

## Preliminary Risk Screening For Cooper Service Water Issues

### Background

Several service water issues were identified near the end of the Cooper refueling outage. The issues involve pump shaft failures, potential icing of the system, and air introduction from the gland seal cooling water system.

### Assumptions

The issue involving air saturated water from the gland seal system occurred late in the outage. The issue only impacted pumps which were in a standby condition. Provided the pumps are started periodically (every 24 hours) the potential for the standby pump to experience an on-demand failure was minimized.

Two service water pumps, in opposite trains, were always in service. Therefore, the failure due to air accumulation only affected the standby pumps which were located in opposite trains.

The impact of potential icing of the service water system did not appear likely. No information was provided which would indicate that either the suction screens or the pump discharge strainer were obstructed due to ice formation. Therefore, the common cause failure of all service water pumps due to icing was not likely.

The pump shaft failure was due to a combination of pre-existing flaws and inadequate pump clearances. An analysis of the significance of this condition was not completed given the successful operation of the pumps during the previous operating cycle. Common cause failure of the pumps was possible given the overhaul of each service water pump during the outage. However, the duration following the maintenance activity was relatively short and there was very low decay heat. Additionally, no information was provided to suggest that a current common cause failure mechanism existed.

### Analysis

The licensee did not model combinations of 2 and 3 service water pump failures. Consequently, the licensee developed special cases to evaluate the risk significance associated with the various combinations. The licensee's results were qualitatively compared to the results associated with single pump failures and the common cause failure of all four service water pumps. Based on the comparison, the licensee's results appeared to be reasonable.

The following table illustrates the number of days necessary to reach a delta CDF of  $1E-6$ /yr. The results were obtained using the zero maintenance PRA model and assumed the condition existed for 1 year of full power operation. The combinations of concern involve two opposite train service water pumps and the failure of a single pump. Because of the information received to date, the combinations of 3 and 4 service water pumps failing were not considered credible. Nevertheless, the data is provided in the event additional information becomes available which suggests the likelihood of 3 or 4 service water pumps failing has increased. The variance in the duration for the pump combinations is due to the design of the service water system.

Pumps Unavailable				Days to 1E-6/yr
SWS A	SWS B	SWS C	SWS D	
X				150
	X			342
		X		150
			X	342
X	X			102
X		X		4
X			X	102
	X	X		102
	X		X	8
		X	X	102
X	X	X		3
X	X		X	5
X		X	X	3
	X	X	X	5
X	X	X	X	0.7

Because the plant was shutdown or at low power, the actual number of days before reaching 1E-6/yr would be much greater. Therefore, it is unlikely that the condition would have exceeded the 1E-6/yr CCDP threshold due to the relatively short duration, the low decay heat, and the number of potentially affected service water pumps.