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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

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

NRC STAFF RESPONSE TO TMIA
MOTION TO REOPEN THE RECORD

Mitzi A. Young
Counsel for NRC Staff

January 24, 1985

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I. INTRODUCTION

On October 31, 1984, the Licensing Board, which was convened to consider GPU Nuclear Corporation's (Licensee) application for amendment of the technical specifications to the Three Mile Island Nuclear Station, Unit 1 (TMI-1) operating license to allow operation of the steam generators following tube repair by the kinetic expansion process, issued its Initial Decision authorizing the issuance of the amendment subject to certain conditions. On December 10, 1984, Intervenor Three Mile Island Alert, Inc. (TMIA) filed a one page "Motion to Reopen the Record on the Basis of New Information" (Motion). In its Motion, TMIA asserts that the Appeal Board should reopen the record to receive "new information which has recently become available to TMIA." TMIA further asserts that the "new information is of safety significance and might have dictated a different result had it been part of the record." As grounds for its Motion, TMIA refers to the discussion in its accompanying brief on appeal

from the Initial Decision. 1/ The Staff response to the Motion is set forth below.

II. DISCUSSION

A. Standards for Motions to Reopen

TMIA's motion to reopen may not be granted unless it meets the factors for reopening a record in a Commission proceeding set forth in Kansas Gas and Electric Co. (Wolf Creek Generating Station, Unit No. 1), ALAB-462, 7 NRC 320, 339 (1978). The Appeal Board has repeatedly set forth the "tripartite test" for reopening as:

> (1) Is the motion timely? (2) Does it address significant safety (or environmental) issues? (3) Might a different result have been reached had the newly proffered material been considered initially?

1/ TMIA's brief, also dated December 10, 1984, is entitled "Brief on Appeal from Initial Decision in TMI-1 Steam Generator Repair OLA and in Support of Motion to Reopen the Record on the Basis of New Information," ("TMIA Brief"). Accompanying the Brief are six attachments. The first five attachments are the first pages of five GPU Nuclear Corporation Inter-Office Memoranda regarding TMI-1 weekly significant event status reports to the corporation's president: Report No. 3000-83-321, Status Report for September 30 through October 14, 1983, dated October 19, 1983 (Attachment 1); Report No. 3000-83-356, Status Report for November 12 through November 25, 1983, dated November 30, 1983 (Attachment 2); Report No. 3000-84-302, Status Report for August 11 through August 24, 1984, dated August 28, 1984 (Attachment 3); Report No. 3000-84-003, Status Report for December 10 through December 30, 1983, dated January 4, 1984 (Attachment 4); Report No. 3000-84-024, Status Report for December 31, 1983 through January 13, 1984, dated January 17, 1984 (Attachment 5). Attachment 6 is a letter to B. W. Churchill, Shaw, Pittman, Potts & Trowbridge, from R. F. Wilson, GPU, dated November 27, 1984 regarding potential defects in steam generator tubes.

Metropolitan Edison Co. (Three Mile Island Nuclear Station, Unit No. 1), ALAB-738, 9 NRC 1350, 1355 (1984), citing, Pacific Gas & Electric Co. (Diablo Canyon Nuclear Power Plant, Units 1 and 2), ALAB-598, 11 NRC 876, 879 (1980).

A motion to reopen is timely presented when the movant shows that the issue sought to be raised could not have been raised earlier. Vermont Yankee Nuclear Power Corp. (Vermont Yankee Nuclear Power Station), ALAB-138, 6 AEC 520, 523 (1973). Irrespective of the timeliness of a motion, a record need not be reopened when the issues sought to be presented are not of "major significance" and absent a showing that the "outcome of the proceeding might be affected." Public Service Co. of Oklahoma (Black Fox Station, Units 1 and 2), ALAB-573, 10 NRC 775, 804 (1979). 2/ A proponent of the motion must present "'significant new evidence . . . that materially affects the decision.'" Diablo Canyon, CLI-81-5, 13 NRC 361, 362-63 (1981). In other words, the proponent must establish the existence of newly discovered evidence having a material bearing on the proper result in the case. Duke Power Co. (McGuire Nuclear Station, Units 1 and 2), ALAB-699, 15 NRC 453, 465 (1982).

In addition, the new material in support of a motion to reopen (1) "[a]t minimum, . . . must be set forth with a degree of particularity

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2/ See also Pacific Gas and Electric Co. (Diablo Canyon Nuclear Power Plant, Units 1 and 2), ALAB-598, 11 NRC 876, 887 (1980); Georgia Power Co. (Alvin W. Vogtle Nuclear Power Plant, Units 1 and 2), ALAB-291, 2 NRC 404, 409 (1975); Vermont Yankee, ALAB-138, 6 AEC 520, 523 (1973).

in excess of the basis and specificity requirements contained in 10 C.F.R. 2.714(b) for admissible contentions" and (2) if the evidence is to materially affect the previous decision, "it must possess the attributes set forth in 10 C.F.R. 2.743(c) defining admissible evidence," that is, it must be "'relevant, material and reliable.'" Diablo Canyon, ALAB-775, 19 NRC 1361, 1366-67 (1984) (footnote omitted). Accordingly, the proponent of a motion bears a "heavy burden." Wolf Creek, supra at 338. In addition, the moving papers concerning a motion to reopen must be strong enough, in light of opposing filings, to avoid summary disposition. Vermont Yankee, supra, 6 AEC at 523. If the undisputed facts establish that an allegedly significant safety issue does not exist, has been resolved, or, for some other reason, will have no effect on the outcome of the licensing proceeding, the motion to reopen should not be granted. Id.

