June 20, 1980

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Office of Nuclear Reactor Regulation
ATTENTION: Mr. T. A. Ippolito, Chief
Operating Reactors Branch No. 3
United States Nuclear Regulatory Commission
Washington, D. C. 20555

BRUNSWICK STEAM ELECTRIC PLANT UNIT NOS. 1 AND 2
DOCKET NOS. 50-324 AND 50-325
LICENSE NOS. DPR-71 AND DPR-62
RESPONSE TO REQUEST FOR INFORMATION
GE TURBINE DISKS

Dear Mr. Ippolito:

This is in response to your May 16, 1980 letter which requested information related to turbine disks. Carolina Power & Light Company's response to your generic and site-specific questions for the Brunswick Steam Electric Plant, Unit Nos. 1 and 2 is attached.

We trust that this information is satisfactory for your use.

Yours very truly,

E. E. Utley
Executive Vice President
Power Supply and
Engineering & Construction

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ADD:	Ltr	Enc
W. Ross	1	1
W. Hazelton	1	1
H. Walker	1	1

JAM/jc (882-311)
Attachments

Sworn to and subscribed before me this 20th day of June 1980

Franklin Murray
Notary Public

My commission expires: October 4, 1981

FRANKLIN MURRAY
NOTARY PUBLIC
WAKE COUNTY, N.C.

8006240475

BRUNSWICK UNITS 1 & 2

SITE SPECIFIC GENERAL QUESTIONS

QUESTION 1A

TURBINE TYPE

RESPONSE

Brunswick Units 1 and 2 utilize an 849MW, GE manufactured, type M7 reheat 1800 RPM tandem compound turbine consisting of a double flow HP turbine and two double flow LP turbines having 43 inch last stage buckets. Steam inlet conditions to the HP are 950 psig, 540°F with HP exhaust steam passing through MSR's and reheated to 515°F at the LP turbine inlet.

BRUNSWICK UNITS 1 & 2

QUESTION 1B

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

RESPONSE

The number of operating hours for Brunswick Units 1 and 2 up to 6/80 is as enumerated below:

UNIT	OPERATING HOURS
BSEP # 1	19,480
BSEP # 2	25,102

The number of operating hours postulated at the time LP turbine wheels are planned to be ultrasonic inspected is noted below:

UNIT	OPERATING HOURS	INSPECTION DATE
BSEP # 1	29,000	Spring, 1982
BSEP # 2	32,600	Fall, 1981

QUESTION 1C

Number of turbine trips and overspeeds.

RESPONSE

The number of trips and overspeeds as of 6/80 is noted below:

UNIT	TRIPS	OVERSPEEDS
BSEP # 1	75	5
BSEP # 2	98	1

QUESTION 1D

For each turbine disk, please provide the following:

a) Type of material including material specifications
b) Tensile properties data
c) Toughness properties data including fracture appearance, transition temperature, and charpy upper steel energy and temperature.
d) Keyway temperatures
e) Critical crack size and basis for the calculation
f) Calculated bore and keyway stress at operating design overspeed
g) Calculated KIC data
h) Minimum yield strength specified for each disk

RESPONSE

It is our understanding that answers to the above questions were provided to the NRC during a meeting between GE and NRC representatives on April 21, 1980, and that the NRC found this an acceptable reply to this question.

QUESTION 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 LP turbines for Brunswick Units 1 and 2 have been inspected as follows:

UNIT	LP-A	LP-B
BSEP # 1	1/79	No later than 3/82
BSEP # 2	3/79	9/77

Inspection to the above LP turbines consisted of peripheral magnetic particle inspection of rotor surfaces, dye penetrant inspection of bucket erosion shields, and UT inspection of bucket dovetail pins; no indications have been revealed by these inspections.

No wheel UT inspections have been performed at this time.

BRUNSWICK UNITS 1 & 2

QUESTION 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

Reactor Water Chemistry

1. Oxygen - 200 ppb (Typical Operating Value)

2. Conductivity (Technical Specification Limits)

   During Power Operation & Startup: <2.0 μΩ/cm @ 25°C; if conductivity is >2.0 μΩ/cm @ 25°C and <10 μΩ/cm @ 25°C, operation may continue for up to 24 hours before shutting down; if conductivity is >10 μΩ/cm @ 25°C, shutdown is required.

   During Hot Shutdown: <10 μΩ/cm @ 25°C; if conductivity is >10 μΩ/cm @ 25°C, shutdown is required.

   During Cold Shutdown and Refueling: <10 μΩ/cm @ 25°C.

3. Chlorides (Technical Specification Limits)

   During Power Operation: <500 ppb; if chloride concentration is >500 ppb, unit must be in Hot Shutdown within 12 hours.

   During Startup and Hot Shutdown: <200 ppb; if chloride concentration is >200 ppb and <500 ppb, operation may continue for up to 24 hours before shutting down; if chloride concentration is >500 ppb, shutdown is required.

   During Cold Shutdown and Refueling: <200 ppb

Condenser inleakages have not been considered to be a problem at this point in operating time for these units.

QUESTION 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

Our plans are to inspect LP turbine wheels on the Brunswick units in accordance with recommendations outlined in GE TIL 857-3. Our current plans are to inspect as noted below:

UNIT	INSPECTION DATE
BSEP # 1	1982
BSEP # 2	1981

QUESTION 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

This question is not applicable to the Brunswick units.

QUESTION 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

A turbine missile analysis was performed for the Brunswick Steam Electric Plant, Unit Nos. 1 and 2, when the plant was licensed. This analysis is summarized in the Brunswick Final Safety Analysis Report, Volume 6, Section 14.7. It concludes that the probabilities of a "worst" case turbine missile being generated and subsequently impacting on a critical area are sufficiently small to be considered non-events.

GENERIC QUESTIONS

QUESTION 1

Describe what quality control and inspection procedures are used for the disc 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.

QUESTION 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.

QUESTION III

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

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.

QUESTION 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.