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.

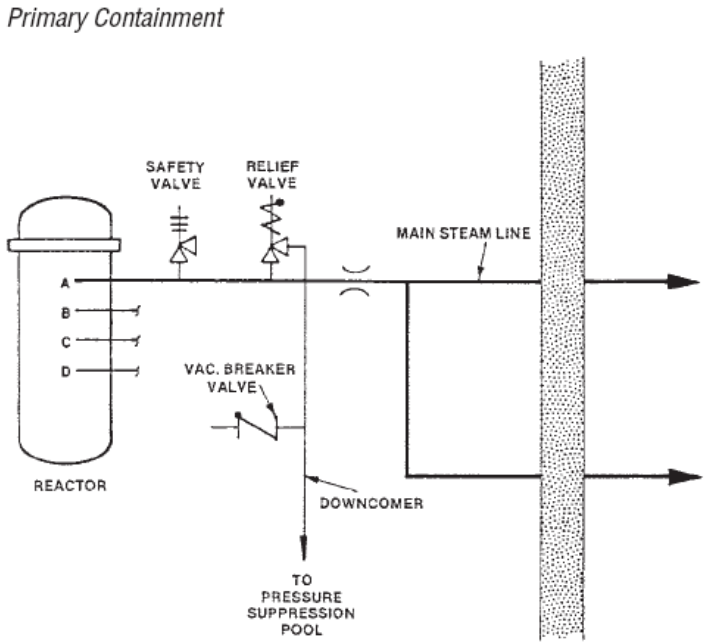
Check valves used as vacuum breakers in main steam downcomers have been a continuing problem in Boiling Water Reactors.

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.



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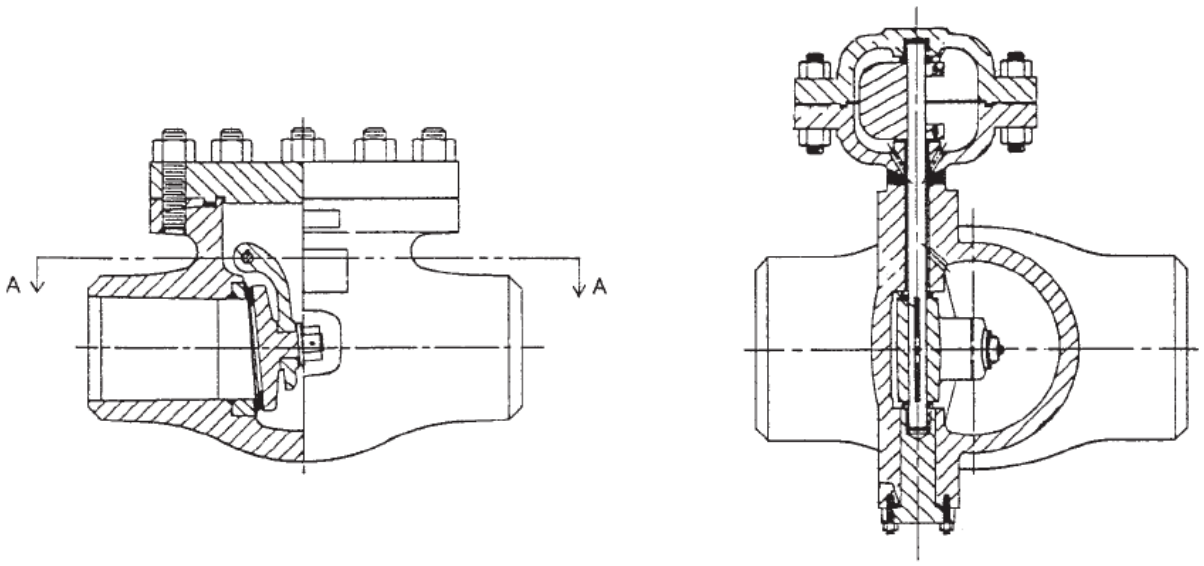
Flowserve analysis of the problem indicated that a swing check valve was the logical valve for the service. It was also determined that a counterweight was the only practical means of providing the operating sensitivity needed, providing it could be installed without the counterweight shaft seal (packing) 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

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