B. TMIA's Motion

TMIA asserts that the record should be reopened on the basis of "new information" contained in six documents appended to its motion. First, TMIA argues that the failure of 280 of 1006 plugs in the TMI-1 steam generator supports TMIA Contention 1.c which alleges that kinetic expansion has reduced the ability of tubes to retain plugs. TMIA Brief at 8-10. Second, TMIA argues that the increase in sulfates and chlorides in the primary and secondary side of the steam generators (Attachments 1, 2, 4 and 5) and the recent eddy current indications of defects in the tubes (Attachment 6) indicate that (a) the corrosive contaminant and failure mechanism have not been identified, as alleged in TMIA

Contention 2.a, (b) the cleaning process has initiated additional corrosion, as alleged in TMIA Contention 2.b.1, and (c) the 20-50% sulfur remaining trapped in the oxide layer after cleaning has reinitiated corrosion, as alleged in TMIA Contention 2.b.2. TMIA Brief at 9-11.

1. Timeliness

With respect to the first part of the test for reopening, the timeliness of the request, TMIA's motion discloses that the "new" information "recently" became available to TMIA and Attachments 1-5 were "submitted to TMIA in the course of discovery on the reopened hearings on training issues." Motion at 1. TMIA does not specify when it discovered the existence of or received this information other than to state that the "new information has come to light since the close of the hearing." TMIA Brief at 1.

The documents concerning tube failures reported in August 1984 (Attachment 3) and the increased sulfate levels reported to have occurred several times during the period from October 1983 to mid-January 1984 (Attachments 1, 2, 4 and 5) apparently were acquired by means of discovery conducted in the Fall of 1984 in the TMI-1 restart proceeding. Discovery in the TMI-1 restart proceeding on training issues was concluded in late October. An apparent one to three month delay in filing the instant motion is, in the Staff's view, not so unreasonable as to mandate a denial of the motion at the outset. 3/ Clearly, the new information on possible

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3/ TMIA states that it received Attachments 1 through 6 through discovery in the training proceeding. Motion at 1. TMIA arguably could have obtained Attachments 1, 2, 4 and 5 prior to the steam generator hearing through routine discovery in the instant proceeding and offered them for the Board's consideration at the hearing.

further tube degradation provided in the November 27, 1984 letter (Attachment 6) was timely raised. On balance, in the circumstances TMIA's motion is arguably sufficiently timely that it ought not be rejected on timeliness grounds.

2. Significance of the New Information

As to the second part of the test, the safety significance of the matters raised by the motion, the Intervenors have not met their burden. TMIA asserts that the failure of 280 of 1006 plugs to meet performance criteria during pull testing, the increased sulfur and chloride levels in the primary and secondary sides of the steam generators (Attachments 1, 2, 4 and 5), and the tube defects indicating "cracking has reinitiated" (Attachment 6) raise significant safety issues. TMIA Brief at 8-11. TMIA's suggestion that the information raises a significant safety concern is conclusory and totally lacking in an explanation of safety significance apart from the claim that the information provides support for certain TMIA contentions which were dismissed on summary disposition. Neither is the safety significance of the information in the attachments self-explanatory. As explained in the attached Affidavit of Paul C. S. Wu and Conrad E. McCracken, none of the attachments raises a significant safety issue.

Attachment 3 sets forth the preliminary results of pull testing of the steam generator plugs. The cause of the loose plugs was due to improper installation by using inadequate procedures and a universal joint which resulted in reduced net torque being delivered to some plugs. Wu/McCracken Affidavit at 4. The Licensee has rerolled all installed plugs to restore improperly installed plugs to an acceptable installed condition and to ensure that the plugs meet original design

criteria. Id. The Staff has evaluated the plug failures and determined they do not pose a risk to the public health and safety. Id. The Staff has also determined that there is reasonable assurance that the plant can operate with the missing plugs without significantly affecting reactor core behavior. Id. at 5.

The temporary increases in sulfates and chlorides are not unexpected. Id. at 7-8. Various sources contribute to the increases such as contaminants in chemicals added to the system, impurities from the atmosphere, decomposition of ion exchange resins, or the dissolution of residual sulfur on the surface of the oxide film on the tubes. Id. The increased sulfate levels have been demonstrated not to present a risk of corrosion in conditions such as cold shutdown or wet layup and thus would not initiate the intergranular stress assisted corrosion cracking which necessitated the TMI-1 kinetic expansion tube repair effort. Id. at 9-16. In addition, the administrative controls implemented by the Licensee were effective in minimizing sulfate concentrations within the primary coolant and prevent corrosive conditions. Id. at 7, 12. Thus, these levels do not present a significant safety concern. Id. at 7-13.

The recently reported defects also do not present a significant safety concern. The Staff has concluded based on its preliminary review of the Licensee's analysis that the defects are not caused by a continuation or reinitiation of IGSCC. Id. at 13-14. The defects result from grain dropout and grain boundary separation of previously existing degradation. Id. Should the defects result in either excessive tube degradation or exceedance of leak rate limits, the tubes will be taken out of service by plugging. Id. at 2-3, 13. In sum, neither the increased chemical impurities,

the so-called additional tube defects nor the tube plug failures raise a significant safety concern. Id. at 2-4, 15-16.

