UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	'84 APR -3 P2:15
	)	
METROPOLITAN EDISION COMPANY	)	Docket No. 50-289
	)	(Steam Generator Repair)
(Three Mile Island Nuclear Station, Unit 1)	)	
	)	

TMIA RESPONSE TO LICENSEE AND STAFF MOTIONS FOR SUMMARY DISPOSITION

TMIA hereby responds to Licensee and Staff motions for summary disposition on TMIA Contentions 1.a, 1.b, 1.c, 1.d, 2.a, 2.b.1, and 2.b.2, received by TMIA February 27, 1984, pursuant to 10 C.F.R. § 2.749. None of these contentions warrant dismissal as alleged by Licensee and the Staff. TMIA submits statements constituting genuine material issues of fact with regard to each contention, in support thereof.

This response is based upon discovery material received by TMIA, as well as Licensee and NRC documents which can be found in the public document room. In particular, TMIA recently came upon an ACRS transcript of a combined subcommittee meeting held January 28, 1983 on the subject steam generator tube repairs.

In addition, TMIA consulted Dr. George C. Sih, Director of Fracture Mechanics, Lehigh University during the week of March 19, 1984. Dr. Sih was able to provide comments on certain aspects of Licensee's motion by March 28, (Attachment 2), but due to time limitations, these comments could not be converted into affidavit form. Attachment 4 is a very brief statement by Dr. Sih as presented in hearings before U.S. Senator Arlen Specter in Harrisburg last December.

In TMIA's reponse to discovery requests, TMIA broadly maintained that there was no reasonable assurance that the kinetic expansion repair program could insure safe plant operation, but that without technical assistance, the precise technical aspects of the program could not be competently refuted. Until this time, TMIA has tried to locate voluntary technical assistance on all relevant aspects of this case, but has been unable to do so. Thus, TMIA has found it necessary to respond to the Licensee and Staff motions without technical assistance, save what invaluable help Dr. Sih has been able to contribute in his particulary area of expertise.

However, even without competent technical help, TMIA has uncovered a sufficient number of genuine material issues of fact to withstand these motions. Meanwhile, although TMIA suspects many of the more technical aspects of Licensee and Staff documents contain additional issues, TMIA has of necessity been forced to address only those aspects of Licensee and Staff documents which raise the types of obvious questions which lay people can understand, in supporting these contentions.

In conclusion, there are genuine material issues of fact requiring adjudication of the above referenced TMIA Contentions. Summary disposition should not be granted.

Respectfully submitted,

Three Mile Island Alert

Joanne Doroshow

Joanne Doroshow
Louise Bradford

April 3, 1984

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TMIA STATEMENTS OF MATERIAL FACTS AS TO WHICH THERE ARE GENUINE ISSUES TO BE HEARD

A. TMIA CONTENTION 1.a

1. TMIA contention 1.a alleges that Licensee' post-repair and plant performance testing are inadequate to provide reasonable assurance that tube ruptures will be prevented.

2. Since Licensee and the Staff both insist that Licensee' post-repair and plant performance testing are simply meant to provide "additional assurance" that ruptures will be prevented, but that primarily reliance is being placed upon Licensee's qualification program and in-process inspection of the kinetic expansions, see Licensee's Statement of Material Facts ("Licensee Facts") ¶¶44, 56-57, the adequacy of Licensee's qualification program and in-process testing must first be determined. See also, NRC Staff Motion for Summary Disposition, p. 4.

The kinetic expansion repair.

3. Contrary to Licensee's implication at Licensee Facts ¶ 8, the repair program which Licensee has undertaken in this case if far from routine, and there is no evidence these types of repairs have ever been conducted at a nuclear power plant in the large scale manner as has been done at TMI-1. Indeed, the Staff has always considered the process unique and experimental. Attachment 1.

4. Further, the fact that the kinetic expansion repair may have been used in other steam generators, Licensee Facts ¶ 8, is irrelevant without come evidence of its previous success rate.

Qualification testing.

5. There are additional genuine material issues of fact concerning the accuracy and sufficiency of the qualification testing done by Licensee.

6. According to Licensee, the qualification program was to demonstrate that "the expansion joint meets licensing basis," and is "at least as effective as the original rolled and welded joint." Licensee Facts ¶ 15. Thus, by definition, the program itself was not meant to be a comprehensive test to determine compliance with GDC 14, 10 CFR Part 50, App. A, i.e., that the steam generator tubes have "an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture. Licensee Facts ¶ 12. The program was only designed to see if the actual repaired joint will meet the GDC requirement, but was apparently not designed to analyze the propagation of fatigue cracks in the tubes.

7. Through qualification testing, a qualification criteria was established for kinetic expansion as follows: tubes to be expanded must have a 6" ECT defect free expansion length, a minimum of two inches left unexpanded between the tube and the lower face of the tubesheet, a defect free 1/8" to 1/4" transition zone, and a < 40% throughwall crack. Licensee Facts ¶ 9-11. It was determined that tubes which met this criteria could be safely expanded. Indeed, except to the extent that a 6" expanded joint and the transition zone are directly affected, potential problems arising from the type and extent of tube failures

due to IGA and the corrosive environment, were expressly not part of the qualification program.

Quality and Quantity of Samples Tested

8. The qualification, as far as it goes in relation to GDC 14 requirement, is seriously flawed. First, there is a serious issue regarding the reliability of archive tubes for pullout and leak tests. Licensee Facts ¶ 17, 36; See also Reference Document 19 at p. 26.

9. The accurate simulation of actual TMI-1 conditions is an obvious prerequisite to establishing the validity of tests run on archive tubes.

10. The question of whether laboratory conditions can be accurately simulated is at least an open question, since the actual chemistry and sequence of the orginal tube cracking, and the chemical agent which caused the cracking, are not known and to some extent are in dispute.

11. As most clearly put by Licensee during discussion before the ACRS concerning the issue of system cleaning,

> There are a number of unknowns which actually increase the uncertainty of predicting this potential for further corrosion. And these unknowns are addressed here as the next four points. We really don't know what the total amount of sulfur is in the reactor coolant system. Sure, we have done sampling to try to indicate how much is there, but we really don't have a definitive value for the total amount of sulfur. Even if we did have that information, we don't know what the threshold value for deposited sulfur in corrosion film, what the threshold value is for that to cause corrosion of sensitized Inconel 600 in PWR environments.
>
> We are sure that that threshold is very high during operating conditions with lithium chemistry control. However, we have not done the testing to investigate every possible condition that one could get into going to power operation and then back to an oxidizing shutdown condition, but even if we knew this, if we knew the threshold value, we knew the total quantity of sulfur in the system, we still would not

> have all the answers we need. We really do not know the detailed conditions that can in fact produce metastable sulfur states from nickel sulfide that is already on the tube surfaces.
>
> Furthermore, we do not know the conditions that produce that. We don't know what the lifetime of those states are during operating conditions. Even with that lithium control. The lifetime may be so short that we don't get corrosion, but we have no testing and no data in the literature that can really give us a good handle on this factor.

ACRS Tr. at 255-256. See also, ACRS Tr. at 71, ("So, I don't think we can tell you which one of those intermediate forms caused the attack."), and Licensee Facts ¶ 172 and Staff Facts ¶ 9, Contention 2.a, discussing previous contaminations, adding additional variables to evaluation of the tubes physical properties.

12. Further, as explained by the Staff in its SER,

> "staff consultant [MacDonald] (Attachment 3) expressed concern about an inconsistency in the licensee's Topical Report 008, Rev. 2. In pages 13-14 of this report, the licensee stated that sulfur reduction might have occurred during the hot functional test, and that the subsequent OTSG tube degradation was as a consequence of reduced sulfur species. In the Test Section of the same reort, laboratory data indicate that cracking of senitized type 304 Stainless Steel (SS) and Inconel 600 specimens in low temperature, oxygenated water contaminated with thiosulfate proceeds without the presence of other reducing agenst. The consultant's concern is that in one case reduced sulfur species is suggested as the corrosion initator, while in the other case it is shown that corrsion will occur in the absence of reduced species. We are of the opinion that irrespective of the exact sceanarios, the thiosulfate contaminant has been removed from the system."

Thus, the Staff position is to attach no significance to these critical analytical differences, which were of express concern to its own expert consultant. The Staff, however, clearly does not dispute that these differences exist. MacDonald also states that sulfur deposits of an

unknown form were found on the control rod drive leadscrew, MacDonald at p. 20, and that

> sulfur and sulfur-induced corrosion damage has been observed in regions of the RCS which have not been exposed to a liquid environment (e.g. general corrsion and pitting in the PORV and cracking in the WDG piping). This indicates that besides thiosulfate, which can only exist in the dissolved state (note that it is anion), a volatile polysulfur species must be present in the system).

MacDonald at 20-21.

13. With regard to simulation of tube and tubesheet oxidation, which Licensee also attempted to simulate to determine the relative effect of oxide thickness on kinetic expansion joint integrity, Licensee Response to TMIA Interrogatory 8, Licensee acknowledged before the ACRS that "the potential does exist that during certain transient conditions, there can in fact be a change in oxidation states," and that "based on knowledge of what the potential environments are that can be seen during operation and shutdown in a PWR plant, that in fact we may be able to get into a state at some time which is a metastable sulfur state." ACRS Tr. at 254-255.

14. More uncertainties were expressed by the Staff and its consultants. See Dillon at p. 12 ("I don't know that the apparent inconsistencies in describing the cracking environment are important to the reactor recovery operation, but they certainly invite questions."),and the SER at 8 ("The specific mechanistic steps involved in the sulfur-induced stress corrosion cracking phenomena have not been clearly established.").

15. The TPR pointed out "minor differences" in the two independent metallurgical failure analyses performed. TPR 2/18/83 at p. 9. The

TPR provides no explanation as to what these differences were, or their significance. Licensee suggests an explanation, i.e. that the differences resulted from equipment and technique differences. But Licensee also suggested that the differences resulted from differences in the tube samples which were tested, thus supporting the premise that the physical properties of the tubes vary significantly enough to effect test results.

16. Moreover, in Licensee's Motion for Summary Disposition at p. 29, lines 2 to 4 on top, the statement, "...the data were developed to characterize the material properties of Inconcel-600, and are independent of material or loading geometry", is self-contradictory. It is well-known that all data collected from specimen tests are sensitive to changes in specimen size and loading rates. Therefore, it is necessary to simulate the conditions experienced in the structural components when collecting material data. Attachment 2, p.2

17. Licensee further stated to the ACRS, "You can't draw an exact correlation of these laboratory tests with the exact condition in the steam generator." ACRS Tr. at 71. See also, TMIA Contention 2.a, infra.

18. The problems in duplicating the physical properties of the steam tubes also demonstrate how unique the physical properties of each tube within the actual TMI-1 steam generator actually is. In describing the lead test corrosion program in 008, it appears that Licensee pulled a random sample of a few tubes, but acknowledged that an IGA may cluster in non-obvious places, away from cracks, and the locations of such IGA clusters are impossible to determine. TDR 008 at

81-90. Such would of course also be true of TMI-1 tubes pulled for qualification testing.

19. Thus, results based on extrapolations from tests performed on only one or a few "representative" actual TMI-1 tubes, must necessarily be questioned. See, for example, confirmatory tests for platicity failures, which Licensee performed on only one TMI-1 tube which it deemed "representative." Licensee Response to TMIA Interrogatory 9.

20. This illustrates another major concern, i.e. the small quantity of samples tested. See, e.g., page 6 of Licensee's Reference Document 20 supplied in response to TMIA Request for Production fo Documents, ("Reference Documents"), where an engineer refers to the small sample data in a handwritten note at the side of the test result. See also TPR 2/18/83 at p. 16.

21. In addition, because of the experimental nature of the repair process, undoubtedly contributing to Licensee's desire to protect from public disclosure even the statistical data base relied upon for the qualification program, and because Licensee has thus been forced to rely on a limited data base to begin with, reliance on whatever data has been experimentally developed through Licensee's testing is made all the more statistically significant. See, e.g., Attachment 3, ¶¶ 2, 6, referring to data unavailable before testing.

22. Yet there is evidence that certain data developed, which should have been statistically significant, was either ignored or discounted by Licensee. The test results of an entire test block, with leak results "initially higher than we had expected," Transcript of January 28, 1983 ACRS combined subcommittee meeting, ("ACRS Tr.") at 91, are not mentioned in Licensee or Staff motions. In Reference

Document 7 at p. A-46, mention is made of results from test block H, where leakage was 60 times allowable limits. No mention is made in Licensee's Facts.

23. There are also numerous "failure discrepencies" noted in some of B&W's test reports, of which there is no mention, and apparently to which no statistical significance is attached.

24. For example, in Reference Document 22, a series of pullout and leak tests results and failure discrepency reports ("FDRs") are described on tube mock-up blocks.

