August 21, 1984

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY, ET AL.	)	Docket No. 50-289-OLA
	)	ASLBP 83-491-04-OLA
(Three Mile Island Nuclear Station, Unit No. 1)	)	(Steam Generator Repair)
	)	

LICENSEE'S REPLY TO THE PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW FILED BY TMIA AND THE NRC STAFF

Licensee hereby submits its reply to the proposed findings of fact and conclusions of law filed by Intervenor TMIA and the NRC Staff on August 10 and August 20, 1984, respectively.1/ Licensee is largely in agreement with the Staff's filing; accordingly, this reply will focus primarily on the filing of TMIA.

1/ "Proposed Finding of Fact and Conclusions of Law of Three Mile Island Alert, Inc. (TMIA) on the Issue of Steam Generator Repair on Unit No. 1," August 10, 1984 (hereafter cited as "TMIA FF ___") and "NRC Staff Proposed Findings of Fact, Conclusions of Law, and Order in the Form of an Initial Decision," and "NRC Staff Brief in Support of Staff's Proposed Findings of Fact," August 20, 1984 (hereafter cited as "Staff Findings" and "Staff Brief," respectively).

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This reply does not extensively address each of TMIA's points with which Licensee disagrees. Nor is the Licensing Board required to expressly address each and every finding proposed by each party. See Public Service Co. of New Hampshire (Seabrook Station, Units 1 and 2), ALAB-422, 6 N.R.C. 33, 41 (1977), and cases cited therein. Where the disagreements are obvious, and further discussion is unnecessary, Licensee has attempted not to restate its position as set out in "Licensee's Proposed Findings of Fact, Conclusions of Law, and Brief in the Form of a Proposed Initial Decision," August 3, 1984 (hereafter cited as "Licensee Findings").

1. Issues 1.a - 1.c (TMIA FF 2)

TMIA has proposed an ultimate finding that Licensee's testing program is inadequate and the proposed license conditions insufficient. Contrary to the Board's instructions at Tr. 685-86, the discussion does not support this finding with any subsidiary findings or with citation to any record evidence. TMIA has also failed to address or otherwise comment upon Licensee's proposed findings of fact, including record citations, which support a contrary conclusion. See Licensee Findings, ¶¶ 4-54 at 50-75.

2. Issue 1.d -- Long Term Corrosion Tests (TMIA FF 3-12)

TMIA here asserts that Licensee's long term corrosion tests are not "adequately predictive" of conditions in the TMI-1 steam generators because (1) mechanical stresses are not

included in the test sequence and (2) "actual" TMI-1 tubes will not withstand loads greater than 1,100 pounds. TMIA FF 12. The record shows both statements to be incorrect. Moreover, as is discussed below, many of the other statements made by TMIA in support of its assertions are also inconsistent with the record.

TMIA's position seems to derive from a misperception that Licensee's long term corrosion test program was intended to be "predictive of future tube failure." TMIA FF 3. That overstates the purpose of the test program. Licensee has testified that the sole purpose of the long term corrosion test program is to verify that corrosion will not reinitiate. Licensee has never contended that any broader conclusion was to be drawn from the program. Licensee - Issue 1.d at 2-3;2/ Tr. 345-46 (Croneberger); see Licensee Findings at 33-34 and ¶¶ 56-58 at 75-76.

In line with the stated purpose of the test program, the testing included stress loadings for the purpose of predicting the effects of stresses on corrosion. The test program included both thermal and load cycling of tubing specimens. Tubing sections in mockups were maintained at normal operating loads, and periodically cycled to simulate transient loading. The

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2/ "Licensee's Testimony of Don K. Croneberger and F. Scott Giacobbe on Issue 1.d," following Tr. 231.

magnitude of load change associated with flow-induced vibration was compared to the heatup/cooldown transient loads simulated, and is bounded by them for purposes of predicting the effect of stresses on corrosion. Accident loads were simulated for purposes of corrosion testing by including, in addition to the full tube mockups, a number of tubing strips which were bent to near yield, called C-ring specimens. Licensee - Issue 1.d at 8; Staff - Cont. 1.a at 11-13;3/ Tr. 346 (Croneberger); Tr. 369-70 (Giacobbe). Thus, stresses on the tubes during normal, transient and accident conditions were adequately simulated to predict with reasonable assurance that corrosion will not reinitiate in service. TMIA's assertion at TMIA FF 6 that "Licensee has failed to account for the mechanical stresses present in the steam generators" is therefore incorrect.4/

TMIA has attempted to use the parameters of the long term corrosion program to argue that the tubes will not withstand loads greater than 1,100 pounds, TMIA FF 9-12, and asserts that if the long term corrosion tests do not provide assurance that

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3/ "Testimony of Conrad E. McCracken and Paul C. Wu on TMIA Contention 1.a," following Tr. 589.