3. Likelihood of Different Results

Finally, TMIA has failed to meet its burden with respect to the third test, whether the Board would have ruled differently had it initially considered the proffered new information. First, TMIA asserts that new information indicating that 280 of 1006 plugged tubes in the TMI-1 steam generator failed in pull tests (Attachment 3) supports TMIA's Contention 1.c which asserts that the kinetic expansion repair process reduced the steam generator tubes' ability to retain plugs. TMIA Brief at 8-9. Second, TMIA asserts that new information in Attachments 1, 2, 4 and 5 to its Brief indicating "unexplained" increases in sulfate and chloride concentrations on the primary and secondary side of the steam generators (despite the physical removal of the sodium thiosulfate tank thought to be the source of contaminants and stringent administrative controls on chemical contaminants in the reactor coolant system) and new indications of tube defects (Attachment 6) all support TMIA's Contention 2.a which asserts that the corrosive contaminant and failure mechanism have not been adequately identified. TMIA Brief at 9-10. Third, TMIA asserts that new information indicating unexplained increases in sulfates on the primary and secondary sides of the steam generators (Attachments 1, 2, 4 and 5) and new indications of tube defects (Attachment 6), support TMIA's assertions in Contention 2.b.1 that the cleaning process used by Licensee might initiate additional corrosion and the assertions in Contention 2.b.2 that sulfur remaining in the system after cleaning will reinitiate corrosion. TMIA Brief at 10-11.

(a) Plug Failures

The "failure" of Westinghouse mechanical plugs in the "A" steam generator, if considered, would not alter the result below. The jurisdiction of the Licensing Board below was circumscribed by the Notice of Opportunity for Hearing. Commonwealth Edison Co. (Zion Station, Units 1 and 2), ALAB-616, 12 NRC 419, 426 (1980); Public Service Co. of Indiana, Inc. (Marble Hill Nuclear Generating Station, Units 1 and 2), ALAB-316, 3 NRC 167 (1976). The notice stated that the amendment requested by the Licensee was to revise the technical specifications to recognize steam generator tube repair techniques (the kinetic expansion repair), other than plugging. 48 Fed. Reg. 24231 (May 31, 1983), amended 48 Fed. Reg. 24231 (June 14, 1983). The Board recognized that only contentions which are within the scope of the amendment could be considered and thus did not admit those portions of Contention 1.c which questioned the number of tubes requiring plugging, the choice of tubes to be plugged and the failure to plug certain degraded tubes. Memorandum and Order, dated January 9, 1984, at 4. Accordingly, TMIA Contention 1.c was revised to raise only the issue of whether the kinetic expansion repair had weakened the tubes such that the plugs would not retain their seal. Id. at 5.

As discussed above, the Board properly ruled that plugging per se was not an issue within the scope of an amendment proceeding to consider tube repair by the kinetic expansion process. Consequently, if there is no nexus between the repair and the failure of this number of plugs, the plug failures will not have a material bearing on the outcome of the

proceeding. 4/ TMIA provides nothing, apart from conclusory assertions, which establishes that the plug failures were caused by tubes weakened by kinetic expansion.

The majority of reported plug failures did not occur in the region of the tubes where the repair took place and all the failures bear no relationship to the kinetic expansion process. Wu/McCracken Affidavit at 4. The kinetic expansion repair was performed in the upper tubesheet. The majority of loose plugs are located at the bottom of the lower tubesheet, a full 60 feet away from where the tubes were kinetically expanded. Id. Repaired tube ends actually retained plugs better than unrepaired tube ends. Id.

In sum, the failed plugs resulted from the plug installation process and not from the effects of the kinetic expansion repairs. Id. Most of the failed plugs were located 60 feet from where the kinetic expansion repairs took place and were unaffected by the kinetic expansion repair process. The new information regarding numbers of failed plugs does not support TMIA Contention 1.c or any other contention in this proceeding and should not affect the Licensing Board's decision in any way.

(b) Increased Impurities and Newly Reported Defects

It was established below with respect to Contention 2.a that degradation of the steam generator tubes was due to intergranular stress corrosion cracking caused by a reduced sulfur species, during cooldown or

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4/ If the plug failures posed a significant concern, but had no relationship to the issues in this amendment proceeding, TMIA's remedy would be to file a 10 CFR 2.206 petition.

cold shutdown after hot functional testing. Memorandum and Order (Ruling on Motions for Summary Disposition), dated June 1, 1984 ("SD Order") at 60-63. The corrosive contaminant, most likely sodium thiosulfate, and the failure mechanism were identified and verified by extensive testing using sections of tubes removed from the steam generators and analysis of liquid samples taken from many plant systems and tests which simulated plant conditions. Id. at 62-63.

The evidence as to Contention 2.b.1 established that during tube cleaning, the sulfate concentrations were never greater than .4 ppm (or 400 ppb) and caused no detectable damage to the system as evidenced by the low primary-to-secondary leakage. SD Order at 68-70. Also, short and long term corrosion testing using the sulfur concentrations experienced during cleaning confirmed the safety of the hydrogen peroxide cleaning process. Id. at 68. The concentrations of sulfur during cleaning never reached the 5-10 ppm predicted by staff consultant Dillon, whose observations form the basis for Contention 2.b.1, and Mr. Dillon himself concluded that the risks of the hydrogen peroxide process injecting sulfur compounds in the system were small. Id. 68-69. The Third Party Review Group also concluded that the risks of peroxide flushing were inconsequential. Id.

The Board determined that Mr. Dillon stated that he was neither strongly for or against the cleaning process. Id. at 69. Mr. Dillon never stated that there was a substantial risk either in cleaning or leaving the sulfur in place but was concerned that a sulfate level of 5-10 ppm, in the presence of oxygen and a high temperature, was conducive to stress corrosion cracking of sensitized stainless steel. Id. at 69. The decision to clean the reactor coolant system was responsive to his

concern as to the potential for reinitiation at high temperatures, for even though the potential for reinitiation was considered remote, it was preferable from the standpoint of the public health and safety to initiate stress corrosion cracking during cleaning with the reactor shutdown. Id. Another Staff consultant, Digby McDonald, also concluded that cleaning was necessary. Id.

