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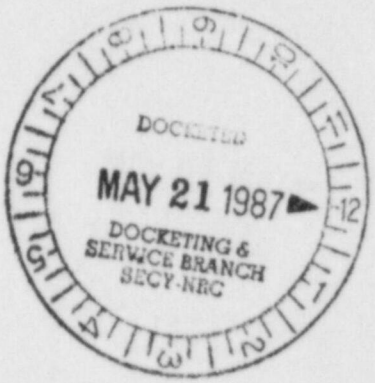
LBP-87-15

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Administrative Judges:

James L. Kelley, Chairman
Glenn O. Bright
Dr. James H. Carpenter



In the Matter of

INQUIRY INTO THREE MILE ISLAND UNIT 2
LEAK RATE DATA FALSIFICATION

Docket No. LRP

ASLBP No. 86-519-02 SP

SERVED MAY 21 1987

RECOMMENDED DECISION

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RECOMMENDED DECISION

Appearances

Harry H. Voigt, Michael F. McBride, and James W. Moeller, Esqs., LeBoeuf, Lamb, Leiby & MacRae, Washington, D.C., for Applicants.

Smith B. Gephart, Esq., Killian & Gephart, Harrisburg, Pennsylvania, for Numerous Employees.

Ernest L. Blake, J. Patrick Hickey, and John N. Nassikas III, Esqs., Shaw, Pittman, Potts & Trowbridge, Washington, D.C., for GPU Nuclear.

James B. Burns, Chicago, Illinois, and Christopher W. Flynn and Frederick C. Williams, Esqs. Washington, D.C., Isham, Lincoln & Beale, for Jack Herbein.

Michael W. Maupin and M. Christina Hensley, Esqs., Richmond, Virginia, Hunton & Williams, for Gary P. Miller.

Marjorie M. and Norman O. Aamodt, Lake Placid, New York, Pro Se.

Jack R. Goldberg and Mary E. Wagner, Esqs. Bethesda, Maryland, for the Nuclear Regulatory Commission Staff.

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Synopsis

This inquiry was instituted by the Commission in December 1985, following investigations by the NRC Staff and GPU Nuclear Corporation ("GPUN") consultants that flowed from former employee Harold Hartman's allegations of leak rate surveillance improprieties at TMI-2 during 1978-79. Hartman had alleged that the tests were at times purposely manipulated in several different ways and that records of unacceptable results were discarded to cover up problems with this surveillance. We accepted into evidence the reports of the prior investigations, which include a voluminous analysis of the technical aspects of the leak rate surveillance at TMI-2 and interviews of people that had been involved. However, we have assessed independently the implications of this and other evidence to reach our own conclusions concerning the issues before us.

On December 31, 1985, the Board sent a letter to 120 present and former employees at TMI-2 who might have knowledge of or involvement with the subject of this inquiry. The ensuing petitions to intervene resulted in admission of six parties to this proceeding; (1) a group of 25 present and former employees of TMI-2 ("Numerous Employees"), (2) Mr. Kidwell, a former employee, (3) Mr. Herbein, a former officer of Metropolitan Edison Company ("Met-Ed"), (4) Mr. Miller, an employee of Met-Ed, (5) GPUN and (6) Marjorie M. and Norman O. Aamodt. The petition of Marvin I. Lewis was denied. Pursuant to the Commission's initial Order, the NRC Staff did not participate as a party; however, the Staff

provided extensive documentary material and Staff witnesses appeared at the hearing to respond to several hundred questions on the technical aspects of leak rate testing at TMI-2. In addition, technical experts who had prepared reports for Met-Ed and GPUN were called as "Board witnesses" to answer questions concerning technical aspects of their work.

The hearing began in September 1986 and required 33 hearing days with a resulting transcript of over 5,000 pages. Forty-seven witnesses testified, most of whom prefiled testimony. Twenty-five exhibits were entered into the record. All parties filed proposed findings of fact and reply findings which we have considered in detail in reaching our assessment of this record.

The "Numerous Employees" submitted a memorandum of law in support of their proposed findings of fact, in which several issues including the question of the appropriate standard of proof were raised. Upon consideration of comments from various parties, we concluded that the usual "preponderance of the evidence" standard is appropriate, except with respect to findings of manipulation and falsification. Primarily because findings of manipulation and falsification are likely to have strong reputational impacts, we apply the "clear and convincing" standard to such evidence.

The scope of this inquiry was delineated in the Commission's Order in the form of four multipart issues. Our findings are arranged to address these specific issues. We also developed findings on the organizational structure at TMI-2 during 1978 and 1979, the TMI-2

Technical Specifications ("Tech Specs") and the training program to provide a perspective viewpoint in considering the performance of individuals.

1. Tech Spec interpretation

The first Commission issue covered the interpretation and implementation of Tech Spec 3.4.6.2 and the events of October 1978 when an NRC inspector discovered that that Tech Spec was not being properly interpreted. Tech Spec 3.4.6.2 established five leakage limits, including one gallon per minute ("1 gpm") for "unidentified" leakage, the leakage measured by the leak rate test involved in this inquiry. The "Action Statement" in Tech Spec 3.4.6.2 stated that if leakage exceeded that limit, the operators must "reduce the leakage rate to within limits within 4 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours." Tech Spec 4.4.6.2 stated that Reactor Coolant System leakages shall be demonstrated to be within limits by four different surveillances, including "performance of a RCS water inventory balance at least once per 72 hours during steady state operation."

Virtually all Operations Department personnel worked under an erroneous interpretation of the above Tech Specs under which entry into the Action Statement was required only if they were unable to obtain a leak rate test result of 1 gpm or less once in a 72-hour period. If a test result of less than 1 gpm were obtained, any other tests run during

the same period that showed excessive leakage were not considered to require entry into the action statement. This incorrect interpretation coupled with the operators' cynicism about the test, resulted in a practice whereby test results greater than 1 gpm were routinely discarded, and test results of 1 gpm or less were filed.

Some Operations Department personnel would search for leakage or "eyeball" plant parameters for indications of excessive leakage after obtaining a test result greater than 1 gpm, but many did not. Particularly during the last three months of operation, the operators were, in effect, going through the motions of satisfying a procedural requirement, without regard to the validity of the test results.

During our questioning of the operators and foremen, it became apparent that there was a pervasive ignorance of the safety significance of the leak rate test. Classroom training on the leak rate Tech Specs and associated surveillances was virtually non-existent during 1978-79. We were quite surprised by the operators' total unfamiliarity with the "leak-before-break" concept, and the safety analysis of leaks in the TMI-2 FSAR. The conclusion is inescapable that the lack of meaningful training was a major cause of improper attitudes toward leak rate testing at TMI-2.

The improper interpretation of the Tech Specs was discovered by an NRC inspector in October 1978 and the chronology of events associated with this inspection is detailed in our hearing record. The resulting Licensee Event Report conveyed no clear explanation to the NRC or to the operating personnel that the interpretation of the Tech Specs had been

wrong. Similarly, an Operations Memorandum to shift foremen and supervisors contained only a single, cryptic paragraph that was an inadequate attempt toward instruction on proper leak rate practice. The clear answer to the Commission's question whether the licensee's corrective action was sufficient is no.

2. Difficulties with leak rate surveillances

The second Commission issue pertained to the difficulties operators experienced in conducting leak rate surveillances. The test was performed by typing a code into the computer; the computer then carried out the data acquisition and computation of the leak rate at the end of a 1 hour test interval. The difficulty the operators experienced was that the test results were quite variable. Successive tests during a shift or from shift to shift showed computer-calculated leak rates that were inconsistent and, therefore, unbelievable, i.e., a large leak does not spontaneously become smaller. There is near unanimity in the record that there was a lack of confidence in the computer-calculated test results and, yet, these tests were routinely approved by operators and shift foremen and the papers filed as a demonstration of compliance with the surveillance requirement. Such specious performance was remarkably unprofessional.

The specific reasons for the difficulty were not known to anyone in the operations department, but were generally thought to be in the computer program. Unreliability of the computer-based surveillance

should have led the operators to use the manual procedure that also is part of the TMI-2 Surveillance Procedure 2301-3D1. Furthermore, the Operations Department personnel failed to follow Administrative Procedure 1010 to conclude that the tests were not satisfactory and to classify them as either an exception or deficiency. If deficient test results had been retained and properly classified, it seems probable that appropriate attention might have been given to the technical defects in the test.

The technical defects represented the summation of (a) procedure errors, (b) instrument inaccuracies and (c) oscillations in plant conditions. The technical experts identified 13 procedure errors, of which 4 were quantitatively important and, singly or in combination, may have produced errors of 1 gpm or more on some tests. Instrument inaccuracies or variability were estimated by the technical witnesses as possibly producing errors of up to approximately plus or minus 1 gpm. Plant oscillations contributed another large (plus or minus 1 gpm) source of variability to the leak rate test results. It is clear on this record that the operators at TMI-2 were faced with a grossly inadequate surveillance system. However, we also find that much of the difficulty could have been attenuated if attention had been given to the problem. For example, the effects of the instrument errors and plant oscillations could have been drastically reduced by extending the test interval; i.e., a 1 gpm error with a 1 hour test interval would become a 0.25 gpm error with a 4 hour test interval.

