DISTRIBUTION AFTER ISSUANCE OF OPERATING LICENSE

NRC FORM 195 (2-76) — U.S. NUCLEAR REGULATORY COMMISSION

DOCKET NUMBER: 50-289

FILE NUMBER:

NRC DISTRIBUTION FOR PART 50 DOCKET MATERIAL

TO: Mr. R. W. Reid

FROM: Met Ed
Reading, Pa. 19603
J. G. Herbein

DATE OF DOCUMENT: 09/06/77

DATE RECEIVED: 09/07/77

LETTER ☒ ORIGINAL ☐ COPY — ☐ NOTORIZED ☒ UNCLASSIFIED

PROP

INPUT FORM

NUMBER OF COPIES RECEIVED: 1 Signed

DESCRIPTION

Furnishing response to NRC's ltr. dtd 09/01/77 providing justification that the TMI-1 decay heat pumps in their present condition con perform their function as prescribed in the Safety Analysis for Unit # 1 and advising no intention to conduct pump inspection to commence on 09/09/77...

4p

ENCLOSURE

DO NOT REMOVE

ACKNOWLEDGED

PLANT NAME: THREE MILE ISLAND UNIT # 1
jcm 09/08/77

1491 119

FOR ACTION/INFORMATION

SAFETY	
BRANCH CHIEF: (7)	Reid

INTERNAL DISTRIBUTION

REG FILE
NRC PDR
I & E (2)
OELD
HANAUER
CHECK
STELLO
EISENHUT
SHAO
BAER
BUTLER
GRIMES
J. COLLINS

EXTERNAL DISTRIBUTION

LPDR: HARRISBURG, PA.
TIC
NSIC
16 CYS ACRS SENT CATEGORY B

CONTROL NUMBER

772510227

7910300521

METROPOLITAN EDISON COMPANY

POST OFFICE BOX 542 READING, PENNSYLVANIA 19603 TELEPHONE 215 – 929-3601

September 6, 1977
GQL 1223

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

Regulatory

Dear Sir:

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

1491 120

NRC letter dated September 1, 1977, required that Met-Ed would disassemble and inspect the TMI-1 decay heat pump shafts at the keyway under the impellers, and that this inspection would start on September 9, 1977, unless an evaluation showing that the decay heat pumps meet the requirements of the TMI-1 Final Safety Analysis Report was submitted to and accepted by the Office of Nuclear Reactor Regulation. This letter is in response to the NRC letter, and provides justification that the pumps in their present condition can perform their function as prescribed in the Safety Analysis for Three Mile Island Unit 1.

We understand that the reasons for the NRC's concern about the TMI Unit 1 decay heat pump shafts is that the shaft on an identical pump at Crystal River Unit 3 failed. Based on discussion with B&W, Worthington, Crystal River Unit 3 personnel and preliminary visual inspection of the failed shaft, we understand, that this failure had the following characteristics:

The pump shaft failed about 3½ inches from the centerline of the impeller. It should be noted that because of the short distance from the centerline of the impeller to the failure location, this location is subject to relatively low bending stresses.

The exact starting point of the shaft failure is not certain. A detailed metallurgical failure analysis will be required to determine the exact cause of failure. At the time the pump shaft failed, the plant had only recently completed its preoperational test program, and thus the pump had not been operated extensively. The exact length of time that the pump had operated with normal or recirculation flow is not known but has been estimated by Crystal River operations personnel to be approximately 10 minutes. Normal recirculation flow during operation against a closed discharge valve for the pump was approximately 80 gpm, about 3% of rated flow.

Inspection of the impeller and wearing rings on the failed Crystal River pump did not indicate any seizing or unusual contact between these parts, and interaction between the impeller and wear rings is not believed to be a cause of failure or to have resulted in high torsional loads.

7725100227

The Crystal River failure could have resulted from one of two possible failure mechanisms. The first failure mechanism could be a manufacturing flaw. The second could be stresses which occurred during operation at low recirculation flow.

We have performed stress analyses of the pump shaft to determine which location on the pump shaft would be most likely to fail if there were no preexisting defects. These calculations indicate that the cyclic stresses at the keyway are about 31% of the cyclic stresses at a step on the shaft close to the bearings. Since the failure occurred in the keyway and not at the step near the bearing, we believe that the Crystal River failure must have been due to some preexisting defect at the keyway. This is confirmed by discussions with Worthington and B&W pump experts, who indicate that, in the absence of preexisting defects, fatigue failures normally occur at the step adjacent to the bearing, where bending stresses are largest.

There has been some discussion that a possible contributing factor to failure of the pump shaft was loads associated with the low flow rates during operation in the recirculation mode. We concur that low flows can lead to relatively higher loads, however, both B&W and Worthington have advised us that experience with similar pumps indicates that intermittent operation at recirculation flow rates, totalling many hours over the life of the pumps will not damage the pumps.