After referring to the report by Mr. Dillon (NUREG-1019, Attachment 3), the Licensing Board concluded that the concern expressed by Mr. Dillon, which TMIA relied on to formulate its contention, was overstated. SD Order at 70-71. Mr. Dillon's concern was that "[t]here are risks associated with the sulfur oxidation and removal as well as the alternative of living with a large S inventory in the system." Id. 5/ The Board concluded, despite TMIA's urgings to the contrary, that the decision to clean the tubes adequately considered the concerns of Mr. Dillon, as well as public safety considerations. Id. at 69-71.

With respect to Contention 2.b.2, reinitiation by the 20-50% sulfur remaining in the oxide layer, it was established below that the contention concerned the reinitiation of corrosion during plant operation. SD Order at 71. Sulfate and sulfide are the dominant equilibrium species

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5/ TMIA Contention 2.b.1 states:

> The Staff's own consultant on this issue, R. L. Dillon, believes that the risk associated with cleaning, i.e., that a relatively large inventory of sulfur compounds will be put into solution, are greater than simply "living with large S inventory in the system," supporting a conclusion that the only two possibilities being considered by the Licensee and Staff pose substantial risk that corrosion will reinitiate.

during normal reactor coolant system operation. Id. at 73. The sulfate which is present in the reactor coolant and sulfide present on tube surfaces are not harmful to the tubes. Id. at 73. The intermediate species which are aggressive and could reinitiate the cracking mechanism can only persist within a very restricted pH and oxidation range. Id.

During the August-September 1981 hot functional test, thiosulfate contaminating the primary system transformed towards more reduced metastable species and when oxygen was introduced to the system during cooldown the aggressive metastable species caused the cracking. Various controls were taken, among them, the physical disconnection of the thiosulfate tank from the reactor coolant system and the imposition of a limit of 100 ppb for concentrations of sulfates, chlorides and floride, levels which do not cause IGSCC. Id. 74-75.

The Board found the extensive corrosion test program, using actual specimens from the TMI-1 steam generator under worst permissible chemistry conditions, showed that there was no reinitiation of corrosion with up to 300 days of exposure. Id. at 79. Further, the low concentrations of sulfur observed during cleaning and in hot functional testing (HFT) and absence of corrosion during a one month HFT at full temperature and presssure provided additional assurance that the remaining sulfate would not lead to corrosive conditions. Id.

As discussed in the preceding section, the temporary increases in sulfates and chlorides in the primary system were not unexpected and were adequately maintained in the primary coolant such that stress corrosion cracking should not occur. Wu/McCracken Affidavit at 7, 9-16. The contaminant levels reported are under conditions where the potential for

corrosion cracking is small and are not likely to have caused further corrosion. Id. at 7-12, 15-16. Furthermore, the chemical excursion in the secondary side has no nexus to the primary side-initiated tube degradation remedied by the kinetic expansion repair process. Id. at 7. In addition, there is no evidence to indicate that the newly reported defects, which are located away from areas which were kinetically expanded, are the result of continuing or reinitiated stress corrosion cracking. Id. at 13-14. The defects are the result of grain dropout and grain boundary separation, a process affecting previously existing degradation. Id. Because the defects are primarily located in tube regions which were not kinetically expanded, the defects will be handled through routine repair measures such as plugging the affected tubes if necessary. Id. at 13.

In addition, none of the information on which TMIA relies shows that the Licensee's long term corrosion test program is invalid. The corrosive contaminant and failure mechanism have been identified by extensive efforts and the use of prototypic TMI-1 steam generator tubing enables the testing to accurately predict future corrosion. Id. at 9-16.

Briefly, none of the matters raised by TMIA would result in a different outcome than the summary disposition of the contentions. As discussed above, the cause of plug failures was the improper plug installation process and not the kinetic expansion repair. Id. at 4. The corrosive contaminant and failure mechanism have been adequately identified and are not questionable as a result of temporary and expected increases in chemical impurities and the separation of grains. Id. at 9-16. Thus, there is no evidence that the Licensee's long-term

corrosion testing is not a valid predictor of plant performance. Id. at 15-16. Furthermore, there is no evidence that the sulfur released by the cleaning process or remaining in the oxide layer has reinitiated corrosion. Id. at 9-16. In any event, the newly reported defects are primarily located outside of the kinetic expansion repair area and will be repaired by plugging if necessary. Id. at 13. Thus, TMIA offers no material evidence which would result in a record different in kind from that already established on Contentions 2.a, 2.b.1 and 2.b.2. In turn, this "new information" is not likely to affect any of the Board's decisions below.

In sum, while its motion may not be objectionable on timeliness grounds, TMIA has not demonstrated that a safety significant issue exists or that there is a likelihood of development of an evidentiary record on Contentions 1.c, 2.a, 2.b.1 and 2.b.2, which is different in kind or consequence from that already developed and which would result in a different decision by the Licensing Board.

III. CONCLUSION

For the reasons discussed above, the motion to reopen should be denied.

Respectfully submitted,

Mitzi A. Young
Counsel for NRC Staff

Dated at Bethesda, Maryland
this 24th day of January, 1985.

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NUCLEAR REGULATORY COMMISSION

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METROPOLITAN EDISON COMPANY, ET AL.	)	Docket No. 50-289
	)	(Steam Generator Repair)
(Three Mile Island Nuclear Station, Unit No. 1)	)	

AFFIDAVIT OF PAUL C. S. WU AND CONRAD E. McCRACKEN

I, Paul C. S. Wu, being duly sworn state as follows:

1. I am employed by the Nuclear Regulatory Commission as a Chemical Engineer in the Chemical Engineering Branch of the Division of Engineering, Office of Nuclear Reactor Regulation. A copy of my professional qualifications is already on record in this proceeding.