Apart from these technical defects, there were certain "idiosyncrasies" associated with the TMI-2 leak rate test that made it even more difficult for the operators to demonstrate compliance with the 1 gpm limit. Thus, when Regulatory Guide 1.45 refers to 1 gpm as being measurable in sumps as an industry experience, it seems clear that room temperature is implied. In the TMI-2 Tech Specs, the 1 gpm limit is applied at reactor operating temperature, thereby effectively reducing the limit to 0.72 gpm.

The TMI-2 test limit did not include an "evaporative loss factor" for the RCS, in contrast to some other Babcock & Wilcox power reactors. For example, TMI-1, Rancho Seco and Oconee have evaporative loss factors in their test limits that range from 0.51 to 0.73 gpm. The actual evaporative losses at TMI-2 were not established in our inquiry, but it seems probable that such losses may have been approximately 0.5-0.7 gpm, making it probable that test results would frequently exceed the 1 gpm limit.

The Superintendent of Technical Support (Seelinger in 1978 and Kunder in 1979) and the Unit 2 Superintendent (Logan in 1979) were aware that there were difficulties with the leak rate test, but they did not explore the situation and failed to initiate effective corrective actions. Only one substantive corrective action was finally taken on March 16, 1979 and it was technically flawed. Unidentified leakage was calculated as the difference between gross leakage and identif ed leakage. Beginning in February 1979, substantial leakage developed from valves on the pressurizer and this identified leakage was estimated from

the rate of water collection in the reactor coolant drain tank (RCDR). One of the errors in the test procedure was the failure to convert the volume of water collected in the RCDT at room temperature back to RCS temperature before it was subtracted from the gross leakage. The volume of a given mass of water is 1.4 times greater at RCS temperature than it is at room temperature. Thus, when the rate of drain tank collection reached 2.5 gpm around February 25, 1979, the net or unidentified leakage was in error by 1 gpm. The March 16 temporary change notice called for a manual calculation that properly corrected for this error, but did not call for correction of the similar error in not converting the volume of water added to the make-up tank to its volume at the RCS temperature. It should have been obvious that both volumes should be corrected to RCS temperature.

The Commission also raised the question whether the operators felt pressure to obtain surveillance results which did not exceed Tech Spec limits. The record shows that the operators felt a general sense of pressure to keep the plant on line and they were asked questions about the status of the leak rate test or told to get a "good" leak rate. However, this pressure did not translate into feelings that adverse actions would be taken against them if they failed to obtain a "good" leak rate test result.

3. Discarding leak rate test results

The Commission raised the question whether unacceptable test results were discarded. The evidence is that fifty percent or more of the tests were discarded. The practice of discarding results greater than 1 gpm began at TMI-1 and carried over to TMI-2. Every CRO, shift foreman and shift supervisor who appeared before us (with one exception) testified he was either aware of the practice or personally discarded tests. Some testified searches for leaks were carried out before a test was invalidated and discarded. Others claimed they compared the test results to plant parameters and apparent inconsistencies led to discarding test results greater than 1 gpm. For the most part, however, any test over 1 gpm was routinely discarded without any effort to "validate" it. Indeed, it was not possible to validate quantitatively against a 1 gpm standard by "eyeball" reference to other plant parameters.

The skepticism with which the operators viewed test results was not unreasonable, but their behavior in discarding the papers rather than documenting the apparent problems permitted those problems to go uncorrected month after month. The Supervisor of Operations, Mr. Floyd, and the Superintendent of Technical Support, Mr. Seelinger, were aware of the practice of discarding tests; we have not found any excuse for their countenancing these improper practices. There is no evidence that any members of management above Floyd and Seelinger knew that tests were being discarded.

4. Leak rate test manipulations

The concluding section of our findings covers the individual responsibility of the thirty individuals who worked in the Operations Department and the Supervisor of Operations, Mr. Floyd, with respect to manipulation and falsification of tests. We do not attempt to summarize these results; the findings for each individual are self-explanatory.

INTRODUCTION AND PROCEDURAL BACKGROUND

The Board adopts and sets forth below GPU Nuclear Corporation's Part I of its proposed findings, entitled "Introduction and Procedural Background," paragraphs 1-28, pp. 1-16, except as paragraph 28 is modified by the Board.

"1. On March 24, 1980, Harold W. Hartman, Jr., a control room operator at Three Mile Island -- Unit Number 2 ("TMI-2") prior to the accident, publicly alleged that reactor coolant system ("RCS") leak rate surveillance tests ("leak rate tests")[1] were at times purposely manipulated and records of unacceptable results were discarded to cover up the fact that over an extended period of time the results of the tests exceeded Technical Specification ("Tech Spec") limits for unidentified leakage. Hartman alleged that the computer program for calculating leak rates was unreliable, frequently yielding unrealistic results. This made it more difficult to get "good" leak rates. Hartman further alleged that operators at TMI-2 sometimes manipulated leak rate test results by inputting wrong data into the computer, adding hydrogen gas to the make-up tank during leak rate tests, adding

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1 The leak rate tests were used to assess whether primary system leakage surpassed limits contained in the facility's technical specifications. The leak rate test is commonly known by several names or acronyms, such as: "Leak Rate," "LRT," "Reactor Coolant Inventory Balance," "RCIB," or "Mass Balance." Generally, the term "leak rate test" will be utilized in this decision except when dictated otherwise in quoting or paraphrasing testimony or documentary evidence.

water to the make-up tank during a leak rate test and not inputting the addition into a computer, and adding water to the make-up tank while performing water transfer operations involving other tanks. Hartman specifically alleged that shift supervision was aware of such improper conduct. Inquiry Into Three Mile Island Unit 2 Leak Rate Data Falsification, CLI-85-18, 22 N.R.C. 877 (1985)."

"2. Shortly after Hartman made these allegations public, the Nuclear Regulatory Commission ("NRC") Office of Inspection and Enforcement ("I&E") began an investigation. In the early stages of this NRC investigation, the United States Department of Justice ("DOJ") was advised of evidence uncovered by the NRC, and on April 28, 1980, DOJ assumed control of the investigation. I&E remained involved only to the extent of providing assistance to DOJ. Board Exh. 1-A, Stier Report, Vol. I at 2.[2] "

"3. On April 16, 1980, Metropolitan Edison Company ("Met-Ed"), then the operator of TMI-2, retained the law firm of Faegre & Benson to conduct an investigation of Hartman's allegations. Id. Because of the criminal nature of the investigation being conducted by DOJ, Faegre & Benson could not gain access to key witnesses. Id.; Board Exh. 2, Faegre & Benson Report, Vol. 1 at 13. However, they did interview

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2 Appendix A provides a list of exhibits offered or received in this proceeding. See Tr. 5221; Board Order of Nov. 19, 1985.

Hartman for two days in April 1980 and performed extensive technical analyses of leak rate testing at TMI-2. Board Exh. 2, Faegre & Benson Report, Vol. 2 at 2; Board Exh. 1-A, Stier Report, Vol. I at 2. Their report was issued on September 17, 1980. Board Exh. 2, Faegre & Benson Report."

"4. While the criminal investigation of leak rate testing was pending, the NRC received a status report from its Region I personnel who had conducted the original investigation. That report was presented on June 3, 1983, and summarized the findings of I&E up to the point where the investigation was turned over to DOJ. The NRC subsequently instructed its Office of Investigations ("OI") to investigate TMI-2 leak rate test practices. On June 27, 1983, OI began an investigation that was also limited because of the pending DOJ investigation. Like Faegre & Benson, OI was not able to interview critical witnesses. Board Exh. 1-A, Stier Report, Vol. I at 2-3."

"5. On November 11, 1983, the DOJ investigation resulted in an eleven-count indictment returned in the U.S. District Court, Middle District of Pennsylvania (Criminal No. 83-00188), charging Met-Ed with criminal offenses arising out of leak rate practices at TMI-2. On February 28 and 29, 1984, Met-Ed entered into a plea agreement with the Government ending the criminal prosecution. Met-Ed pleaded guilty to one count of the indictment and nolo contendere to six other counts of the indictment. Id. at 3; see also id., Vol. V(A) at Tab 3 (Statement of Metropolitan

Edison Company with respect to the Plea Agreement)."

"6. When the Government and Met-Ed entered the plea agreement with the Court, both the United States Attorney and Met-Ed entered statements into the record. Id., Vol. I at 3. In urging the Court to accept the plea agreement, U.S. Attorney David Queen, inter alia, stated that the evidence developed in the Grand Jury inquiry did not indicate that any of the directors and officers of GPU Nuclear Corporation ("GPUN") from its inception in 1982 as successor operator of TMI-2 to Met-Ed to the date of the indictment, or any of the directors of Met-Ed "participated in, directed, condoned, or was aware of the acts or admissions that are the subject of the indictment." CLI-85-18, 22 N.R.C. at 879."

"7. After the Court accepted the plea agreement, Met-Ed and the NRC moved to obtain the release of the evidence presented to the Federal Grand Jury. On April 10, 1984 and June 25, 1984, the Court denied those motions, and the evidence on which the Grand Jury relied has remained sealed. Board Exh. 1-A, Stier Report, Vol. I at 3."