4/ TMIA also states that Licensee has not "introduced transient loads into the testing sequence." TMIA FF 6. As discussed in this section, to the extent TMIA may be referring to accident loadings, these loads are bounded by the near-yield stresses experienced by the C-rings. To the extent TMIA is referring to normal operational transients, those loading have indeed been taken into account in the long term corrosion testing program.

the tubes will not fail by mechanical means, Licensee has provided no alternate means of providing such assurance, TMIA FF 6. Neither statement is correct.

TMIA appears to be attempting to support the first point--inability to withstand loads over 1,100 pound--by incorrectly comparing statements made about two completely different types of test specimens in the long term corrosion test program. The quotation at TMIA FF 10 refers to full pieces of tubing which were put in mockups and stressed, not to failure, but to loads associated with normal steady state and transient operation. Because the maximum load associated with normal transients is 1,100 pounds (experienced during cooldown), the mockup test fixture was designed to put a maximum load of 1,100 pounds on the full tube specimens. Licensee - Issue 1.d at 8; Tr. 541 (Slear). The quotation at TMIA FF 9, on the other hand, refers to the other type of test specimen used in a different part of the program. Circumferential strips of tubing (C-rings) were bent to the maximum load that they could tolerate, which was near the yield strength of the material. This load bears no relationship whatsoever to the 1,100 pound load put on the full tube specimens, and, in fact, did not fall "far short of the 3,140 pound design load" as alleged at TMIA FF 10. To the contrary, it exceeded the maximum design basis load. Therefore, the potential effect of maximum accident loadings on corrosion susceptibility was bounded by the use of C-rings in the long

term corrosion test program. Licensee - Issue 1.d at 8; Tr. 369-70 (Giacobbe).

TMIA is equally in error in stating that Licensee has no basis for assuring against tube failure by mechanical means. TMIA FF 6. The record clearly establishes that assurance against the likelihood of tube failure by other mechanisms is provided by other testing and analysis, including the joint qualification program and verification that the tubing in service meets Code requirements. Licensee Material Facts, ¶¶ 15-17 at 64-66, ¶¶ 25-50 at 68-77, ¶¶ 95-105 at 87-90;5/ Staff Material Facts (TMIA Cont. 1.a), ¶¶ 4-7 at 2-5;6/ Staff Material Facts (TMIA Cont. 1.d), ¶¶ 7-10 at 3-5; Staff - Cont. 1.a at 2-3.

TMIA, in its discussion of Issue 1.d, makes several other erroneous statements which, although not of great significance, should be noted. At TMIA FF 4, TMIA suggests that only one test specimen with a known defect was used by Licensee when, in fact, the evidence shows that several were used in the four test loops. Licensee - Issue 1.d at 5. In the same proposed

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5/ "Licensee's Statement of Material Facts as to Which There Is No Genuine Issue To Be Heard," Licensee's Motion for Summary Disposition of Each of TMIA's and Joint Intervenors' Contentions, February 24, 1984, at 59 et seq.

6/ Staff's "Statement of Material Facts as to Which There is no Genuine Issue to be Heard (TMIA Contention ___)," NRC Staff Motion for Summary Disposition of TMIA Contentions 1.a, 1.b, 1.c, 1.d, 2.a, 2.b.1, 2.b.2, and 2.c, February 24, 1984.

finding, TMIA states that there was no evidence as to the number of tube sections included in the test sequence. While a specific number was not given, the breadth of the sample was discussed. Licensee and the Staff testified that samples were selected to cover the range of tube chemistries, mechanical properties, material susceptibility and axial locations. Licensee - Issue 1.d at 5-6; Staff - Cont. 1.a at 11-12; Tr. 353, 355 (Giacobbe).

TMIA states that "[o]ther testing" performed by Licensee utilized archival tubes. TMIA FF 15. The test specimens used by Licensee in the long term corrosion tests were all from actual tubes taken from the TMI-1 steam generators. Licensee - Issue 1.d at 5. To the extent TMIA is asserting at TMIA FF 5 that archival tubing was used in tests other than the long term corrosion test program, Licensee agrees, but would make the obvious observation that such an assertion is not germane to Issue 1.d. In any event, Licensee disagrees with the assertion that archive tubes "do not reflect the history of the tubes which have been in the TMI-1 steam generators for ten years." As will be discussed further in conjunction with Issue 3 below, the record contains extensive testimony demonstrating that the relevant history of the tubes was taken into account in the use of archival tubes for testing.