I, Conrad E. McCracken, being duly sworn state as follows:

2. I am employed by the Nuclear Regulatory Commission as the Section Chief of the Chemical and Corrosion Technology Section, Chemical Engineering Branch, Division of Engineering, Office of Nuclear Reactor Regulation. A copy of my professional qualifications is already on record in this proceeding.

3. The purpose of this affidavit is to address TMIA's "Motion to Reopen the Record on the Basis of New Information" (Motion to Reopen) and "Brief on Appeal from Initial Decision in TMI-1 Steam Generator Repair OLA and in Support of Motion to Reopen the Record on the Basis of New Information," dated December 10, 1984. Appended to the Motion to Reopen

are 6 attachments. Attachments 1 through 5 are TMI-1 Plant Status Reports dated October 19 and November 30, 1983, August 28, January 4 and January 17, 1984, respectively. Attachments 1, 2, 4 and 5 discuss increases in sulfates and chlorides in the primary and secondary side of the steam generators. Attachment 3 indicates that approximately 280 of 1,006 plugs failed to pass pull tests (i.e., they either moved slightly then stopped or came out). Attachment 6 is a letter dated November 27, 1984 concerning indications of potential defects in steam generator tubes inspected during the normal periodic eddy current inspection.

4. TMIA argues that the documents attached to its Motion to Reopen raise two issues for reopening: (1) steam generator plug failures may have been precipitated by the kinetic expansion repair process and (2) "unexplained" increases in levels of sulfates and chlorides in the steam generator through January 1984 may have caused newly discovered defects in the steam generator tubes and thus stress corrosion cracking is continuing or has reinitiated. TMIA Brief at 8-12.

5. Briefly, the Staff position on the motion is as follows. The kinetic expansion repair technique was applied only to tubes within the upper tubesheet which had degradation in the top 16 inches of the 24-inch thick tubesheet. Defects outside of the tubseheet or within the bottom 8 inches of the 24-inch thick upper tubesheet are dispositioned in accordance with the plant technical specifications that were in effect prior to the amendment change request. Dispositioning these tubes includes taking the tubes out of service by plugging if tube degradation is excessive or causes leak rate limits to be exceeded. The Board correctly ruled on summary disposition that plugging per se was outside

the scope of the hearing and admitted only those portions of TMIA's contention which related to the repair process. Order at 4. TMIA's motion to reopen is without merit because (a) the newly reported defects are located outside of the kinetic expansion repair location and are to be repaired by plugging, and not by kinetic expansion, (b) no evidence exists to indicate that the kinetic expansion repair has influenced or been influenced by the newly reported defects, (c) TMIA relies in part on chemistry excursions on the secondary side which are not relevant to primary side initiated corrosion which was the focus of the kinetic expansion repair, (d) the temporary increases in sulfate and chloride do not indicate that stress corrosion cracking is continuing or has reinitiated, and (e) neither the temporary increases in sulfate and chloride nor the loose plugs present a significant safety concern.

A. Failed Plugs

6. TMIA's Contention 1.c, which was disposed of on summary disposition, alleged that the kinetic expansion repair process had weakened the steam generator tubes such that they would not be capable of retaining plugs. Attachment 3 contains the results of pull testing done on Westinghouse mechanical plugs in TMI-1 OTSGs and lists the number of tubes plugged, tube plugs passing the pull test, plugs moving slightly, and plugs that came out. TMIA argues that the reported failure in August 1984 of 280 out of 1,006 plugs in the "A" steam generator is safety significant and warrants reopening the record on this contention. TMIA Brief at 11-13.

7. The "failure" of plugs to meet performance criteria has no relationship to the kinetic expansion repair process. The kinetic expansion repair process was used only in the upper tubesheet. The majority of loose plugs are located at the bottom of the lower tubesheet which is 60 feet away from where the kinetic expansion repair process was performed. GPUN letter dated October 23, 1984. Repaired tube ends actually retained plugs better than the unrepaired tube ends.

8. In a letter dated October 23, 1984, the Licensee submitted its evaluation of the Westinghouse mechanically rolled plugs, the rolled plug qualification program, and the repair program results performed under the provisions of 10 CFR 50.59. The Staff has reviewed the Licensee's submittal and determined that the Licensee has correctly identified the cause of loose plugs in TMI-1 OTSGs was due to the use of inadequate procedures and a universal joint in the rolling tool which resulted in a reduced net torque being delivered to some plugs. Safety Evaluation on Loose OTSG Plugs transmitted by Memorandum for R. Starostecki, NRC Region 1, from D. Eisenhut, NRR dated January 23, 1985. The Licensee has re-rolled all installed plugs, using a procedure proven by a specific qualification program to restore any improperly installed plugs to the original acceptable installed condition and to ensure that the installed plugs meet the original design criteria. The Licensee also simulated loss-of-coolant accident conditions by conducting hydrostatic plug ejection tests and demonstrated that a plug is unlikely to be ejected under LOCA conditions. The Staff concludes that, by virtue of analysis, testing and qualification programs, the repaired plugs are able to meet their specified design objective and thus maintain primary pressure boundary integrity. Thus the reported plug failures are not a significant safety concern.

9. TMIA also implies that missing plugs will affect safe operation of the plant. See TMIA Brief at 11. In July, 1984, following plant hot functional testing, seven rolled plugs were identified as missing from their installed positions. Four of the plugs were from the bottom tubesheet of OTSG "A", two were from the bottom tubesheet of OTSG "B", and one was from the upper tubesheet of OTSG "A". Only the plug from the upper tubesheet of OTSG "A" was recovered. The remaining six plugs are believed to be in the bottom of the reactor vessel.

