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DOCKET NUMBER 50-289

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TO:	FROM:	DATE OF DOCUMENT
Mr. R. W. Reid	Metropolitan Edison Company Reading, Pa. J. G. Herbein	11/2/77
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DESCRIPTION

Consists of response to requested info. concerning Decay Heat Pump Shafts.....

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ENCLOSURE

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PLANT NAME: Three Mile Island Unit No. 1
RJL 11/7/77

FOR ACTION/INFORMATION

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November 2, 1977
GQL 1496

Director of Nuclear Reactor Regulation
Attn: R. W. Reid, Chief
Operating Reactors Branch No. 4
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

Three Mile Island Nuclear Station Unit 1 (TMI
Docket No. 50-289
Operating License No. DPR-50
Decay Heat Pump Shafts

During a telephone conversation on October 19, 1977 between the NRC (Mr. Zewtzig) and Met-Ed (Mr. Stevens), the NRC requested Met-Ed to provide a summary of the stress analysis performed for the TMI-1 Decay Heat Pump Shafts. This information was to be provided in two parts. Our letter GQL 1477, of October 27, 1977, provided information on loads and stresses at a recirculation flow rate of 80 gpm. This letter provides the remaining information and delineates the loads acting on the decay heat pump shafts at flow rates of 135, 550, and 3,000 gpm.

1. Steady-State Radial Loads

Steady-state radial loads were calculated using parameters in a Worthington report of radial loads. 1/ The calculated loads are as follows:

Flow Rate, gpm	Radial Load, lbs
80	40
135	40
550	80
3,000	120

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1/ "An Experimental Investigation of Radial Thrust in Centrifugal Pumps" by A. Agostinelli, et al, Transactions of the ASME-Journal of Basic Engineering, April 1959.

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It is noted that these values are somewhat lower than the 260-pound value calculated by Worthington and reported in our letter of October 27, 1977. The Worthington value was calculated using a conservative approximation rather than the more accurate detailed method given in the referenced Worthington paper. Using either method, the steady-state radial loads are very low at all flow rates and result in very low stresses.

2. Steady-State Torque Loads

The steady-state torque loads were calculated by converting the pump brake horsepower to a torque value using the standard textbook formula. 2/ The calculated loads are as follows:

Flow Rate, gpm	Torque, lb-in
80	5,250
135	5,250
550	5,680
3,000	11,900

The highest steady state torsional load occurs at 3000 gpm and results in a steady state stress of 21,000 psi 3/ which includes the effects of a stress concentration factor (5.0). This stress is well below the torsional yield stress of 62,500 psi. (1/2 the Armco catelogue tensile yield strength for H-1150 heat treated condition).

3. Alternating Radial Loads

Worthington has advised us that they do not have any methods for estimating the alternating radial loads, either at low flows or at rated flow. Accordingly, the upper bound value of 670 pounds we provided you in our October 27, 1977, letter for an 80 gpm flow rate is the only load estimate available. However, it is expected that the alternating radial loads will decrease at higher flows, since there is less likelihood of recirculation type flow instabilities within the pump at higher flow rates.

4. Alternating Torque Loads

Worthington has advised us that they do not have any methods for estimating the alternating torque loads, either at low flows or at rated flow. The upper bound value of 11,300 lb-in we provided you in our October 27, 1977 letter is the only load estimate available for flows of 80 and 135 gpm. However, based on discussions with personnel at B&W and Southwest Research

2/ "Formulas for Stress and Strain", 5th Edition, McGraw Hill, Inc., Copy Right 1975, Page 321, Raymond J. Roark and Warren C. Young.

3/ "Formulas for Stress and Strain", 4th Edition, McGraw Hill, Inc., Copy Right 1965, Page 194, Chapter 9, Table 9, Raymond J. Roark.

Institute, we estimate that at flows of 550 to 3,000 gpm, the alternating torque loads would be in the range of 1% to 6% of the steady state loads given in Item 2 above. Thus, the estimated alternating loads are as follows:

Flow Rate, gpm	Alternating Torque, lb-in
80	11,300
135	11,300
550	340
3,000	710

In summary, the loads acting on the pump shaft are calculated to be less than design allowable. The highest alternating loads are calculated to occur at 80 gpm and as discussed in our letter of October 27, 1977, result in an upper limit alternating stress of 21,660 psi much below the normal design allowable of 45,000 psi. The maximum steady state loads are calculated to occur at 3000 gpm, and result in a maximum torsional shear stress of 21,000 psi which is much less than a torsional yield stress of 62,500 psi.

Sincerely,

J. G. Herbein
Vice President

JGH:WEP:tas