There has also been some discussion that lack of a radius at the root of the keyway under the impeller led to early failure of the Crystal River Unit 3 pump shaft. In this regard, we note that the main stresses acting on the shaft are bending and axial stresses, and thus are parallel to the keyway. Therefore, the sharp corner of the keyway will not act as a significant stress riser, and would not be expected to lead to fatigue problems. In our discussions with Worthington, they have indicated that they do not consider the sharp corner of the keyway to be a significant cause of failure and that their experience with similar pumps is that failures normally occur at the shaft step near the support bearings, i.e. about 10-3/4 inches away from the end of the keyway rather than at the keyway itself.

For the reasons discussed above; the approximate 10 minute run time of the Crystal River pump prior to failure; inspection of the failed shaft; stress analysis of the pump's shaft; the failure location; and the elimination of the keyway as a contributing factor, we consider the probable cause of failure of the Crystal River Unit 3 pump shaft to be a preexisting defect. As further support of this conclusion experience shows that the likelihood of failure due to preexisting defects is greatest early in life and that substantial operation such as that experienced at TMI-1, virtually eliminates the possibility of preexisting defects in the decay heat pump shafts at TMI Unit 1.

We have taken further steps to ensure that the TMI Unit 1 decay heat pumps in their present condition can perform their functions as prescribed in the Safety Analysis for Three Mile Island Unit 1.

An ultrasonic inspection was performed on the shafts of decay heat pump 1A and 1B on September 3 and 4, respectively. These inspections were performed down the pump shaft from the coupling end and found both to be free from defects with no discontinuities.

In addition, vibration tests were performed to confirm that operation in the recirculation mode does not result in harmful oscillating radial loads. These tests were performed on both pumps at approximately 80 gpm and 600 gpm flow (about 3% and 20% rated flow).

Results of vibration tests were compared with the acceptance criteria of the Hydraulic Institute Standard and the IRD Mechanalysis Vibration Severity Chart. The vibration tests included a search of all frequency bands in an attempt to locate a predominant frequency, none was found. At 1800 Hz the worst case reading for the A pump measured 0.4 mils at 80 gpm flow and for the B pump measured 0.9 mils at 600 gpm flow. Both of these are well below the acceptance criteria of 3.5 mils. The larger of the two readings represents about 25% of the Hydraulic Institute acceptance standard and is therefore indicative of extremely smooth running conditions. The vibration data also demonstrates that both pumps are properly aligned, and balanced. Based on analysis and conclusions drawn from these measurements no evidence exists of a low flow vibration condition which could lead to shaft degradation.

As still a third proof of reliability, it should be noted that running of the vibration tests required running of the 1A and 1B decay heat pumps 35 and 30 minutes respectively in the minimum recirculation mode. This in addition to the run time of these pumps during the last three years of TMI-1 operation, which is estimated to be 140 minutes each, provides confidence in the ability of decay heat pump 1A and 1B to perform their functions as prescribed in the Safety Analysis Report.

Even though we have confidence in the pump's reliability we consider it prudent to revise the surveillance test procedures to eliminate operation under low recirculation flow conditions. These changes will be completed prior to the next normal planned operation of these pumps.

As still a further precaution, a metallurgical analysis will be performed of the Crystal River Unit 3 failed pump shaft to determine, as exactly as possible, the cause of failure. We expect this analysis to be completed within the next two months.

In summary we have, by this letter, conveyed the following key points:

1. We consider that the probable cause of failure of the Crystal River Unit 3 pumps was the presence of a preexisting manufacturing flaw in the shaft.

2. During a postulated LOCA event, a period of operation at low recirculation flow will take place. This operation is considered by the pump manufacturer to be well within the capability of the pumps.

3. Though we are confident in our DH pumps performance capability we will make changes to TMI surveillance procedures as outlined to eliminate unnecessary low (80 gpm) flow during ES testing. These changes will essentially eliminate normal operation of the pumps at low recirculation flow rates.

4. Further we have demonstrated the integrity of TMI-1 pumps to perform their function through both vibration and UT testing as well as extended operation of these pumps at minimum recirculation flow.

In view of the foregoing inspections tests and analyses Met-Ed believes that further disassembly and inspection of the pumps would not yield substantial additional information and is therefore unnecessary. Additionally, we have concluded that the previously described inspections tests and analysis have thoroughly demonstrated the ability of the TMI-1 decay heat pumps to perform their safety functions as described in the FSAR.

Based on the above conclusion, and subject to both NRC and B&W's concurrence, we do not plan to conduct the decay heat pump inspection commencing on September 9, 1977.

Sincerely,

J. G. Herbein

J. G. Herbein
Vice President

JGH:WEP:tas

1491 123