VERMONT YANKEE NUCLEAR POWER CORPORATION

SEVENTY SEVEN GROVE STREET

RUTLAND, VERMONT 05701

B.3.2.1.

WVY 80-91

REPLY TO:
ENGINEERING OFFICE
TURNPIKE ROAD
WESTBORO, MASSACHUSETTS 01581
TELEPHONE 617-366-9011

June 19, 1980

United States Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Office of Nuclear Reactor Regulation
Division of Operating Reactors
Thomas A. Ippolito, Chief
Operating Reactors Branch #2

Reference: (a) License No. DPR-28 (Docket No. 50-271)
(b) USNRC letter, T. A. Ippolito to R. L. Smith, dated May 16, 1980

Subject: Request for Information on Turbine Discs

Dear Sir:

In response to Reference (b) concerning turbine disc integrity and the potential generation of cracks in the keyway and bore sections of discs, the following is submitted for your information.

Site Specific General Questions

I. Provide the following information for each LP turbine:

A. Turbine Type:

Response: Steam Seal Turbine (MHC) Type M4

B. Number of hours of operation for each LP turbine at time of last turbine inspection or if not inspected, postulated to turbine inspection.

Response: Low Pressure Turbine A - No. of hours 24,742
Low Pressure Turbine B - No. of hours 13,134
Note: At time of last inspection

C. Number of turbine trips and overspeeds

Trips 90 Overspeeds 11
Note: Only one overspeed was the result of a load reject, all other over speeds were due to surveillance. Also, overspeed surveillance trips are included in the total trips shown above.

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D. For each turbine disc, please provide the following:

1) Type of material including material specifications
2) Tensile properties data
3) Toughness properties data including Fracture Appearance, Transition Temperature and Charpy upper steel energy and temperature
4) Keyway Temperatures
5) Critical crack size and basis for calculation
6) Calculated bore and keyway stress at operating design overspeed
7) Calculated K_{1c} data
8) Minimum yield strength specified for each disc

Response to question I - D:

Answers to these questions involves data which are proprietary to the General Electric Company. Information was provided directly to the NRC during a meeting between General Electric and NRC representatives on April 21, 1980. It is our understanding that this information is generic to all General Electric Turbines.

II. Provide details of the results of any completed inservice inspection of LP turbines rotors, including areas examined, since issuance of an operating license. For each indication detected, provide details of the location of the indication, its orientation, size, and postulated cause.

Response: No NDE testing has been performed on these rotors since issuance of the operating license. As a result of visual examinations, water cutting was observed on the hub of the 10th and 12th stage wheels TE and GE at 180° and at the base of the 9th and 11th stage wheels TE and GE at 0°.

III. Provide the nominal water chemistry conditions for each LP turbine and describe any condenser inleakages or other significant changes in water chemistry to this point in its operating life.

Response: PH 6.8 to 7.2
Conductivity approx. .2 micro mho's
Chlorides less than 20 PPB
Dissolved oxygen 200 PPB

No significant condenser leakages over the past 8 years

IV. If your plant has not been inspected, describe your proposed schedule and approach to ensure that turbine cracking does not exist in your turbine.

Response: Vermont Yankee plans to perform Ultrasonic Testing of the discs on one low pressure unit during the next scheduled refueling outage.

V. If your plant has been inspected and plans to return or has returned to power with cracks or other defects, provide your proposed schedule for the next turbine inspection and the basis for this inspection schedule, including postulated defect growth rate.

Response: Not applicable at this time.

VI. Indicate whether an analysis and evaluation regarding turbine missiles have been performed for your plant and provided to the staff. If such an analysis and evaluation has been performed and reported, please provide appropriate references to the available documentation. In the event that such studies have not been made, consideration should be given to scheduling such an action.

Response: See Vermont Yankee FSAR Appendix I, Amendment 16, Item 14.3 and its references which provide such an evaluation.

Generic Questions

I. Describe what quality control and inspection procedures are used for the disk bore and keyway areas.

Response:

After the rough machined wheel/disk forging has been tempered, material is removed from surface locations to measure mechanical properties. The forging is then subjected to a 100% volemetric ultrasonic inspection. If the test results meet stringent acceptance standards, the forging is released for final machining. During final machining, attention is continually paid to the finish, contour and dimensions of every surface. For instance, the keyway depth, width, location, radii, and surface finish for every wheel is checked for conformance to drawings. Quality control personnel assure that tolerances are maintained. Any deviation from accepted tolerances are reported to engineering for disposition.

Only coolants and lubricants approved by engineering are used in the manufacturing and assembly process. These coolants and lubricants have undergone extensive laboratory corrosion testing to ensure their acceptability prior to their approval for use in manufacturing. Periodic sampling is done on all such fluids to verify that their chemistry is within acceptable limits. If required, corrective actions are taken to maintain the chemistry within limits.

After finish machining, each wheel is thoroughly cleaned and given a magnetic particle inspection of all surfaces. If acceptable, the buckets are assembled and the wheel is static balanced. After assembly on the shaft, each wheel is inspected and measurements are made to assure its proper location. The assembled rotor is then spun to 20% overspeed following a high speed balance. Finally, after a magnetic particle

inspection of the buckets, the rotor is cleaned to prepare for shipment.

II. Provide details for the General Electric repair/replacement procedures for faulty disks.

Response:

Stress corrosion cracks have not been observed to date in nuclear wheels manufactured by General Electric, and we do not anticipate that removal or replacement of wheels will be required because of this phenomenon. The water erosion which has been observed in the keyways of wheels on several non-reheat machines is being studied intensively. We currently believe that the erosion process is self-limiting and should not require the replacement of any wheels.

III. What immediate and long term actions are being taken by General Electric to minimize future "water cutting" problems with turbine disks? What actions are being recommended to utilities to minimize future "water cutting" of disks?

Response:

No immediate actions are required to minimize water erosion because of the apparent self-limiting nature of the phenomenon. However, if future inspections show an unexpected progression of the water erosion, appropriate operating restrictions and/or modifications will be recommended.

IV. Describe fabrication and heat treatment sequence for disks, incuding thermal exposure during shrinking operations.

Response:

The wheel/disk forgings are heat treated in the rough machined condition. The heat treatment consists of soaking at a temperature above the upper critical temperature with the time and temperature sufficient to ensure complete austenitization throughout the forging, followed by a quench in cold, vigorously circulated water for a sufficient time to ensure complete transformation throughout the section. The forgings are heated uniformly to a tempering temperature below the lower critical temperature and held for a sufficient time to soften to the desired tensile range. After tempering, the forgings are still-air cooled to room temperature.

After final machining, the wheels (disks) are uniformly heated in an electric furnace to a temperature below the embrittling range, but sufficiently high to increase the wheel diameter enough to assemble on the shaft with the required shrink fit.

We trust the above supplied information is satisfactory; however, should you desire any additional information, please contact us.

Very truly yours,

VERMONT YANKEE NUCLEAR POWER CORPORATION

J. E. Tribble
Vice President

COMMONWEALTH OF MASSACHUSETTS)
)ss.
COUNTY OF WORCESTER)

Then personally appeared before me, J. E. Tribble, who, being duly sworn did state that he is a Vice President of Vermont Yankee Nuclear Power Corporation, that he is duly authorized to execute and file the foregoing request in the name and on the behalf of Vermont Yankee Nuclear Power Corporation and that the statements therein are true to the best of his knowledge and belief.

ROBERT H. GROCE
MASSACHUSETTS
NOTARY PUBLIC

Robert H. Groce Notary Public
My Commission Expires September 14, 1984