10. The Staff has reviewed the safety analyses reports prepared by the Licensee and B&W with regard to the operation of the TMI-1 plant having missing OTSG tube plugs in the reactor system. Our review and evaluation have concluded that (1) the flow blockage effect of the loose plugs would not have a significant adverse effect on Departure from Nucleate Boiling and fuel assembly holddown force; (2) the number of reactor fuel failures from fretting wear caused by loose plug fragments would be small and detectable; (3) the control rod operation would not likely be affected, and if affected, it will not constitute an unresolved safety question; and (4) if incore instrumentation is damaged by the loose plug fragments, this would be monitored and the damage of a few incore detectors would not be a significant safety concern; and (5) the likelihood of other flow paths for the loose plugs is small and if the plugs were to follow other flow paths, no significant safety concern would result. Therefore, there is reasonable assurance that operation of the TMI-1 plant with the missing OTSG plugs remaining in the reactor system will not result in a significant concern in terms of core behavior. Safety Evaluation on Loose Plugs at 5.

B. Increased Sulfates and Chlorides and Newly Discovered Defects

11. In Contentions 2.a, 2.b.1, and 2.b.2, TMIA asserted that (1) the corrosive contaminant and failure mechanism had not been adequately identified, (2) the cleaning process utilized by the Licensee posed a risk of initiating additional corrosion, and (3) the 20-50% sulfur remaining trapped in the oxide film after cleaning could potentially reinitiate corrosion. TMIA contends that the identification of the contaminant is invalid because "sulfur and chloride levels unaccountably increased in both the primary and secondary side of the steam generators" from October 1983 until, at least, January 17, 1984 (despite the removal of the sodium thiosulfate tank thought to be the primary source of the contaminant and stringent administrative controls on chemicals added to the reactor coolant system). TMIA Brief at 9. TMIA also contends (a) that the increases show that another form of sulfur, the cleaning process, or the 20-50% sulfur remaining in the system may be causing further corrosion, as evidenced by the November 27, 1984 letter (Attachment 6), and (b) failure to conclusively identify the corrosive species and exact sequence of contamination invalidates the Licensee's long term corrosion testing "as an accurate predictor of future corrosion." TMIA Brief at 9-11, 13.

12. As concluded in the Staff's SER (NUREG-1019) and supported by Staff consultants' independent evaluation (NUREG-1019, Attachments 2, 3 and 4), cracking of TMI-1 OTSG tubes was caused by sulfur-induced stress corrosion cracking which occurred during the cooldown or cold shutdown

after the hot functional tests. Memorandum and Order, June 1, 1984 ("SD Order") at 60-63. The cracking was induced by intermediate metastable sulfur species (NUREG-1019; Licensee's Report 008, Rev. 3).

13. Some of the documents TMIA cites as showing increases in concentrations of sulfates and chlorides (Motion to Reopen, Attachments 1, 4, and 5) refer, in whole or in part, to the secondary side of the OTSGs which is not associated with primary side corrosion mechanisms which led to the TMI-1 OTSG tube cracking, and is, therefore, technically irrelevant. Only Attachments 1 and 2 refer to increases in sulfate on the primary side of the OTSGs and show sulfate concentrations approaching 100 ppb. Based on information in the TMIA attachments, the Licensee's Answer to TMIA's Motion to Reopen, and the attached affidavit by Scott Giacobbe and technical data report (TDR 638 Rev. 0), we have determined that the increases are both temporary and very small in magnitude. Also, in each case where sulfate concentrations have increased, the reactor coolant was purified immediately and the impurity concentrations rapidly reduced.

14. In addition, although secondary side OTSG corrosion is beyond the scope of the hearing and has thus been improperly referenced by TMIA, the secondary side impurities at the concentrations stated in Attachments 1, 4 and 5 are typical in the secondary water of PWR steam generators and have not been shown to be of significant corrosive concern.

15. Temporary increases in sulfate and chloride concentrations are not unexpected in the reactor coolant. There are many potential sources for the slightly increased concentrations of sulfate and chloride in the primary water. Minor impurity increases such as those seen at TMI-1

typically occur in all reactor coolant systems. The impurities could come from contaminants in the normal chemical additives to the reactor coolant, impurities from the atmosphere during refilling conditions, decomposition of ion exchange resins (which would discharge sulfate and chloride), or dissolution of remaining sulfur from surface oxide films. However, irrespective of the cause of impurity spikes, it is recognized that this happens and chemistry limits of 0.1 ppm for sulfates and chlorides were established to ensure that impurities are controlled. NUREG-1019, at 31; SD Order at 74.

16. Contrary to TMIA's apparent assertion, the addition of ammonium hydroxide to control pH has nothing to do with the concern expressed by staff consultant Dillon. Dillon's concern was that the peroxide cleaning process, which converted all intermediate metastable sulfur species, including volatile polysulfurs (Dr. McDonald, NUREG-1019, Attachment 4), and sulfide into innocuous sulfate, would put large quantities of sulfur (5-10 ppm) in solution during the cleaning process (NUREG-1019, Attachment 3). Therefore, Dillon's precleaning concern had nothing to do with the temporary sulfate increases which may have resulted, in part, from the addition of amonium hydroxide. In addition, during the cleaning process, only 0.4 ppm of total sulfate was generated which is significantly less than the 5 to 10 ppm of concern to Dillon. SD Order at 69. Bubble, drip and eddy current test (ECT) examinations conducted by the Licensee subsequent to the hot functional testing after the cleaning process verified that the cleaning process has not introduced a corrosive environment (letter from W. Johnston to G. Lainas regarding Increase in OTSG Leakage Rate, July 11, 1984).

