TOLEDO EDISON

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License No. NPF-3

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Mr. Robert W. Reid, Chief
Operating Reactors Branch #4
Division of Licensing
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Reid:

This letter is in response to the NRC letter dated May 13, 1980, on Low Pressure Turbine wheel cracks as applicable to Davis-Besse Nuclear Power Station Unit No. 1. Attached is Toledo Edison's required 30 day response to Enclosure 3.

Yours very truly,

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Attachment

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SITE SPECIFIC GENERAL QUESTIONS

Item I: Provide the following information for each LP Turbine:

A. Turbine type

Response: The Davis-Besse Unit I Turbine is a General Electric M-7 design tandem-compound. The Turbine consists of three sections: a double flow high-pressure section. and two double flow low-pressure sections.

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

Response: A magnetic particle inspection has just been completed on the "B" Low Pressure Turbine. The "A" Low Pressure Turbine was not inspected and has been in-service for 11,882.4 hours since initial startup. The "A" Low Pressure Turbine will receive a Magnetic Particle inspection in late 1981.

C. Number of turbine trips and overspeeds.

Response: The Turbine has had 34 trips from Power and has had 32 Overspeed Trip tests.

D. For each turbine disk, 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_{IC} data
8) Minimum yield strength specified for each disk

Response: General Electric was requested to provide the answer to question I-D. They have stated that these answers are proprietary to General Electric Company, and they have also stated that this information has already been provided to the NRC during a meeting on April 21, 1980.

Item 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 indication, its orientation, size and postulated cause.

Response: The Magnetic Particle inspection of the "B" Low Pressure Turbine was performed on the buckets only. The wheels were inaccessible using the Magnetic Particle technique. This inspection found no indications of any cracks or flaws.

Item 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: With about 50% of the Moisture Separator Drain flow being returned to the condenser most of the time, the feedwater quality has been excellent. Chemistry of the feedwater is reflected in the following table:

Cation Conductivity	0.2 umho/cm
pH	9.5
Sodium	< 3 ppb
Silica	3 ppb
Suspended Iron	<10 ppb
Dissolved Oxygen	7 ppb
Hydrazine	40 ppb

There have been about eight condenser leaks since initial plant startup. They have ranged in magnitude from about one or two gpm to about ten gpm. The effects on feedwater and steam contamination have been minimized by efficient use of the condensate polishing demineralizers. When Feedwater quality was out of spec for more than a few hours, a plant shutdown was initiated.

Item 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: The Low Pressure Turbines will receive an ultrasonic inspection after about six years, and the High Pressure Turbine will receive an ultrasonic inspection after about ten years of service as recommended in General Electric's TIL 857.

Item 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: Inspections have found no cracks or defects in the Low Pressure Turbine.

Item 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: The following answer was provided by Bechtel:

Davis-Besse was licensed on the basis of a turbine missile penetration analysis which is documented in the Davis-Besse Final Safety Analysis Report, Section 3.5 and Questions 3.5.1 and 3.5.2. The penetration analysis was done using modified Petry formulas which are documented in FSAR Section 3.5.8.

The NRC staff evaluated the probability of ejecting a massive high velocity turbine missile that could impact and penetrate the containment, and cause a failure of safety related equipment and result in a subsequent release of radioactivity sufficient to exceed 10 CFR Part 100 limits. The staff estimate of the probability of this event is 1.4×10^{-6} per turbine year. This value was derived assuming the probability of a destructive overspeed to be 4×10^{-5} per year; the probability of a massive, high energy missile striking the containment to be 1.7×10^{-1}; the probability of that missile penetrating the containment to be 1.0; and the probability of impacting safety related equipment to be 2×10^{-1} (Ref. 1).

As explained in Reference 2, the staff analysis of the auxiliary building was qualitative. Safety related systems in the auxiliary building were noted to be below the turbine operating deck elevation (Elevation 623'). In order to penetrate into the lower areas of the auxiliary building, turbine missiles would have to impact the turbine operating deck at an extremely shallow angle of incidence. This was described as a ricochet shot at the auxiliary building. Penetration of the auxiliary building by a ricocheting turbine missile was not postulated to occur.

The control room is outside the postulated low trajectory missile strike zones (Ref. 2, page 114).

Turbine missiles may also be produced at high trajectories; however, the probability of impacting a safety related structure is substantially less from a high trajectory missile. Therefore, risks of radiological releases from a destructive overspeed are dominated by low trajectory missiles (Ref. 1).

Item VI: (Continued)

References:

1) Safety Evaluation Report by the Office of Nuclear Reactor Regulation, United States Nuclear Regulatory Commission in the matter of Toledo Edison Company, Cleveland Electric Illuminating Company, Davis-Besse Nuclear Power Station, Unit 1, Docket No. 50-346; December, 1976; NUREG-0136; pp. 3-5 and 3-6.

2) Stenographic transcript of the proceedings of the United States Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards 201st General Meeting; January 6, 1977; pp. 104-117.

GENERIC QUESTIONS

The following answers were provided to Toledo Edison by the General Electric Company:

Item 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% volumetric 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.

Item II: Provide details of 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.

Item 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 "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.

Item IV: Describe fabrication and heat treatment sequence for disks, including 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.