Southern California Edison Company

P. O. BOX 800
2244 WALNUT GROVE AVENUE
ROSEMEAD, CALIFORNIA 91770

M. O. MEDFORD
MANAGER, NUCLEAR LICENSING

TELEPHONE
(818) 302-1749

September 19, 1985

Director, Office of Nuclear Reactor Regulation
Attention: J. A. Zwolinski, Chief
Operating Reactors Branch No. 5
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

Subject: Docket No. 50-206 Transamerica Delaval Inc. (TDI) Diesel Generators
San Onofre Nuclear Generating Station
Unit 1

References:
1. FaAA-84-12-14, Evaluation of Transient Conditions on Emergency Diesel Generator Crankshafts at San Onofre Nuclear Generating Station, Unit 1, Revision 1.0, dated April 1985
2. FaAA-84-6-54, Evaluation of Emergency Diesel Generator Crankshafts at Midland and San Onofre Nuclear Generating Stations, dated June 1984

On September 13, 1985, representatives of Southern California Edison Company (SCE) met with you and members of your staff to discuss the NRC staff concerns regarding the crankshaft of diesel generator no. 1 which is in standby emergency service at the San Onofre Nuclear Generating Station, Unit 1. SCE presented information contained in a handout at the meeting. In accordance with your request at the meeting, this letter summarizes additional information discussed at the meeting but not included in the handout.

The purpose of the transient evaluations in Reference (1) was to define a conservative basis for establishing the nature of inspections necessary to qualify the San Onofre Unit 1 diesels for continued operation. That analysis made use of calculations performed at 6,000 KW engine load for the most vulnerable portion of the crankshaft (main journal number 9) and generalized the results as being applicable to other locations. However, Table 7.4 of Reference (2) shows that crankshaft journal numbers 11 and 12 are subject to significantly lower steady state operating stresses than those associated with journal number 9, which served as the basis for the inspection interval recommendations. Therefore, a much larger crack than was assumed by the Reference (1) calculations must develop in journal number 12 before the crack can grow during power operations.

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Since the maximum engine load is now limited, FaAA has performed new calculations to predict the effect of a preexisting crack on the crack growth rate in journal numbers 11 and 12 at a reduced load of 4,500 KW. The results of these new calculations are summarized as follows:

1) Using the same conservative one-degree-of-freedom crack model used in Reference (1), a preexisting crack depth of .057 inch or larger is necessary for the crack to grow under steady state operating conditions at 4,500 KW load.

2) An elapsed running time of at least 224 hours at 4,500 KW load would be required for a .057 inch deep crack to propagate to failure.

While Reference (1) assumed the existence of cracks, it did not attempt to define a hierarchy for crack initiation sites. Data from the oil hole inspections indicate that the primary crack initiation sites are located on journal number 9, with decreasing severity indicated for journal numbers 10, 8 and 11, in that order. The quality of finish in the oil holes inspected was good. Therefore, we conclude that crack initiation in the dowel hole of journal number 12 is unlikely or, at worst, would be confined to the minimal crack indication revealed in the inspection of journal no. 11.

Accordingly, we have concluded that there is no reasonable basis for assuming that a crack exists in the dowel hole of journal number 12 which is large enough to propagate under the 4,500 KW operating conditions. Furthermore, the operating demands placed upon the emergency diesel generators under worst case accident conditions are not sufficient to propagate a preexisting crack to failure.

Based on the above, we believe that an early inspection of the dowel hole of journal number 12 is not justified and that the planned inspection schedule does not jeopardize plant safety.

If you have any questions, please contact me.

Very truly yours,

M. O. Medford

cc: R. Dudley, NRC/NRR San Onofre Unit 1 Project Manager
F. R. Huey, NRC Senior Resident Inspector, Units 1, 2 and 3
C. L. Ray, Jr., Duke Power/TDI D. G. Owner's Group
P. R. Johnston, Failure Analysis Associates

Failure
Analysis
Associates

ENGINEERING AND METALLURGICAL CONSULTANTS
2225 EAST BAYSHORE ROAD, P.O. BOX 51470,
PALO ALTO, CALIFORNIA 94303 (415) 856-9400 TELEX 704216

September 18, 1985

Mr. David F. Pilmer
Manager, Nuclear Engineering
Southern California Edison Company
P. O. Box 800
2244 Walnut Grove Avenue
Rosemead, CA 91770

Re: Inspection recommendation for the dowel hole on main journal number 12 of the TDI DSRV-20-4 crankshaft in DG1 at San Onofre Unit 1.

