

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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In the Matter of)
METROPOLITAN EDISON COMPANY, ET AL.)
(Three Mile Island Nuclear Station,)
Unit No. 1))

Docket No. 50-289
(Steam Generator Repair)

NRC STAFF BRIEF IN SUPPORT OF
STAFF'S PROPOSED FINDINGS OF FACT

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I. INTRODUCTION

On May 9, 1983, GPU Nuclear Corporation ("Licensee") applied for an amendment ("Amendment") to the Technical Specifications of the operating license for the Three Mile Island Nuclear Station, Unit No. 1 ("TMI-1"). The Amendment would permit operation of TMI-1 with steam generator tubes repaired by the kinetic expansion repair process. The current Technical Specifications authorize the use of only the "plugging" method as a means of repairing leaking tubes. The NRC subsequently published a Federal Register Notice entitled "Issuance of Amendment to Facility Operating License and Proposed No Significant Hazards Consideration Determination and Opportunity For Hearing", 48 Fed. Reg. 24231 (May 31, 1983), amended, 48 Fed. Reg. 27328 (June 14, 1983).^{1/}

^{1/} The Federal Register Notices and the "Notice of Hearing on Issuance of Amendment to Facility Operating License," 48 Fed. Reg. 36707 (August 12, 1983) made it clear that the Amendment, and the hearing, were limited to Licensee's request for authorization of use of the kinetic expansion repair process.

Petitions to intervene were filed by two intervenor groups, Three Mile Island Alert, Inc. ("TMIA") and Ms. Jane Lee, Mr. Norman Aamodt and Dr. Bruce Molholt ("Joint Intervenors"), (together, "Intervenors"). In November 1983, the Intervenors were admitted as parties to the proceeding,^{2/} and the Board admitted eight contentions of TMIA and three contentions of Joint Intervenors.

On February 24, 1984, the NRC Staff and Licensee filed motions for summary disposition of all of Intervenors' contentions. These motions were granted^{3/} with respect to all three of Joint Intervenors' contentions, and accordingly Joint Intervenors were dismissed as a party to this proceeding. The Board also dismissed, in their entirety, six of TMIA's contentions, and dismissed in part the other two, Contentions 1.a and 1.b. As for the remaining parts of Contentions 1.a and 1.b, the Board identified specific issues on which it wanted to hear evidence. Order at 23, 32.

From July 16 through July 18, 1984, a hearing was held in Middletown, Pennsylvania before the Atomic Safety and Licensing Board on the remaining issues identified in the Board's Order. Staff and Licensee presented testimony of each of the sub-issues. TMIA, and the Commonwealth, presented no direct evidence.

^{2/} On July 9, 1984 the Commonwealth of Pennsylvania filed a motion, pursuant to 10 C.F.R. § 2.715(c), requesting leave to participate in the hearing as an interested state. The motion was granted, subject to the understanding that the Commonwealth took the proceeding as it found it and that its participation at the hearing would be limited to examination on TMIA's remaining contentions.

^{3/} Memorandum and Order (Ruling on Motions for Summary Disposition), June 1, 1984 ("Order").

At the conclusion of the hearing, the Board issued an oral order directing each party to file, inter alia, a brief discussing the important issues in this proceeding and how they should be resolved. (Tr. 685-86). The Staff hereby submits its brief in compliance with that order.

II. DISCUSSION

A. TMIA Contention 1.a (Adequacy of Repair Technique, Post Repair and Plant Performance Testing and Proposed License Conditions)

TMIA Contention 1.a, as originally admitted by the Board, alleged:

Neither Licensee nor the NRC Staff has demonstrated that the kinetic expansion steam generator tube repair technique, combined with selective tube plugging, provides reasonable assurance that the operation of TMI-1 with the as-repaired steam generator can be conducted without endangering the health and safety of the public, for the following reasons:

- a. Post repair and plant performance testing and analysis including the techniques used, empirical information collected, and data evaluation, and proposed license conditions are inadequate to provide sufficient assurance that tube ruptures, including but not limited to those which could result upon restart, a turbine trip at maximum power, thermal shock from inadvertent actuation of emergency feedwater at high power or following rapid cooldown after a LOCA, will be detected in time and prevented to avoid endangering the health and safety of the public through release of radiation into the environment beyond permissible limits.