25. In tests on Block L, the tube in the #2 hole was improperly placed. In the middle of the test, it was removed by dry drilling and replaced with tubing of the same heat number which had been left over from the "5 year" qualification testing. FDR 15-001. The effect of this tube change is not factored into the test result.

26. Moreover, during the above referenced tube change, approximately 8% of the qualification hole surface oxide coating was disturbed. The supervisor's recommendation was to "accept as it, damage to oxide coated area should not seriously affect leakage rate. If necesarry, this tube could be excluded from test sample at a later date." FDR 15-002. Without a better explanation as to why an 8% change in the oxide coating is not statistically significant, a genuine material issue of fact is raised.

27. In another Block L test, tube #7 was accidently penetrated at the thermocouple location while drilling Block L for thermocouples. The disposition of this was as follows: "The location of the drilled hole makes leak testing impossible, tube must be plugged during leak testing, plugs removed during thermal cycle to allow proper temperature

distribution. Thermocouple relocted 1/8" circumferentially from designated position. Redrilling the hole and removeing tube #7 from data should not cause any problem. FDR 15-003. (step 6.3). No statistical significance it attached to the removal of this tube from an already limited data base, and without further explanation, a genuine material issue of fact is raised.

28. Further, spurious thermocouple readings at three locations on each of Blocks J, K, and L were caused by a malfunctioning Texas Instrument recorder. These involved thermal cycle tests, where one of the objectives is to measure the delta T. The determination was made, however, that these small temperature variations should not affect the test results. See FDR 15-007 Yet due to lack of confidence in these Texas Instrument recorder readings, the thermocouples were disconnected from that recorder and connected individually to a Doric 400 temperature recorder. This allowed considerable time to elapse between readings. Therefore those readings were not accurate. Id. at p. 3. The inaccuracy of temperature readings affected delta T data on those blocks involved. There is no indication that this test was rerun in order to obtain more accurate data.

29. The Penn State study, which was a qualification test used to determine residual stress in the inner tube surface of the transition region, produced results which can be interpreted as unfavorable to qualifying the kinetic expansion repair. See, TDR 007 at p. 2-15, 16. This study showed stresses in the transition zone, which is an area of high residual stress, Reference Document 55 App. 1 p. I-2, to have

> varied substantially in localized region within the transition zone, and the maximum hoop and axial residual stress as about [PROPRIETARY] ksi, respectively. The 34 ksi value exceeds the .45% Y-S criteria by 48%.

—— Reference Document 19, p. 43/79. (emphasis added). B&W rationalizes the result by simply saying that it shouldn't matter, since the average tensile stresses are "well below" that criteria. This skewed result was not mentioned in the Licensee or the Staff motions. See, e.g., Licensee Facts ¶ 19-24. It should go without saying that the purpose of this program is to test maximum, not average conditions, and to the extent that repair criteria for residual stresses is exceeded in actual operation, this aspect of the qualification program is seriously flawed.

Additional Concerns

30. The qualification program raises additional concerns which constitute genuine material issues of fact. The maximum pullout load tested was defined by Licensee to be 3140 lbs, meant to simulate loads in a MSLB. In addition to problems regarding pullout load data and the reliability of test blocks used, see ¶¶ 8-29, supra, Licensee did no analysis to determine whether individual tube loads would vary during a MSLB, and exactly what those loads could be, particularly in sensitive areas like peripheral tubes where axial stresses are the highest. SER at 4.

31. The same problem is applicable to compressive load testing, which simulated a 1025 compressive load. Licensee Facts ¶ 30. This testing was to take into account lost preload resulting from the kinetic expansion repair. Lose of preload, which adds to the compressive load, violates Licensee's repair goal and was an original staff concern because of bowing and buckling which could result. Attachment 1. See SER at p. 16, 20. And while the 1025 lbs. is higher than the "conservative maximum compressive load postulated for normal,

transient or accident design basis conditions" of 840-lbs., assuming lost preload, Licensee Facts ¶ 29, bowing was detected at 800 lbs. Licensee Facts ¶ 25. Further, lateral displacement occurs at least at 1025 lbs. Licensee Facts ¶ 25.

32. Licensee simply speculates that there is no safety significance to the bowing and lateral displacement which would result, Licensee Facts ¶ 31. Licensee provides no reasoned support for this position, nor does the Staff explain why its previous concerns are no longer relevant.

33. Additionally, TMIA repeatedly asked Licensee in interrogatories to define the precise location within the tube bundle of tubes tested. Having received no answers, e.g. Licensee Response to TMIA Interrogatories 1-4, one can only assume that tube location was not considered or factored into the pullout and compressive load tests results.

34. Further, tests conducted on the Mt. Vernon steam generator, Licensee's major load pullout verification program, Licensee Facts ¶ 17, are of questionable value because of the significant differences between the Mt. Vernon and TMI-1 steam generators.

35. Not only was there the general problem already referred to in ¶¶ 8-18 supra in attempting to duplicate the physical tube properties, but the Mt. Vernon steam generator had no post weld heat treatments, and of course had no operating experience. TDR 007, p. 2-7. Even if these deficiencies were factored into the results, which is unclear, their accuracy at least raises a genuine material issue of fact.

36. Additionally, the qualification program was defective because of certain key tests which were not conducted. For example, Licensee conducted no tests to determine if and why certain tubes failed earlier than others, even within the two month timespan which Licensee alleges that the cracking occurred. Licensee Response to TMIA Interrogatory 11. Such information could be vital in better predicting the cause and sequence of cracking. Licensee asserts that "no evidence" exists that certain tubes failed earlier than other, but there is no evidence tests were conducted to determine this. The fact that no leakage was "reported" before September 1981, id., is simply not conclusive evidence that certain tubes failed, or began failing before September 1981.

37. An additional test, which the TPR originally strongly recommended and later suggested, but which was not done, was a flow induced vibration test. See Licensee Response to TMIA Interrogatory T-29. Among the reasons Licensee presented for not conducting this test were that "such an addition would severly impact the complexity, reliability, and schedule of the program." Reference Document 64 at p. 3. These are inappropriate considerations given the risks and uncertainty associated with the crack propagation potential for undetected cracks. See ¶¶48-68, infra.

38. Further, qualification tests were not done to determine the effects of broken off tube chunks in certain tubes which were broken during kinetic expansion repair, due to the intersection of axial and circumferential cracks in the heat affected zone (HAZ) at the top of the tubesheet near the seal weld. See TPR 008 at p. 16-17. The HAZ is an area where the residual stresses are highest, Reference Document 55,

and IGA has been found in the HAZ in close to 50% of the tubes. Licensee Response to TMIA Interrogatory 33.

39. Further, no tests were conducted to determine the effect of corrosive contaminant on stress levels or the fatigue life of TMI-1 tubes, because corrosive contaminants were determined by Licensee to have no affect on stress levels or fatigue life. Licensee Response to TMIA Interrogatory 3. Yet all cracks were determined to have IGA, so one can reasonably assume the corrosive contamination had some affect on stress levels and/or fatigue life.

40. Moreover, Licensee's own statistics provide a 99% confidence level that 99% of the tubes meet the qualification standard. While this may appear high, it at least demonstrates that Licensee can not quarentee the qualification of approximately 29 tubes. Yet as staff consultant Dillon pointed out, even a small number of defective tubes should be of enormous concern in this situtation. ¶ 63 , infra.

Tube Selection

41. There are additional genuine material issues of fact concerning the process used by Licensee to qualify and select which tubes to expand and which to plug (and stabilize). Once qualification criteria were determined, fundamental to the program's success was an accurate mechanism to determine which tubes met the qualificaiton criteria, and which degraded tubes required plugging and stabilization. SER pp. 25-26.

42. Licensee's reliance on eddy current testing (ECT) as the mechanism to determine which tubes met this criteria was faulty because ECT can not accurately detect tube defects.

43. There is no dispute that ECT can not pick up all cracks. During the ACRS combined subcommittee meeting of January 28, 1983, Mr. R.F. Wilson, Vice President for Technical Functions for GPU Nuclear, stated,

> "We then started thinking about things we might not know or which are different in the generator compared to when it went into service. The thing that stands out very succinctly is there is the possibility due to the threshold of sensitivity of our inspection and nondestructive examination of the generator. Remeber there is a million and a half lineal feet of tubing in those generators, and while we pulled 100-odd feet of those, we have probably done more metallurgical eddycurrent examination than anyone alse in the country. There is a limit as to what we can find, and there can be -- and we cannot rule out that there are incipient cracks or defects on the surface of the tubing.

ACRS Tr. at 135. See also, Id. at 52 ("So there is a band of sensitivity around which it is difficult to determine exactly what is going on.").

44. Identical concerns were expressed by Licensee's Third Party Review Group in its February 18, 1983 report submitted as an

attachmentto the Staff's SER (TPR 2/18/83) at p. 10. See also, Licensee's TDR 008, Rev 3 at p. 79-81.

45. Further, Licensee recognized before the ACRS that "the tube sheet itself does give a signal which results in higher background noise," and that, "the signal-to-noise ratio is not as optimum within the tube sheet, and therefore our sensitivity is decreased within the tube sheet." ACRS Tr. at 57.

46. Adding to the ECT uncertainty is Licensee's apparent inability to determine the smallest crack opening displacement detectable by its methods, since Licensee was asked to describe this in a TMIA interrogatory and as far as TMIA can tell from Licensee's indirect response, Licensee could not. Licensee Response to TMIA Interrogatory 22.

47. Not only can thruwall cracks exist and go entirely undetected, TDR 008 at 81, but the ECT process itself can result in "random equipment and interpretation error. Id. Yet there is no dispute that Licensee has chosen to rely upon results of the potentially flawed ECT process as the basis on which it asserts that undetected cracks will not propagate during operation, id.

48. The TPR discusses the question of whether tubes with undetected cracks, which it calls the "primary candidates for breaking tubes," will leak before they break. TPR 2/18/83 at p. 17. The TPR concludes yes, based on ERPI's analysis that "small defects at the ID of a tube have about the same fatigue crack growth rates toward the OD as along the circumferance, provided that the stress throughout the wall are axisymmetric and tensile." Id. (emphasis added). Yet Licensee states in its Facts, ¶ 98-100, that stresses in all areas

other than the transition zone should be considered asymmetric, thus challenging the credibility of this TPR conclusion.

49. Further, in the area of the transition zone, the TPR does conclude that tubes with undetected defects may indeed break before they leak, precisely because the stresses there are not simply axisymmetric, i.e., there are other stresses which are superimposed on the axial stress. TPR 2/18/83 at 17. See also, the Penn State study, discussed 29, supra.

50. Further, in discussing stress levels in the steam generators, the TPR asks if they "can be expected to be significantly higher, or the strength of the tubes significantly lower, than those in a normal OTSG?" TPR 2/18/83 p. 14-18. It concludes, "from the information received, the answer appears to be negative, with a minor qualification regarding the undetected defects that are left in the tubes." (emphasis added). The TPR also states that small defects could leave tubes in a weak condition.

51. Moreoever, the stress intensity approach used by TPR and the Staff cannot accurately determine the state of affairs for partial through-wall cracks. Licensee's Motion for Summary Disposition at p. 31, lines 11 and 12. Licensee Facts ¶ 104. In fact, the stress intensity factors as defined in the linear elastic fracture mechanics are zero at the intersection of the crack and free surface. Hcwever, damage does occur near the surface. Attachment 2, pp. 3-4.

52. Further, the TPR and the Staff have apparently failed to understand that the stress intensity, when it can be applied, may not be a monotonic function of the crack length under thermal environments. See, Licensee's Motion for Summary Disposition at p. 31-32; Licensee

Facts ¶ 105. Global instability can occur for cracks that are much smaller than those estimated by approximated and invalid analyses. Thepoint is that the true nature of the thermal crack behavior may not be reflected by the analysis made by TPR and the Staff. Attachment 2 p.4.

53. Thus there are genuine material issues of fact as to the extent of ECT undetected cracks, particularly whether they will propagate during operation, and the potential consequences of small crack propagation.

54. There are other genuine material issues of fact regarding the fracture mechanics analysis used to interpret the ECT results. The TPR commented at p. 10 of its TPR 2/18/83 that "through a fracture mechanics analysis, GPUN arrived at a tentative conclusion that the steam generator defects below a certain size range will not propagate due to flow induced vibrations." See also, TPR 5/19/83 at p.8.

55. Licensee's fracture mechanics methodology was criticized for is failure to address accumulative damage, by Dr. George C. Sih, Director of the Institute for Fracture and Solid Mechanics, Lehigh University, in testimony presented before Senator Arlen Specter during recent hearings held in Harrisburg. Attachment 4. Dr. Sih further stated, with regard to the fracture mechanics theory used, that it is not justifiable to claim as the state-of-the-art which is irrelvant to the safe eveluation of nuclear reactor components. Other means and approaches for evaluating the damage caused by surface flaw have been available in the open literature for many years. Attachment 2 p.4.

