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Technical Bulletin **No. 0594-1**

ISOLATION VALVE CLOSURE FOLLOWING A HIGH ENERGY LINE BREAK

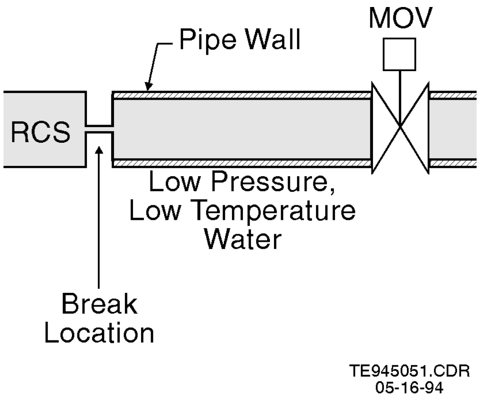

Figure 1 Line schematic.

Under accident conditions the developed differential pressure an MOV must overcome is strongly dependent on the pipe geometry and dynamic effects of valve closure. In cases where the original design basis evaluation did not consider transient effects, the results may significantly over state the actual MOV differential pressure. In light of the cost of complying with the requirements of Generic Letter 89-10, *Safety-Related Motor-Operated Valve Testing and Surveillance*, a more accurate assessment of the MOV closing differential pressure has proved to be a reasonable approach compared to valve replacement.

Accident sequences which involve the discharge of high pressure, high energy RCS fluid into a cold, water-filled, steel pipe as the result of a ruptured pressure boundary have recently been analyzed (see Figure 1). The dynamic processes which were addressed include,

- the magnitude of the break flow;
- flashing of the high energy fluid (i.e., generation of steam "voids") as it enters the low pressure line;
- progression and collapse of steam voids along the length of the line;
- heat loss from the high energy fluid to the initially cold pipe wall; and
- the time-varying hydraulic resistance of the MOV as it closes.

The evaluation of these process requires detailed modeling of the line physical characteristics and a coupled solution of the transient mass, energy, momentum, and heat conduction equations, such as is provided by the TREMOLO (Thermal hydraulic REsponse of a Motor-Operated valve Line) computer program.

Consider the case of a low pressure piping system (100 psig/100 F) containing an MOV which must close to isolate the ruptured RCS pressure boundary (RCS at 2350 psig/525 F).

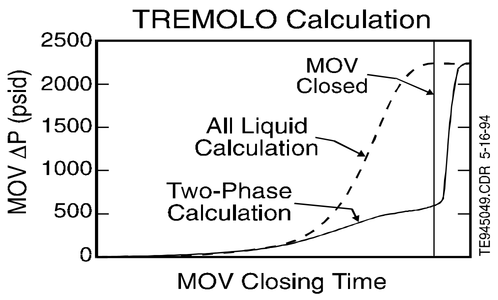

Figure 2 Transient pressure calculations.

Several approaches can be used to determine the maximum differential pressure across the MOV. First, if a steady state analysis is applied, then the differential pressure is based on the full RCS pressure (i.e., ΔP = 2250 psid). Next, if a transient analysis is performed which neglects void generation (i.e., an all liquid calculation), the differential pressure may still develop rapidly to 2250 psid during the valve closure period as seen in Figure 2. Finally, if transient, two-phase methods are applied, as in TREMOLO, the differential pressure is shown to be limited by the saturation pressure of the high energy, two-phase fluid at the time of valve closure (see Figure 2).

This reduced differential pressure is a direct result of the steam voids which form early on in the transient are sustained throughout the valve closure period, as depicted in Figure 3. Of course, the degree of the voiding depends on the RCS conditions, the actual line geometry, and the MOV time-dependent hydraulic resistance.

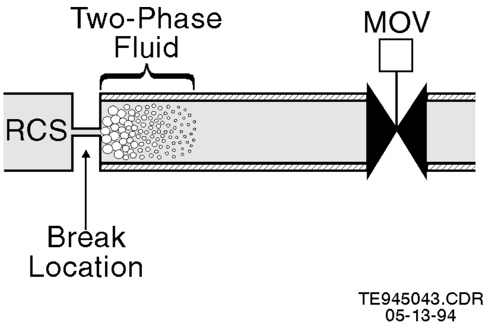

Figure 3 Approximate void distribution at MOV closure.

Related Technical Bulletins:

No. 1093-2 MOV Closure ΔP

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