"8. In January of 1984, GPUN retained Edwin Stier, a former Director, New Jersey Division of Criminal Justice, to conduct an independent investigation into leak rate testing at TMI. Id. at 4. Stier's report examined the attitudes and behavior of TMI-2

personnel toward leak rate testing during the full year of TMI-2 operation, the 222 leak rate tests for which records presently exist, and statements made by individuals possibly involved in leak rate testing. See id. at 11-16. The Stier Report, entitled "TMI-2 Reactor Coolant Inventory Balance Testing," was issued on September 5, 1985. Board Exh. 1-A, Stier Report."

"9. The Commission asked OI to examine whether Michael Ross, Manager of Operations at TMI-1, had participated in, directed, or condoned leak rate falsifications at TMI-2. OI interviewed Ross and others under oath regarding Ross's involvement at Unit 2, reviewed pertinent records, and concluded that Ross's role at TMI-2 was minimal. In its report of April 16, 1984, OI found that during the period falsifications took place, Ross was present at TMI-2 only the minimum time necessary to maintain his TMI-2 license and was not involved in the falsifications. See CLI-85-18, 22 N.R.C. at 879."

"10. In July 1984, the NRC Staff issued NUREG-0680, Supp. No. 5, dealing with the restart of TMI-1. Among the subjects discussed in that report was management involvement in leak rate testing at TMI-2. The NRC Staff relied on two sources of information: (1) the statement issued by the U.S. Attorney and (2) all of the evidence that had been gathered by the NRC up to that time, including evidence developed by OI in its then pending investigation. Board Exh. 1-A, Stier Report, Vol. I at 4.

"11. OI issued a report on August 15, 1984 summarizing its findings as of that date. In his cover memorandum, OI Director Ben Hayes described his report as follows: "[I]t does not set forth the facts and evidence obtained as a result of a completed investigation but sets forth the information accumulated by the NRC since May 1979." Id. (citing Memorandum, Ben B. Hayes to NRC Commissioners, Three Mile Island Nuclear Generating Station Unit 2/Alleged Falsification of Leak Rate Surveillance Test Data (1-83-010), August 15, 1984 at 1)."

"12. Both the August, 1984 OI Report and the July, 1984 NUREG-0680, Supp. No. 5, indicated that the NRC Office of Nuclear Reactor Regulation ("NRR") and OI would jointly continue an investigation of leak rate test practices by some individuals who had been licensed at TMI-2 or had held dual licenses for TMI-1 and TMI-2. NRR worked with OI on investigations of 10 licensed operators[3] to determine their involvement, if any, in improper activities associated with leak rate testing at TMI-2 before the accident. NRR performed a technical evaluation of 161 leak rate

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3 The ten operators were Raymond R. Booher, Joseph R. Congdon, Martin V. Cooper, Craig C. Faust, Edward R. Frederick, Carl L. Guthrie, Theodore F. Illjes, Hugh A. McGovern, Adam W. Miller, and Dennis I. Olson. NRC chose to investigate these individuals because they continued, at the time, to be licensed NRC operators. Although Booher and Olson were no longer licensed by the time NRC completed the investigation and issued the NRR/OI Report, the Report included findings, conclusions, and recommendations concerning all ten. See Board Exh. 5-A, NRR Report.

tests performed at TMI-2 during the period September 30, 1978 to March 28, 1979.[4] In addition, joint NRR/OI interviews were conducted with 13 former control room operators and two shift foremen. NRR prepared a report on each of the 10 individuals under investigation, identifying the individual's role in leak rate testing irregularities and evaluating the individual's current performance.[5] Board Exh. 5-A, NRR Report, Vol. 1 at Enclosure 1. On April 1, 1986, the joint NRR/OI Report -- "Results of NRR's Investigation and Evaluation of Ten Licensed Operators Involved in TMI-2 Preaccident Leak Rate Testing Irregularities" -- was issued. Board Exh. 5-A, NRR Report."

"13. In an Order issued in the TMI-1 Restart Proceeding on February 25, 1985, the Commission stated that it would institute a separate hearing apart from the Restart Proceeding to develop

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4 Stier reviewed all 222 leak rate tests at TMI-2 for which records presently exist. Stier used different numbering of tests from NRR. Generally, the Board will refer to the number assigned to the test by NRR (e.g., NRR Test No. 1). Stier test numbers will be used for those tests which NRR did not review or when Stier's evaluation of the test is being discussed (e.g., Stier Test No. 1). NRR tests are found in Board Exh. 5-A, NRR Report, Vols. 2-4. Stier tests are found in Board Exh. 1-A, Stier Report, Vols. IV(C)-(K). Appendix C provides a list correlating the NRR and Stier test numbers.

5 The Board excluded as evidence in this proceeding portions of the NRR/OI Report regarding current performance. The individuals' current performance and recommendations for actions that may be taken with respect to anyone involved in leak rate falsifications were beyond the scope of our fact-finding process. See CLI-85-18, 22 N.R.C. at 883-884.

the facts surrounding the RCS leak rate data falsifications at TMI-2 prior to the March 28, 1979 accident in sufficient detail to determine the ultimate status of those possibly involved. The Commission's Order specifically excluded those individuals whom the U.S. Attorney at the sentencing hearing of Met-Ed had stated were not involved and those individuals whom OI already had reviewed and found not to be implicated in its TMI-1 leak rate investigation (i.e., Michael Ross). Metropolitan Edison Company, et al. (Three Mile Island Nuclear Station, Unit 1), CLI-85-2, 21 N.R.C. 282, 298-299 (1985)."

"14. In December 1985 the Commission issued an Order and Notice of Hearing for this proceeding. CLI-85-18, 22 N.R.C. 877. It directed this Board to address the following issues:

> (a) How were the Technical Specification 3.4.6.2 requirements for reactor coolant system unidentified leakage interpreted and implemented by control room operators (CROs), shift foremen, shift supervisors and on-site and off-site management? Following the discovery by an NRC inspector in October 1978 that Technical Specification 3.4.6.2 requirements were not properly interpreted or implemented, what corrective action was taken by management personnel? Was the corrective action taken sufficient to insure compliance with the Technical Specification 3.4.6.2 by the personnel performing and reviewing the leak rate surveillance tests?
>
> (b) What difficulties, if any, were operators experiencing when conducting leak rate surveillance tests required by Technical Specification 4.4.6.2.d? Who knew about these difficulties? What corrective actions were taken? Did operators feel pressure to obtain leak rate

surveillance test results which did not exceed technical specification limits? If so, what type of pressure was perceived or exerted and who was responsible?

(c) Were unacceptable leak rate surveillance test results required by Technical Specification 4.4.6.2.d discarded? If so, who knew of, condoned or directed this practice? Were unacceptable leak rate surveillance test results discarded in an attempt to hide them from the NRC?

(d) Did operators manipulate data or take other actions during leak rate surveillance testing in an attempt to improperly influence test results? Who performed, condoned, directed or was knowledgeable of data manipulation or other improper actions during leak rate surveillance testing? This would include, but is not limited to the following:

(i) inputting the wrong data into the plant computer;

(ii) adding hydrogen gas to the make-up tank during the test in an attempt to influence make-up tank level indication;

(iii) adding water to the make-up tank during the test and either not including the addition in the computer calculation or underrecording the addition in the computer;

(iv) taking advantage of differences or inaccuracies in plant instrumentation (e.g., make-up tank level indicators) in an attempt to influence parameters critical to the leak rate surveillance test calculation;

(v) taking or failing to take any action in violation of technical specification requirements?

CLI-85-18, 22 N.R.C. at 880-881.

"15. The Commission's Order and Notice of Hearing of

December 18, 1985 established the procedures for the hearing. Pursuant to the Order and Notice of Hearing, the hearing was not conducted under 10 C.F.R. Part 2, Subpart G, except as noted in the Commission's Order. The Presiding Board ("Board") did have the powers specified in 10 C.F.R. §§ 2.718(a), (e), (f), (h), (i), (j), and (k). The hearing was conducted using a legislative hearing format. Id. at 882."

"16. The Commission directed the Chief Administrative Judge, Atomic Safety and Licensing Board Panel, to appoint a three-person Presiding Board to rule on petitions to intervene, to conduct any prehearing procedures and the hearing, and to render a recommended decision setting forth the facts surrounding the falsifications and identifying those individuals who participated in, or knew of and condoned, or by their dereliction or culpable neglect allowed, the leak rate falsifications at TMI-2. Id. at 881."

"17. On December 20, 1985, Administrative Judges James L. Kelley, Glenn O. Bright, and Jerry R. Kline were appointed to serve as the Board. Judge Kelley was appointed the Chairman. On August 27, 1986, Administrative Judge James H. Carpenter replaced Judge Kline, who was unable to continue because of a schedule conflict. Appointment of Presiding Board to Conduct a Legislative Hearing, 50 Fed. Reg. 53,489 (1985)."

"18. Any person who had an interest that the hearing may have affected was allowed to petition to intervene. If the Board determined that the petitioner had an interest that could be affected and the petitioner was likely to contribute to the development of an adequate record, the petition was to be granted. CLI-85-18, 22 N.R.C. at 881-882."