17. The long term corrosion tests were designed in part to verify that the proposed operating chemistry limits are adequate to prevent reinitiation or propagating of tube degradation. The test program chemistry conditions bounded the plant's experience by including impurity concentrations at or slightly above the 0.15 ppm primary water contaminant "spikes" reported in TMIA's attachments. Giacobbe Affidavit, TDR 638, Rev. 0., page 12. Thus, applicable testing has shown that impurity "spikes" which have ocurred do not cause stress corrosion cracking and do not pose a significant safety concern.

18. TMIA's Contention 2.a alleged that the corrosion contaminant and the failure mechanism had not been adequately identified. The licensee undertook an extensive program to identify the extent and cause of tube failure. SD Order at 60-63. The Staff concluded in its summary disposition that a reduced sulfur species is the causative agent, because: 1) the corrosion occurred at low temperature; 2) sulfur was present at concentrations high enough to cause the IGSCC; 3) oxidants were introduced during the cooldown and when cold; and 4) the mechanism was duplicated and verified in laboratory tests. See SD Order at 66-67. The Staff also stated that extensive tests have been conducted which have clearly identified the causative agent as a reduced sulfur species. SD Order at 62. In addition, laboratory tests conducted by the Licensee and a Staff consultant verified that a reduced sulfur species can cause the type of stress corrosion cracking observed. SD Order at 62.

19. TMIA also argues that Dr. McDonald's concern that other volatile polysulfur species might be responsible for the corrosion is supported by the increases in sulfates and the newly uncovered tube defects and thus,

the corrosive contaminant and failure mechanism has not been identified as alleged in Contention 2.a. See TMIA Brief at 8-11.

20. With respect to TMIA's Contention 2.a., it was established that sodium thiosulfate was the contaminant leading to the tube failure and the corrodant was one or more intermediate species of sulfur created from the thiosulfate during the hot functional test period. See SD Order at 62-63. Although the specific sulfur species or volatile polysulfur compound which constitutes the corrodant has not been identified, the source of the corrodant, sodium thiosulfate, has been clearly identified and removed. The reported increase in sulfate and chloride in the primary coolant (Attachments 1, 2, and 4: TMI-1 Plant Status Reports) provides no evidence that Licensee and Staff have incorrectly identified the contaminant or the failure mechanism. The failure mechanism was established as sulfur-induced stress corrosion cracking which occurred during the cooldown or cold shutdown condition after the hot functional tests. SD Order at 62-63. Nothing in TMIA's "new information" leads to a conclusion other than that the corrosion occurred during cooldown and shutdown following hot functional testing. Furthermore, the new information presented by TMIA in Attachments 1, 2, 4 and 5 fails to show primary-side tube degradation occurred in the TMI-1 OTSGs by any mechanism other than a reduced sulfur species.

21. In Contention 2.b.1, TMIA alleged that the reactor coolant system cleaning process utilized by licensee itself posed a risk of initiating additional corrosion. Specifically, TMIA alleged that reinitiation of the IGSCC might be prompted by the hydrogen peroxide cleaning process based on a concern stated by Staff consultant, R. L.

Dillon, that the conversion of sulfides on the tube surfaces to soluble sulfate might put dangerously high levels of sulfur compounds in solution. A similar concern was expressed by the Third Party Review Group (TPR), namely, that "there is much about the reactions between peroxide and systems material that is not well understood." NUREG-1019, Attachment 6 at 6. TMIA further argues that the November 27, 1984 letter from R. F. Wilson to counsel for licensee (Motion to Reopen, Attachment 6) "indicates that cracking has reinitiated and Dillon's theory concerning the cleaning process cannot be ruled out as the cause." TMIA Brief at 10-11.

22. The purpose of cleaning the TMI-1 OTSG tubes and the RCS was to convert all intermediate metastable sulfur species, such as the sodium thiosulfate, volatile polysulfur and sulfide into stable non-corrosive sulfate. Laboratory testing had shown that 50 to 80% of the sulfate would be removed during the cleaning process. NUREG-1019, Supplement 1, at 17. The remaining 20 to 50% of sulfate would gradually diffuse into the reactor coolant during subsequent periods. The administrative chemistry limit (NUREG-1019, page 31) requires that sulfate concentration in the reactor coolant system be kept below 0.1 ppm by the use of demineralization as necessary.

23. In fact, during the reactor coolant system cleaning operation at TMI-1 in May 1984, the sulfate concentration reached 0.4 ppm (400 ppb) without showing any harmful effect as evidenced by the low primary to secondary leakage. SD Order at 68-70. Furthermore, no corrosion was found in tests performed before the cleaning using actual TMI-1 tubing and simulated solutions spiked with concentrations of 20 ppm sulfate

(Licensee's Motion for Summary Disposition of Each of TMIA's and Joint Intervenors' Contentions, February 24, 1984 ["Licensee's SD Motion"] at 39). Consequently, the minor increases in sulfate and chloride concentration in the primary system, as well as the temporary increases in the secondary side, under reactor shutdown conditions do not cause a significant corrosion concern. Moreover, as indicated in the October 19, 1983 report (Attachment 1), the Licensee promptly reduced the primary coolant sulfate concentration to approximately 30 ppb which is well below the 100 ppb limit by using an anion bed demineralizer. The presence of impurity excursions similar to the chloride and sulfate spikes which have occurred at TMI-1 are common in light water reactor operation and are routinely corrected by the use of demineralization without evidence of corrosion. The concentrations detected would not cause a reinitiation of the stress corrosion damage which previously occurred at TMI-1.