Dear Mr. Pilmer:

This letter provides the basis for Failure Analysis Associates' (FaAA) recommendation that the inspection of the dowel hole on main journal number 12 of DG1 may be delayed until the next refueling outage scheduled to begin on November 30, 1985. The content of this letter was discussed at a meeting with NRC staff on September 13, 1985.

In FaAA's April 1985 report [1], an initial inspection was recommended for the holes in main journals number 4 through 12 with subsequent inspections occurring at outages so that the inspection interval is approximately 50 start-stops. This interval was established by determining the number of start-stops required to propagate a crack that can be detected with confidence to a depth which will propagate under steady-state operating stresses, and then dividing this number by a safety factor of approximately 3. It is important to note that the transient start-stop stresses on this crankshaft are much higher than the steady-state operating stresses.

With appropriate inspection procedures, a 10 mil deep crack may be detected with confidence. The largest range of steady-state stresses occurs on main journal number 9 as shown in Table 7.4 [2]. Using the one-degree-of-freedom crack model [1], an 18 mil deep crack will propagate under steady-state operating stresses on main journal number 9 at an engine load of 6000 kW. Once a crack starts to propagate under these stresses it will grow rapidly since engine operation at 450 rpm produces approximately 13500 stress cycles/hour compared with less than 100 per start-stop. Thus, the effective life of the crankshaft is the number of start-stops required to grow a crack from a depth of 10 mils to a depth of 18 mils. The calculations in the April 1985 report [1], including Figure 5-9, assumed initiation had already taken place, and further assumed the worst case steady-state operating stresses at 6000 kW, which actually occur only in main journal number 9, occurred in all journals. This approach was taken to determine one inspection interval for all journals.

Since the maximum engine load has now been limited to 4500 kW, rather than 6000 kW, an analysis was performed to determine the crack depth which will propagate under steady-state operating stresses at the reduced load in main journal number 12. Using the same conservative one-degree-of-freedom crack model used in the April 1985 report [1], this crack was found to have a depth of 57 mils.

A further calculation was performed to determine the number of hours of operation at 4500 kW that are required to propagate a postulated 57 mil deep crack to failure in main journal number 12. This number was found to be 224 hours. It is seen that because the steady-state operating stresses are much lower in main journal number 12 than in main journal number 9, the growth of a crack in number 12 is quite slow.

The analytical model used to predict transient start-stop stresses in the April 1985 report [1] shows that maximum torsional stresses are approximately equal in main journals 9, 10, 11 and 12. Initiation life predictions for these journals do not demonstrate that number 9 should initiate prior to 11 and 12. However, the torsional model is not accurate enough to make this distinction since a 5% change in peak stress is enough to change the prediction as to which journal will initiate first.

However, the evidence from inspections is that the number 9 journal has the deepest cracks in DG1 and the only cracks in DG2. The crack depth then decays on either side so that on DG1 shallower cracks were found on main journal number 10 and still shallower on main journals 8 and 11. The stresses in main journal number 12 are identical to those in main journal 11 so that similar cracking would be expected in both journals.

While it is not possible without inspection to determine the surface condition in the hole of main journal 12, it is worth noting that the oil hole finish on other journals which were inspected was good. FaAA did not make a recommendation to polish machine marks in any oil hole on crankshafts in DG1 or DG2, unlike many other crankshafts.

In summary, the steady-state operating stresses on main journal number 12 at 4500 kW are considerably lower than those at main journal number 9 at 6000 kW, which were used to determine the inspection interval in the April 1985 report [1]. A crack in main journal number 12 will not propagate under steady-state stresses at 4500 kW until it is 57 mils deep. At that point, it will have a remaining life of 224 hours.

If you have any questions, please do not hesitate to call me at (415) 856-9400.

Sincerely,

Paul R. Johnston, Ph.D.
Manager, Structural Analysis

PRJ/gg
cc: Clarence Ray, Duke Power, TDI Owners' Group

References:

1. "Evaluation of Transient Conditions on Emergency Diesel Generator Crankshafts at San Onofre Nuclear Generating Station Unit 1," Failure Analysis Associates, Report FaAA-84-12-14, Revision 1.0, April 1985.

2. "Evaluation of Emergency Diesel Generator Crankshafts at Midland and San Onofre Nuclear Generating Stations," Failure Analysis Associates, Report FaAA-84-6-54, June 1984.