"19. On December 31, 1985, as a supplemental notice to potentially interested individuals, the Board sent a letter by certified mail to about 120 present and former employees of Met-Ed who were associated with TMI-2 between February 2, 1978 and March 28, 1979. The group represented those employees who might have been involved in or had knowledge of the RCS leak rate data that was the subject of this inquiry.[6] Memorandum and Order, February 14, 1986 at 1. We enclosed a copy of the Commission's Order and Notice of Hearing of December 18, 1985 and invited those interested to file a petition to intervene by January 30, 1986."

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6 One of the objectives of this proceeding was to exculpate individuals whose names have arisen in connection with falsified leak rate testing at TMI-2. Memorandum and Order, July 16, 1986 at 15. After conducting a comprehensive evidentiary hearing, the Board has determined that the record warrants the exoneration of any addressee of our letter whom we do not discuss in this opinion. Of course, as to those whom we do discuss, our decision governs.

"20. Following the Commission's Order and Notice of Hearing and this Board's supplemental notice, the Board received petitions to intervene from the following: (1) twenty-five present and former employees of Met-Ed ("Numerous Employees"),[7] (2) John M. Kidwell, a former employee of Met-Ed, (3) John G. Herbein, a former officer and employee of Met-Ed, (4) Gary P. Miller, an employee of Met-Ed, (5) GPUN, (6) Marvin I. Lewis, and (7) Marjorie M. and Norman O. Aamodt. Each of the first five petitions alleged facts demonstrating an interest of the petitioner that this proceeding could have affected, and a likely ability to contribute to the record -- the standards for intervention established by the Commission. For those reasons, the Board granted the first five petitions listed above.[8] Id. at 4."

"21. The Numerous Employees filed oppositions to the petitions to intervene from the Aamodts and from Lewis. We initially had questioned

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7 The following employees sought intervention: Charles D. Adams, Raymond R. Booher, John A. Brummer, Kenneth P. Bryan, Joseph J. Chwastyk, Mark S. Coleman, William T. Conaway, Joseph R. Congdon, Craig C. Faust, James R. Floyd, Edward R. Frederick, Leonard P. Germer, Carl L. Guthrie, Gregory R. Hitz, Sr., Kenneth R. Hoyt, Theodore F. Illjes, George A. Kunder, Walter J. Marshall, Hugh A. McGovern, Brian A. Mehler, Charles F. Mell, Adam W. Miller, Frederick J. Scheimann, Bernard G. Smith, and William H. Zewe.

8 On May 7, 1986, Bryan, one of the original Numerous Employees, and Kidwell withdrew as parties to this proceeding. Memorandum and Order, May 22, 1986 at 13. Both men, however, submitted prefiled testimony and testified in this proceeding. See Tr. 4539-4610 (Bryan); Tr. 3285-3399 (Kidwell).

whether the Aamodt and Lewis petitions met the standards for intervention in this proceeding and had called for further information in our Memorandum and Order of February 14, 1986. We subsequently received written responses to our request from the Aamodts and Lewis. In addition, Mrs. Aamodt attended the prehearing conference on March 7, 1986 and argued her entitlement to intervention. We subsequently allowed the Aamodt intervention but denied Lewis' request. Memorandum and Order, March 26, 1986 at 1."

"22. The NRC Staff did not participate in this proceeding as a party. See CLI-85-18, 22 N.R.C. at 882. The Staff made available to the parties and to the Board relevant documentary material within its possession. In addition, the Staff provided testimony and assistance to the Board to help ensure that the hearing record was fully developed.

"23. Under the Commission's Order and Notice of Hearing, no discovery was conducted. The Commission intended the hearing to serve as the fact-finding mechanism. Id."

"24. Only the Board was allowed to call witnesses or to question them. The Board also had the power to issue subpoenas if necessary to compel the attendance of witnesses. Id. Prior to the commencement of the hearing, we made available to the parties a list of the individuals that we intended to call as witnesses. Memorandum and Order, March 26, 1986 at Attachment A. We invited the parties to submit recommendations

regarding additional witnesses. See, e.g., Memorandum and Order, March 26, 1986 at 10; Memorandum and Order, May 22, 1986 at 3; Tr. 3604-05 (Kelley, J.)."

"25. Because the Board had exclusive authority to call witnesses, we considered all witnesses to be "Board witnesses." We even extended the designation of "Board witnesses" to experts (Rockwell and Stier) who had prepared reports as paid consultants to Met-Ed and GPUN and in the conventional licensing case would have been expected to appear as witnesses for GPUN. Memorandum and Order, April 3, 1986 at 3. Although these experts were paid by GPUN, they appeared as Board witnesses. Tr. 216-18 (Kelley, J.). In addition, the Board proposed and subsequently adopted a "no access" rule to promote on-the-record discussion of the issues and equal party access to the facts and to minimize burdens on technical witnesses. See Memorandum and Order, April 13, 1986 at 3; Memorandum and Order, May 22, 1986 at 13. The rule prohibited counsel for any of the parties from communicating with these Board witnesses prior to their appearance at the hearing. See Memorandum and Order, May 22, 1986. We subsequently modified this rule to allow the parties to contact these Board witnesses to discuss their conclusions and opinions concerning individual culpability for leak rate falsification at Unit 2. Memorandum and Order, August 7, 1986 at 3."

" 26. Before each witness testified, we invited the parties to submit questions in writing to the Board that they believed we should

pose to the witness. The Board had the discretion to use the questions suggested by the parties. CLI-85-18, 22 N.R.C. at 882. All witnesses testified under oath."

"27. The hearing commenced on September 8, 1986 in Bethesda, Maryland. It consumed 33 hearing days and resulted in over 5,000 transcript pages. Forty-seven witnesses appeared and testified, most of whom filed prefiled testimony.[9] Twenty-five exhibits were entered into the record. See n.2, supra."

28. The following findings of fact address the specific issues the Commission directed this Board to consider. See ¶ 14, supra. The findings are divided into six major parts. The first part of the findings covers the organization of TMI-2. The second part gives an

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9 Appendix B provides a list of witnesses and transcript citations to their testimony, as well as a list of documentary material bound into the transcripts.

Because Wright did not adopt his prefiled testimony, we had his prefiled testimony bound into the record, not as substantive evidence, but as a brief accurate summary of a longer statement placed in the record (Board Exh. 6, OI Report, Exh. 18, Wright Interview) and regarded as substantive evidence. Tr. 2662-63 (Kelley, J.).

John J. Blessing was subpoenaed by the Board. However, he did not comply with the subpoena and did not testify. See Tr. 4332, 4542 (Kelley, J.).

overview of the TMI-2 Tech Specs and procedures concerning leak rate testing. These first two parts provide a background and overview necessary to an understanding of these findings and conclusions. The third part discusses the conduct of leak rate testing at TMI-2 in 1978 and 1979, including training on the subject, and events and actions relating to an NRC inspection of TMI-2 in October 1978. The fourth part addresses the difficulties operators were experiencing when conducting leak rate tests, who knew of those difficulties, the actions taken to correct those difficulties, and whether operators felt pressure to obtain leak rate results that did not exceed Tech Spec limits. The fifth part covers the documentation and retention of leak rate tests at TMI-2." The third through fifth parts are largely concerned with patterns of conduct, as distinguished from individual responsibilities (although individual responsibility issues concerning certain senior supervisory and management personnel are also discussed). For example, in discussing widespread misinterpretation of the technical specifications, we cite the testimony of several operators to show the prevalence of the problem, but not to provide a complete listing of the operators involved. The sixth part addresses individual responsibility issues concerning each CRO, Shift Foreman, Shift Supervisor and the Supervisor of Operations in Unit 2, Mr. Floyd. This part is organized by shifts and begins with a summary description of improper conduct common to that shift -- e.g., discarding tests. We then address whether the operator manipulated data to influence test results improperly or took other improper actions. We also consider whether the shift foreman

or supervisor participated in, condoned, directed, knew of, or by culpable neglect allowed manipulation of leak rate tests or other improper actions.

29. All parties filed proposed findings of fact and reply findings. The Board has considered all the proposed findings. Except in a few instances, we have not separately discussed findings or lines of findings with which we disagree, or which we find to be irrelevant or unnecessarily detailed. We believe, however, that our findings and the reasons for them are fully stated, and that we have addressed all of the significant points.

30. The Board adopts the following proposed reply findings of GPUN: "Both the Aamodts and Numerous Employees requested at the time of the submission of their findings that the Board take into account as evidence certain documentary materials which never had been introduced (or attempted to have been introduced) in what is a very lengthy hearing record. We were asked at the findings stage in two instances by Numerous Employees and two instances by the Aamodts to take "official notice" of documents, and in the case of two other documents by the Aamodts at this stage to consider them for the Board's convenience. No explanation was provided for the timing of these requests. We reject this notion, absent good cause, that parties may wait until months of hearings are completed and thousands of pages of documentary evidence are compiled, and at the time of filing findings ask the Board to take

additional materials into account through official notice or some other device. These documents are not necessary to our decision and we decline to take them into evidence for the reasons outlined above and discussed in more detail hereafter."

