Telephone 617 366-9011
TWX
710-390-0739

YANKEE ATOMIC ELECTRIC COMPANY

WYR-80-104
B.3.2.1

20 Turnpike Road Westborough, Massachusetts 01581

September 5, 1980

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

Attention: Mr. Dennis M. Crutchfield, Chief
Operating Reactors Branch #5
Division of Licensing

Reference: (a) License No. DPR-3 (Docket No. 50-29)
(b) YAEC Letter to USNRC dated August 29, 1980 (WYR 80-99)
(c) Westinghouse Steam Turbine Division Letter dated March 4, 1980 from J. Schmerling, W to D. Eisenhut, NRC

Subject: Information Related to Turbine Discs

Dear Sir:

This letter submits information related to the Yankee Rowe turbine which had inadvertently not been included in our letter transmitting the turbine disc failure analysis [Reference (b)]. Much of this information has already been supplied in discussions with the staff in late January, 1980, and responds to site specific questions. Responses to generic questions have been prepared by the W Turbine Disc Integrity Task Force and were submitted to you by Westinghouse at the request of the Task Force. These responses are contained in Reference (c).

A complete UT inspection of the keyway and disc bore areas of the low pressure rotor has been performed. Discs No. 1 and 2 on both generator and governor ends have been removed. These two discs represented the most likely discs to show cracking due to the stress corrosion phenomenon. The inspection showed that no detectable cracking exists in the remaining discs. A determination has been made that the rotor is suitable for satisfactory operation until the next inspection period.

The information contained in Attachment A contains proprietary information of the Westinghouse Electric Corporation. We request that this information be withheld from public disclosure. Westinghouse is preparing the necessary application for withholding this information and an affidavit to set forth the basis on which the information may be withheld. These documents will be forwarded to you shortly.

Very truly yours,

YANKEE ATOMIC ELECTRIC COMPANY

J. A. Kay

J. A. Kay
Senior Engineer Licensing

JAK/kab

Enclosures

Information Related to Turbine Discs

Site Specific General Questions

I. Provide the following information for each LP turbine:

A. Turbine Type - tandem compound, double exhaust steam turbine with shrunk on disc construction and operating at 1800 rpm. The unit is designated by Westinghouse as a AT-4008 frame with last row blades having a nominal length of 40 inches. The design inlet condition is 450 PSI throttle pressure and 460°F throttle temperature. There are two moisture separators with no reheat capability.

B. Number of turbine operating hours - 134,468 hours

C. Number of turbine trips and overspeed -

turbine trips - 191		
overspeeds -	1	20% overspeed (factory test)
	20	11% overspeed

D.1. Type of material including material specifications - the disc material is a Ni Cr Mo V grade of steel manufactured in accordance with Westinghouse specifications 9322 and 5875. These specifications are similar to ASTM-294-79, Class C and ASTM-A471 (vintage circa 1959) materials.

D.2. Tensile properties data - this data is shown on Table 3.

D.3. Toughness properties - Toughness testing was not required during turbine disc fabrication. Consequently this data is unavailable; however, additional information is supplied for disc no. 1 regarding its toughness properties in Reference (b).

D.4. Keyway temperatures - this information is contained in Table 4. This is the calculated temperature two inches from the exhaust face of the disc at the bore during full power operation.

D.5. Calculated keyway crack size for turbine time specified in "B" above - not applicable since an inspection has been performed and no cracks exist.

D.6. Critical crack size - due to the unavailability of Charpy V-notch data, a range of K_{IC} values will be developed to determine the critical crack size for purposes of disc re-inspection. Some testing has been performed on the No. 1 generator end disc to determine its toughness properties. This information is contained in Reference (b).

D.7. Ratio of calculated crack to critical crack size - not applicable since an inspection has been performed and no cracks exist.

D.8. Crack growth rate - this information is contained in Table 4.

D.9. Calculated bore and keyway stress at operating and design overspeed - the bore tangential stress at 1800 rpm and design overspeed (20%) are presented in Table 4. The values presented include stresses due to the shrink fit and centrifugal force loads only.

D.10. Calculated K_{IC} data - See Items D.3 and D.6 above.