56. See also, the report of Staff consultant Dillon, at p. 7, ("I understand the fracture mechanics calculations of residual tube

properties in circumferentially cracked tubes are presently unsupported by experimental data).

57. Further, the TPR refers to the "large extrapolation of a lmited crack-propagation-rate data base," making a firm conclusion on crack propagation "hard to substantiate," TPR 2/18/83 at 10. By its May revision, the TPR still felt extrapolations were necessary, despite additional data supplied to it, prompting it to suggest additional tests be done which Licensee has said it will not do. TPR May report at 5. See Licensee Reference Documents 63, 64. This problem is of obvious concern to the TPR. The Staff simply ignores this recommendation.

58. It is possible that a crack could propagate throughwall in one day. ACRS Tr. at 78-79. Futher, plugged tubes which are not stabilized may continue to degrade and severe. ACRS Tr. at 33.

59. ECT randomly conducted after kinetic expansion repair revealed 15 tubes with small pits and scratches below the sensitivity of the .540" standard differential high gain probe. SER at 14. The Staff decided to rely on mid-cycle ECT to "confirm the decision that they are acceptable," but was clearly unable to confirm this at the present time, providing no explanation as to why this has no safety significance.

60. If small undetected defects which exist close to the lower portion of the tubesheet propagate during a transient and the tube shrinks or the joint slips, an actual guillotine break could occur. Further, the same could happen to tubes with free span cracks which have been plugged but not stabilized. Thus, an "in-sheet" break can not be guarenteed.

61. Further, the TPR orginally recommended that because the particular cracks at TMI-1 are stress corrosion cracks, tubes with ID indications <40% throughwall be plugged. TPR 2/18/83 at p. 6. Three months later, the TPR withdrew this recommendation, indicating it felt assured that cracks of critical size would be detected in enough time to avoid breakage. The Staff seems to go along with this. Yet as has already been discussed, supra, Licensee's criteria and method for determining critical crack size is a major open question. Further, the TPR's original point was that the stress corrosion nature of the cracks warranted this precaution. This point is simply dropped by the TPR, and not addressed at all in the SER.

62. The TPR also recommends that tubes within three rows of the lane region and the wedge-shaped region at the periphery which have OD indications at the 15th support plant or higher, be plugged as has been done in other plants. TPR 2/18/83 at p. 6. By May, the TPR withdrew this on this recommendation also, insisting it is sufficient that GPU only plug the first row. The SER does not discuss the issue. But the original point was that this is standard in all steam generators. There is no explanation from the TPR or the Staff why the TMI-1 steam generators warrant an exception.

63. Finally, the decision of Licensee and the Staff to ignore or discount the significance of potential ECT errors in qualifying tubes for kinetic expansion repair, and in determining which tubes can safely remain in operation without plugging, belies such concerns as articulated by staff consultant Dillon,

> "the policy which dictates kinetic expansion and resealing of qualified tubes and plugging of those tubes not suceptible to successful resealing infers a crack detection system of considerable reliability.

> The presence of even a few tubes capable of open-ended breaks is a matter of serious safety concerns.

Dillon at 9.

In-Process and Post Repair Testing

64. Licensee maintains that meeting the "design basis " through the qualification program and in-process repair testing program "provides the same reasonable assurance that tube ruptures will not occur during any postulated transient." Licensee Facts ¶ 57.

65. It has previously been demonstrated that the qualification program is deficient. See, supra. The random in-process testing which was done is additionally inadequate to provide any confindence repairs will insure tube integrity. Thus, the design besis has not been met through the qualification and in-process testing program.

66. Moreover, by failing to run the system through some hard transients in post repair testing, there is no technical basis to conclude the repairs can safely withstand such transients.

67. Clearly, no amount of qualification testing can insure that each individual tube has been properly expanded, or that it meets the qualification criteria. Each tube is unique and the only way to be sure each was properly expanded is to examine each of the 29,000 tubes individually, or to run the system through the actual loads which it was qualified to withstand.

68. Licensee would probably argue that the sheer number of tubes which had to be reparied made it impractical for Licensee to conduct 100% profilometry verification or post expansion diameter guaging and depth check samplings. Licensee Facts ¶ 41, 43.

69. Yet clearly, the individuality of each tube and its physical properties, as well as its surrouding environment, raises questions

concerning potential problems. And while Licensee may have tried to take precautions to avoid minimize the risk of such problems, they are of sufficient concern to have at least demanded more extensive post repair testing.

70. First, while Licensee tried to take precautions to remove, before expansion, impurities other than corrosion in the gap between the tube and tubesheet, the potential for the existence of such impurities was recognized by the Licensee. ACRS Tr. at 88.

71. Second, tubes in the outer periphery of the tube bundle, where a majority of tube defects are located, may have "caused problems" because of difficulty in injecting the candle in those tubes. See Attachment 5, p. 1 (inside).

72. Third, not only were there occassional misfires, see ACRS Tr. at 116, Reference Document 18 at §2.3.5.7, but in at least one instance, a tube misfired and its location could not be more precisely defined than "one of the first 7000 tubes expanded in steam generator B." Id. GPU chose not to reexpand those 7000 tubes, stating,

> [I]n the unlikely event that the unidentified tube joint slips, the worst case assumption would be for it to lock up in the axial direction and lower the tube under some conditions.... A lowered tube could conceivably wear against a neighbor and cause a rupture of that tube. An analysis has been made that indicates that plants can safely shut down in the event of a tube rupture.

Id. at 2-22-23.

73. Such a rationale is obviously inadequate. Licensee's stated justification for proceeding with these repairs is the assurance that such a rupture, particularly one which can damage surrounding tubes,

can not occur. The safety significance of this is a genuine material issue of fact.

74. Given the potential problems, as well as uncertainties regarding qualification testing, it is somewhat remarkable that post-repair testing was so limited.

75. For example, despite Licensee's claim that "the hardening effect on both the inner and outer surfaces of mechanically expanded tubes is more pronounced than in the kinetically expanded tube," and thus "kinetic expansion may be expected to be less susceptible to stress assisted corrosion cracking than the mechanical expansion," Licensee Facts ¶ 22, Licensee did no post repair hardness testing on corroded tubes, claiming such tests are not required to support any conclusion concerning the effectiveness or adequacy of the repair process." Licensee Response to TMIA Interrogatory 15. See Attachments 2 and 4, p. 2.

76. In addition, when questioned before an ACRS subcommittee on a major issue of concern, i.e. whether kinetic expansion may have caused the tubes to weaken, thus increasing the risk of tube failure, Licensee responded that they had examined the issue only peripherally, explaining,

> We have looked at wall thinning due to the explosive expansion process compared to hardening due to rolling. Hardening is a much less wall-thinning operation. What that says exactly I'm not sure, but that's the kind of a comparative statement between the two, between the ratcheting.

ACRS Tr. at 165. (emphasis added).

77. Second, the only post repair plant performance tests performed were the bubble leak test, Licensee Facts ¶ 46, and the hot functional test, where the steam generators were put through normal operating

conditions. Licensee Facts ¶ 48 et seq. These tests can not overcome the already demonstrated deficiences in the qualification program for several reasons.

78. First, leak test results may be misleading. Licensee has claimed that leaks are self-sealing because corrosion products will deposit in the cracks and seal the leaks. Attachment 6-1 ; ACRS Tr. at 99, 100. Further, as the Staff points out, due to the loss of pretension, the leakage rate for various threshold cracks may be reduced. SER at 21. Thus, decreased leakage may mask cracks which additional compresive loads and bowing could cause to mouth open, or top create new corrosion initiation sites. See Attachment 1, at p.2.

79. Further, Licensee has remarked that there is inadequate technical data to really know the significance of corrosion sealed cracks as they impact on tube integrity. ACRS Tr. at 99-100.

80. Second, the repaired system has not been run through any transient conditions, such as those listed in TMIA Contention 1.a or a MSLB. Licensee asserts that by qualifying tubes to withstand a 3140 lb pullout load or 1025 lb. compressive load, there is no need to test the system out. Yet there is a clear need to determine if these tubes actually can withstand these loads while maintaining tube integrity. See, supra.

81. In response to TMIA Contention 1a, Licensee discusses the impact of one transient: inadvertent actuation of emergency feedwater at high power. Licensee Facts ¶ 62 et seq. Licensee states that if emergency feedwater is injected into the steam generator, which Licensee asserts is unlikely, the resulting thermal stresses will not be enough to cause a rupture because the location of any thermal shock

would be remote from the repaired portion of the tube. Licensee Facts ¶ 65. TMIA members are not technical experts and thus we do not know the precise location where the EFW may strike the steam generators. Yet it seems clear that no matter where the direct thermal shock is, the increased load will pull on the entire tube, thus increasing risk of pullout anywhere on the tube, particularly including areas of high residual stress like the transition or HAZ zone. The effect of this particulary transient has not been adequately explained by Licensee.

82. Further, hot functional testing did not simulate the stresses which would result from a rapid cooldown following a LOCA, which by Licensee's own estimates would be 2641 lbs. Licensee Facts ¶ 67.

83. Moreover, at TMI-1, 31,000 tubes failed, and 29,000 tubes were kinetically expanded. The TMI-1 steam generators are is considered by the NRC to be the worst damaged steam generators in the country. See, Statement of Harold Denton, Director of Nuclear Reactor Regulation, before the Committee on Interior and Insular Affairs, February 1, 1982. the amount of damage can not compare to that of any other steam generator in the industry. Yet the accident consequences of one rupture i.e. what can be expected in a normal, design basis steam generator, was of sufficient concern to cause the Staff to write in 1982:

> During postulated accident conditions, such as main steam line break (MSLB), feedwater line break, or LOCA, the S.G. tubes are subject to increased pressure differentials and possible pressure waves (e.g., subcooled decompression phenomena) and vibrational loadings, These loads increase the potential for failure of degraded S.G. tubes, which could exacerbate the accident sequence. In the event of MSLB, failed S.G. tubes would provide a leakage path from the primary to secondary system and several potential leak paths for radioacitivity to the environment would then exist. In the event of a LOCA, the core reflood rate could be retarded by seam binding....S.G. tube failures

> would create secondary to primary leak path which aggrabates the steam binding effect and could leak to ineffective reflooding of the core....Large MSLBs and LOCAs are considered extremely low probability events, but are postulated as bounding conditions. More realistice events might include small and intermediate size MSLBs and LOCAs. Although these postulated accidents pose a less severe challenge to S.G. tube integrity, tube ruptures leading to or following such events could have serious consequences.

SECY 82-72, p. 3,.

84. Licensee and the Staff attitudes that qualification testing is sufficient to guarentee that this system can withstand transients, belies such serious concerns.

License Conditions

85. Licensee has assured compliance with certain required "license conditions" to provide assurance against possible tube ruptures. Licensee Facts ¶ 51.

86. One condition is a requirement of plant shutdown if increased leakage of .1 gpm is detected. Licensee Facts ¶ 52. While this limit may be only 10% of the technical specification current limits, the tech specs are themselves "the most liberal in the PWR industry." Attachment 1.

87. As has already been discussed, leak rates may indeed be misleading, and may be inadequate to detect cracks which propagate thruwall in one day. See, ¶ 78 , supra.

88. Further, as the Staff points out, due to the loss of pretension, the leakage rate for various threshold cracks may be reduced. SER at 21. Thus, decreased leaks may mask cracks which additional compresive loads and bowing could cause to mouth open.

89. Also, the TPR's support for the established administrative limit of .1 gpm is based in part on a fracture mechnics analysis which

can be questioned. See, ¶¶54-5 supra. Moreover, according to resumes supplied by Licensee, no one on the TPR has any expertise in the fracture mechanics field. See, Licensee Response to TMIA Interrogatory T-2.

90. Another License Condition is a promise to conduct a special ECT after either the first 90 or 120 of operation. Licensee Facts ¶ 53. Even apart from the problems raised by ECT, (see, ¶¶ , supra), a one time ECT can hardly guarantee that as the plant ages, cracks will even be noticed. The Staff originally believed the "prudent" approach to be at least on ECT after 30-60 days, followed by one after 150-210 days, and then during refueling. Attachment 1. No explanation for this reversal of position is provided.

91. In addition, power ascension will be at staged intervals. The TPR, however, recommeded "substantial" extended operation at low power, and even suggested operation with one steam generator at a time at high power.

92. Licensee also will rely on long term corrosion tests to simulate operating conditions. As discussed previously, accurate simulation of actual TMI-1 tube properties is virtually impossible. See, ¶¶, supra.

93. In conclusion, there are genuine material issues of fact regarding TMIA Contention 1a.

B. TMIA CONTENTION 1.b

1. Licensee has determined questions concerning simultaneous tubes ruptures to be irrelevant. Licensee Facts ¶ 68-71. Licensee disputes concerns expressed by ACRS subcommittee Chairman Paul Shewmon and similar concerns in SECY 82-72.