"31. In their proposed findings of fact dated February 2, 1987, the Aamodts requested the Board to take official notice of the following documents provided to the Board as attachments: (1) "Preliminary Notification of Event or Unusual Occurrence -- PNO-79-67," dated March 28, 1979 (Attachment 1), and (2) reproduced pages of TMI-2 Control Room Logs "covering the six weeks preceding the accident (February 15 through 4 a.m. March 28, 1979)" (Attachment 2). Aamodt Proposed Findings of Fact ("Aamodt Findings") at 9, 14.[10] The Aamodts also attached to their findings, "for the Board's convenience," "Table 1, which tallies daily water additions and Figure 1 which plots this data from the control room logs provided" (Attachment 3). Aamodt Findings at 14."

"32. None of these documents attached by the Aamodts to their findings after the close of the record of this proceeding will be considered by the Board. If the Aamodts wished to have the documents

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10 By letter to the Board dated February 3, 1987, forwarding "Errata," the Aamodts apparently backed away from "all, or nearly all" of one attachment to their findings while adding still more attachments. We decline to consider any of the "attachments" as evidence.

entered into the record, where they would have been subject to objections by the parties, they should have raised the documents as exhibits before the close of the record. They did not do so."

"33. The request of the Aamodts for the Board to take official notice of Attachments 1 and 2 is baseless. The rules and regulations on official notice carve out a narrow area of applicability and clearly indicate that official notice of the Aamodt attachments would not be appropriate. See 10 C.F.R. § 2.743(i); Fed. R. Evid. 201; see also Union Electric Co. (Callaway Plant, Unit 1), ALAB-740, 18 N.R.C. 343, 349-50 (1983); Armed Forces Radiobiology Research Institute (Cobalt-60 Storage Facility), ALAB-682, 16 N.R.C. 150, 154 n.3 (1982); Public Service Co. of Oklahoma (Black Fox Station, Units 1 and 2), CLI-80-31, 12 N.R.C. 264, 277 (1980). Like Attachments 1 and 2, Attachment 3 should have been proposed as an exhibit before the close of the record and not provided along with findings under the guise of "the Board's convenience."

"34. In a similar fashion, the Numerous Employees sought to introduce into evidence after the close of the record two documents attached as appendices to Volume One of their Proposed Findings of Fact and Conclusions of Law filed on January 23, 1987: (1) the Indictment filed on November 7, 1983 in United States v. Metropolitan Edison Co. (Criminal No. 83-00188) (Appendix C) and (2) eight pages excerpted from "Transcript of Proceedings/Change of Plea and Sentencing," dated

February 28-29, 1984, again in United States v. Metropolitan Edison Co. (Appendix D). In a letter accompanying its findings submitted to the Board on January 23, 1987, Counsel for the Numerous Employees simply stated that the Board should take official notice of Appendices C and D "because the Commission did so in its order establishing this proceeding."

"35. The Commission, however, did not take official notice of Appendices C and D in its order establishing this proceeding; the Commission only referred to the indictment and plea agreement in its section on "Background." See Inquiry Into Three Mile Island Unit 2 Leak Rate Data Falsification, "Order and Notice of Hearing," CLI-85-18, 22 N.R.C. 877, 878-79 (1985). The regulations, rules, and caselaw on official notice cited above in discussing the Aamodts' requests apply with similar force and effect to the request of the Numerous Employees. Mere reference by the Commission to documents in a background section of an order and notice of hearing does not provide sufficient basis for a request that the Board take official notice of those documents as evidence in this proceeding. Like the Aamodts, if the Numerous Employees were interested in introducing Appendices C and D into evidence, they should have followed the proper course of proposing that the Board enter the documents as exhibits before the close of the record."

36. Several of the parties and the NRC Staff proposed numerous corrections to the transcript. No objections were filed to these proposals, except that the Numerous Employees objected to a few such proposals from two parties and the Staff. All of the proposed corrections are adopted, except that the objections of the Employees are sustained and the alternative proposals they advance are adopted.

STANDARDS OF PROOF AND OTHER ISSUES SUGGESTED BY THE NUMEROUS EMPLOYEES

1. The Numerous Employees submitted a memorandum of law in support of their proposed findings of fact. The Board then invited comments on certain of the issues they had raised; comments were received from the NRC Staff, GPUN and the Aamodts. The Employees filed comments on the Board's invitation. These matters are discussed in this part and also arise, implicitly or explicitly, in certain of the findings.

Standards of Proof

2. The Commission could have specified a standard or standards of proof for this unique, discretionary proceeding, but it did not do so. Therefore, those questions devolve upon the Board. As the Numerous Employees point out, the theoretical choice is between the three generally-recognized standards -- "preponderance of the evidence," "clear and convincing evidence" or "guilt beyond a reasonable doubt."

See Addington v. Texas, 441 U.S. 410, 423-424 (1979). Since the criminal standard of guilt beyond reasonable doubt is clearly inappropriate in a civil inquiry where the Board lacks any sanctioning power, the real choice is between the "preponderance" and "clear and convincing" standards.[11]

3. There appear to be no controlling precedents and, as we view the relevant factors, the choice is fairly arguable. Two factors weigh in favor of the more stringent clear and convincing standard.

4. First, a finding in this proceeding that, for example, a particular individual has falsified leak rate tests at least implies dishonesty or fraud and could result in severe reputational injury. Arguably, more than a bare preponderance of evidence should underlie such a finding. See Addington v. Texas, supra at 424. We note, however, that findings of fraudulent conduct can sometimes be based on the preponderance standard. See Steadman v. SEC, 450 U.S. 91 (1981).

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11 Mr. Christopher, chief investigator and author of the OI Report, Exhibit 6, testified that he had applied a "beyond a reasonable doubt" standard in reaching his conclusions about individuals. Tr. 2385-86. While we do not apply that standard, we note that Mr. Christopher's application of it will have no effect on our conclusions. Our interest in the OI and other investigative reports in the record is in the evidence they present on the issues before us and the investigators' analyses of that evidence. We are attaching little or no weight to the ultimate conclusions the investigators may have drawn about particular individuals. See Order of May 22, 1986 at 6.

5. Second, this Board's inquiry came very late in the day. The events in question occurred in 1978-79 and the witnesses were finally asked to testify about those events before this Board in the Fall of 1986, seven to eight years later. While certain of the issues could be adequately explored through documentary evidence, proof of many important and disputed points depended upon faded or lost recollections about persons present, what was said and done, and by whom. It was obvious to the Board that many witnesses honestly could not remember details about their participation in leak rate testing at TMI-2. Apparently at the request of the Justice Department, which was then seeking criminal sanctions for TMI-2 leak rate activities, the NRC did not interview many persons involved in the criminal investigation between 1980 and 1984. See Stier Report, Vol. I, pp. 2-4; Tr. 172. As a result, this inquiry, which otherwise probably could have been conducted in 1982, did not occur until 1986. We did not probe the reasons for the prolonged delay in the NRC investigation because, from the employees' standpoint, those reasons were irrelevant. Whatever the reasons, the delay before serious charges against them could be fully aired was greatly protracted. In a case like this, where an issue depends on strained and faded memories, it would be unfair to find a person guilty of dishonest or fraudulent conduct on a mere preponderance of the evidence, which can mean only that the record underlying a finding makes it slightly more likely than not.

6. Several other factors, however, suggest that the less stringent preponderance standard may be appropriate, at least on some types of issues. Generally speaking, the stringency of the standard of proof depends upon the sanction that may be imposed in the proceeding. Thus, the highest standard applies in a criminal case, particularly felony cases (records receive their closest scrutiny in death penalty cases). But if it is only a matter of money -- a damage award or a traffic ticket -- a preponderance suffices. The Board in this proceeding does not have the power to impose any sanction, not even a traffic ticket. Indeed, the Commission has explicitly provided that any facts we find "will not be binding in [any] subsequent enforcement or licensing proceeding." Commission order of December 18, 1985, p. 11. This total lack of sanctioning power and de novo treatment of our factual determinations suggests the appropriateness of a preponderance standard.

7. Moreover, while a finding of falsification of leak rates would carry with it severe reputational injury, many of the issues we are addressing do not have comparable potential for reputational impact. For example, we see no realistic expectation of severe reputational injury attaching to a finding that a person ran a test when the reactor was not in "steady state".

8. Furthermore, one can argue that public health and safety considerations support application of the preponderance standard in this

context. In order to protect the public safety -- that argument would run -- inquiries should be structured to maximize detection of violations of safety standards, even at the risk of possible unfairness to some individual operators.

9. Balancing the foregoing factors, we believe that we probably could apply the preponderance standard to all issues in this proceeding. As a matter of discretion, however, we are applying the clear and convincing evidence standard to findings of manipulation and falsification because those findings are likely to have strong reputational impacts and because they tended to involve the most serious memory difficulties in this proceeding. We resolve all other issues on the basis of the preponderance of the evidence test.

10. We conclude our consideration of standards of proof questions with these observations:

Although we use the traditional verbal formula "clear and convincing" evidence, we note that we are not bound by that exact form of words (see Consumers Power Co. (Midland Plant), 7 SEC 19, 32, n.27 (1974)) and that, in any event, that standard does not imply a complete lack of conflicting evidence. Otherwise, a mere denial from a person against whom there is strong evidence of falsification would defeat an adverse finding against him. By "clear and convincing evidence" we mean that we are reasonably, if not entirely, sure that an adverse finding

against a person on a particular issue is warranted, based on the record as a whole.