TMIA FF 8, asserting that Licensee could have simulated transient loads during the long term corrosion tests but

"chose" not to, is misleading in that TMIA has mischaracterized the Board's question, Tr. 541, and has taken the witness' answer out of context. The Board asked whether the actual TMI-1 tube specimens used in the long term corrosion test program could have been load tested in the same manner as those in the qualification test program to supplement the archival tube testing. Tr. 540-42. As such, the question dealt with the qualification program, not the long term corrosion test program, and was unrelated to Issue 1.d.7/

3. Issue 2 -- Inadvertent Initiation of Emergency Feedwater Flow

TMIA has submitted no proposed findings of fact on Issue 2.8/

7/ TMIA also omitted from the quoted answer at TMIA FF 8 the key statement that "[Licensee has] done a lot of things which you don't normally do, but in this case we have evaluated and concluded in our minds that the data we had was adequate."

8/ Based on the testimony of Licensee's witness at Tr. 426-27 (Lee), Staff Findings, ¶ 31 at 6, and the Staff Brief at 14, suggest that the emergency feedwater system would not be activated in the event of a main steam line break ("MSLB"). Licensee's witness testified on cross-examination that there was not a signal for emergency feedwater initiated by an MSLB. While no such direct signal is installed, the MSLB accident analysis assumes that emergency feedwater will be initiated to the unaffected steam generator, indirectly as a result of loss of flow from the main feedwater pumps, and the calculated design basis loads would therefore reflect the actuation of the emergency feedwater system. See FSAR, Section 14.1.2.9. Because the MSLB was not part of Issue 2, this information is extra-record, and the Staff's finding 31 need not be addressed by the Board.

4. Issue 3 -- Hardness Testing (TMIA FF 13-18, 26-33)

The issue litigated was whether Licensee should have included hardness testing as part of its post-repair testing program. The evidence presented at the hearing showed beyond doubt that post-repair hardness testing was neither necessary nor practical. See Licensee Findings at 40-42 and ¶¶ 83-97 at 86-91; Staff Brief at 15. TMIA has not addressed or commented upon Licensee's proposed findings of fact. In particular, TMIA makes no mention of the fact that it is not possible to perform hardness tests on the repaired tubes in the TMI-1 steam generators. Licensee - Issue 3 at 4;9/ Staff - Cont. 1.a at 17.

Contrary to TMIA's initial statement at TMIA FF 13, hardness tests were not designed to determine the degree to which the TMI-1 tubing material has become "embrittled." There is no evidence that the material has become embrittled in any way, nor is Inconel-600 expected to become embrittled in operation. Staff - Cont. 1.b at 2;10/ Tr. 655-56 (Wu, McCracken); see Staff - Cont. 1.a at 18; Tr. 461-64, 514-15, 526-28 (Giacobbe); Tr. 546-48 (Slear, Giacobbe); Tr. 634-35 (McCracken). Hardness testing was instead conducted to assess the comparative degree

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9/ "Licensee's Testimony of Douglas E. Lee, F. Scott Giacobbe and David G. Slear on Issue 3 (Contention 1.a)," following Tr. 423.

10/ "Testimony of Conrad E. McCracken and Paul C. Wu on TMIA Contention 1.b," following Tr. 652.

of "cold working" of the tube surface in the repaired area, and thus the relative susceptibility to intergranular stress-assisted cracking ("IGSAC"). Licensee - Issue 3 at 3-4.

At TMIA FF 17, the suggestion is made that, because the kinetic expansion process increases hardness, the yield strength and ductility of the tubes will be reduced. There is no record evidence cited by TMIA in support of this assertion. In fact, TMIA's sole supporting citation is to a statement of Licensee's expert witness that, "[f]or the very small change in hardness introduced by the expansion process, there is essentially no change in ductility." Tr. 442 (Giacobbe). In any event, the record clearly shows that the adequacy of the expansion joint, for which yield strength and ductility are key characteristics, has been established in the qualification program. Licensee Material Facts, ¶¶ 15-50 at 64-77; Staff Material Facts (Cont. 1.a), ¶¶ 4-7 at 2-5.

In TMIA FF 14 and 15, TMIA has misconstrued the testimony of Licensee and Staff witnesses. Licensee's hardness test program was fashioned to compare a non-stress-relieved roll expansion (known to be acceptable for use in steam generators) with a kinetic expansion, and both with an unexpanded tube, to infer relative susceptibility to IGSAC. Licensee - Issue 3 at 4; Tr. 441, 465-467 (Lee); Staff - Cont. 1.a at 16. TMIA asserts that such a comparison could only be meaningful if all three measurements were taken from tubes of the same population.