The Board, in its Order ruling on summary disposition motions, characterized the issue presented by TMIA Contention 1.a as follows:

We are being asked to rule whether the repair technique provides reasonable assurance that operation of TMI-1 can be conducted without endangering public health and safety. Contention 1.a

further alleges that post repair and plant performance testing, and proposed license conditions, are inadequate to assure against steam-generator tube ruptures.

Order at 14. In that Order, the Board specifically ruled that qualification programs and in-process testing are not included within the scope of the contention. Order at 14, 15. It also rejected, as not feasible, TMIA's suggestion that tubes in the steam generator should be individually inspected or subjected to deliberate design basis accident conditions. Order at 18. The Board identified a total of seven issues and sub-issues to be litigated with respect to TMIA Contention 1.a (Issues 1.a through 1.d and Issues 2, 3 and 4). These issues are discussed in turn below.

1. Issue 1 (Proposed License Conditions)

In its Order, the Board enumerated TMIA's concerns about the inadequacies of certain of the Staff's proposed license conditions, and noted that, although TMIA had not related any of its allegations to a specific scenario for tube rupture nor offered specific proposals for revising the license conditions, the Board could not resolve this issue without more detailed information. It set forth four areas of concern with respect to the proposed license conditions (Issues 1.a through 1.d). Id. at 21. Issues 1.a through 1.d are discussed in turn below.

a. Issue 1.a (Reliability of Leak Rate Measurements)

Issue 1.a, as set forth in the Board's Order, states:

1. The rationale underlying certain proposed license conditions should be addressed, with attention to:

a. Reliability of leak rate measurements.

Licensee presented a panel of three experts to testify on Issue 1.a.^{4/} The Staff presented a panel of two experts on this issue.^{5/} Each panel underwent extensive cross-examination by intervenor TMIA and by the Board. Nothing in the testimony elicited in the course of cross-examination caused the witnesses to change their direct testimony, or cast any doubt on the validity of the facts and opinions set forth in that testimony. Accordingly, the uncontroverted evidence presented on Issue 1.a supports a Board finding that the Staff's proposed license condition No. 4, which contains limitations on the leakage rate for TMI-1, provides reasonable assurance that the health and safety of the public is protected.

As set forth in Staff testimony, the purpose of proposed license condition No. 4 is to provide a rapid determination as to the source of any increased primary to secondary leakage so that appropriate repairs can be made. LF 8; SF 8, 15.^{6/} Some small amount of leakage is

4/ "Licensee's Testimony of Richard F. Wilson, David G. Slear and Don K. Croneberger on Issue 1.a (Contention 1.a)," ff. Tr. 224. Mr. Wilson is Vice President of Technical Functions for GPU Nuclear Corporation; Mr. Slear is Manager of Engineering Projects for TMI-1 at GPU; Mr. Croneberger is Director of Engineering and Design at GPU.

5/ "Testimony of Conrad E. McCracken and Paul C. Wu on TMIA Contention 1.a," ff. Tr. 589 (hereafter "Staff - Cont. 1.a"). Mr. McCracken is Section Chief of the Chemical and Corrosion Technology Section, Chemical Engineering Branch, Division of Engineering; Dr. Wu is a Chemical Engineer in the Chemical and Corrosion Technology Section of the Chemical Engineering Branch.

6/ The reference "LF" indicates a citation to Licensee's Proposed Findings of Facts filed on August 3, 1984. References to Staff's Proposed Findings of Fact, filed contemporaneously herewith, are indicated by the designation "SF." Because the Staff has adopted Licensee's proposed findings to a large extent, in each instance the Staff is providing a parallel citation to the paragraph of Staff findings where the cited Licensee finding has been adopted.

to be expected. SF 13. Licensee's leak detection methods will detect primary to secondary leakage at levels significantly below the shutdown limit of 0.1 gpm above baseline. The current limit in the technical specifications (1.0 gpm) is comparable to those at most other pressurized water reactors in the United States; the proposed license condition of 0.1 gpm is not only one tenth of that limit, but is also the most restrictive limit that the NRC has ever imposed on a plant. LF 16, 12; SF 12, 10.

