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Nebraska Public Power District

May 6, 1980

Director, Nuclear Reactor Regulation
Attn: Darrell G. Eisenhut, Acting Director
Division of Operating Reactors
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Westinghouse Turbine Disc Cracking
Cooper Nuclear Station
NRC Docket No. 50-298, DPR-46

Reference: A) Letter from D. G. Eisenhut to J. M. Pilant
Dated February 25, 1980, Same Subject

B) Letter from J. M. Schmerling to D. G. Eisenhut
Dated March 14, 1980

Dear Mr. Eisenhut:

Reference A requested a response to various site specific general questions related to turbine discs prior to restart of Cooper Nuclear Station. This information is contained in Enclosure 1. Reference A also requested a response to various generic questions. Nebraska Public Power District agrees in the consensus responses to these generic questions which were prepared by the Turbine Disc Integrity Task Force and submitted to the NRC by Reference B.

Following the turbine disc repair discussed in Enclosure 1, it is anticipated that CNS will start up from the present refueling outage approximately May 21, 1980.

If you have any questions relating to the enclosed information, please contact me.

Sincerely,

Jay M. Pilant

Jay M. Pilant
Director of Licensing
and Quality Assurance

JDW/cmk
Enclosure

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STATE OF NEBRASKA)
) ss
PLATTE COUNTY   )

Jay M. Pilant, being first duly sworn, deposes and says that he is an authorized representative of the Nebraska Public Power District, a public corporation and political subdivision of the State of Nebraska; that he is duly authorized to submit this information on behalf of Nebraska Public Power District; and that the statements in said application are true to the best of his knowledge and belief.

Jay M. Pilant

Jay M. Pilant

Subscribed in my presence and sworn to before me this 6th day of May, 1980.

Marilyn R. Hohndorf

NOTARY PUBLIC

My Commission expires Oct. 14, 1980.

GENERAL NOTARY - State of Nebraska
MARILYN R. HOHNDORF
My Comm. Exp. Oct. 14, 1980

REQUEST FOR INFORMATION RELATED TO TURBINE DISCS
SITE SPECIFIC GENERAL QUESTIONS
COOPER NUCLEAR STATION

Reference: 1) Letter from J. M. Pilant to T. A. Ippolito Dated February 22, 1980, "L.P. Turbine Disc Cracking Potential"

I. Provide the following information for each L.P. turbine:

A. Turbine type
B. Number of hours of operation for each L.P. turbine at time of last turbine inspection or if not inspected, postulated to turbine inspection
C. Number of turbine trips and overspeeds
D. For each disc:
   1. type of material including material specifications
   2. tensile properties data
   3. toughness properties data including Fracture Appearance Transition Temperature and upper energy and temperature
   4. keyway temperatures
   5. calculated keyway crack size for turbine time specified in "B" above
   6. critical crack size
   7. ratio of calculated crack to critical crack size
   8. crack growth rate
   9. calculated bore and keyway stress at operating design overspeed
   10. calculated K_{1c} data
   11. minimum yield strength specified for each disc

Response

This information was provided in Reference 1. The number of hours of operation for each L.P. turbine prior to the present shutdown when cracks were discovered is 41,913 hours (Gray Book hours commercial).

II. Provide details of the results of any completed inservice inspection of L.P. 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.

Response

As the District committed in Reference 1, Cooper Nuclear Station was shut down March 1, 1980 and a full UT inspection of all L.P. rotor disc keyways and bore areas was performed, with the exception of the areas on the downstream side of discs #6. As the NRC was informed, this area is not inspectable due to the location of the balance ring. Cracks were discovered in locations as shown in the following TABLE I.

TABLE I
COOPER NUCLEAR STATION
DISC INSPECTION RESULTS

INDICATION DEPTH							
		GOV. END			GEN. END		
		DISC #			DISC #		
LP #	Key-way	3	2	1	1	2	3
1	1		.41		2.4		
	2				2.9	.75	
	3		.10				.32
2	1			2.95			
	2			2.4			
	3						
	Inlet Side Bore Cracks			2.4			
				1.7			

The L.P. 1 disc 1 was removed from the generator end. This eliminates concern about cracks in this disc.

