim and body. Because of the uncontrolled cavitation and flashing, the plant was constantly repairing the valve bodies and replacing the valve internals. Not only did this damage add to the maintenance costs there was a sizeable impact on plant efficiency due to leakage. Several fixes were attempted, but each acted only to slightly prolong the time between maintenance intervals. Because of this the plant decided to look for alternatives to address the problem.

Since the valves were supplied with little cavitation protection, installing adequate cavitation and flashing protection while still achieving maximum capacity proved to be an issue.

Installing a larger valve was the most common proposed solution to the problem. While this option was feasible related to technology and cost, the plant was concerned with the additional costs of removing the valves and installing the new valves.

One other option was to retrofit the valves with a trim that addressed the concerns with cavitation and flashing while meeting the capacity requirements. However, only one of the proposed retrofit solutions could meet both requirements.

Dirty Service Trim

After reviewing the multiple proposals, the plant elected to go with a retrofit trim solution provided by Fisher Controls. The solution consisted of installing the proven Dirty Service Trim (DST) into the valves. While the application did not contain any entrained particulate, the large passage DST trim could address the cavitation and flashing concerns and allow the capacity demands to be met.

The DST design utilizes combined axial and radial flow paths that feature large openings that allow flowing particulate up to $^3/_4$" in diameter. Figure 1 shows a cross section of a four-stage DST solution, which was used for the motor driven pump recirculation valve.

Because of the lower inlet pressures, the turbine driven pump recirculation valves utilized three-stage constructions.

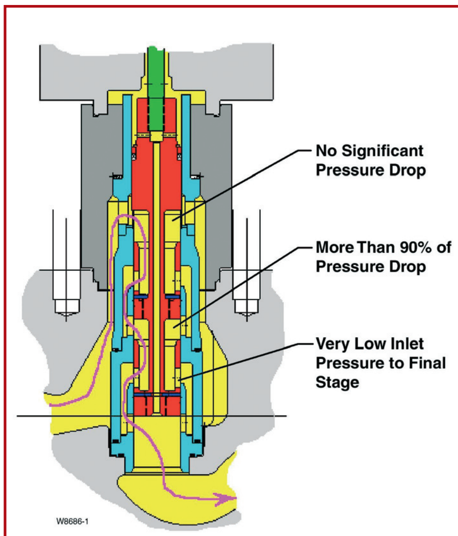


Figure 1: Cross Section of Four-stage DST Trim

The DST staged pressure reduction design takes the majority of the pressure drop in the initial stages of the trim, which dramatically reduces the available energy of the fluid leaving the final stage. Because the flashing phenomena is process driven and can not be eliminated, this feature protects the valve body from high-energy fluid impingement that can lead to extensive valve erosion.

Since these valves are normally closed, the maintenance of tight shutoff is absolutely critical. To address this, the design incorporates a protected seating surface that separates the shutoff and throttling locations. All significant pressure drop is taken downstream of the seating surface. As a result, the seating surfaces are not worn away by throttling control action (unless throttled near the seating surface for extended lengths of time) resulting in improved leakage performance over time. Also, the throttling areas are not required to have the superior surface conditions otherwise needed for tight shutoff.

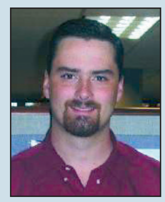
The DST technology also subjects all clearance flow to a staged pressure drop. This eliminates the possibility of fluid going directly from P1 to P2, which is a situation that can occur within traditional linear cage-style anti-cavitation trim. In the linear trim, the high velocity impingement on the seating surfaces results in poor control and loss of shutoff.

It has been three years since the retrofit trim was installed and the plant has not yet had to open the valves. Shutoff has been substantially improved helping to improve the plant's efficiency by at least one percent. The DST solution also possesses enough capacity that will allow the plant to continue to use the existing valves as the plant goes through a unit up-rate.

Conclusion

As can be seen in this example, it is not always necessary to replace valves that experience issues with erosion, leakage or capacity restrictions. Recent advancements in new valve trim solutions can breathe cost effective new life into existing nuclear facilities that still utilize the original severe service valves. ■

About the author



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