Licensee testified that the nominal leak rate of 0.1 gpm above baseline was supported by a number of considerations, including: the need to establish a leak rate monitoring capability sensitive enough to detect extremely low level leakage, the fact that some low level leakage is to be expected and does not indicate a reduction in load carrying capability, the need for confidence that a change in leakage is statistically meaningful, and the fact that multiple leakpaths contribute to the aggregate leakage. LF 14; SF 11.

While TMIA conducted cross-examination on the effect of loss of pretension on leak rate measurement, and on the fact that there is a certain amount of self-sealing of leaks past the joint, no evidence was adduced to contradict the direct testimony of Staff and Licensee witnesses.

TMIA questioned whether the loss of pretension might cause the leakage rate for cracks to be reduced, and whether a decreased leakage rate might mask cracks that might propagate due to additional stress or corrosion. Licensee witnesses testified that a loss of pretension on some of the TMI-1 tubes does not affect the usefulness of leak testing. If there is leakage past the repair joint, it will be through the tight

crevice between the tube and tube sheet. The loss of pretention does not affect the tightness of this joint and thus cannot affect the potential leakage flow path once fixed. LF 22, 24; SF 14.

TMIA was concerned that the leak test results might be misleading because some leaks are "self-sealing". The uncontroverted testimony on the self-sealing phenomenon demonstrates that there is no safety-significance associated with leakage that might be masked by self-sealing. LF 20-21; SF 14.

Accordingly, the evidence establishes that proposed license condition No. 4 provides a rapid determination as to the source and amount of any increased primary to secondary leakage, and provides adequate assurance that the leakage will be responded to prior to the potential for tube rupture. Therefore, the Licensing Board should approve proposed license condition No. 4.

b. Issue 1.b (Frequency of Eddy Current Testing)

Issue 1.b, as set forth in the Board's Order, states:

1. The rationale underlying certain proposed license conditions should be addressed, with attention to:

* * * *

b. Method of determining frequency of ECT tests.

Licensee presented a panel of three experts to testify on Issue 1.b.^{7/} The Staff presented a panel of two experts on this

^{7/} "Licensee's Testimony of Richard E. Wilson, David G. Slear and F. Scott Giacobbe on Issue 1.b (Contention 1.a)," ff. Tr. 226. Mr. Giacobbe is Manager of Materials Engineering/Failure Analysis, GPU Nuclear.

issue.^{8/} Nothing in TMIA's cross-examination casts doubt on the validity of the testimony presented. That testimony demonstrates that proposed license condition No. 3, which addresses the frequency of ECT, provides adequate assurance that, in the unlikely event of reinitiation of corrosion, it would be detected in a timely manner and corrective action would be taken.

Licensee cited several factors supporting the proposed frequency of ECT testing. LF 35-36, SF 18. Both Staff and Licensee witnesses testified that the provisions of proposed license condition No. 3 impose a conservative testing requirement which will confirm their conclusions that crack initiation or propagation by chemical or mechanical means is not anticipated following return of the steam generators to service. LF 32, 34; SF 16, 18.

TMIA presented no evidence contradicting this testimony, nor did it elicit any evidence on cross-examination which would refute it. However, TMIA cross-examined Staff witness McCracken on a statement contained in an NRC memorandum drafted by Mr. McCracken in May of 1982. In that memorandum, it was suggested that ECT should be conducted within 30-60 days after restart. Mr. McCracken explained that the statement in the memorandum was based on the fact that, at the time it was written, the Staff did not know what the corrosive mechanism was and whether further degradation was expected. Mr. McCracken also testified that the

^{8/} Staff - Cont. 1.a, ff. Tr. 589.

Staff revised the time frame for ECT, to the current proposed 90-120 day period, based on knowledge gained after preparation of the memorandum. LF 37; SF 18.