2. The Staff asserts that the Paul Shewmon's memo, as further interpreted by Richard Major, is not supportive of the contention because Paul Shewmon was not concerned with the risk of simultaneous ruptures, but rather with tube plugging and soley with free span defects. Staff Facts ¶ 2, 3, 8-10.

3. The Staff's position clearly misinterprets the clear language of both the Shewmon and Major memos. Both address two concerns, one being tube plugging, the other being simultaneous ruptures.

4. Significantly, the Staff did not obtain an affidavit from Shewmon himself. The Staff's twisted interpretation is based on an affidavit of someone who had no first hand knowledge of Paul Shewmon's intent, and whose interpretation should be given no weight.

5. On the other hand, in the absence of an affidavit from Shewmon, his remarks during an ACRS subcommittee meeting, which both Licensee and the Staff attended, should be entitled to a great deal of weight. Shewmon stated there,

> From a personl viewpoint, it seems to me that the thing you have to show is the odds are vanishingly small that you're going to have trouble on both steam generators at once because of the excursion of faults you have had heretofore. And that may be an impossible problem, but it seems to me that that, at least in my mind, is a critical question rather than fatigue cracks.

ACRS Tr. at 159.

6. Further, Shewmon's concern was supported by the TPR's first report, which concluded "safe operation of the TMI-1 plant after repair of the steam generators will be dependent on several remaining major activities; [including] completion of analysis including ... the contingency of multiple tube ruptures. TPR 2/18/83 at 4. Clearly, the TPR meant to distinguish the contingency of multiple tube ruptures from other possible situations which were tested and analyzed by Licensee. Licensee asserts that "these comments were intended merely to flag to the reader that the conclusions drawn were incomplete at that time since Licensee had no completed its analytical or planning efforts." Licensee Response to TMIA Interrogatory T-8.

7. Three months later, the TPR, for unexplained reasons, withdrew this as an open issue needing resolution before plant start up. The basis for the TPR's later conclusion that such analysis was no longer required is unexplained and at least raises suspicious questions. See, TPR 5/18/83 at p. 2. This is particulary true since the TPR was apparently sufficiently concerned with the possibility of simultaneous ruptures that it suggested running one steam generator at higher power than the other, which would have put this system in so abnormal a configuartion that GPU refused to do it. TPR 2/18/83 p. 12; Reference Document 64.

8. It is clear that during all qualification testing done by Licensee in 1982, the consequences of multiple tube ruptures, which including ruptures in both steam generators, was never treated as a subject warranting special testing. And in fact, Licensee later asserts with regard to the simultaneous rupture case, that since this is "not a design basis accident for any plant, neither the TPR nor the

Staff have required analysis for such an event in their respective approval for returning the plant to service." Motion at p. 26.

9. Clearly, as Paul Shewmon noted above, the number of failures and unique type of repair used in the TMI-1 steam generators demand that the risk and consequences of simultaneous ruptures receive special attention. The Staff and Licensee can not simply close their eyes to a contingency which the Staff has already considered of major importance with regard to normal steam generators. (See, SECY 82-72, where the Staff notes that if ruptures occur in both steam generators, unless the plant can be rapidly depressurized and brought onto Residual Heat Removal, there is the potential to continuously lose ECC water outside the containment.)

10. Further, while the Staff maintains such a possibility is unlikely, no probabalistic risk assessment has been done. Attachment 7.

11. In contradiction to their states position that the simultaneous tube rupture possibility requires no separate analysis, Licensee and the Staff both recognize that this contingency must be considered in operator training and emergency procedures. See, TDR 406.

12. However, whether emergency procedures will provide adequate guidance to instruct operators in the event of such an accident is a significant open issue. There is no question that when a simultaneous rupture occurs, no automatic system can cool the plant down. This type of accident requires the operators to respond with spur of the moment decisions, so that training is crucial. Further, operator instructions for simultaneous ruptures currently instruct operators to follow the

steaming, filling, and isolation criteria as written for single tube ruptures, which themselves violate a number of past safety limits.

13. For example, the procedures reduce the subcooling margin in the RCS, which risks the formation of steam bubbles in the reactor and reactor coolant piping which could block the circulation of cooling water through the core. The Staff says that this will not occur, because operators have been instructed not to let it occur. Staff Response to TMIA Interrogatory 92. But see, ¶ 19, infra.

14. Further, reducing the subcooling margin may violate the "fuel in compression" limit, which could cause fuel rods to swell or balloon and thus block or reduce the cooling water flow between the fuel rods. The Staff acknowledges that this could occur, but rationalizes that because steam generator tube ruptures are expected to occur at cooldown, thus involving only moderate to low cladding temperatures, the affect on the fuel will be negligible. Staff Response to TMIA Interrogatory 93. This assumption relies entirely on a possibly incorrect interpretation of the original tube failure scenario. See Contention 2.a, infra.

15. As is indicated in TDR 406, Rev. 1, p.4, the existing tube to shell delta T at TMI-1 had been 100 °F. But Licensee discovered that before tube/shell delta T exceeded 100°F, the leaking tube was placed under tensile stress and the tube was pulled into a circumferential tear. Thus, Licensee and the Staff have required operators to keep the delta T to 70 °. This is a clear safety measure meant to eliminate the tension or load on the tubes in the event of a transient which could result in tube breakage. However, the NRC has no instrumentation requirements to measure delta T because the Staff claims such instrumentation is not safety related. See, Staff

Response to TMIA Interrogatory 93. Thus, there is currently no assurance that Licensee's equipment for such measurements, if they have any at all, is reliable.

16. Second, there is no requirement that the plant computer be operable during plant operation. The Staff asserts that if computer capability does not exist, it is sufficient if the operators rely on estimations of delta T based on past cooldown rates. Id.. Further, the Staff indicated that it really does not know what the effect maintaining delta T at 70° will be on total cooldown time, but is hoping it will be small. Staff Response to TMIA Interrogatory 94.

17. Third, as the Staff admits, maintaining the delta T at 70° depends squarely on the ability of operators to precisely modulate the controls. Thus, their training is crucial. See, Staff Response to TMIA Interrogatory 95.

18. Clearly, considering that these particular types of accidents depend upon the operators to precisely respond, they must not only have complete information, which is questionable ¶ 16, supra.

19. But the operators must be extremely well-trained. Yet at p. 21 of the most recent TDR 406, a "comment" indicates that operators who were being trained in the use of the revised guidelines found the training to be of "dubious value" and B&W would not endorse the material. This raises extremely serious safety concerns when considering the environmental contamination which is risked in the event of a simultaneous tube rupture.

20. Thus, TMIA Contention 1.b raises genuine material issues of fact.

C. TMIA CONTENTION 1.c

1. Licensee's position regarding Contention 1.c is that the kinetic e pansion repair process did not in any way "weaken" the tubes or otherwis affect the retention capability or leak tightness of the plugs. See, Licensee Facts ¶ 75, regarding roll plugs; Licensee Facts ¶ 92 regarding weld plugs.

2. The TPR initially raised the question of whether tubes may have been weakened. In discussing stress levels in the steam generators, the TPR asked if they "can be expected to be significantly higher, or the strength of the tubes significantly lower, than those in a normal OTSG?" TPR 2/18/83 p. 14-18. It concludes, "from the information received, the answer appears to be negative, with a minor qualification regarding the undetected defects that are left in the tubes." (emphasis added). The TPR also states that small defects could leave tubes in a weak condition. Id. at 16.

3. The TPR's reasons that t' e kinetic expansion repair of the tubes could affect the stress levels, if the process would change the strength or dimensions of the tubes, but say further that the kinetic expansion repair process is not expected to affect significantly the stress levels in the tubes. The question of whether the strength or dimensions of the tubes were changed, to what degree they were changed, the significance of that change, and the question of how stress levels were changed, are simply left hanging by the TPR, or the SER.

4. The question of whether tubes may have been weakened was also raised by the ACRS as follows: "Perhaps that doesn't have any influence on stresses, but you do, it seems to me, increase the process of ratcheting up there from thermal expansion, and you have also

thinned the wall out where you have gone through this procedure. Have you looked at this as a possible failure mechanism? ACRS Tr. at 165-166. The question is answered in an ambiguous, inconclusive manner. See, Contention 1.a, p. 22.

5. Further, while relying on comparative hardness tests between the kinetically expanded and mechnically rolled tubes to test for tube weakness, Licensee admits that it conducted no post-repair hardness testing. Id.

6. It is well-known that increases in hardness results in a reduction in toughness. Hence, the repaired tubes with increased hardness obviously suffer a reduction in toughness and hence are no long restored to their original state. See, Attachment 2, p. 3. Sih raised similar concerns in his statement before Senator Specter's committee. Attachment 4.

7. Second, regarding rolled plugs, Licensee states that "since most cracking stopped just below the seal weld before the rolled portion of the tubes began, cracks would not be in the area engaged by the plug," Licensee Facts ¶ 80, and that the cracks which were found within the tube rolled region were circumferential and tight which would not affect the ability of the plug to hold. Licensee Facts ¶ 81, 83. Licensee also stated that "there was no general condition of IGSAC identified in the rolled region." Licensee Facts ¶ 82.

8. However, Licensee has stated in other documents that tube ends behind the seal weld have IGSAC cracks near the HAZ and down the inside surface of the tube, approximately 3/8" from the top of the tube end. Licensee Response to TMIA Interrogatory 33. Further, Licensee could only state that "at least 50% of the specimen tubes are not affected by

IGA in the HAZ," leaving open the possibility that close to 50% may indeed be affected. Id.

9. Moreover, damage to the tube ends was visibly detected after kinetic expansion repair. Licensee examinations showed cracks above the seal weld to be both axial and circumferential, so that in this area, where the cracks intersected, the kinetic expansion blew parts of the tube away. TDR 008 at 16. Further, ductility in those area appeared to be lost. Id.

10. In addition, some cracks extended through the tubing behing the weld to the tubing below, id., so in situations where circumferential and axial cracks intersect in this area, the risk that chuncks of the tube could loosen and break away similarly exists. Id. at 17. This risk can not simply be ignored with a statement that the possibility is "unlikely." Id.

11. If this should happen in a plugged tube, it seems the plug retention capability would be affected. It is also unclear whether Licensee would then by relying upon the seal weld in the HAZ as the primary pressure boundary. This is clearly a genuine material issue of fact needing further examination.

12. The fact of 23 leaking plugged tubes found after testing is claimed by the Staff to be "normal." Staff Facts ¶ 5. Yet the Staff's conclusion is devoid of any suporting data or evaluation to determine if in this highly unusual case, leaks may have been related to kinetic expansion repair.

13. Moreover, the Staff incorrectly states that the effect of kinetic expansion repair is irrelevant to the integrity of a plugged tube, since a plugged tube is no longer part of the pressure boundary. Staff Facts ¶ 6. Yet is is well recognized that plugging a tube will

not arrest degradation, so if not stabilized, a severed plugged tube could indeed damage tubes surrounding it during operation.

12. Thus, there are several genuine material issues of fact concerning TMIA Contention 1.c

D. TMIA CONTENTION 1.d

1. Contention 1.d addresses the credibility of the two reviews which attempted comprehensive evaluations of the safety questions raised by Licensee's fix for the TMI-1 steam generator problem. Neither the TPR nor the Staff in its SER conducted separate testing, but instead based evaluations primarily upon Licensee documents. The Staff also used its own consultants, whose reports, along with the TPR reports, became attachments to the SER. See, SER at p. 3, 4 where the Staff describes the TPR as "an independent operation and safety evaluation." See also, Licensee Response to TMIA Interrogatories T-8, et seq.

2. According to the Staff, the SER's purpose is to evalute the specific repair method used by the Licensee and to evaluate subsequent operation using the repaired steam generators. According to a presentation made by Licensee in October, 1982, the TPR was to determine compliance with NRC rules and regulations, and to determine the adequacy of the steam generator repairs that will allow safe operation of the nuclear unit. Attachment 6-2. Yet dispite their virtually identical missions, there were safety significant differences in the reports' evaluations. With regard to those safety issues raised by the TPR, the Staff made a specific finding that those TPR comments were "non-safety significant," SER at p. 4, providing no clear explanation why this was so.

3. And while both review groups ultimately recommended plant start-up, there were a substantial number of concerns raised initially by the TPR which do present clear safety significant questions. At no time in this proceedings has Licensee provided first hand explanations

from any TPR member as to why certain questions originally raised by the TPR suddenly became non-issues. (See, Licensee Response to TMIA Interrogatories T-1 et seq.)

4. TMIA did attempt in Interrogatories to discover the bases for TPR findings and conclusions, particularly ones subsequently reversed in later TPR documents. Despite specific instructions to the contrary, Licensee itself, the subject of the TPR's critical review, responded to all questions asked of the TPR. The conflict of interest problems are obvious, and Licensee's responses which "speak for" the TPR should be given little or no weight. Further, these explanations appear to be grounded on questionable assumptions or facts. See, infra.

