



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE INSPECTION OF LOW PRESSURE TURBINE ROTORS

SOUTHERN CALIFORNIA EDISON COMPANY

SAN ONOFRE UNIT 2 (SONGS 2)

DOCKET NO. 50-361

1.0 INTRODUCTION

Section 10.2.2 "Turbine Disc Integrity" of the SER (NUREG-0712) describes a problem of stress corrosion cracking in some low pressure turbine discs. The staff had meetings and reviewed topical reports submitted by two vendor suppliers (the Westinghouse and General Electric Company) to ascertain the probable extent and severity of the problem. Early inspections were performed on turbines that had long operating times, particularly turbines with discs of marginal material properties or history of secondary water or steam chemistry problems. The inspections on numerous low pressure turbine units of both vendors detected indications of cracking, some of which was severe. The method used by the two suppliers of low pressure turbines and by the NRC staff to predict crack growth rates is based on evaluating all cracks found to date in low pressure turbines in this country, past history of similar turbine disc cracking, and results of laboratory tests. This prediction method takes into account two main parameters: the yield strength of the disc, and the temperature of the disc at the bore area where the cracks of concern are occurring. The higher the yield strength of the material and the higher the temperature, the faster the crack growth rate will be.

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The turbine units for San Onofre 2 and 3 were fabricated by General Electric Company of England (not associated with General Electric of the United States) to their own specifications and design. During the OL review of San Onofre 2 and 3, the staff evaluated the minimum material properties of the low pressure turbine discs, as well as the calculation of the minimum critical crack size provided by the licensee. Since the staff had no service experience with the design or with the turbine vendor, the staff utilized the most conservative approach in evaluating the submitted data. Using these conservative criteria the staff calculated that the low pressure turbines could operate in excess of ten years before inspection. However, a condition was included in the operating license for each unit, which states:

"Turbine Disc Inspection (Section 10.2.2, SER)

Prior to startup following the second refueling outage, the bores of the low pressure turbine disc shall be inspected for ultrasonic indications."

In a letter dated June 20, 1986, the licensee transmitted the inspection reports related to all three low pressure turbine rotors at SONGS 2. The objective of this safety evaluation is to describe the staff's review of the letter related to License Condition 2.C.(15).

2.0 SUMMARY OF LICENSEE'S SUBMITTAL

The licensee submitted two reports prepared by General Electric Company of England. The inspection of two of the rotors was performed during the first refueling outage. The inspection of the remaining rotor was performed during the second refueling outage. The results of the ultrasonic inspections show no evidence of stress corrosion cracking in the disc bore region and dowel holes. A number of small isolated indications were recorded in the hub and bore region of several discs but these were attributed to original non-metallic inclusions in the disc forgings or, where located on the bore, to surface irregularities which occurred during fitting of the discs to the shaft.

The licensee's reports describe the examination procedure, ultrasonic testing equipment, transducers, calibration standard, and acceptance criteria. The general examination procedure has been used on other turbine rotors. Transducers were selected to examine accessible contours on the turbine discs and hub. The reports contain figures for each disc describing the scanning area and the corresponding angle, type, and frequency of transducer that was used. Drawings were provided of the basic calibration blocks. A universal calibration block was designed for the disc bore examination to accommodate each of the probe angles because of the impracticality of providing an individual calibration block for each configuration of disc. The block contains machined reflectors and

was made of similar material to that of the disc and machined to a similar surface finish.

Tables were included in the reports that summarized the results of the inspections. The location of each indication, transducer identification and signal amplitude were defined. The licensee's conclusions are as follows:

1. No evidence of stress corrosion cracking was found on any of the dowel holes or the disc bore regions on any rotor.
2. For the LP2 and LP3 rotors, the indications recorded in the hub of various discs were generally point-type, isolated in position and are considered to arise from non-metallic inclusions or, where present on the bore, surface irregularities which occurred during the fitting of the disc to the shaft.
3. For the LP1 rotor, the minor indications in the hub region of discs 4 Front and 5 Rear were generally point-type and attributed to the presence of isolated non-metallic inclusions. Indications on the bore were attributed to surface irregularities arising during the fitting of the discs to the shaft.

3.0 STAFF EVALUATION AND CONCLUSION

The staff has completed the review of the licensee's letter dated June 20, 1987 related to the inspection of all three low pressure turbine rotors at SONGS 2. The licensee performed an ultrasonic inspection of the bores of the low pressure turbine discs prior to the startup following the second refueling outage. The results of the examinations show no evidence of stress corrosion cracking in the disc bore region and the dowel holes. The licensee characterized the indications that were detected as isolated spot anomalies associated with the original fabrication and fit up of the discs to the shaft. Based on the information in the licensee's letter, the staff concludes that License Condition 2.C(15) for SONGS 2 has been completed.

As discussed in Section 10.2.2 of NUREG-0712, the staff does not have long-term service experience with turbine units fabricated by General Electric Company of England. Although License Condition 2.C(15) has been fulfilled and the Section 10.2.2 of NUREG-0712 indicates that the low pressure turbines could operate in excess of ten years without inspection based on the information available at the time of publication of the SER (February 1981), the staff believes that it is prudent for the licensee to perform future inservice inspections to confirm the SER's conclusions because of the lack of operating experience for these types of turbines.