Based on the foregoing, the record evidence supports a conclusion that any reinitiation of corrosion would be detected in a timely manner and corrective action would be taken such that there is reasonable assurance that the health and safety of the public would be protected. Therefore, the Licensing Board should approve proposed license condition No. 3.

c. Issue 1.c (Power Ascension Limitations)

Issue 1.c, as set forth in the Board's Order, states:

1. The rationale underlying certain proposed license conditions should be addressed, with attention to:

* * * *

c. Method of determining power ascension limitations.

Licensee presented a panel of three expert witnesses to testify on Issue 1.c.^{9/} The Staff presented a panel of two experts on this issue.^{10/} TMIA presented no direct case on this issue.

Licensee testified extensively as to the considerations that went into the development of its initial power test program, including test requirements as a result of core reload, plant modifications made since

^{9/} "Licensee's Testimony of Richard W. Wilson, David G. Slear and T. Gary Broughton on Issue 1.c (Contention 1.a)," ff. Tr. 229. Mr. Broughton is Director of Systems Engineering.

^{10/} Staff - Cont. 1.a, ff. Tr. 589.

the plant was last operated, and operator training requirements. Primary factors in determining test sequence and plateaus included verification that the physics parameters are as predicted and that nuclear instruments, the integrated control system, and the turbine protective system, are calibrated and functioning properly. LF 41; SF 24.

The evidence further shows that Licensee reviewed its power ascension/post-critical testing program for its effect on the steam generators. Because the pre-critical testing verified the effectiveness of the repair and the operability of the steam generators, Licensee concluded that no additional tests were needed in the post-critical test program because of the repair. LF 43; SF 24.

Staff testified that proposed license conditions Nos. 1 and 2, relating to power ascension, are not intended to limit power ascension itself, but rather to require that test results be made available to the NRC at each stage of the power ascension test program. Staff testified further that the power ascension limitations are not a necessary part of the OTSG repair program, since the steam generators have been repaired to their original licensing basis, which is consistent with full power operation. SF 23.

TMIA cross-examined Licensee as to whether Licensee's power ascension limitations are in accord with the recommendations of the Third Party Review Group (TPR). The evidence adduced shows that GPU made some changes in its program based on the TPR recommendations, and that the TPR found that GPU's responses to its recommendations were satisfactory. LF 48-52; SF 24. Accordingly, TMIA presented no evidence, and

developed no testimony on cross-examination, that would shed doubt on the appropriateness of Licensee's proposed power ascension limitations. The record amply demonstrates that the Staff's proposed license conditions on power ascension limitations are conservative, will corroborate the adequacy of the repair process, and afford reasonable assurance that the health and safety of the public will be protected. Therefore, the Licensing Board should approve proposed license conditions Nos. 1 and 2.

d. Issue 1.d (Long Term Corrosion Tests)

Issue 1.d, as set forth in the Board's Order, states as follows:

1. The rationale underlying certain proposed license conditions should be addressed, with attention to:

* * * *

- d. Adequacy of simulation of operating conditions by long-term corrosion tests.

Licensee presented a panel of two experts to testify on Issue 1.d.^{11/} The Staff presented two experts.^{12/} Nothing in TMIA's cross-examination cast any doubt on the validity of the facts and professional opinions set forth in that testimony. Accordingly, the evidence presented on Issue 1.d is uncontroverted.

The evidence on Issue 1.d demonstrates that the long-term corrosion test program includes tests which closely simulate the typical operating

^{11/} "Licensee's Testimony of Don K. Croneberger and F. Scott Giacobbe on Issue 1.d (Contention 1.a)," ff. Tr. 231.

^{12/} Staff - Cont. 1.a, ff. Tr. 589.

environment of the steam generator tubing during steady state and transient conditions, and that the program will enable Licensee to predict the performance of actual TMI-1 tubes in the steam generators prior to return to operation. LF 59, 73; SF 27. Proposed license condition No. 6 requires that the results of those tests be reported to the NRC.