Licensee agrees that it would be best to use tubes from the same population, and, in fact, that is what Licensee did. All three measurements were performed on archival TMI-1 tubing. Tr. 441-42 (Lee). The hardness testing described as performed on actual TMI-1 tubing was part of Licensee's program to confirm that the tubing retained its original yield strength and ductility, and serves only to supplement the hardness comparison studies. See Tr. 542-43 (Giacobbe).

TMIA FF 5, 14, 16, 26-33 relate to the question of Licensee's use of archival tubes, as compared to tubes actually removed from the TMI-1 steam generators, for hardness and other testing in the qualification program. TMIA's argument as to the propriety of selecting archival tubes for hardness testing lacks the support of any expert testimony. The record evidence clearly demonstrates that where archival tubes were used, the appropriateness of the relevant mechanical characteristiscs of the archival material had been adequately demonstrated. See Licensee Findings at 41-42 and ¶¶ 91-94 at 89-90; see also Staff Brief at 15.

TMIA, at TMIA FF 16, suggests, without record citation, that hardness testing on archival tubes may have been inappropriate because the archival tubes had not been sensitized, and that it is not known whether sensitization had increased hardness. The evidence of record shows, as noted in Licensee Findings, ¶¶ 91-94 at 89-90, establishes that the relevant

mechanical characteristics of the tubing material -- tensile strength and ductility -- are unaffected by operating experience in the TMI-1 steam generators. Staff - Cont. 1.a at 18; Staff - Cont. 1.b at 2, 4-5; Tr. 461-64, 514-15, 526-28, 546-48 (Giacobbe); Tr. 538-40 (Slear); Tr. 634-35, 655-56, 668-69 (McCracken, Wu). With respect to sensitization, the Staff specifically testified that the sensitization process did not change the strength or ductility of Inconel-600. Staff - Cont. 1.b at 3-4; Tr. 653-56 (Wu, McCracken). There was no evidence to the contrary.

At TMIA FF 27, TMIA questions whether the archival tubes used were "identical" or "representative" of the tubes in the steam generators. TMIA appears to have taken two different statements out of context to support a single conclusion. At Tr. 465, Mr. Giacobbe responded to a Board question on archival tubing, stating that, so far as one could tell in testing, the archival tubes were identical with tubing specimens removed from the steam generators. In a totally unrelated discussion at Tr. 530-32, Mr. Slear used the word "identical" in describing the selection of tube specimens removed from the steam generator, and their similarity to the remainder of the tubes in the steam generator which had experienced cracking. In this case, he agreed that "identical" was synonymous with "representative."

As to TMIA's assertion at TMIA FF 27-28 that Licensee has somehow fallen short of industry practice in the number of tubes it tested to assure the appropriateness of using archival tubes, the opposite is true. At Tr. 532, Mr. Slear states that a total of twenty-seven tubes were removed from the TMI-1 steam generators and used for a variety of purposes. He compares this total with typical industry practice of pulling one or two tubes total (not two or three as misstated by TMIA). The three-heat sample population used to help establish that yield strength was unchanged is better compared with Staff's statement at Tr. 668-69 (McCracken):

> We have in the past simply accepted verification of heat numbers and not actual testing to prove that a tube has maintained dutility, because in all the examinations where we have had tubes removed from operating steam generators, we have not seen any indication of a change in ductility in an operating steam generator tube that would have put it outside the normal specification for a nuclear grade tube.

TMIA then suggests at TMIA FF 29 that Licensee could have used actual tubes for all tests, but did not, with the "feeble excuse" that to do so would have created problems of "dual responsibility" between two of Licensee's contractors. TMIA mischaracterizes the record. Any problem of dual responsibility suggested by Mr. Slear at Tr. 538 was described by him in

the very next sentence as feasible to overcome. Tr. 539. TMIA failed to mention that the real reasons for using archival tubes rather than actual tubes for some of the tests were that Licensee had determined that the key parameters associated with tubing properties could be adequately modeled with archival tube, and that the use of actual tubes would have resulted in "quite a bit of man-rem exposure." Tr. 539 (Slear).11/ TMIA's suggestion at FF 29 for "a meaningful series of tests, the results of [which] would have provided an accurate prediction of expected conditions in the steam generators," has in fact been accomplished by Licensee, without unnecessarily exposing workers to radiation.

