Flowserve – Anchor Darling Vacuum Breaker Valves
Vacuum Breaker Valves

Problem
Certain accident scenarios in boiling water reactors that results in suction of reactor coolant into the suppression pool.

Solution
Flowserve-Anchor/Darling vacuum breaker valves designed to relieve vacuum between the reactor and suppression pool water.

Check valves used as vacuum breakers in main steam downcomers have been a continuing problem in Boiling Water Reactors.

To prevent over-pressurization of the main steam lines and the reactor pressure vessel, relief valves are installed at various locations on the main steam header. In the event of a reactor malfunction, the lifting of these main steam relief (MSR) valves causes steam to be discharged through downcomers into the suppression pool. As the steam is cooled by the pool water, pressure in the downcomers is reduced to near atmosphere.

Under some accident conditions, cooling of the steam in the reactor pressure vessel by the emergency core cooling systems (ECCS) can create a situation where the pressure in the reactor falls below atmospheric and below that of the suppression pool. This creates a vacuum in the downcomers, which could cause the loss of additional reactor water. To prevent this possibility, swing check valves are installed with the checking side (normal to downstream) connected to the downcomers and the upstream side open to the containment or a dry well atmosphere.

The swing check valves are required to seal tightly when there is pressure in the downcomer. This ensures that the MSR discharge goes only to the suppression pool and does not pressurize the containment. On the other hand, the swing check valves must open to relieve the vacuum whenever the pressure in the downcomer is less than that of the containment. The check valves originally installed did not meet these requirements. Several swing checks from different manufacturers have all failed at some point.

It is not surprising that an ordinary swing check valve failed to function, in view of the actual operating conditions. The check valve must be bubbletight with 0.1 psid across the disc. To break the vacuum, the valve must be fully open with 0.4 psid across the disc. This type of sensitivity is not inherent in the ordinary swing check valve design. The small force available from the 0.4 psid is insufficient to overcome the weight of the disc and the hinge bearing friction. Adding a counterweight to overcome this bearing friction and counteract the weight of the disc was not a successful solution. Packing friction from the counterweight shaft penetration through the body reduced sensitivity and varied as packing dried or was adjusted.
Flowserve analysis of the problem indicated that a swing check valve was the logical valve for the service. It was also determined that a counterweight was the only practical means of providing the operating sensitivity needed, providing it could be installed without the counterweight shaft seal (packing) through the body. The apparent solution was to extend the pressure boundary and encapsulate the counterweight, thus eliminating the need for any seal.

Anchor/Darling vacuum breaker swing check valves, installed at Pilgrim Unit 1 have verified these predictions. These valves, in fact, have performed so well that additional valves were purchased. Based upon this successful operation, Flowserve Anchor/Darling Valves offers these “proven in service” vacuum breaker swing check valves to any plant. Flowserve engineers will analyze system requirements and design the vacuum breaker swing check to meet any BWR system requirement.

Solving this vacuum breaker valve problem is another example of Flowserve Anchor/Darling Valves continuing commitment to provide equipment that functions as required to meet the actual service conditions found in operating nuclear power plants.

Section A-A
Flowserve Corporation has established industry leadership in the design and manufacture of its products. When properly selected, this Flowserve product is designed to perform its intended function safely during its useful life. However, the purchaser or user of Flowserve products should be aware that Flowserve products might be used in numerous applications under a wide variety of industrial service conditions. Although Flowserve can (and often does) provide general guidelines, it cannot provide specific data and warnings for all possible applications. The purchaser/user must therefore assume the ultimate responsibility for the proper sizing, selection, installation, operation and maintenance of Flowserve products. The purchaser/user should read and understand the Installation Operation Maintenance (IOM) instructions included with the product and train its employees and contractors in the safe use of Flowserve products in connection with the specific application.

While the information and specifications contained in this literature are believed to be accurate, they are supplied for informative purposes only and should not be considered certified or as a guarantee of satisfactory results by reliance thereon. Nothing contained herein is to be construed as a warranty or guarantee, express or implied, regarding any matter with respect to this product. Because Flowserve is continually improving and upgrading its product design, the specifications, dimensions and information contained herein are subject to change without notice. Should any question arise concerning these provisions, the purchaser/user should contact Flowserve Corporation at any one of its world-wide operations or offices.

For more information about Flowserve Corporation, contact www.Flowserve.com or call USA 1-800-225-6989