The tests reproduced all the parameters which influence IGSAC, i.e. susceptible material, environment, and stress. To assure that the influence of prior operation and layup on tubing was adequately represented, only tube sections removed from the TMI-1 steam generators were used as specimens. Environmental chemistry parameters were selected to either simulate, or be more aggressive than, the water chemistry which will be maintained in the RCS. In order to simulate the changes in axial load, full tube specimens were loaded at a level corresponding to steady state loads during heatup, cold shutdown, and operation. C-ring sections were stressed so as to encompass all steady state and transient stresses. Since residual stresses induced by the explosive expansion are also a source of loads on the tubes, full tube specimens simulating repaired joints were kinetically expanded using the same process as in the actual steam generators to ensure representative residual stresses. These specimens were also exposed to the axial loads so that the worst case combination of loads also was tested. LF 60-72; SF 27.

The above record evidence demonstrates that the long-term corrosion test program includes tests which provide a valid simulation of the conditions that the OTSG tubing will experience in future TMI-1 opera-

tion, and will enable Licensee to make a comprehensive assessment, prior to return to operation, of the performance of actual TMI-1 tubes in the steam generator. Accordingly, it has been amply demonstrated that the testing required by proposed license condition No. 6 provides a clear basis for predicting steam generator tube performance. Therefore, the Licensing Board should approve proposed license condition No. 6.

2. Issue 2 (Inadvertent Initiation of Emergency Feedwater Flow)

Issue 2, as set forth in the Board's Order, states:

2. The effect of inadvertent initiation of emergency feedwater flow at rapid cooldown after a LOCA should be addressed with attention to calculation of maximum transient stresses in steam generator tubes.

Licensee presented a panel of three witnesses on this issue.^{13/}

The Staff present a panel of two witnesses.^{14/} TMIA presented no direct evidence.

The cross-examination by TMIA was wholly ineffective and in no way effected the validity of the direct testimony. That testimony establishes that inadvertent initiation of the emergency feedwater pumps while the plant is operating at full power would not result in injection of emergency feedwater into the steam generators and thus could not cause rupture of a steam generator tube. LF 76; SF 30.

^{13/} "Licensee's Testimony of Douglas E. Lee, Don K. Croneberger and David G. Slear on Issue 2 (Contention 1.a)," ff. Tr. 421. Mr. Lee is Manager of the Mechanical Engineering Section of the Engineering Department of Babcock & Wilcox.

^{14/} Staff - Cont. 1.a, ff. Tr. 589.

If one were to assume both inadvertent actuation of EFW pumps and inadvertent initiation of EFW valves, resulting in injection of EFW into the steam generators at full power, the resulting thermally induced axial tube load would not be sufficient to cause rupture of the steam generator tubes. LF 77; SF 30.

Furthermore, Staff witnesses testified that the most severe accident, in terms of loading, on the OTSG tubes would be a break in the main steam lines (MSLB). This design basis accident would result in a maximum tube load of 3140 pounds. SF 29. The effect of inadvertent initiation of emergency feedwater flow at high power or following rapid cooldown after a LOCA is bounded by the MSLB load. LF 81-82; SF 30, 32. Moreover, a Licensee witness testified that a MSLB would not initiate the EFW system. SF 31.

Accordingly, the uncontroverted record evidence provides ample support for the conclusions that emergency feedwater injection into the steam generators does not induce large changes in tube axial loads, and does not cause the rupture of steam generator tubes.

3. Issue 3 (Hardness Testing on Repaired Tubes)

Issue 3, as set forth by the Board, states as follows:

3. The reasons for not including hardness tests on repaired tubes in the post-repair testing program should be addressed.

Licensee presented a panel of three witnesses on Issue 3.^{15/} The Staff presented a panel of two witnesses.^{16/} TMIA presented no direct evidence.

^{15/} "Licensee's Testimony of Douglas E. Lee, F. Scott Giacobbe and David G. Slear on Issue 3 (Contention 1.a)," ff. Tr. 423.

^{16/} Staff - Cont. 1.a, ff. Tr. 589.

As set forth in the uncontradicted testimony of Licensee and Staff witnesses, there is no need for hardness measurement on repaired tubes, because hardness is not a parameter required in the evaluation or analysis of stress corrosion cracking and or crack propagation. Moreover, testing for hardness of the repaired tubes was not practical. LF 89-90, 95; SF 33, 34. Nothing in TMIA's cross-examination gives rise to any reason to doubt the validity of this testimony.