The L.P. 2 disc 1 was removed from the governor end. This eliminates concern about cracks in this disc.

The L.P. 1 disc 3 was removed from the generator end for steeple cracking concerns. This eliminates the concern about the keyway crack in that disc. The 0.75 inch crack in #2 keyway of #2 disc on the generator end of L.P. 1 was removed by enlarging the keyway to 1-5/8". This eliminates the concern about the crack in this keyway.

The L.P. 1 disc 3 was removed from the governor end for steeple cracking concerns. The 0.41 inch crack in #1 keyway of #2 disc on the governor end of L.P. 1 was removed by enlarging the keyway to 1-1/4". This eliminates the concern about the crack in this keyway. The 0.10 inch crack in #3 keyway of #2 disc on the governor end of L.P. 1 was also removed by enlarging the keyway to 7/8". This eliminates the concern about the crack in this keyway.

III. Provide the nominal water chemistry conditions for each L.P. turbine and describe any condenser inleakage 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.

Response

Steam is supplied to the turbine from a Boiling Water Reactor (BWR). The steam comes directly from the reactor vessel to the high pressure turbine, through moisture separators, and then in a parallel path to each L.P. turbine. Thus, each L.P. turbine receives steam with the same water chemistry. Normal water chemistry is:

pH - 6.7
Conductivity - 0.1 μmho/cm at 25°C
Chloride - $\leq$ 30 ppb
Silica - 50 ppb

Due to the radiolytic decomposition of water in the reactor vessel, approximately 20 ppm oxygen and 3ppm hydrogen is carried over with the main steam to the turbine.

BWR reactor water chemistry control is based on keeping the reactor water and feedwater impurities as low as practical. This is accomplished by full flow condensate filter demineralizers and reactor water cleanup filter demineralizers. Continuous conductivity monitors are provided on each of these systems. Reactor water purity has a limiting condition for operation in CNS Technical Specifications. This limiting condition allows operation above 1 μmho/cm at 25°C for two weeks/year with a maximum limit of 10 μmho/cm at 25°C.

Brief history of reactor water chemistry.

A maximum of 174.2 cumulative hours/year of operation with reactor water conductivity above 1 μmho/cm was recorded in the year ending March 28, 1975. These normally short increases were primarily due to condenser inleakage of Missouri River water and filter demineralizer resin leakage when these systems were in their early stages of operation. On three occasions prior to August 1975, the upper conductivity operational limit of 10 μmho/cm was exceeded for a short period of time. The first of these occasions was due to condenser leakage which caused the reactor water conductivity to increase above 1 μmho/cm for 30 hours until it reached the upper limit of 10 μmho/cm at which time the reactor was shutdown and repairs on the condenser initiated. On another occasion, resins from one of the reactor water cleanup filter demineralizers entered the reactor vessel causing reactor water conductivity to increase to 11.5 μmho/cm, exceeding the 10 μmho/cm limitation for two hours and be above the 1 μmho/cm limitation for a total of 17 hours. The third occasion was the result of preoperational testing of the radwaste liquid concentrator. A solution of trisodium phosphate was being used in this testing and a small amount inadvertently reached the reactor vessel, causing the reactor water conductivity to rise to 12.3 μmho/cm. The upper 10 μmho/cm limit was exceeded for 3 hours and the 1 μmho/cm limitation was exceeded for a total of 30 hours.

From August 1975 to October 1977, a total of 94.6 hours of operation above 1 μmho/cm was recorded.

From October 1977 to date, CNS has had 0 hours of operation above the 1 μmho/cm limitation.

Chloride concentration in the reactor water has never exceeded the Technical Specification limits of 0.5 ppm when the reactor is not pressurized; 0.1 ppm prior to startup, during hot standby, and up to 10% rated power; or 0.2 ppm in excess of 10% rated power.

Although CNS has experienced cracks in discs in the low pressure turbine, reactor water chemistry and steam purity has been excellent.

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

Not applicable.

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.

Response

All crack indications have been removed by either removing the discs or enlarging the keyways. (See details following TABLE I.) We do not plan a disc inspection for at least two years.

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

Reference 1 contained a complete discussion of the analyses performed regarding Turbine Disc Containment and Turbine Missiles.