24. The concerns of R. L. Dillon and the TPR were expressed before the cleaning which actually took place in July, 1983. There is no evidence that cleaning had any adverse effects on the tubes, as confirmed by Licensee's safety analysis (Topical Report 008, Rev. 3), or that it created conditions which someday might cause IGSCC. In addition, during the cleaning only 0.4 ppm total sulfate was generated by the hydrogen peroxide process which is signifcantly less than the 5-10 ppm of concern to Dillon. SD Order at 63, 69. Tests performed before the cleaning found no corrosion when actual TMI-1 tubing underwent simulated cleaning in a solution spiked with concentrations of 20 ppm sulfate (Licensee's SD Motion at 39).

25. Based on the information stated in paragraphs 12 through 17 and 20 through 24, the Staff concludes that sulfate and chloride at the concentrations detected in the reactor coolant would not cause significant corrosion at the OTSG shutdown conditions and thus, does not present a significant safety concern.

26. Contrary to TMIA's claim, (see TMIA Brief at 10-11), the November 27, 1984 letter states only that there are "indications" of potential tube defects and does not mention "cracking." This new information provides no evidence that the primary side sulfur-initiated tube degradation is continuing. As stated in the Licensee's Answer to TMIA's motion to reopen (TDR 638, Rev. 0, page 8), the eddy current test (ECT) conducted by the Licensee in November 1984 indicates that the number of indications is much higher in A-OTSG than B-OTSG. In A-OTSG, 2.0% of the tubes (299 out of approximately 14589) have indications greater than 40% through wall, while in B-OTSG, 0.5% (33 out of approximately 6576) have such indications (TDR 638, Rev. 0, page 8). These "indications" occurred away from the kinetic expansion location, and will be repaired by plugging if necessary (¶ 5).

27. Extensive investigation conducted by the Licensee indicates that the degradation detected by ECT in late 1984 is not a continuation of the old IGSCC, but rather is intergranular attack (IGA) which occurred simultaneously with the IGSCC in 1981. Licensee's Answer at 13. The reason why these indications were not previously detected was due to their small circumferential size and very little volume loss (i.e., loss of metal grains). Because eddy current sensitivity is highly dependent

on degradation volume, detection of IGA by eddy current is more difficult than IGSCC. Reasonable assurances exist that operational forces during the hot functional testing performed in 1983, subsequent to the recorded eddy current examinations in 1982, caused grain dropout and grain boundary separation of previously existing IGA, and these grain dropouts enabled ECT to detect this degradation. The Staff's preliminary review of the information contained in the Giacobbe Affidavit and the attached technical data report leads it to believe that the Licensee's conclusions are correct.

28. TMIA asserts in Contention 2.b.2. that "[e]ven if the proposed cleaning process presented no risks, there is no assurance that the proposed process can remove more than 50-80% of the contamination, thus there can be no assurance that the contamination which would be left after the process is complete will not cause reinitiation." TMIA implies in its motion to reopen that the tube degradation reported in Wilson's letter on November 27, 1984 was caused by sulfur trapped in the oxide film after cleaning. TMIA Brief at page 10.

29. TMIA's concern that sulfur remaining after cleaning will reinitiate tube cracks is without merit and was dismissed on summary disposition. See SD Order at 71-80. TMIA does not recognize that the purpose of the cleaning process was to convert reducing sulfur species to stable non-corrosive sulfate (¶ 23). The Staff has determined that operation control procedures (see SD Order at 74-75) will prevent the creation of potentially harmful intermediate species from the sulfur. NUREG-1019, § 3.6.

30. TMIA claims that the Licensee failed to notify the Licensing Board regarding problems with increasing levels of sulfur and chlorides,

and of Licensee's concern over those levels, but relied on its position that long-term corrosion testing "provided additional assurance that reinitiation would not occur." TMIA Brief at 10. TMIA further claims that failure to conclusively identify the corrosive species and exact sequence of contamination invalidates the long-term corrosion testing as an accurate predictor of future corrosion. TMIA Brief at 13.

31. The Licensee's long term corrosion testing is based on a proper identification of sodium thiosulfate as the causative source of the corrodant. With the identification of the causative agent and the failure scenario determined as IGSCC, even though the exact reduced sulfur species which acts as the corrodant has not been identified (see paragraph 9, supra), the use of prototypic TMI-1 steam generator tubing enables the testing to accurately predict future corrosion. Nothing in TMIA "new information" invalidates the Board's conclusion regarding the utility of long term corrosion testing. In addition, as discussed in paragraph 25, testing performed shows that minor increases in the concentrations of sulfate and chloride in the primary coolant will not cause significant corrosion at the low temperature refilling conditions and therefore does not present a significant concern.

32. The only other substance identified which has been associated with IGSAC of OTSG tubes is carbon, which by itself is an inert material. In instances where it has been associated with corrosion it was initially present as carbonates. Therefore, the presence of small amount of sulfate and chloride (100 ppb), would not cause the primary side initiated OTSG tube cracking at TMI-1. Furthermore, the Licensee has demonstrated its ability to promptly reduce the sulfate and chloride concentrations in both the primary and secondary side by using an anion bed demineralizer.

The impurity concentrations reported have no safety significance and the long-term corrosion testing provides additional assurance that reinitiation of tube cracking will not occur. The November 27, 1984 letter (Attachment 6) does not indicate that corrosion has reinitiated or a new corrodant and failure mechanism is present. Thus the "new information" does not present a significant safety issue which would affect the Licensing Board's rulings.

The foregoing is true and correct to the best of our knowledge.

Paul C. S. Wu

Paul C. S. Wu

C. McCracken

Conrad E. McCracken

Subscribed and sworn to before me
this 24th day of January, 1985

Malinda L. McDonald
Notary Public

My Commission expires: 7/1/86