It was established, during cross-examination of Licensee's witnesses by the Board, that hardness testing was performed on archival tubing that had been kinetically expanded during the pre-repair qualification program. Licensee demonstrated that the archival tubes and the TMI-1 tubes had the same mechanical properties. LF 91; SF 33. The hardness tests on the kinetically expanded archived tubing indicated that there was less residual stress and less potential susceptibility to stress corrosion cracking in the transition areas than in the original as-fabricated tubes. LF 86-89; SF 33.

Licensee testified that the archival tubes were manufactured with, and to the same specifications as, the tubes actually used in the TMI-1 steam generators. Moreover, the kinetic expansion procedures used in expanding the archival tubes were the same as the procedures used in the steam generators. LF 92, 91; SF 33. The evidence demonstrates convincingly that the results of the tests on the archival tubes were representative of the tubes in the steam generators. Therefore, the Licensing Board should find that hardness tests on repaired tubes during the post-repair testing program is neither feasible nor necessary.

4. Issue 4 (Effectiveness of Kinetic Expansion as a Repair Versus a Manufacturing Process)

Issue 4, as set forth in the Board's Order, states:

4. Recalling Licensee's statement in ¶ 6-8 that the use of kinetic expansions to seal heat exchanger tubes within tubesheets has a broad base of successful experience, information is requested about whether tube integrity during subsequent operation depends on whether the process is a repair, or a manufacturing process using new materials.

Licensee and Staff presented extensive evidence on Issue 4.^{17/} TMIA's cross-examination failed to elicit any evidence controverting this testimony.

The Staff witnesses testified that the steam generator tubing alloy, Inconel-600, maintains its mechanical strength and ductility even after prolonged service in a steam generator. Therefore, as long as the repair process is qualified by producing the tube/tubesheet joints which meet the original licensing basis of a pullout strength of greater than 3140 lbs, the structural integrity of the tubes during subsequent operation does not depend on whether the process is repair or a manufacturing process using new materials. LF 112; SF 36.

Both Staff and Licensee witnesses testified at length as to the history of use of kinetic expansion, both as a repair process and in manufacturing. LF 99-101, 103-111; SF 33. Indeed, Staff witness McCracken stated that in his experience the kinetic expansion repair process has been found to be a more reliable and easily controlled process than is the rolling process. LF 100; SF 36.

^{17/} "Licensee's Testimony of Dr. David H. Pai on Issue 4 (Contention 1.a)," ff. Tr. 379; Staff - Cont. 1.a, ff. Tr. 589.

On cross-examination, TMIA raised questions concerning the applicability of industry experience to the repair process used at TMI-1. Both Licensee and Staff witnesses testified that the kinetic expansion process forms an effective seal whether used as a repair method or as part of the manufacture. LF 114; SF 36. Since the mid-1970's, the kinetic expansion process has been used routinely as a method of repair. LF 104; SF 36.

In conclusion, the evidence clearly establishes that the kinetic expansion process is a reliable method of sealing tubes within tubesheets, and that tube integrity during subsequent operation does not depend upon whether the process is a repair or a manufacturing process using new materials. Therefore, the Licensing Board should find that the use of kinetic expansions to seal heat exchanger tubes within tubesheets has a broad base of successful experience and that tube integrity during subsequent operation does not depend on whether the process is a repair or a manufacturing process using new materials.

B. TMIA Contention 1.b (Issue 5--Effect of Repair Process on Probability of Simultaneous Tube Rupture)

TMIA Contention 1.b, as originally admitted by the Board, alleged:

Because of the enormous number of tubes in both steam generators which have undergone this repair process, (1) the possibility of a simultaneous rupture in each steam generator, which would force the operator to accomplish cooldown and depressurization using at least one faulted steam generator, resulting in release of radiation into the environment beyond permissible levels, "isn't an incredible event," (see, September 19, 1982 memorandum from Paul Shewmon, then Chairman of the ACRS), (2) and could lead to a sequence of events not encompassed by emergency procedures, (3) and in the course of a LOCA, such a scenario could create essentially uncoolable conditions.