TMIA's arguments at TMIA FF 30-33 go to the notion that differences in pull-out load test results are "statistically significant," and that this raises questions about the repair joint's ability to maintain its integrity under certain conditions. While the line of questioning was eventually determined to be beyond the scope of proper cross-examination, see generally Tr. 555-70, it should be noted that TMIA's characterization of a statistically significant difference in means as indicative of "failures identified during testing" is

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11/ This was not the only instance where Licensee's concern for worker exposure to radiation was cited as the reason for using archival tubing wherever possible. See Tr. 461-64 (Giacobbe).

incorrect. TMIA FF 32. Regardless of the conditions of the test, and any variations of results due to the conditions, in all cases the pull-out loads exceeded the acceptance criteria (with a statistical support in excess of a 99% confidence level on 99% of the tubes). Licensee Material Facts, ¶ 17 at 64-65.

5. Issue 4 -- Effectiveness of Kinetic Expansion as a Repair Versus a Manufacturing Process (TMIA FF 19-25)

TMIA's proposed findings on this issue focus primarily on industry experience as it relates to leak rates of the kinetically expanded tubes. In fact, the leak tightness on the kinetically expanded joint was not called into question either by TMIA -- whose Contention 1.a dealt with potential for tube rupture -- or by the Board -- which asked about the relevance of distinguishing between manufacture and repair. The record evidence clearly shows that the kinetic expansion repair process is effective for both manufacture and repair, and TMIA has cited no evidence to the contrary. See generally Licensee Findings at 42-45 and ¶¶ 98-116 at 91-98.

TMIA has not addressed the issue defined by the Board for litigation and has ignored Licensee's proposed findings on that issue. Licensee has never claimed that experience with leak rates or leak rate monitoring explicitly supports any particular leak rate limit or license condition. Past experience indicates that a very low leakage situation is to be expected for tubes and tubesheets of similar geometric and yield strengths

as those at TMI-1. Licensee's testimony is that kinetic expansion had been used in a number of applications sufficiently similar to those at TMI-1 to predict success in this application. Staff testimony has supplemented Licensee's with additional successful experience. No negative experiences were known, or have been identified by TMIA. Based on these experiences, Licensee was able to conclude that it was worthwhile pursuing a qualification program to verify that specific acceptance criteria could be achieved. Licensee - Issue 4 at 3-7;12/ Staff - Cont. 1.a at 18-19; Tr. 382-83, 403 (Pai); Tr. 490-91, 511 (Slear); Tr. 620, 630-34 (McCracken). Licensee's qualification program and post-repair testing then fulfilled expectations, demonstrating that the repaired tubes would meet the original licensing basis in all respects, including leakage. Licensee Material Facts ¶¶ 15-50 at 64-77; Staff Material Facts (Cont. 1.a) ¶¶ 4-7 at 2-5.

6. Issue 5 -- No Increased Probability of Simultaneous Tube Rupture (TMIA FF 34-36)

The issue being argued here by TMIA is whether there has been established adequate assurance that the kinetic expansion repair has "significantly reduced" the probability of simultaneous rube ruptures in both TMI-1 steam generators. TMIA FF 39. In contrast, the issue identified by the Board for

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12/ "Licensee's Testimony of Dr. David H. Pai on Issue 4 (Contention 1.a)," following Tr. 379.

litigation, and the original TMIA contention upon which that issue is based, is whether the kinetic expansion repair process has increased the probability of such an occurrence. In any event, TMIA has not established its case for either characterization of the issue.

TMIA FF 34 is simply a summary of the points it had raised in its previous proposed findings, as discussed above. In TMIA FF 35-36, TMIA argues that the loss of preload may result in compressive force on the tubes which may cause bowing which may cause the tubes to "rub and wear" during operation which may cause tube rupture. The record evidence shows otherwise. The compressive load discussed by TMIA occurs only during rapid heat up of the plant while there is differential thermal expansion of the tubes and steam generator shell as the system heats. As steady state temperatures are achieved, the thermally induced load is relieved. Bowing, if any, is also relieved, so that the tubes return to their original conditions

and cannot "rub and wear" during operation. Tr. 516-17 (Croneberger, Slear); Tr. 602-03 (McCracken).

Respectfully submitted,

SHAW, PITTMAN, POTTS & TROWBRIDGE

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Dated: August 21, 1984

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CERTIFICATE SERVICE SERVICE

This is to certify that copies of the foregoing "Licensee's Reply to the Proposed Findings of Fact and Conclusions of Law Filed by TMIA and the NRC Staff" were served, by deposit in the U.S. Mail, first class, postage prepaid, to all those on the attached Service List, except that those marked with an asterisk were served by hand delivery or by deposit with Federal Express, this 21st day of August, 1984.

Bruce W. Churchill, P.C.

Dated: August 21, 1984

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