5. Clearly, the TPR raised questions worthy of critical attention. Yet despite the Staff's abolute responsibility to conduct a thorough and credible review of the safety questions raised by plant operation with these steam generators, the Staff fails to even discuss the TPR's points, or explain why certain TPR advice deserves to be arbitrariy rejected.

6. Material differences of opinion are material inconsistencies, and these differences between the TPR and the Staff findings and conclusions raise genuine material issues of fact.

7. Further, the response of TPR and the Staff clearly indicates that their knowledge of fracture mechanics is limited and superficial. Fundamental misconception prevails throughout the [Licensee Motion for Summary Disposition, pp. 27-32]. What TPR and the Staff have assumed in their analyses are not consistent with the damage as they claimed to have observed in reality. Attachment 2, p. 1.

8. Finally, Licensee repeatedly states in its Motion for Summary Disposition that the analysis for crack resistance, i.e. for the mechnical propagation of fatigue cracks in the tubes, was not part of, and is unrelated to, the evaluation of the kinetic expansion repair technique. See, e.g., Licensee's Motion for Summary Disposition at p. 29. This is incorrect. One of the means of evaluating the adequcy of the expansion repair technique is in fact to analyze the propagation of fatigue cracks in the tubes. Indeed, paragraph 3 on p. 29 confirms this and yet the statement referred to above argues against it. Attention should be focused on the overall technical aspect of the problem and not whether TPR and the Staff happen to discuss a particular aspect of the tube repair technique. Attachment 2, p. 2.

Material Inconsistencies

9. The TPR concludes that the contingency of multiple tube ruptures needs to be examined. TPR 2/18/83 at p. 4. Licensee asserts that "these comments were intended merely to flag to the reader that the conclusions drawn were incomplete at that time since Licensee had not completed its analytical or planning efforts." Licensee Response to TMIA Interrogatory T-8. Three months later, the TPR, for unexplained reasons, withdrew this as an open issue needing resolution before plant start up.

10. It is clear that during all qualification testing done by Licensee in 1982, the contingency of multiple tube ruptures, which including ruptures in both steam generators, was never treated as a subject warranting special testing. And in fact, Licensee later asserts with regard to the simultaneous rupture case, that since this is "not a design basis accident for any plant, neither the TPR nor the

Staff have required analysis for such an event in their respective approval for returning the plant to service." Motion at p. 26.

11. The TPR recommends that because the particular cracks at TMI-1 are stress corrosoin cracks, tubes with ID indications <40% throughwall be plugged. TPR 2/18/83 at p. 6. Three months later, the TPR withdrew this recommendation, indicating it felt assured that cracks of critical size will be detected in enough time to avoid breakage. The Staff seems to go along with this. Yet as has already been discussed, supra, Licensee's criteria and method for determining critical crack size is a major open question. Further, the TPR's original point was that the stress corrosion nature of the cracks warranted this precaution. This point is simply dropped by the TPR, and not addressed at all in the SER.

12. The TPR recommends that tubes within three rows of the lane region and the wedge-shaped region at the periphery which have OD indications at the 15th support plant or higher, be plugged as has been done in other plants. TPR 2/18/83 at p. 6. By May, the TPR withdrew this on this recommendation insisting it is sufficient that GPU only plug the first row. The SER does not discuss the issue. But the original point was that this is standard in all steam generators. There is no explanation from the TPR or the Staff why the TMI-1 steam generators should be treated differently.

13. The TPR suggests the possibility of small cracks in the rest of the RCS, which are difficult to detect. TPR 2/18/83 p. 10. Three months later, the TPR points out indeed, attacks were found in the waste gas system and the pressurizer. Thus, while the TPR's concerns are certainly still valid, it makes a specific recommendation against

more inspections. No explanation is provided, and the SER does not discuss this.

14. With regard to its conclusion that defects below certain size range will not propagate, the TPR discusses the large extrapolation of data still required. TPR 2/18/83 at p. 10. By May, the TPR still feels extrapolation is necessary, and still suggests long-term corossion tests to simulate flow induced vibrations. It is of obvious concern to the TPR. The Staff simply ignores this recommendation.

15. In discussing stress levels in the steam generators, the TPR asked if they "can be expected to be significantly higher, or the strength of the tubes significantly lower, than those in a normal OTSG?" TPR 2/18/83 p. 14-18. It concludes, "from the information received, the answer appears to be negative, with a minor qualification regarding the undetected defects that are left in the tubes." The TPR also states that small defects could leave tubes in a weak condition.

16. The TPR's reasons that the kinetic expansion repair of the tubes could affect the stress levels, if the process would change the srength or dimensions of the tubes, and states further that the kinetic expansion repair process is not expected to affect significantly the stress levels in the tubes. The question of whether the strength or dimensions of the tubes were changed, to what degree they were changed, the significance of that change, and the question of how stress levels were changed, are simply not addressed by the TPR, or the SER, leaving a major, genuine material issue of fact unresolved.

Other Analyses

17. Licensee's Motion for Summary Disposition at p. 27, line two from the bottom, establishes the fact that the cracks in the tube do not propagate axisymmetrically. See also Licensee Facts ¶ 99-100. This implies that a three-dimensional state of stress prevails around the surface flaw. The nonuniformities referred to in the second paragraph on p. 28 and Licensee Facts ¶ 100 are not clearly defined and do not necessarily include the three-demensional effects. Attachment 2, p. 1

18. The fact that TPR and the Staff did not use the results of the axisymmetric stress analysis for the fracture mechanics fatigue or crack analysis is irrelevant. What is relevant is the non-axisymmetry character of the local stress field that should be included in a realistic evaluation of the crack failure mode. Attachment 2, p. 1.

19. Unless the circumferential cracks are completely around the tube, axi-symmetry is not preserved and the stress state is locally a three-dimensional one. This implies that even if the load is normal to the crack plane, the crack can grow in a non self-similar manner. In such a case, the analyses performed by TPR and the Staff are not valid. See, Licensee's Motion for Summary Disposition at p. 28, line three from the bottom. Attachment 2, p.1.

20. In Licensee's Motion for Summary Disposition at p. 29, lines 2 to 4 on top, the statement, "...the data were developed to characterize the material properties of Inconcel-600, and are independent of material or loading geometry", is self-contradictory. It is well-known that all data collected from specimen tests are sensitive to changes in specimen size and loading rates. Therefore, it is necessary to simulate the conditions experienced in the structural components when

collecting material data. No justification along this line has been given by TPR and the Staff on Inconel-600. Attachment 2, p.2

21. If the increase in hardness during repair is claimed to be beneficial, then the simultanious decrease in fracture toughness should also be pointed out and evaluated accordingly. See Licensee's Motion for Summary Disposition at p. 29; Licensee Facts ¶ 101. This relation was not discussed. In this respect, the so-called "toughness" factored into the fatigue model used by the TPR and the Staff may not be valid, particularly when yielding occurs as implied on p. 30. Attachment , p. 2.

22. The concept of stress intensity depends on homogeneity of the crack tip stress field which prevails only when the material is predominantly in the linear elastic range. See Licensee's Motion for Summary Disposition at p. 30. top; Licensee Facts ¶ 102. When yielding or plastic flow occurs, the local stress field becomes non-homogeneous and the concept of a stress intensity ceases to apply. Therefore, the argument outlined on top of p. 30 is irrelvant. Attachment 2, p.3.

23. A fundamental misconception appears in line 10 on p. 30. See also, Licensee Facts ¶ 102. The fracture toughness of a material does not change when yielding occurs. The load carrying capacity of the specimen or structural component on the other hand does increase. Attachment 2, p.3.

24. No claims were ever made that hardness was directly associated with crack growth. See, Licensee's Motion for Summary Disposition at p. 30, middle; Licensee Facts ¶ 103. Neverthless, it is well-known that increases in hardness results in a reduction in toughness. Hence,

the repaired tubes with increased hardness obviously suffer a reduction in toughness and hence are no long restored to their original state. Attachment 2, p. 3.

25. Despite the assertions by Licensee, at Licensee's Motion for Summary Disposition at p. 31, top; Licensee Facts ¶ 104, the propagation of small and/or large cracks in a thermal environment is important to the kinetic expansion repair technique since the restoration of the system to its original state is at issue. Hence, it would be relevant to establish the life discrepancy of the repaired tubes as compared with those used in the original design. Attachment 2, p. 3.

26. Further, the stress intensity approach used by TPR and the Staff cannot accurately determine the state of affairs for partial through-wall cracks. Licensee's Motion for Summary Disposition at p. 31, lines 11 and 12. Licensee Facts ¶ 104. In fact, the stress intensity factors as defined in the linerar elastic fracture mechanics are zero at the intersection of the crack and free surface. However, damage does occur near the surface. Attachment 2, p. 3-4.

27. The TPR and the Staff have apparently failed to understand that the stress intensity, when it can be applied, may not be a monotonic function of the crack length under thermal environments. See, Licensee's Motion for Summary Disposition at p. 31-32; Licensee Facts ¶ 105. Global instability can occur for cracks that are much smaller than those estimated by approximated and invalid analyses. The point is that the true nature of the thermal crack behavior may not be reflected by the analysis made by TPR and the Staff. Attachment 2, p.4.

28. To conclude, the relevant isse is the validity of the technical evaluation made by TPR and the Staff on the repaired tubes. The problem must be viewed in its entirety based on consistency and validity of the technical approach. The fracture mechanics discipline is not limited to the views and definitions as conceived by TPR and the Staff. Disposal of the issue on legal grounds as the sacrifice of techincal understanding and safe control can further lead to unexpected shutdowns and further repairs, imposing additional burdens on an alrady ecomonically-illed nuclear industry. Attachment 2, p.4.

E. TMIA CONTENTION 2.a

1. TMIA Contention 2.a alleges that because the corrosive contaminant and original failure analysis have not been properly identified, Licensee's assertion that corrosion will not reinitiate during plant operation is undermined.

2. Licensee and the Staff assert that by disallowing conditions which could recreate the unique combination of chemistry, temperature, and oxidation which allowed cracking to occur within a relatively short time in 1981, cracking will not reoccur. Licensee Facts ¶ 134, 135. Implicit in the assurance that these conditions will not reoccur is the assumption that the unique combination of chemistry, temperature, and oxidizing conditions which allowed cracking to occur, has been precisely identified.

3. Both Licensee and the Staff claim that the causative agent has been clearly identified, and that the failure scenario has been conclusively determined. See Staff Facts ¶ 2, 4; Licensee Facts ¶ 123.

4. The Staff argues that despite the fact that the specific mechanistic steps involved in the sulfide induced stress corrosion cracking have not been clearly established, an overall conclusion can be reached affirming Licensee's analysis as to the cause of the cracking. Staff Facts ¶ 3. How the Staff reached this conclusive determination without any confidence that the cracking sequence is known, is itself a genuine material issue of fact.

5. Further, the Staff does not support its position that the conditions which caused cracking have been identified. Staff Facts ¶ 4. It merely states that "a reduced sulfur species was the causative

agent," Id., saying nothing about the actual cracking conditions, including oxidation states.

6. Licensee argues that expert consultants, Batelle and B&W, were retained to develop the cracking scenerio. Licensee Facts ¶ 107. However, Licensee later explains that Batelle and B&W were merely hired to conduct confirmatory testing on an already proposed scenario. Licensee Facts ¶ 136, 137; Giacobbe Affidavit ¶¶ 44-51.

7. Further, even Batelle and B&W disagree in what Licensee describes as "immaterial" respects. Licensee Facts ¶ 107. No explanation is provided as to what these "immaterial respects" are, to allow an independent evaluation of their significance.

8. Licensee also supports its analysis with reference to unnamed "scientific literature." Licensee Facts ¶ 122. Licensee provides no information from which one could conclude that such "literature" is in fact supportive of Licensee's analysis.

9. Licensee presents its proposed chemical analysis at Licensee Facts ¶ 112 et seq., and failure scenerio at Licensee Facts ¶ 123 et seq. No mention is made of the uncertainty presented previously by Licensee before the ACRS, where Licensee stated:

> There are a number of unknowns which actually increase the uncertainty of predicting this potential for further corrosion. And these unknowns are addressed here as the next four points. We really don't know what the total amount of sulfur is in the reactor coolant system. Sure, we have done sampling to try to indicate how much is there, but we really don't have a definitive value for the total amount of sulfur. Even if we did have that information, we don't know what the threshold value for deposited sulfur in corrosion film, what the threshold value is for that to cause corrosion of sensitized Inconel 600 in PWR environments.
>
> We are sure that that threshold is very high during operating conditions with lithium chemistry control. However, we have not done the testing to investigate every possible condition that one could get

> into going to power operation and then back to an [illegible]izing shutdown condition, but even if we knew this, [illegible]we knew the threshold value, we knew the total quantity of sulfur in the system, we still would not have all the answers we need. We really do not know the detailed conditions that can in fact produce metastable sulfur states from nickel sulfide that is already on the tube surfaces.
>
> Furthermore, we do not know the conditions that produce that. We don't know what the lifetime of those states are during operating conditions. Even with that lithium control. The lifetime may be so short that we don't get corrosion, but we have no testing and no data in the literature that can really give us a good handle on this factor.