In its order ruling on summary disposition motions, the Board stated Issue 5 as "whether the repair process has increased . . . the

probability of simultaneous tube ruptures involving both TMI-1 steam generators." Order at 32. Licensee presented a panel of three witnesses on this issue.^{18/} and the Staff presented two witnesses.^{19/} TMIA presented no witnesses, and its cross-examination was ineffective.

Both Staff and Licensee witnesses provided compelling evidence that the probability of a simultaneous tube rupture involving both steam generators is not increased by the use of the kinetic expansion repair process. As explained in the testimony, the kinetic expansion repair has returned the TMI-1 steam generators to their original licensing basis. LF 120; SF 37.

The Board noted in its Order (at page 32) that it did not have sufficient information at that time to enable it to accept Staff and Licensee's argument that the design basis for a new plant, constructed using new materials, is relevant to restart of an operating reactor after extensive repairs. In this regard, the Staff testified at the hearing that the steam generator tube material, Inconel-600, retains its strength and ductility despite previous operation, and because the repair process itself did not affect that strength and ductility, the tubes are as resistant to rupture now, after the repair, as they were when they were

^{18/} "Licensee's Testimony of Douglas E. Lee, Don K. Croneberger and David G. Slear on Issue 5 (Contention 1.b)." ff. Tr. 424.

^{19/} "Testimony of Conrad E. McCracken and Paul C. Wu on TMIA Contention 1.b," ff. Tr. 652 (Staff - Cont. 1.b, ff. Tr. 652").

new and had not experienced operation. LF 120; SF 37. Therefore, the evidence establishes that the repair process has not increased the probability of a simultaneous tube rupture, and the Board should so find.

C. REPLY TO TMIA'S PROPOSED FINDINGS

TMIA concludes in their proposed findings that the Amendment should be denied.^{20/} The Staff has reviewed those proposed findings and believes that they are not supported by the evidentiary record and generally misconstrue and ignore facts in the record. Accordingly, the Board should reject TMIA's proposed findings and adopt the Staff's proposed findings, which incorporate by reference the majority of Licensee's proposed findings. It is the Staff's view, however, that there are two items as to which a Staff response may be helpful to the Board.

First, in its proposed findings 8-12, TMIA asserts that because the Licensee failed to include mechanical stresses greater than 1100 pounds on the tubes as part of the long-term corrosion test program, the testing is not adequately predictive of operating conditions in the TMI-1 steam generators. The evidence does not support such a finding. The cause of TMI-1 OTSG tube failure has been established as stress corrosion cracking. Order at 64-66. The purpose of the long-term corrosion test program is to verify that sulfur-induced intergranular stress-assisted cracking will not reinitiate or propagate under actual

^{20/} 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, dated August 10, 1984, at 18. Although the Board directed each of the parties to file a brief in support of their proposed findings (Tr. 684-86), TMIA failed to do so.

operating conditions. The tests simulate typical conditions during steady state and transient operation, and in particular, reproduce all parameters which influence intergranular stress-assisted cracking. Tube samples were loaded to approximately 1100 pounds, corresponding to steady state loads during heatup, cold shutdown and operation. The tests also took into consideration residual stresses produced by the explosive expansion process. Furthermore, C-ring specimens were loaded to a stress level just slightly below yield, which is significantly higher than the level seen by the tubes in actual service. Consequently, the high stress on the C-rings bounds loads induced by any accident transients (a maximum of 3140 lbs.). LF 56-74; SF 27, 29. Therefore, because the purpose of the long-term corrosion test program was not to test the qualification of kinetically expanded tubes to design basis accident loads,^{21/} the failure to apply a 3140 pound load to the tubes does not render the testing defective. In any event, contrary to TMIA's assertion, there is no evidence to show that the maximum capability of the tubes is 1100 pounds. Therefore, TMIA's proposed finding that the long term corrosion test is not adequately predictive is without foundation.