D.11. Minimum yield strength specified for each disc - this information is contained in Table 3.

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

The HP and LP rotors were both ultrasonically inspected for cracking in the keyway and disc bore areas. The inspection encompassed all keyways on discs 3 thru 5 on the LP rotor and discs 1 thru 3 on the HP rotor. Also, an ultrasonic 360° scan was made on the inlet and outlet side of each disc.

The inspection results are as follows:

LP - The discs on this rotor were free of indications. The No. 1 and No. 2 discs, both generator and governor end, were removed prior to inspection, and did not require nor receive inspection. These discs have been temporarily replaced by baffling.

HP - The discs on this rotor were free of indications with the following exceptions:

The No. 1 disc, governor end, displayed a tangential aim indication on the inlet side. The No. 2 disc, governor end, displayed a tangential aim indication at the keyway of balance hole No. 17. In both cases, further inspection revealed each indication ha no depth.

III. Provide the nominal water chemistry conditions for each LP turbine and describe any condenser inleakages or other significant changes in secondary water chemistry to this point in its operating life. Discuss the occurrence of cracks in any given turbine as related to history of secondary water chemistry in the unit.

The nominal water chemistry conditions are shown in Table 1. The history of water chemistry at Rowe has demonstrated the capability to operated essentially free of contaminants. Early operation of the plant emphasized tight controls on phosphate addition (approximately 4-5 ppm) with a subsequent switchover to all violatile chemistry. Presently, the plant operates with a continuous feed of hydrazine (approximately 2-10 ppb) and continuous blowdown. The chemistry of the steam generator water, steam, and feedwater is essentially the chemistry of pure water containing a trace of ammonia.

Condenser inleakage from Sherman pond is essentially pure water. A typical chemical analysis is given in Table 2. The water is low in contaminants and is neither acid forming nor alkali forming at steam generator water temperatures.

The integrity of the Rowe condenser has been excellent. During the 19 years of operation, only 210 tubes of the 12,495 tubes have been plugged, half of these being plugged as a precautionary measure; during the entire operating period, no evidence of denting has been observed. Condenser leaks are generally detected and corrected at 500 gpd or less and a steam generator chloride concentration of less than 1 ppm.

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

Not applicable since Yankee Rowe has been inspected and no cracks were found.

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

A re-inspection schedule has not been established. Westinghouse will not have a recommended time interval available until the current series of all low pressure disc inspections is completed and reviewed. This is not expected for several months. We will notify you at that 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.

Westinghouse is presently calculating missile probabilities and energies specifically for the Yankee Rowe machine. Results are expected later this year. This information will be factored into the SEP Topic III-4.B review scheduled for mid-1981.

TABLE 1

TYPICAL STEAM GENERATOR BLOWDOWN CHEMISTRY AT FULL POWER
(Approximately .1% Steam Flow)

I. 1969 - PRESENT (All Volatile Chemistry)

pH	8.0 - 8.5
Cation Conductivity	0.8 - 1.8 µmho/cm
Ammonia	0.1 - 0.2 ppm
Sodium	20 ppb
Chloride	30 ppb
Silica	50 ppb
Free Hydroxide	None

II. 1960 - 1968 (Phosphate Chemistry)

pH	9.9
Conductivity	50 µmho/cm
Phosphate	4 ppm
Ammonia	0.3 ppm
Sodium	3 ppm
Chloride	0.15 ppm
Silica	1 - 2 ppm
Free Hydroxide	Negative
Disolved Oxygen	5 ppb
Hydrazine	0 - 20 ppb

TABLE 2

TYPICAL CHEMICAL ANALYSIS OF SHERMAN POND WATER

pH		5.9 - 7.1
P	Alkalinity (Free)	0 ppm
M	Alkalinity (Bicarbonate)	9 ppm
Hardness		10 ppm
Total Dissolved Solids		25 ppm
Organic Macromolecules (Fulvic and Humic Acids)		5 - 10 ppm
Sodium		3 ppm
Calcium		7 ppm
Magnesium		3 ppm
Chloride		2 ppm
Sulfate		2 ppm
Silica		4 ppm
Bicarbonate		9 ppm