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CRBR PUMP WATER TEST EXPERIENCE

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ABSTRACT

The hydraulic design features and water testing of the hydraulic scale model and prototype pump of the sodium pumps used in the primary and intermediate sodium loops of the Clinch River Breeder Reactor Plant (CRBRP) are described. The Hydraulic Scale Model tests performed and the results of these tests are discussed. The Prototype Pump tests performed and the results of these tests are discussed.

INTRODUCTION

The Clinch River Breeder Reactor Plant (CRBRP) employs liquid sodium as the coolant in the primary and intermediate heat transport systems. The sodium flow is maintained by three pumps located in the three parallel hot legs of the primary coolant system. The intermediate coolant system also uses three parallel flow paths, but the three pumps are located in the cold-leg piping. Both primary and intermediate pumps are hydraulically and structurally identical to each other except for different nozzles in the upper region of the pump tank, the radiation shield is filled in steel shot on the primary pump and stainless steel wool on the intermediate and the thermal shield is not used on the intermediate pump.

The primary and intermediate pumps normally operate at 538°C (1000°F) and 343°C (650°F) respectively and must continue to operate during the most adverse plant thermal events. To provide assurance of operability under all plant conditions, a prototype pump was designed, fabricated and subjected to water and sodium testing. This report will address only the water performance since the analysis of the sodium test data has not been completed.

A hydraulic scale model (HSM) pump (scale factor of .5) was designed, fabricated and tested to verify the hydraulic design to be utilized on the prototype pump. The HSM pump included prototypic mechanical and hydraulic features. For example, it had the same vertical shaft orientation as the prototype pump, and the shaft length was modelled to simulate the prototype pump shaft to hydrostatic bearing degrees of freedom.

Two HSM hydraulic designs were tested. The first was a ducted-suction design and the second was a full-flow-suction design. The change in design from ducted suction to full-flow suction was to reduce excessive thermally induced stresses and deformations in the ducted-suction hydraulic assembly. The inside of the ducted suction pump case was directly exposed to the thermal transients, whereas the outside was isolated. This resulted in a thermal lag between the inner and outer surface of the hydraulic assembly wall causing the noted excessive stresses and deformations. The full-flow suction design exposes the inner and outer case walls equally to the thermal shock and brings the thermal induced stresses and deformations within acceptable limits.

The ducted-suction and the full-flow suction pump hydraulics are shown in Figures 1 and 2, respectively.

DESCRIPTION OF PROTOTYPE PUMP

General

The CRBRP prototype primary pump is a vertical, single-stage, double-suction, centrifugal pump as shown in Figure 3. The hydraulic assembly contains a triple-volute in the pump case, and the impeller is double-suction with full-suction flow around the inside of the pump tank. There are two hydrostatic bearings straddling the impeller. Each of the upper and lower suction openings to the impeller is continuous, except eight equa ly spaced webs which results in eight inlet ports. The hydraulic assembly is supported by the webs at the top suction and