Second, TMIA asserts in its proposed finding 36 that because the Licensee has not established the exact location of the tubes without preload, it is possible that if bowing occurs in adjacent tubes, the bowed adjacent tubes will rub and wear during operation and at least one tube will rupture in each steam generator. With respect to that proposed finding, TMIA offered no evidence, and indeed there is no evidence in the

^{21/} In fact, the Board ruled that qualification of the tubes is not within the scope of Contention 1.a. Order at 16-18.

record, to support a finding that adjacent tubes will bow, rub and rupture either in one steam generator or simultaneously in both generators.^{22/} TMIA cites no testimony as to the length of time the bowing is expected to occur, and, more importantly, the probability of tube rupture. The evidence with regard to the length of time bowing would occur shows that bowed tubes would return to their original position after heatup, which lasts about 8-10 hours (McCracken, Tr. 602). In short, TMIA did not pursue at any length the question of possible tube rupture due to rub and wear caused by bowing. TMIA has failed to present a convincing argument which would warrant the adoption of its proposed finding 36. Therefore that proposed finding should be rejected.^{23/}

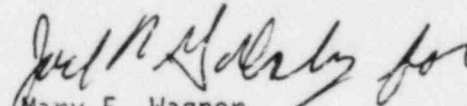
^{22/} As the Board observed in its Order ruling on summary disposition, TMIA never identified, as a basis for its contentions, a specific scenario for tube rupture. Order at 21. Certainly, TMIA should be precluded from raising this issue for the first time in its proposed findings.

^{23/} As noted above (n.22), the scenario of tube rupture due to the rubbing of adjacent, bowed tubes was not raised until after the hearing in TMIA's proposed findings, and therefore was not specifically addressed at the hearing. However, there is evidence in the record that maximum compressive loads occur during normal heatup transients (100°F/hr) (LF 129; SF 37), that an 800 pound compressive load is required to initiate bowing (Croneberger, Tr. 282), and that compressive loads adequate to produce bowing would last only until the heatup is over (McCracken, Tr. 602). Had this scenario been identified before the hearing, the Staff would have further testified that in the highly unlikely event that two adjacent tubes in each steam generator would exceed the 800 pound compressive load required to initiate bowing and bow toward each other, any touching of tubes would be of short duration and the tubes would not be expected to rub and wear during operation so as to cause a rupture of one or more tubes in each steam generator. Because this issue was not raised until after the hearing, the Staff did not offer evidence to support this position as it would have done had the scenario been raised by TMIA prior to the hearing. For the reasons described above, namely the absence of any evidence to support TMIA's scenario, the Staff believes that TMIA's proposed finding on this issue should be rejected.

III. CONCLUSION

Based on the extensive and uncontroverted evidence in the record in this proceeding on all the issues enumerated in the Board's Order, a decision should be granted in favor of Licensee and Staff. The Licensing Board should approve the issuance of the amendment with proposed license conditions Nos. 1, 2, 3, 4 and 6. The Licensing Board should conclude that, insofar as the issues enumerated in the Board's Order bear on the issuance of this Amendment, based on the evidence in the record, those issues have been conclusively resolved in favor of the Staff and Licensee positions and the Amendment should be issued.

Respectfully submitted,


Mary E. Wagner
Counsel for NRC Staff

Dated at Bethesda, Maryland
this 20th day of August, 1984

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

DOCKETED
USNRC

'84 AGO 23 P5:02

In the Matter of)
METROPOLITAN EDISON COMPANY, ET AL.)
(Three Mile Island Nuclear Station,)
Unit No. 1))

Docket No. 50-289
(Steam Generator Repair)

CERTIFICATE OF SERVICE

I hereby certify that copies of "NRC STAFF BRIEF IN SUPPORT OF STAFF'S PROPOSED FINDINGS OF FACT" and "NRC STAFF PROPOSED FINDINGS OF FACT, CONCLUSIONS OF LAW, AND ORDER IN THE FORM OF AN INITIAL DECISION" in the above-captioned proceeding have been served on the following by deposit in the United States mail, first class, or, as indicated by an asterisk, by deposit in the Nuclear Regulatory Commission's internal mail system, this 20th day of August, 1984:

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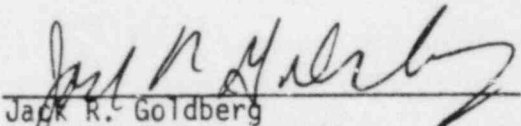
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