As to many of our findings, no question arises as to standard of proof because the finding is based directly on voluntary statements of the person in question and/or because the adverse finding is warranted under any standard of proof -- e.g., that virtually all the CRO's discarded leak rate tests.

Finally, owing to the way in which this proceeding was structured, no party had the "burden of proof" in the traditional sense of that phrase. In the final analysis, the burden was on the Board to ensure that each of its findings is supported by evidence that meets the applicable standard.

11. Other Issues. The Numerous Employees took the position in their Memorandum of Law (pp. 14-20) that Met Ed Administrative Procedures are not legal requirements imposed on the employees. We invited the parties to comment on that legal position and on whether we should make findings on violations of administrative procedures, even if such procedures were not legally binding on the employees.

12. We agree with GPUN and the Staff that we need not reach the legal question of whether a violation of a Met Ed administrative procedure can form the basis of NRC enforcement action. This is a

factual inquiry. It is clear from the record that various Met Ed administrative procedures were violated and that such violations contributed to the problems with leak rate testing at TMI-2. As such violations are relevant to the factual issues put to us, we are making appropriate findings. We leave to the Staff and the Commission whether such violations can form the basis of NRC enforcement action.[12]

13. We asked for comment on the Employees distinction between procedures being "established, implemented and maintained" versus their being "adhered to". We agree with the Staff and GPUN that this distinction is unsound.

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12 The Board notes that on February 27, 1987, Counsel for the Numerous Employees filed the following clarification of their position:

> The licensed operators who are parties to the Memorandum of Law intend to adhere to all facility operating procedures, including administrative procedures, and the legal position taken by Numerous Employees at pages 14-18 of the Memorandum of Law does not conflict with the individual written and oral statements concerning adherence to procedures made by those licensed operators to the NRC during its investigation of leak rate testing at TMI-2.
>
> This clarification is being filed with the Presiding Board so as to avoid the necessity (in the Staff's view) for enforcement action while the issue herein is pending before the Board.

The Aamodts' motions of March 11, 1987, based on the Employees' filing of Feburary 27, 1987, to reopen and expand this proceeding are patently without merit and are denied.

14. We asked whether the TMI-2 tech specs required satisfactory leak rate test results measuring unidentified leakage as a condition of continued operation. That is the import of the literal language of the Tech Specs. See IIA ¶ 5, below. As explained by the Staff and GPUN (taking somewhat different approaches), the answer to that question is affirmative. In that connection, we asked whether any of the other three surveillance methods could have been employed to demonstrate continued compliance with the 1 gpm Limiting Condition For Operation ("LCO"). The Staff says no, emphasizing that the leak rate test was the only test that could measure unidentified leakage as defined in the Tech Specs, a definition that included intersystem leakage. We agree that that point is technically valid. We also believe, however, that inclusion of intersystem leakage in the definition made little practical difference because, as implemented at TMI-2, the operators were told to subtract steam generator leakage from the unidentified leak rate computation. Such leakage is the principal component of intersystem leakage. In any event, we agree with GPUN that, in fact, no other method was used to demonstrate compliance with the 1 gpm LCO.

15. GPUN suggests that the sump method could have been used to measure unidentified leakage. We agree that that method could have provided a measurement of unidentified leakage into containment but would not have met the Tech Specs broader definition of unidentified leakage. In any case, as GPUN points out, during the time period in

question, no effort was made to demonstrate compliance with the 1 gpm LCO with sump data.

16. Related to the preceding point, we asked whether it was necessary to enter the action statement "when a leak rate test showed unidentified leakage in excess of 1 gpm and there was no clear basis for invalidating the test." The Numerous Employees say no, and we disagree. The Staff and GPUN endorse our view, that that is precisely the situation in which the action statement must be entered. The leak rate test was the only method the employees had and used to demonstrate compliance with the 1 gpm LCO.

17. Finally, we sought comment on a contention of the Employees that they had met all relevant NRC requirements regarding retention of leak rate tests. This issue is discussed at length in Part V. Suffice it to say here that we agree completely with the NRC Staff's comments on this issue, and that we find the Employee's arguments devoid of merit.

FINDINGS OF FACT

The Board adopts in substantial part and sets forth below GPU Nuclear Corporation's Part IIA subtitled "What was the organizational structure of TMI-2 during 1972 and 1978?", paragraphs 39-73, pp. 16-35. Board changes or additions are indicated in brackets.

I. WHAT WAS THE ORGANIZATIONAL STRUCTURE OF TMI-2 DURING 1978 AND 1979?

"1. The Operations Department at TMI-2 was responsible for the administration of the leak rate test. The Supervisor of Operations headed the Department. The chain of command below this position consisted of the shift supervisors, shift foremen, control room operators ("CROs"), and auxiliary operators. The Supervisor of Operations, together with the Unit 2 Superintendent of Technical Support, reported to the Unit 2 Superintendent. The Unit 2 Superintendent reported to the Station Superintendent, who was the highest member of management at the facility. The Station Superintendent reported to the Manager of Generation, who in turn reported to the Vice President of Generation. After the Station Superintendent became Station Manager in March 1979, the position reported directly to the vice presidential level. The offices of both the Vice President and the Manager of Generation were located in Reading, Pennsylvania, about 50 miles from the facility. Board Exh.

1-A, Stier Report, Vol. I at 47, 131-32; id., Vol. VI(F), Herbein 2/8/85 Interview at 9; Herbein, ff. Tr. 5268 at 6-7."

"2. In addition to the chain of command, several bodies existed to [provide] independent review of plant activities and to provide management with a source of information concerning operation of the plant. These groups included the Plant Operations Review Committee ("PORC"), the Generation Review Committee ("GRC"), the Quality Assurance Department ("QA"), and the General Office Review Board ("GORB"). Board Exh. 1-A, Stier Report, Vol. I at 132."

A. Management [13]

"3. John G. Herbein was the Vice President of Generation for Met-Ed, stationed in Reading, Pennsylvania. He was responsible for the overall operation, maintenance, administration, quality assurance, and related technical engineering support activities at the nuclear, fossil, and hydro generating stations owned and operated by Met-Ed. Herbein, ff. Tr. 5268 at 3-4."

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13 Board note: This section essentially provides an overview of management structure. The Board's conclusions about the responsibilities of particular individuals in management positions are found at pp. 108-121 below.

"4. The Manager of Generation Operations (Lawyer) reported to Herbein. In March 1979, the TMI Station Manager (G. Miller) began reporting directly to Herbein rather than to the Manager of Generation Operations. Id. at 7."

"5. Herbein relied on the chain of command and the formal review committees to bring issues requiring his input to his attention. On a day-to-day basis, he received information primarily from the managers who reported to him. About every 4-6 weeks, he visited TMI to meet with station management. During those visits, he periodically would speak with employees to indicate that upper management was interested in and supportive of them and that the Reading corporate organization was concerned about activities at TMI. Id. at 5-7."

"6. Lawrence L. Lawyer was the Manager of Generation Operations, stationed in Reading, Pennsylvania. He was responsible for the maintenance and operation of Met-Ed's nuclear, fossil, and hydro generation stations. Lawyer reported to the Vice President of Generation (Herbein). The Station Superintendents of the generating stations, including the TMI Station Superintendent (G. Miller) until March 1979, reported to Lawyer. In March 1979, when the TMI Station Superintendent's title changed to Station Manager, the Station Manager began reporting directly to the Vice President of Generation rather than to Lawyer. Board Exh. 1-A, Stier Report, Vol. VI(G), Lawyer 11/10/83 Interview at 5-7, 9; G. Miller, ff. Tr. 5039 at 4-5."

"7. Generally, Lawyer received daily station status reports during morning conference calls to each station superintendent. The TMI Unit Superintendents participated in the call with the TMI Station Superintendent. While Lawyer did receive daily copies of the Daily Plant Status Reports, he primarily depended on the daily morning conference calls and other phone calls from the plant to identify problems that needed his attention.[14] In addition to monthly meetings with his station superintendents, which occasionally took place at TMI, Lawyer usually traveled to TMI once a week to meet with the TMI Station Superintendent. Board Exh. 1-A, Stier Report, Vol. VI(G), Lawyer 11/10/83 Interview at 7-10, 19-22, 62-63."

"8. Gary P. Miller held the title of Station Superintendent at TMI until March 1979 when the title of the position changed to Station Manager. This position, the highest level of management stationed at TMI, was responsible for the supervision of TMI-1 and TMI-2 and was responsible for compliance with the operating licenses, Tech Specs, and all applicable regulations. While Station Superintendent, Miller reported to the Manager of Generation Operations (Lawyer). When the position title changed to Station Manager, Miller began reporting

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[14] The Daily Plant Status Report listed plant parameters, including unidentified leak rate, and provided areas for comments and special problems. G. Miller, ff. Tr. 5039 at 13. See, e.g., Board Exh. 1-A, Stier Report, Vol. V(B) at Tab 10.

directly to the Vice President of Generation (Herbein). Persons in three principal operating positions reported to the Station Superintendent/Station Manager. They were the Unit 1 Superintendent, the Unit 2 Superintendent, and the Site Maintenance Superintendent, who was responsible for maintenance at both units. G. Miller, ff. Tr. 5039 at 2-5; Herbein, ff. Tr. 5268 at 7; Board Exh. 2, Faegre & Benson Report, Vol. 3B, Exhibit 70 at 2."