ACRS Tr. at 255-256. See also, ACRS Tr. at 71, ("So, I don't think we can tell you which one of those intermediate forms caused the attack.").

10. Licensee and the Staff discount the significance of previous sulfur contaminations, (see Licensee Facts ¶ 172 and Staff Facts ¶ 9, Contention 2.a) but clearly these prior contaminations add variables in evaluating the attack sequence.

11. Licensee's staement of facts fails to mention Licensee's concern as previously expressed to the ACRS that "the potential does exist that during certain transient conditions, there can in fact be a change in oxidation states," and that "based on knowledge of what the potential environments are that can be seen during operation and shutdown in a PWR plant, that in fact we may be able to get into a state at some time which is a metastable sulfur state." ACRS Tr. at 254-255. Licensee further stated to the ACRS, "You can't draw an exact correlation of these laboratory tests with the exact condition in the steam generator." ACRS Tr. at 71.

12. These particular uncertainties were also of explicit concern to Staff consultants. For example, as explained by the Staff in its SER,

> "...staff consultant [MacDonald] (Attachment 3) expressed concern about an inconsistency in the licensee's Topical Report 008, Rev. 2. In pages 13-14 of this report, the licensee stated that sulfur reduction might have occurred during the hot functional test, and that the subsequent OTSG tube degradation was as a consequence of reduced sulfur species. In the Test Section of the same reort, laboratory data indicate that cracking of senitized type 304 Stainless Steel (SS) and Inconel 600 specimens in low temperature, oxygenated water contaminated with thiosulfate proceeds without the presence of other reducing agenst. The consultant's concern is that in one case reduced sulfur species is suggested as the corrosion initator, while in e other case it is shown that corrsion will occur in the absence of reduced species. We are of the opinion that irrespective of the exact sceanarios, the thiosulfate contaminant has been removed from the system."

Thus, the Staff position is to attach no significance to these critical analytical differences, which were of express concern to its own expert consultant. The Staff, however, clearly does not dispute that these differences exist. MacDonald also states that sulfur deposits of an unknown form were found on the control rod drive leadscrew, MacDonald at p. 20, and that

> sulfur and sulfur-induced corrosion damage has been observed in regions of the RCS which have not been exposed to a liquid environment (e.g. general corrsion and pitting in the PORV and cracking in the WDG piping). This indicates that besides thiosulfate, which can only exist in the dissolved state (note that it is anion), a volatile polysulfur species must be present in the system).

MacDonald at 20-21.

13. The Staff argues that since MacDonald's comments were raised in the context of a "cleaning" recommendation, they are irrelevant in

the context of TMIA Contention 2.a. Clearly, his concerns are directly on point with regard to this contention.

14. Other uncertainties were expressed by the Staff consultants. See Dillon at p. 12 ("I don't know that the apparent inconsistencies in describing the cracking environment are important to the reactor recovery operation, but they certainly invite questions.").

15. Moreover, the TPR pointed out "minor differences" in the two independent metallurgical failure analyses performed. TPR 2/18/83 at p. 9. The TPR provides no explanation as to what these differences were, or their significance. Licensee suggests an explanation, i.e. that the differences resulted from equipment and technique differences. Licensee Facts ¶ 171. But Licensee also suggested that the differences resulted from differences in the tube samples which were tested, id., thus supporting the premise that the physical properties of the tubes vary significantly enough to effect test results.

16. Licensee further speculates as to why some cracking occurred in the "lower elevations" of the tubes, such cracking plainly inconsistent with Licensee's proposed scenerio. Licensee speculates that this occurred because of the "dynamic environment" in the lower elevations, which Licensee does not precisely define. Licensee Facts ¶ 131. This confirms the uncertainty regarding the specific sequence and conditions which led to cracking.

17. Licensee also explains why it believes cracking terminated, Licensee Facts ¶ 132, but the Staff seems more uncertain. See, SER p. 6. If there is no conclusive determination why or how the cracking terminated, a very clear genuine material issue of fact arises concerning whether it will reinitiate.

18. In conclusion, there are genuine material issues of fact in conjuction with TMIA Contention 2.a.

F. TMIA CONTENTION 2.b.1.

1. TMIA Contention 2.b.1 alleges that concerns raised by Staff consultant Dillon regarding the risk of further corrosion from the cleaning process itself have not been conclusively resolved.

2. Licensee first asserts that the results of its long term corrosion testing assures that no damage resulted from the cleaning process. Licensee Facts ¶ 174, 178-181. As already discussed in the context of qualification testing, TMIA Contention 1.a, ¶ 8 et seq., supra, there are significant questions regarding the accuracy of such tests. Further, Staff consultant MacDonald criticized the accuracy of testing being conducted by Licensee. MacDonald at p. 15.

3. Licensee further claims that Dillon's concerns are now moot because hot functional testing and low leakage has proven the cleaning process was successful, and no adverse effects or damage was detected. Licensee Facts ¶ 176. Deficiencies in these types of tests have also been discussed and documented, supra. See, TMIA Contention 1.a, ¶ 64 et seq.

4. In any event, neither Licensee nor the Staff have supplied any first hand indication from Dillon himself whether or not he is now satisfied the tubes were not damaged as a result of the cleaning process, particularly whether he is satisfied with the post cleaning testing which was done. Absent this, the genuine material issue of fact originally raised by Dillon is still open.

G. TMIA CONTENTION 2.b.2

1. TMIA Contention 2.b.2 addresses the safety risk associated with the 20-50% sulfur remaining trapped in the oxide film after cleaning. Licensee and the Staff both recognize the potential for reinitiation. Both rely heavily on enforcement of precise chemistry and oxidation controls to prevent reinitiation. Licensee Facts ¶ 192 et seq., Staff Facts ¶ 1 et seq.

2. Staff consultants raised specific concerns reagarding rapid crack propagation due to nickel sulfide remaining on the tube. MacDonald at p. 7. MacDonald states the nickel sulfides are "easily oxidized in aqueous environments." Further, "introduction of oxygen into the environment can lead to regeneration of thiosulfate and other equally aggressive polythionic species, which in turn may cause the propagation of cracks. Id. at p. 8.

3. Moreover, MacDonald states, "during periods of low oxygen levels, reactions 5 and 6 [described above], which lead to rapid cracks propagation, will occur whereas introduction of oxygen into the environment, for example, during wet lay-up may result in a burst in thiosulfate concentration, which in turn could induce cracking of the sensitized OTSG tubes." Id.

4. MacDonald also states that testing does demonstrate that intergranular stress assisted cracking of TMI-1 OTSG tubes can occur in the presence of any or very small concentrations of sodium thiosulfate. Id., p. 17.

5. Licensee suggests that MacDonald now has dropped his concerns regarding the oxidation of nicklel sulfide. Licensee Facts ¶ 215. Yet in light of his detailed report, which consistently presents

reasons for concern, a good deal more than a self-serving statement by Licensee is required to simply decide his views are no longer relevant.

6. Further, Licensee asserts that nickel sulfide remains stable under normal operational conditions, but acknowledges that oxidation can occur if the primary system is cooled and oxygenated. Licensee Facts ¶ 199-200. Thus, to prevent this from happening, a precise control of system oxygen is essential.

7. Bu Licensee clearly can not anticipate controlling all oxygen levels during unanticipated transients. And Licensee indicated before the ACRS, "the potential does exist that during certain transient conditions, there can in fact be a change in oxidation states," and that "based on knowledge of what the potential environments are that can be seen during operation and shutdown in a PWR plant, that in fact we may be able to get into a state at some time which is a metastable sulfur state." ACRS Tr. at 254-255.

8. Further, there is no reason to assume that the lower than expected .4 ppm sulfate level which was found in the solution removed during cleaning indicates anything other than the possibility that the oxide film trapped more sulfur than expected, or simply that a very small amount of sulfur caused the very severe corrosive attack in the first place. Thus, there is no assurance whatever sulfur is left trapped on the tubes will not cause further damage.

9. Moreover, no piping < 1" in diameter was flushed. Despite assurances by Licensee at Licensee Facts ¶ 222, and and the Staff at Staff Facts ¶ 7, there is simply no evidence that sulfur remaining in those pipes is too small to cause corrosive attack, considering that

only a very small amount is necessary to cause cracking. MacDonald at p. 17.

10. Also, future reliance on chemistry control should be viewed with Licensee's past record in mind, for it was gross error within Licensee's chemistry department which caused the initial contamination.

11. Reliance on lithium control is also questionable. Licensee Facts ¶ 203. Not only does MacDonald state that lithium control is not well understood, MacDonald at p. 99, but Licensee admitted as much such before the ACRS. See, ACRS Tr. at 175. But even with lithium addition, Licensee still "has a concern" regarding oxidation states. ACRS Tr. at 254-255.

12. Further, RC control prodedures are only required during cooldown because that is when Licensee anticipates cracking will occur, thus entirely ignoring other possible cracking scenerios. Licensee Facts ¶ 211.

13. In addition, the TPR recommeded that GPU implement corrective measures or to verify existing programs for minimizing ingress of all impurites into the RCS. TPR 2/18/83 p. 9. In its May report, the TPR responds that GPU's actions are considered adequate for safety, but further comments that it has a poor understanding of the role of "carbonacious material," a major impurity near tube failure. Also, the TPR specifically disagrees with the chemistry control program on the issue of sodium limits. And while the TPR says this is not safety significant, it is of sufficient concern to the TPR that it recommends the sodium limit be reduced 10 times. This analysis by the TPR at least raises questions regarding Licensee's chemistry control program.

14. To conclude, the right combination of chemistry and oxygen states once resulted in enourmous damage to these steam generators. If there is a risk the same could happen again during plant operation or accident conditions, simple assurances by Licensee that its controls will be striclty enforced raises genuine material issues of fact in light of Licensee's past record of incompetence, having caused the damage in the first place.

Respectfully submitted,

Three Mile Island Alert

By Joanne Doroshow
Louise Bradford

April 3, 1984

Attachment 1

Attachment 1

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

MAY 19 1982

MEMORANDUM FOR: Thomas Novak, Assistant Director
for Operating Reactors
Division of Licensing

FROM: William V. Johnston, Assistant Director
Materials & Qualifications Engineering
Division of Engineering

SUBJECT: STAFF EVALUATION OF TMI #1 STEAM GENERATOR CORROSION PROBLEM

We have determined that the subject problem constitutes an unreviewed safety question and recommend that formal staff review be required. Our determination is based on four primary factors, as follows:

1. Uniqueness and extent of the S.G. corrosion damage.

2. Potential for this type of corrosion to affect other primary pressure boundary materials.

3. Uniqueness of the repair method which is proposed by GPUNC.

4. Unpredictability of ECT in detecting and quantifying this type of corrosion.

In all likelihood, the GPUNC program will answer the questions which are necessary to ensure that a significant safety hazard does not exist.

Enclosed is a more detailed discussion of our rationale in support of this recommendation.

William V. Johnston

William V. Johnston, Assistant Director
Materials & Qualifications Engineering
Division of Engineering

Contact: L. McCracken
Ext. 28595

cc: See next page

Rationale for Determination of The potential for TMI No. 1 S.G. Corrosion Problems to Constitute an Unreviewed Safety Question

The proposed repair by TMI-1 to resolve their steam generator problems appears to be reasonable. Basically, they are in the process of identifying:

1. The extent of degradation in the S.G.'s,
2. The extent of degradation, if any, in the remainder of the reactor coolant system,
3. The causative agent(s) and their source,
4. Cleanup techniques to remove the causative agent(s) and
5. Optimum S.G. repair techniques.

However, we believe there are a number of issues regarding the program which should be formally reviewed by the staff. Our reasoning in deciding that formal staff review is required is based on three major factors.

A) To the extent that we have not experienced this type of behavior before, the corrosion mechanism is unique, thus the staff has not reviewed the potential consequences of additional operations subsequent to repair of known defects. Particularly, the potential for this type of corrosion to rapidly progress upon restart and adversely affect the S.G. primary pressure boundary.

B) The potential for this type of corrosion to adversely affect other primary pressure boundary materials.

C) The proposed S.G. tube repair technique, although having a similarity to some past repair techniques is in itself unique.

We consider the existance of a type of corrosion which has extensively degraded the steam generators, to also have the potential to degrade other reactor coolant system materials. In addition, the licensee proposes to employ a unique repair technique. We believe that the combination of all these becomes an unreviewed safety question.

As stated at the beginning, the program which GPUNC is conducting appears reasonable. In all likelihood, the GPUNC program will answer the questions which are necessary to ensure that a significant safety hazard does not exist.

