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MEMORANDUM FOR: File

FROM: Eugene Imbro  
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of Operational Data

SUBJECT: EVALUATION OF HPSI PUMP OPERABILITY  
WITHOUT SERVICE WATER

Reference: ANO-2, Evaluation of HPSI Pump Operability  
Without Service Water, forwarded by letter  
dated January 13, 1981 to USNRC (R. A. Clark)  
from Arkansas Power and Light (David C. Trimble)

During the investigation of the service water system in September 1980, as a result of the forced outage due to system fouling by Asiatic clams, the licensee discovered that the flow to the bearing oil coolers and seal water coolers of all three HPSI pumps was blocked by the accumulation of silt. The licensee stated that cooling water is not necessary for HPSI operation. Therefore, this has not been reported as an "Abnormal Occurrence." The referenced document was submitted by the licensee in an attempt to justify this contention. Based on a review of this submittal, it is my opinion that the licensee has not conclusively demonstrated that the HPSI pumps can operate during the post-LOCA recirculation mode without the availability of service water. This is primarily due to the fact that the higher pump shaft temperature that would occur during post-LOCA recirculation was not considered in the determination of maximum bearing temperatures.

In the tests conducted by the licensee on each of three HPSI pumps, the pumps were run without service water until the lube oil temperature and seal water temperatures stabilized. The bearing temperatures were measured by monitoring the temperature in the bearing lube oil reservoirs and the seal water temperature was measured by placing a dial indicating thermometer in the seal water cooler vent connection. In addition, bearing temperatures were measured at several times during the test using a contact pyrometer. The bearing race temperatures were found to be 4 to 6°F hotter than the lube oil temperature. The data obtained during the tests is presented below.

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	<u>Outboard Bearing (F°)</u>	<u>Inboard Bearing (F°)</u>	<u>Outboard Seal Water (F°)</u>	<u>Inboard Seal Water (F°)</u>	<u>Room* (F°)</u>	<u>RWT Temp (°F)</u>
2P89A						
Idle	69	69	69	66	68.6	75
Stable	122	101	142	130	68.6	75
2P89B						
Idle	65	66	62	66	75.4	76
Stable	168 <sup>1/</sup>	90	126	103	74.3	76
2P89C						
Idle	61	62	68	57	73.4	74
Stable	142	112	126	119	87.3**	74

Note: 2P89B test performed on 11/9/80. 2P89C test performed on 11/9/80.  
2P89A test performed on 11/20/80.

\*Thermometer was located just above the outboard bearing

\*\*Reason for temperature rise due to small room for 2P89C.

<sup>1/</sup>

HPSI Pump 2P89B was not used in the licensee's analysis since it was felt that the anomalous outboard bearing temperature was indicative of the pump needing maintenance.

The criteria of acceptability used by the licensee was as follows:

1. The bearing temperatures, extrapolated to post-LOCA conditions, should be less than 180°F, and
2. The seal water temperature, extrapolated to post-LOCA conditions, should be less than 350°F. (This was not stated explicitly in the referenced submittal).

The following corrections were applied to the test data by the licensee to extrapolate it to post-LOCA conditions:

1. The difference between the RWT temperature during the test and the assumed post-LOCA containment sump temperature was added to the seal water temperature; and
2. The difference between the measured room ambient temperature and the expected room temperature during a LOCA (115°F) was added to both the bearing oil cooler and seal water temperatures.

The following table shows the results of this analysis.

<u>Pump</u>	<u>Outboard Bearing Temp °F</u>	<u>Inboard Bearing Temp °F</u>	<u>Outboard Seal Water Temp °F</u>	<u>Inboard Seal Water Temp °F</u>
2P89A	168	147	363(317)*	351(305)*
2P89C	170	140	330(302)*	323(295)*

\*Bracketed numbers are those calculated by the licensee. They differ by the difference in ambient between the test conditions and the assumed post-LOCA ambient of 115°F. This appears to be a calculational error by the licensee.

A review of the above data indicates that the HPSI pump 2P89A seal water temperatures slightly exceed the 350° limit if the differential in ambient temperature is considered as the licensee stated. This however is not significant considering that the seal manufacturer projects a wear life of 4770 hours with nil seal leakage at seal temperatures of 350°F.

Of greater significance is the fact that the licensee has not accounted for the heat transferred to the bearings by the pump shaft in the extrapolation of the bearing temperatures. (During the post-LOCA recirculation the pump shaft will be heated due to pumping of 250°F containment sump water.) Also not accounted for is the 4 to 6°F difference between the bearing lube oil temperature and the actual bearing temperature obtained by measurement with the contact pyrometer.

Since the test was conducted pumping 75°F water from the RWT the pump shaft probably acted as a heat sink and provided some cooling for the bearings. During operation in a post-LOCA recirculation mode the reverse would occur and the shaft would act to heat the bearings and the lube oil. An additional but perhaps unquantifiable side effect is that heat input to the pump bearings via conduction through the shaft may affect the running clearances, possibly causing even higher bearing temperatures.

Since pumps 2P89A and 2P89C were within 12°F and 10°F of their acceptable limit, by the licensee's extrapolation, additional upward corrections considering the factors mentioned above may cause the bearing temperatures to exceed the 180°F limit imposed by the licensee.

Based on the above, it is felt that the licensee has not adequately justified the operability of the HPSI pumps without service water and a more refined

analysis or tests with heated water are necessary. Therefore, the question as to whether this event should be written up as an "Abnormal Occurrence" is still unanswered.

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