"9. Insofar as operation of the units was concerned, Miller relied principally on the Unit 1 and 2 Superintendents. Typically, he spent most of the time from 9 a.m. to 5 p.m., Monday through Friday, in meetings. He did not regularly attend meetings involving plant operations. Miller estimated that he spent from 20% to 40% of his time away from TMI. While his goal was to visit the Control Rooms about once a week, Miller in practice was not able to visit them that frequently. G. Miller, ff. Tr. 5039 at 6, 12, 14; Tr. 5041, 5066-67 (G. Miller)."

"10. Miller kept abreast of the daily status of the units primarily through two mechanisms, namely the Daily Plant Status Report and a daily morning conference call typically involving Miller, the Unit 1 and 2 Superintendents, and his superior in Reading. On those days when he was at TMI, Miller tried to review the Daily Plant Status Report each morning. While he did not recall seeing shift supervisor turnover notes attached to the reports, Miller believed, based on documents shown to him during the Stier Unit 2 leak rate investigation, that he did receive

them. Miller recalled that he relied on the morning call as his principal daily source of information on the status of the units. G. Miller, ff. Tr. 5039 at 12-14."

"11. On matters of plant operations Miller expected his subordinates to use normal channels. His office was outside the security fence at TMI precisely so that employees would deal with their unit managements rather than coming directly to him on routine operation matters. Id. at 15."

"12. Because of his numerous responsibilities, Miller necessarily depended on his subordinates to bring to his attention operating matters that involved safety or unit availability. He was not in a position independently to seek out such problems. Id. at 11; Tr. 5066 (G. Miller)."

"13. Until late 1978, Miller concurrently held the title of Unit 2 Superintendent at TMI along with the Station Superintendent title. Joseph B. Logan, who had been hired by the company in January 1978 for the position of Unit 2 Superintendent, formally assumed the position toward the end of 1978 after obtaining an NRC Senior Reactor Operator License and familiarizing himself with the unit and staff. G. Miller, ff. Tr. 5039 at 3; Board Exh. 1-A, Stier Report, Vol. VI(G), Logan 3/27/85 Interview at 3."

"14. Miller believed that while he himself held both the Station Superintendent and Unit 2 Superintendent positions in 1978, James L. Seelinger, the Unit 2 Superintendent of Technical Support, substantially discharged the responsibilities of Unit 2 Superintendent. Miller testified that because of his station responsibilities he depended on Seelinger to supervise day-to-day operations. G. Miller, ff. Tr. 5039 at 3-4; Tr. 5050-53 (G. Miller). Seelinger took issue with Miller's view of him as acting Unit 2 Superintendent. Seelinger did allow that his and Miller's perception of his role in Unit 2 could have differed. Seelinger clearly did not view his authority as broadly as Miller did. See Seelinger, ff. Tr. 4623 at 4-6; Tr. 4627-28 (Seelinger)."

"15. The Unit 2 Superintendent reported to the TMI Station Superintendent and was responsible for the administration, operation, and maintenance of TMI-2 and for ensuring compliance with the Tech Specs. Administrative Procedure ("AP") 1010, "Technical Specification Surveillance Program," gave him specific responsibility for ensuring compliance of the Surveillance Test Schedules with the Tech Specs. Board Exh. 1-A, Stier Report, Vol. V(A) at Tab 6 (Unit Superintendent Position Description); id., Vol. V(C) at Tab 17 (AP 1010, Section 2.1.)."

"16. The four principal operating positions reporting to the Unit 2 Superintendent were the Unit Superintendent of Technical Support, the Supervisor of Operations, the Supervisor of Maintenance, and the

Supervisor of Radiation Protection and Chemistry. G. Miller, ff. 5039 at 4; Board Exh. 1-A, Stier Report, Vol. VI(G), Logan 11/18/83 Statement at 1."

"17. As Unit 2 Superintendent, Logan generally kept abreast of plant status and activities by participating in the morning conference calls between TMI and management in Reading, attending plan of the day ("POD") meetings,[15] and reviewing the Daily Plant Status Reports, shift supervisor turnover notes, control room logs, and documents generated by PORC. He also made tours of the plant and visited the control room several times each day. Board Exh. 1-A, Stier Report, Vol. VI(G), Logan 3/27/85 Interview at 20-22, 27-31, 33."

"18. James L. Seelinger was the Unit 2 Superintendent of Technical Support at TMI until December 1978, when he became the Unit 1 Superintendent and George Kunder replaced him as Superintendent of Technical Support. Seelinger, ff. Tr. 4623 at 1; Kunder, ff. Tr. 4800 at 1."

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15 The POD meetings Logan attended were held daily in each unit early on the 7 a.m. - 3 p.m. shift. The primary purpose of those meetings was to discuss plant problems and plant evolutions scheduled to be performed that day. The typical attendees included the Unit Superintendent, the Supervisor of Operations, the Superintendent of Technical Support, one or more shift supervisors, and a representative from the Maintenance Department. Tr. 4678-79 (Seelinger); Bryan, ff. Tr. 4540 at 2; Mehler, ff. Tr. 3842 at 3;
(Footnote Continued)

"19. The Unit 2 Superintendent of Technical Support reported to the Unit 2 Superintendent and was responsible for supervision of the technical aspects of plant engineering and for ensuring TMI-2 operation complied with the Tech Specs. The lead engineers assigned to TMI-2 reported to him. In addition to other responsibilities, the Unit 2 Superintendent of Technical Support chaired the PORC. Kunder, ff. Tr. 4800 at 1; Board Exh. 1-A, Stier Report, Vol V(A) at Tab 6 (Unit Superintendent of Technical Support Position Description)."

"20. Seelinger perceived his responsibilities as principally being charged with the writing and approval of the procedures for operating TMI-2. Board Exh. 1-A, Stier Report, Vol. VI(J), Seelinger 4/4/84 Interview at 7. He typically attended the POD meetings. Tr. 4678 (Seelinger)."

"21. Kunder saw his relationship to the Operations Department as advisory, with no direct role in the operation of the unit and no responsibility for operational decisions. He usually learned about operational problems through members of his staff who performed the engineering tasks assigned to the department. Kunder, ff. Tr. 4800 at 1-2. Typically, assignments to the department did go through him;

(Footnote Continued)
Board Exh. 1-A, Stier Report, Vol. VI(G), Logan 11/18/83 Statement at 1-2.

however, plant personnel could deal directly with Kunder's engineers in accomplishing tasks. Tr. 4814-16 (Kunder). Kunder normally attended most of the POD meetings. Board Exh. 1-A, Stier Report, Vol VI(G), Kunder 3/6/85 Statement at 26."

B. The Operations Department

"22. The Operations Department at TMI-2 was headed by the Supervisor of Operations, James R. Floyd, who reported to the Unit 2 Superintendent. He was responsible for the overall administration of his department and for ensuring compliance with the Tech Specs. The shift supervisors and two operations engineers reported to him. The Supervisor of Operations was required to hold an NRC Senior Reactor Operator License. Board Exh. 1-A, Stier Report, Vol. V(A) at Tab 6 (Supervisor of Operations Position Description); Floyd, ff. Tr. 4894 at 1-2; Marshall, ff. Tr. 4380 at 1; G. Miller, ff. Tr. 5039 at 2-3. An Administrative Procedure 1012, "Shift Relief and Log Entries," required the Supervisor of Operations to review and sign the Control Room Log and Shift Foreman's Log at least once per week. Board Exh. 1-A, Stier Report, Vol. V(C) at Tab 18 (AP 1012, Section 2.2)."

"23. Floyd delegated the actual running of TMI-2 to the shift supervisors and expected them to discuss any problems they had with him. He perceived his job as primarily that of a "crisis fighter," living out

of the control room and the shift supervisor's office with close contact with CROs. Floyd, ff. Tr. 4894 at 2; Tr. 4969, 4974-75 (Floyd)."

"24. One means by which Floyd gave direction to the Operations Department was through the periodic issuance of Operations Memoranda, which were compiled in a binder in the Control Room. Tr. 4943, 4999-5001 (Floyd); Tr. 2637 (Coleman); Board Exh. 1-A, Stier Report, Vol. VI(I), A. Miller 3/22/85 Interview at 84."

" 25. Floyd believed he attended the POD and shift supervisor meetings, but rarely PORC meetings. Tr. 5031 (Floyd). Although he was on the distribution list for the Daily Plant Status Reports, he did not scrutinize them. He viewed them as the means by which his superiors were advised of plant status on a daily basis. Floyd, ff. Tr. 4894 at 6-7."

"26. The TMI-2 Operations Department work force was divided initially into five groups, referred to as "crews" or "shifts," that would rotate among three daily shifts of 7 a.m. - 3 p.m., 3 p.m. - 11 p.m., and 11 p.m. - 7 a.m. Board Exh. 1-A, Stier Report, Vol. I at 47. Prior to the establishment of the six-shift rotation, certain individuals were specified for relief. After addition of the extra shift, however, it became easier to provide relief personnel since a relief shift became a part of the normal shift rotation. Tr. 2329 (Russell). A shift supervisor, who held an NRC Senior Reactor Operator

License, headed each shift. The license authorized him to direct the licensed activities of licensed operators and to manipulate the controls of the plant. The license itself stated that "[i]n directing the licensed activities of licensed operators and in manipulating the controls . . . the licensee shall observe the operating procedures and other conditions specified in the facility license . . . ." Because the shift supervisor was responsible for overseeing Operations Department activities at both Units 1 and 2, he divided his time between TMI-1 and TMI-2 during his shift. The shift foreman for each unit reported to the shift supervisor. Board Exh. 1-A, Stier Report, Vol. I at 47, 49; id., Vol. V(A) at Tab 6 (Shift Supervisor Position Description); Board Exh. 10-A, SRO License."