Based on our knowledge to date, we have the following points and/or concerns:

1. Eddy current test requirements in the plant technical specifications and in the ASME code are by themselves inadequate to assure that a meaningful inspection will be performed, given the nature of the

corrosion mechanism which exists at TMI-1. The licensee's inspection program including the scope of the inspection should be evaluated by the staff for its adequacy.

2. Licensee is proposing to employ an alternative repair technique to plugging which is the required tube repair method and specified in the plant Technical Specification.

Thus, some modification of the plant Tech. Specs. would be necessary.

3. The proposed repair technique involves a leak limiting rather than a leak free seal against primary to secondary leakage. Because the expansion joint seal will function as the primary pressure boundary for as many as 20,000 tubes, leakage characteristics under normal and postulated accident conditions should be established by test. Testing should include expansion into dirty crevices.

. The staff has some questions pertaining to the proposed repair. For example, will pre-existing cracks on the repair process itself result in a significant relaxation of tube preload? If so, excessive compressive loading may result upon heatup of the plant which could lead to bowing or local buckling which could cause new corrosion initiation sites.

. The corrosion mechanism is unique, apparently very fast acting, and not well understood. The licensee's recovery program should be closely reviewed by the staff to establish that there is adequate assurance against rapid failures occuring upon plant restart. In addition, some licensing actions may be necessary, such as (a) more restrictive limits on primary to secondary leak. (Note the current 1 gpm limit is the most liberal in the PWR industry) and (b) frequent shutdowns for inspection as part of the restart program.

onsidering the above listed concerns, we believe that specific staff eview and concurrence is required at least in the following areas:

. Review of ECT data and scope of the inspections performed to determine that indications outside the tubesheet have been adequately characterized and addressed in the repair program.

. Review of ECT data and basis for rolling/plugging various tubes. Including an assessment of tube relaxation due to cracking or the repair technique (if tubes have been relaxed from tension due to cracking, excessive compressive loads may exist on restart).

Review of the proposed roll technique, including the supporting analytical and test verification program.

Review of the basis for and materials selected for primary side examination to detect the presence on corrosion on other pressure boundry materials. Also, an evaluation of the examination techniques to determine the presence of corrosion in these materials.

The staff should be present during examination of some pre-selected primary system materials.

Review of test data which supports the method selected for sulfur removal from system surfaces or conversely, the data which demonstrate that removal is not necessary.

Review of the current Tech. Spec. limit (1.0 gpm) for primary to secondary leakage to determine the impact of operation with up to that volume of leakage and whether it adequately supports the leak before break objective.

Review of the restart program to ensure that sufficient check points are included to determine that excessive primary pressure boundary degradation does not occur during subsequent operations. At least the following general type of program would seem to be prudent.

a) Perform a series of leak checks utilizing nitrogen, helium etc. prior to pressurization.

b) Conduct a hydrostatic test

c) Perform a full temp. and press. hot functional for two to three weeks. Then, shutdown and ECT a selected number of tubes to ensure that excessive degradation is not occurring.

d) Operate for 30 to 60 days. Then, shutdown and ECT to assess the progression of degradation.

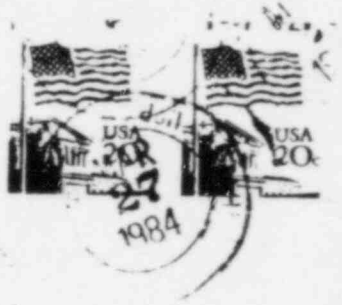
e) Assuming no excessive degradation in "d" above, operate for 150 to 210 days. Then ECT again.

f) During refueling, ECT and examine additional primary system materials for evidence of corrosion. If no new or excessive corrosion is found, return to normal reg. guide test frequencies.

Attachment 2

George C. Sih, Director
LEHIGH UNIVERSITY
Institute of Fracture and Solid Mechanics
Packard Lab. Bldg. #19
BETHLEHEM, PENNSYLVANIA 18015

SPECIAL
DELIVERY



MAR
27
1984

TMI Alert
315 Peffer Street
Harrisburg, Pennsylvania 17102

ATTENTION: Joanne Doroshow

SPECIAL
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SPECIAL
DELIVERY

Attachment 2

COMMENTS ON RESPONSE BY TPR AND THE STAFF: REF: pp. 27-32

The response of TPR and the Staff clearly indicates that their knowledge of fracture mechanics is limited and superficial. Fundamental misconception prevails throughout the above reference material. What TPR and the Staff have assumed in their analyses are not consistent with the damage as they claimed to have observed in reality.

(1) Reference to Comments on p. 27:

Line two from bottom establishes the fact that the cracks in the tube do not propagate axisymmetrically. This implies that a three-dimensional state* of stress prevails around the surface flaw. The nonuniformities referred to in the second paragraph on p. 28 are not clearly defined and do not necessarily include the three-dimensional effects.

(2) Reference to Line 3 from bottom of p. 28:

Unless the circumferential cracks are completely around the tube, axi-symmetry is not preserved and the stress state is locally a three-dimensional one. This implies that even if the load is normal to the crack plane, the crack can grow in a non self-similar manner. In such a case, the analyses performed by TPR and the Staff are not valid.

*The fact that TPR and the Staff did not use the results of the axisymmetric stress analysis for the fracture mechanics fatigue or crack analysis is irrelevant. What is relevant is the non-axisymmetry character of the local stress field that should be included in a realistic evaluation of the crack failure mode.

(3) Reference to Lines 2 to 4 on top of p. 29:

The statement (quote) "--- the data were developed to characterize the material properties of Inconel-600, and are independent of material or loading geometry", is self-contradictory. It is well-known that all data collected from specimen tests are sensitive to changes in specimen size and loading rates. Therefore, it is necessary to simulate the conditions experienced in the structural components when collecting material data. No justification along this line has been given by TPR and the Staff on Inconel-600.

(4) Reference to middle of p. 29:

One of the means of evaluating the adequacy of the expansion repair technique is in fact to analyze the propagation of fatigue cracks* in the tubes. If the increase in hardness during repair is claimed to be beneficial, then the simultaneous decrease in fracture toughness should also be pointed out and evaluated accordingly. This relation was not discussed. In this respect, the so-called "toughness" factored into the fatigue model used by TPR and the Staff may not be valid, particularly when yielding occurs as implied on p. 30.

(5) Reference to Material on top of p. 30:

The concept of stress intensity depends on homogeneity of the crack tip stress field which prevails only when the material is predominantly in the linear elastic range. When yielding or plastic flow occurs, the local stress field becomes non-homogeneous and the concept of a stress intensity ceases to apply. Therefore,

---

*Indeed, paragraph 3 on p. 29 confirms this and yet the statement above argues against it. Attention should be focused on the overall technical aspect of the problem and not whether TPR and the staff happen to discuss a particular aspect of the tube repair technique.

the argument outlined on top of p. 30 is irrelevant.

A fundamental misconception appears in line 10 on p. 30. The fracture toughness of a material does not change when yielding occurs. The load carrying capacity of the specimen or structural component on the other hand does increase.

(6) Reference to middle of p. 30:

No claims were ever made that hardness was directly associated with crack growth. Nevertheless, it is well-known that increase in hardness results in a reduction in toughness. Hence, the repair tubes with increased hardness obviously suffer a reduction in toughness and hence are no longer restored to their original state.

(7) Reference to Material on top of p. 31:

The propagation of small and/or large cracks in a thermal environment is important to the kinetic expansion repair technique since the restoration of the system to its original state is at issue. Hence, it would be relevant to establish the life discrepancy of the repaired tubes as compared with those used in the original design.

(8) Reference to Lines 11 and 12 on p. 31:

The stress intensity approach used by TPR and the Staff cannot accurately determine the state of affairs for partial through-wall cracks. In fact, the stress intensity factors as defined in the linear elastic fracture mechanics

theory* are zero at the intersection of the crack and free surface. However, damage does occur near the surface.

(9) Reference to Material at bottom of p. 31 and top of p. 32:

TPR and the Staff have apparently failed to understand that the stress intensity, when it can be applied, may not be a monotonic function of the crack length under thermal environments. Global instability can occur for cracks that are much smaller than those estimated by approximated and invalid analyses. The point is that the true nature of the thermal crack behavior may not be reflected by the analysis made by TPR and the Staff.

To conclude, the relevant issue is the validity of the technical evaluation made by TPR and the Staff on the repaired tubes. The problem must be viewed in its entirety based on consistency and validity of the technical approach**. Disposal of the issue on legal grounds at the sacrifice of technical understanding and safe control can further lead to unexpected shutdowns and further repairs, imposing additional burden on an already economically-illed nuclear industry.

---

*It is not justifiable to claim as the state-of-the-art which is irrelevant to the safe evaluation of nuclear reactor components. Other means and approaches for evaluating the damage caused by surface flaw have been available in the open literature for many years.

**The fracture mechanics discipline is not limited to the views and definitions as conceived by TPR and the Staff.

Attachment 3

Attachment 3

MEETING REPORT

Place: B&W Plant, Lynchburg, VA

Date: September 20, 1982

Present: John Pearson)
Alvin McKim)
Bob Lite) Babcock & Wilcox
Tracy Saville)
John Phillips)

Mary Jane Graham -GPU Nuclear

Vincent Luk)
Charles Davey) FRC

The purpose of this meeting was to discuss the remainder of the items requested by FRC to complete its review and evaluation of the TMI-1 OTSG repair process. These 8 items (see attached list) were drawn up at the conclusion of the Sept. 15 meeting at NRC at which time the formal RAI submitted by FRC was reviewed, item by item, to identify the still outstanding information.

In this report, a summary of the discussions at Lynchburg is given, numbered according to the attached agenda.

1. Mechanical Drawings

We reviewed the mechanical drawings of tube bundle and tube sheet assembly together with tube support system. Bob Lite of B&W identified the locations of the steam generator where B&W conducted strain gauge measurements at Mt. Vernon. The two locations are as follows: one at the junction between the inlet header and the tubesheet, and the other at the weld location underneath the tubesheet. The strain gauge measurements were taken at the two ends of a diametral row of 132 tubes expanded at the same time. B&W planned to document these findings and to calculate peak stresses and stress intensity for fatigue evaluation. Their preliminary results indicated that the usage factor at these two locations is less than 0.1. We requested B&W Drawings #131102E and 131112E which describe the structural configuration at these two locations. These two drawings were promised by September 24, 1982.

2. Dynamic Stress-Strain Curves

These curves are not available. Since GPU, B&W and FW are taking an experimental approach, they claim there is no need for dynamic data.

3. Coefficients of Expansion

Handbook values are used. Data supplied to Dr. Luk.

4. Table of Contents of Report.

GPU will not release this TOC because of its "critical" nature. FRC will eventually receive a copy of the final report, due October 1st.

A-1

5. Supporting Data for Pressure Vessel Integrity Assessment.

Some of the statements presented were objectives which require supporting test data. There is some preliminary data and some additional undocumented data which will appear in the October 1 report. We have in hand some of the preliminary data.

6. Dynamic Pressure Profile in Tubes

Once more, claim was that there is no need for these data. All work is experimental. Profilemetric data has apparently been done and will be available (to FRC about 10 Oct. 1982).

7. Critical Data From Mt. Vernon.

Pull tests were performed at Mt. Vernon on three expanded tubes to a limit of 36000 lb, in order to preserve the integrity of the generator. There was no movement in response to loads of this magnitude.

The forthcoming (Oct. 1) report will contain all currently available data from Penn State, Foster Wheeler and B&W.

8. Details of Strain Gauge Instrumentation.

The gauge used was a rossette, Micro Measurements Corporation. It was a film gauge, two elements in quadrature and one at 45°. Gauge factor was 2.

The signal conditioner was a Dickey P22. Output was 1000 microstrain/volt. All signals were FM-multiplexed on one tape track. Frequency response was to 8 KHz.

We were shown signals which covered from -500 ms through event to 3.5 seconds. Overall coverage is 4 seconds. The strain gauge on the tube (axial) gave a very small strain signal (less than 100 microstrains).

Analysis of the spectral content of the strain records showed a level off at about 400 Hz. Little or no signal contribution was made at frequences greater than 400 Hz.

V. Luk
C. T. Davey
9/21/82

ITEMS REQUESTED AT LYNCHBURG MEETING

1) Mechanical drawings of tube bundle and tube sheet assembly together with tube support system.

2) Dynamic stress-strain curves for tube sheet and tubes.

3) Coefficients of expansion for tube sheet and tubes as a function of temperature.

4) Table of contents of October qualification program report and critical data now available.

5) Supporting data for Pressure Vessel Integrity Assessment (presented at 9/15 meeting at Bethesda).

6) Dynamic pressure profile in tubes during explosion (requested by NRC).

7) Critical data from Mr. Vernon tests already run.

8) Details of instrumentation used for tests. Specifically, strain gauge type, signal conditioning equipment, load configuration, recording methods, calibration techniques.

