

DUQUESNE LIGHT COMPANY  
Power Stations Department  
Beaver Valley Power Station, Unit No. 1

Report

Low Head Safety Injection Pumps

Presently installed at Beaver Valley Power Station, Unit No. 1

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I. Introduction

The two Low Head Safety Injection pumps (LHSI) located in the west safeguards area are vertical, dual stage pumps manufactured by Ingersoll Rand Company. Each pump is driven by a vertical shaft, 250 hp, 4160 volt A.C. electric motor. After extensive tests of the hydraulic characteristics of the LHSI pump configuration by the LaSalle Hydraulic Laboratory, Study 11700-2.29-18A, modifications to the LHSI pumps at BVPS-1 were deemed necessary. The LHSI pumps as presently installed at BVPS-1 are essentially identical to the North Anna Power Station LHSI pumps and incorporate all features determined by tests to be desirable for reliable operation. Our purchase requisition to Ingersoll Rand specified that, "These replacement pumps are to be provided with all the design details of those which have been qualification tested at the North Anna Power Station and will have the same number and type of bearings, column sections and shaft couplings."

II. Summary of Modifications to the LHSI Pumps

- A. A "Turbulence Limiter" was added, which directs the flow of water from the suction inlet to the bottom of the pump can and the pump suction bell. This eliminates the impacting of the suction flow on the side of the pump discharge column.
- B. A "Vortex Eliminator" was installed as a false bottom plate approximately 2 inches from the bottom of the pump can and was designed to eliminate vortexing at the pump suction.
- C. Three sets of "Wedge Locking Assemblies" were installed. The three wedges in each assembly are situated radially 120 degrees apart with respect to the pump centerline (shaft centerline) at each of three elevations for a total of 9 assemblies. The wedges are designed to lock the discharge column in position following final assembly. The wedges are not used for the purpose of alignment. In the locked position, the assembly positions the pump discharge column in a fixed position inside the pump can.
- D. The following parts from the original pumps were modified and re-used.
  - 1. Suction Bell - the outside diameter was reduced to permit installation through the "Turbulence Limiter" and the flow vanes were eliminated.
  - 2. First Stage Casing - the addition of a new 5 inch bearing. Machining was done to permit installation of a new style of a 3.5 inch bearing.

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II. Summary of Modification to the LHSI Pumps (continued)

3. Second Stage Casing - support lugs were removed and machining was done to accommodate a new 3.5 inch bearing.
4. First Stage Impeller - the outside wall was ground to a new radius and the hub was bored out to permit installation on a new shaft.
5. Second Stage Impeller - the hub was bored out to permit installation on a new shaft.
6. Discharge Head - the mounting plate and the mid-plate were drilled to accommodate the "Wedge Assemblies" and a new bearing was installed.

E. The following summarizes the new parts and arrangements:

1. Bearings - a total of 13 bearings are installed in each pump. They are Nickel impregnated Graphalloy, tri-lobe bearings (10 @ 3 inch; 2 @ 3.5 inch; 1 @ 5 inch) (Required bearing clearance is now .003" - .010"; the clearance prior to modification was .005" - .014"). These bearings are identical in design to those which have been successfully tested at the North Anna Power Station.
2. Couplings - precision couplings which are identical to that which is installed on the pumps at North Anna has been installed.
3. Pump Columns - New pump column sections with stiffeners have been installed.

F. All other pump parts including shaft sections, shaft couplings, journal sleeves, bearings, precision drive coupling and column sections have been replaced with new parts which duplicate the design features of those parts which have been successfully tested at the North Anna Power Station.

III. Pump Overhaul

The procedure used for the pump overhaul was BVPP No. 89-1 which is a revised edition of Duquesne Light Company's Corrective Maintenance Procedure "1A or 1B Low Head Safety Injection Pump Overhaul" (1-11SI-P-1A-B-1M, Revision 6). The procedure was revised to account for the changes made to the LHSI pumps by Ingersoll Rand under Duquesne Light Company P.O. No. C-007039 and for the addition of the turbulence limiter.

The Ingersoll Rand Company performed an optical alignment of the pumps which included match marking of the pump column sections. Match marking of the pump column sections assured that the pump is properly aligned. The drive motor has been aligned to within .002 inches for both concentricity and parallelism.

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IV. Design Verification

After pump modifications were complete, each pump was tested to verify that the pumps operated as designed. The pump was operated on recirculation flow for six hours. Each pump was then stopped and started 12 times to simulate a full year of periodic testing. The "B" pump was then disassembled and bearing measurements were taken to record the bearing wear. The maximum wear of 1.5 mils occurred in the "L" bearing. Wear in all other bearings was 1.0 mil or less. The "L" bearing is the upper-most bearing located in the discharge head and experienced maximum wear due to its lack of lubrication during startup until the pump approaches operating speed. After inspection, the pump was reassembled and run for 30 minutes. The results of this bearing inspection verified that the assembly procedure was properly performed. Vibration readings taken periodically during the six hour run on the motors of the pumps were less than 1 mil for the "A" pump and 2 mils for the "B" pump. There was no indication of increased vibration as the test progressed.

V. Conclusion

The testing and inspections which have been performed successfully demonstrated that the Low Head Safety Injection Pumps at Beaver Valley Power Station have been properly designed and installed to assure reliable long term operation.

Identical pumps have been qualification tested at the North Anna Power Station of the Virginia Electric Power Company.