Attachment 4

Attachment 4

STATEMENT TO HEARING ON TMI RESTART: STEAM GENERATOR TUBE REPAIR

December 16, 1983

With regard to the technical aspects of steam generator tube repair, there arises the following concern:

(1) It is questionable that the kinetic expansion repair process could restore the tubes to their original condition. Should the hardness of the tube be increased then the resistance of the material to cracking measured by the fracture toughness is likely to drop.

(2) The fatigue life of tubes depends on the sequence and magnitude of the combined thermal and mechanical loading. Predictions based on LEFM* (linear elastic fracture mechanics) may not be reliable since the methodology does not address accumulative damage.

In my opinion, there is not suffucient technical evidence to reach any conclusion on the safety of the repaired steam generator tubes of TMI.

G. C. Sih

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*Application of LEFM cannot be justified on the ground that it is still the state-of-the art of twenty years ago.

Attachment 5

Attachment 5

TMI-1 Steam Generator Tube/Tubesheet Repair

Meeting at Parsipanay, N.J.

1. BACKGROUND

Once Through Steam Generator (OTSG) tube leaks have been found at TMI-1. Failure analysis has resulted in the conclusion that sulfur contamination caused intergranular attack of the TMI-1 OTSG tubes. The attack is inside diameter initiated and circumferential in geometry. The majority of the cracking has been located by Eddy Current Testing (ECT) in the lower end of the Inconel 600 tube at or near the weld heat affected zone (HAZ) and the roll transition. Since the failure analysis results continue to indicate that the areas of tubes free of ECT indications can be successfully returned to service, a repair process has been selected which kinetically expands the existing tube against the upper tubesheet hole. The objective is to expand the OTSG tube with sufficient length below any defects to form a new load carrying and essentially leak tight joint.

2. OTSG TUBE REPAIR

2.1 Sequence of Repair Steps

The TMI-1 OTSG repair process is as follows. It should be recognized that Step 2 may become a part of Step 6 pending the outcome of preliminary qualification testing.

Step	Description
1.	Flush the secondary side tube-to-tube sheet crevice
2.	Clean tube inside diameter in the area of the repair.
3.	Heat crevice to drive out moisture (vaporize water)
4.	Maintain crevice in the repair area at a temperature at least 10°F higher than the dewpoint for OTSG secondary side conditions.
5.	Kinetically expand tubes.
6.	Cleanup debris from kinetic expansion.
7.	Leak test OTSG
8.	Roll/flush (if required to repair leaking tubes.)

INFORMAL TECHNICAL COMMUNICATION

Date AUG 4, 1982

To: JAI RAJAN / RICK JACOBS

U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

(TO BE OPENED BY ADDRESSEE ONLY)

From: TED SHOOK / LARRY LEON

Franklin Research Center
Philadelphia, PA 19103

Reference: NRC Contract NRC-03-81-130
NRC TAC No. _____
Plant TMI-1

FRC Project C5506 ASSIGNMENT 10
FRC Generic Topic TMI-1
FRC Task(s) 311, 312, 313 (A, B, C)

Title: _____

Attachments: TRIP REPORT OF JULY 21 MEETING AT LIVINGSTON, N.J.

Message: TECHNICAL COMMENTS ARE GIVEN, BASED ON PRESENTATION GIVEN. SUMMARY OF MEETING BETWEEN VINCE LUK AND JIM MOORE OF GPU IS INCLUDED. THERE IS STILL CONCERN ABOUT RECEIVING INFORMATION WE NEED TO PERFORM OUR REVIEW AND EVALUATION

Copy of message form only: .

NOTE TO SENDER: Include attachments if information is pertinent to program management.

S. S. Bajwa
NRC Performance Monitor HERBERT BRAMMER
NRC Lead Project Manager CONRAD McCRACKEN

FRC Distribution: SPC, SP, TS, LL, RL, CD, ___, ___, ___

Revised 4/20/82

A3

Franklin Research Center

TRIP REPORT: PROJECT C5506, Assignment 10.

PLACE VISITED: Foster Wheeler, Livingston, NJ

DATE: July 21, 1982

THOSE PRESENT: Representatives from:

NRC
FRC
GPU
FW
B&W

Present from FRC:

L. Leonard
C. T. Davey
V. Luk
T. A. Shook

PURPOSE OF MEETING: To present schedule for qualification program of tube repair, and result of preliminary tests performed. Interface with technical personnel on the status of analytical work.

1. This meeting revealed newer, more up to date plans than previous meetings. It allowed more direct interactions among technical personnel present.

2. Progress was announced on the Ordnance Cord-booster concept for candle initiation. This initiation process should result in less explosive reaction outside the expansion space, and thereby reduce contamination and potential damage as a result of the more brisant primacord initiation process that the Ordnance Cord replaced. Further studies are planned to confirm that Ordnance Cord is appropriate.

   Dr. Pai (Foster Wheeler) expresses belief that the booster will have no more explosiveeffect than an equivalent length of primacord.

3. The schedule for delivery of the six single-tube and two ten-tube test specimens was discussed. Delivery was to be in late September to FRC, however, more recent information indicates that FRC should have all fixtures and hardware by mid-August.

   Foster-Wheeler has partially completed their apparatus for cyclic testing of the ten-tube mock-ups. The test parameters are slightly different than FRC's but at this time it appears that results should be comparable.

4. The pull-out tests showed that the load required to pull out an expanded tube (after the two step process) is essentially independent of the extended length for lengths above about 5 inches. Accordingly, Foster Wheeler is qualifying a six inch length even though the minimum expansion at this time will be 17 in. For tubes which leak in the tube sheet after the 17" expansion, a follow-up 23" expansion can be utilized to seal a new 6" qualified length below the original expansion. Peripheral tubes may cause problems; the candle cannot be injected easily.

5. There were some serious concerns if the expansion is performed too close to the juncture of the tube and the tube sheet, placing the transition near the inside surface of the tube sheet. A double ended rupture was feared that would potentially cause serious leaks.

   Particular concern was expressed in the event of a steam line break during which time a temperature difference would exist in which the tube would be at a lower temperature than the tube sheet. The accompanying tube shrinkage would result in a tensile load on the tube.

   This situation will be investigated by B&W.

6. X-ray diffraction residual stress measurements will be made at Penn State University to evaluate the relative magnitude of stresses induced by tube rolling and explosive expansion both in fully expanded areas and in the transition to the unexpanded region. These tests will take about 2 to 2½ months to complete, and, thus, all results will not be available until the beginning of October. This should present no problem with regard to the implementation of repairs since it is highly likely that the expansion residual stresses will be less than those from rolling. The tests are to demonstrate how much more uniform and less severe the stresses are resulting from explosive expansion than from rolling.

7. Candles will be supplied to FRC by Foster Wheeler for any experiments we wish to run. It was confirmed that FRC is fully licensed to store explosives (Federal, State and City licenses).

8. Multiple expansions are planned at Mount Vernon, Indiana on 5 August 1982. This is a B&W "graveyard" for old steam generators. FRC observers will attend.

9. Materials presented during this meeting will be mailed to FRC by GPUN after appropriate approvals. As of this writing these materials have not been received.

10. A meeting was held between Vincent Luk of FRC and Jim Moore of GPU at GPU. The purpose of the meeting was to discuss the Licensee's stress evaluation program. At the meeting, FRC reviewed a draft GPU Stress Report, TDR No. 346, "TMI-1 OTSG As-Built Stress Analyses." The report focuses on the review and evaluation of the performance of the as-built steam generator, and it does not address the effects of the kinetic expansion process on the performance of the unit. The report will probably be released to public domain by 7/23/82. FRC may get a copy of the report before the end of July 1982. At the meeting, the scope of stress analyses which FRC would like to be covered by licensee was discussed in detail. According to Jim Moore, most items covered in FRC's scope will be included in licensee's test qualification program and the remaining few items will be evaluated analytically by either GPU or B&W. All the results from qualification and stress evaluation programs will be reviewed by FRC when they become available.

11. A request was made to Mary Jane Graham for the following documents:

    a. Mechanical drawings of tube bundle and tubesheet assembly together with tube support system.

b. Proprietary Topical Report, B&W-10002, "Once Through Steam Generator Research and Development Report."

c. B&W-10146, "Determination of Minimum Required Tube Wall Thickness for 177 F/A OTSG's, "Babcock & Wilcox Report."

Attachment 6

Attachment 6

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

OCT 20 1982

Docket No. 50-289

FACILITY: THREE MILE ISLAND, UNIT NO. 1 (TMI-1)

LICENSEE: GPU NUCLEAR CORPORATION (GPUN)

SUBJECT: SUMMARY OF MEETING WITH GPUN ON SEPTEMBER 15, 1982 CONCERNING GPUN'S STEAM GENERATOR (SG) REPAIR PROCESS

Background

As part of their program to recover the SGs from intergranular stress corrosion cracking of the tubes, GPUN has proposed a repair program involving an explosive expansion technique to recover tubes with defects within the upper tubesheet (UTS). The purpose of the September 15, 1982 meeting was to provide a final briefing to the staff prior to start of the actual repair and to resolve any remaining staff or staff consultant concerns regarding the repair itself. A copy of GPUN's presentation is enclosed. A list of attendees is also enclosed.

Discussion

GPUN's proposed repair process consists of kinetically or explosively expanding tubes within the UTS. All 31,000 tubes will be expanded for 17 inches or 22 inches within the 24 inch UTS. In order to establish a qualified seal, there must be a six inch area free of defects. Hence, a 17 inch expansion will recover tubes with defects only within the top 11 inches and a 22 inch expansion will recover tubes with defects only within the top 17 inches of the tube. The process involves use of low level explosives including prima cord, booster, ordance transfer cord and blasting caps. The prima cord and booster are inserted into a polyethylene "candle" and detonated by a blasting cap outside the OTSG via the ordance transfer cord. GPUN will be ready to commence the expansions in mid October 1982. Related actions involve secondary side flush, crevice drying, expansions, debris cleanup, plugging tubes unable to be recovered and testing. GPUN expects to complete these operations by December 1982. The staff issued a Safety Evaluation limited to the steam generator repairs on October 13, 1982. No staff members or staff consultants raised concerns that would postpone or prevent GPUN from commencing the repairs. A meeting has been scheduled October 18 and 19, 1982 (previously October 13 and 14) to discuss remaining aspects of

GPUN's steam generator recovery program.

P. C. Wagner

for Richard H. Jacobs, Project Manager
Operating Reactors Branch #4
Division of Licensing

Enclosures:
1. List of Attendees
2. GPUN's Presentation

cc w/enclosures:
See next page

Attachment 6-1

Process Effect On Cracks/Indications

- Test Results (30 gr./ft)
  - 100% through wall crack opened slightly
  - No ductile growth axially
  - No ductile growth circumferencially
  - Conclusion: crack did not grow
- Leakage Tends to be Self Sealing
  - CR-3 operating experience
  - ARC model boiler test results
    - ~ 5 tubes defected/1 to 2 gph leakage
    - After 1000 hrs operation - no leakage
    - CRUD & corrosion products seal leaks
    - Tubesheet corrosion insignificant by inspection

Attachment 6-2

Third Party Review

Purpose

To provide a timely, independent, objective, safety evaluation of all activities defined in (the scope of) this charter for conformance to:

1) the NRC rules and regulations governing the operation of TMI-1

2) the adequacy of the steam generator repair program that will allow safe operation of the nuclear unit

Scope

- Failure analysis program
- Eddy current examination program
- OTSG performance evaluation
- Repair criteria
- OTSG repair program

9/15/82

Attachment 7

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

CHAIRMAN

May 5, 1983

refile w 3/23/83 Palladino l.t.

The Honorable Edward J. Markey, Chairman
Subcommittee on Oversight and Investigations
Committee on Interior and Insular Affairs
United States House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

This is in response to your letter of March 23, 1983 which raised questions resulting from my letter to you of March 21, 1983 and the Subcommittee on Oversight and Investigations' December 13, 1982 hearing. Responses to the questions in your letter are enclosed.

Additionally, you reminded us of our promise made during the February 22, 1983 Energy and Environment Subcommittee hearing, to provide information relative to the exact status of completion of items in the TMI Action Plan. This information was provided to your staff by our Office of Congressional Affairs on March 25, 1983.

We hope this information resolves your outstanding questions with regard to these subjects.

Sincerely,

Nunzio J. Palladino

Enclosures:
Response to Questions

cc: Rep. Ron Marlenee

QUESTION 3: What analysis has the NRC or the ACRS done to evaluate the probability or consequences of this risk at TMI-1 and what were the reasons?

RESPONSE:

No probabilistic risk assessment of the subject event has been performed by either the NRC staff or the ACRS for TMI-1. Such an assessment is considered unnecessary by the NRC staff for reasons set forth in the responses to Questions 1 and 2, above for the restart of TMI-1.