"27. The shift supervisor was responsible for ensuring that plant operations did not jeopardize the health and safety of the employees and public. The shift supervisor was also responsible for ensuring that the surveillance testing program was conducted in compliance with the Final Safety Analysis Report ("FSAR"). Board Exh. 1-A, Stier Report, Vol. V(A) at Tab 6 (Shift Supervisor Position Description)."

"28. The turnover notes prepared by the shift supervisor on the 11 p.m. - 7 a.m. shift were attached to Daily Plant Status Reports distributed at TMI. Id., Vol. I at 137; id., Vol. VI(H), Mehler 2/28/85 Interview at 76-77; see, e.g., id., Vol. V(B) at Tab 10."

"29. Monthly shift supervisor meetings were held at TMI. The minutes of the meetings indicated that personnel matters were the main topic of discussion. Smith, ff. Tr. 4331 at 2; Bryan, ff. Tr. 4540 at 2; Mehler, ff. Tr. 3842 at 3; Board Exh. 1-A, Stier Report, Vol. II(B), G. Miller Summary at 5."

"30. A shift foreman, who held an NRC Senior Reactor Operator License, directly supervised the TMI Operations Department Staff on shift at each unit. The license authorized him to direct the licensed activities of licensed operators and to manipulate the controls of the plant. The license itself stated that "[i]n directing the licensed activities of licensed operators and in manipulating the controls . . . the licensee shall observe the operating procedures and other conditions specified in the facility license . . . ." The CROs reported to the shift foreman. Board Exh. 10-A, SRO License; Board Exh. 1-A, Stier Report, Vol. V(A) at Tab 6 (Shift Foreman Position Description); id., Vol. I at 48."

"31. Like the shift supervisor, the shift foreman was responsible for ensuring that plant operations did not jeopardize the health and safety of the employees and public and that the surveillance testing program was conducted in compliance with the FSAR. Board Exh. 1-A, Stier Report, Vol. V(A) at Tab 6 (Shift Foreman Position Description)."

"32. The shift foreman would assign work among his subordinates and would personally become involved in the resolution of any problems encountered on his shift. The manner in which shift foremen performed their responsibilities varied. Some foremen spent more time in the Control Room than others who devoted more of their time to inspecting the plant. Id., Vol. I at 48-49."

"33. The outgoing shift communicated information to the oncoming shift through shift turnovers. Floyd, ff. Tr. 4894 at 7; Tr. 2623 (Coleman)."

"34. Although Surveillance Procedure ("SP") 2301-3D1, "RCS Inventory," did not define specific responsibilities for the shift foreman, AP 1010, "Technical Specification Surveillance Program," provided that "[d]ata sheets will be signed by the person performing the task, and reviewed and approved by his foreman where required by the forms and procedures." As a general rule, the shift foreman would approve leak rate test results for filing by signing the leak rate test sheet. Board Exh. 1-A, Stier Report, Vol. I at 48; id., Vol. V(A) at Tab 6 (Shift Foreman Position Description); id., Vol. V(C) at Tab 17 (AP 1010, Section 3.2.2)."

"35. AP 1012, "Shift Relief and Log Entries," required the shift foreman to maintain a Shift Foreman's Log. The shift foreman was responsible for review and sign off of the log at the completion of each

shift. The procedure did not specify that the log contain any information relating to leak rate tests. Id., Vol. I at 44; id., Vol. V(C) at Tab 18 (AP 1012)."

"36. The CROs, under the direction of a shift foreman, were responsible for operating the plant. Each CRO was required to hold an NRC Reactor Operator License. The license issued to the operator, which authorized him to manipulate all controls of the plant, stated that "[i]n manipulating the controls . . . the licensee shall observe the operating procedures and other conditions specified in the facility license . . . ." Board Exh. 10-B, RO License; Board Exh. 1-A, Stier Report, Vol. V(A) at Tab 6 (Control Room Operator Position Description)."

"37. Two to four CROs comprised each shift, possibly including one or more CRO trainees whom the NRC had not yet licensed. The CROs were responsible for directing the work of several auxiliary operators. Board Exh. 1-A, Stier Report, Vol. I at 48; McGovern, ff. Tr. 3148 at 2; Conaway, ff. Tr. 3097 at 2. Although the division of responsibilities among the CROs on shift did vary, one CRO was assigned to the control panel, where his responsibilities included maintaining the Control Room Log. The responsibility for "switching and tagging" equipment to control its proper use and for taking readings from plant instruments was assumed by the second CRO on shift (or divided between two or more CROs on crews that included a total of more than two CROs). The CRO

responsible for taking readings usually would also be responsible for performing the leak rate test. In practice, the CRO duties overlapped somewhat. The switching and tagging CRO might make entries in the Control Room Log, and the CRO assigned to the Control Panel might, on occasion, perform a leak rate test.[16] Board Exh. 1-A, Stier Report, Vol. I at 48-49."

"38. Like the shift foremen, the CROs used turnovers to communicate information from shift to shift. Floyd, ff. Tr. 4894 at 7; Board Exh. 1-A, Stier Report, Vol. VI(G), Illjes 2/7/85 Interview at 45; id., Vol. VI(D), Frederick 3/12/85 Interview at 127-128; Board Exh. 6, OI Report, Exh. 24, Faust Interview at 6."

"39. The procedures implementing the Tech Spec requirements for leak rate testing imposed several requirements on the CRO. AP 1012, "Shift Relief and Log Entries," required CROs to maintain and sign a Control Room Log, including a record of the start and completion or suspension times of all tests required by Tech Specs. Board Exh. 5-A, NRR Report, Vol. 1, Enclosure 1 at 2; Board Exh. 1-A, Stier Report, Vol. I at 44; id., Vol. V(C) at Tab 18 (AP 1012, Sections 2.4 and 3.3.17).

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16 For each of the leak rate tests, Stier and NRR attempted to determine individual assignments for each of the individuals on shift. See Board Exh. 1-A, Stier Report, Vol. III(A), Tables 1-2; Board Exh. 5-A, NRR Report, Vol. 2, Table 11.

AP 1010, "Technical Specification Surveillance Program," provided that the operator performing a surveillance task sign the data sheets where required by the forms and procedures. AP 1012 also required the test performer to document problems encountered during surveillance testing and test results not meeting test acceptance criteria on an "Exception and Deficiency List." Board Exh. 5-A, NRR Report, Vol. 1, Enclosure 1 at 2; Board Exh. 1-A, Stier Report, Vol. I at 45; id., Vol. V(A) at Tab 17 (AP 1010, Sections 3.2.2 and 3.2.4). SP 2301-3D1, "RCS Inventory," required the responsible CRO to enter the Action Statement under Tech Spec 3.4.6.2 if a leak rate test indicated that a limiting condition for operation had been exceeded. Tr. 653 (Kirkpatrick); Board Exh. 1-A, Stier Report, Vol. V(C) at Tab 19 (SP 2301-3D1, Sections 6.4 and 7.2)."

"40. Several auxiliary operators were assigned to each shift. Generally, they reported to the CRO who operated the panel. They were stationed throughout the plant and assisted the CROs. Their duties included operating equipment that could not be operated from the Control Room. Board Exh. 1-A, Stier Report, Vol. I at 48-49. These individuals were not required to hold any NRC license."

"41. The following chart provides the shift compositions for both the five-shift rotation, from September 30, 1978 to December 1978, and the six-shift rotation, from January, 1979 to March 28, 1979:[17] "

Shift	Position	September - December 1978	January - March 1979
A[18]	Shift Supervisor	Zewe, W.	Zewe, W.
	Shift Foreman	Scheimann, F.	Scheimann, F.
	CRO	Frederick, E.	Frederick, E.
	CRO	Faust, C.	Faust, C.
	CRO-in-training	McGovern, H.[19]	

Shift	Position	September - December 1978	January - March 1979
B[20]	Shift Supervisor	Chwastyk, J.	Chwastyk, J.
	Shift Foreman	Conaway, W.	Conaway, W.
	CRO	Kidwell, J.	Kidwell, J.
	CRO	Illjes, T.	Illjes, T.
	CRO-in-training	Mell, C.	Mell, C.

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17 The individuals on a particular shift sometimes varied primarily because of vacations, illnesses, and training. The actual shift composition for a particular test was reconstructed by Stier and appears in Board Exh. 1-A, Stier Report, Vol. III(A), Tables 1 and 2.

18 1978 Shift A--See Board Exh. 5-A, NRR Report, Vol. 1, Enclosure 1 of Enclosure 10 at 6; 1979 Shift A--See id., Enclosure 1 of Enclosure 6 at 1.

19 McGovern was in training until receiving his RO license in November, 1978. See id., Enclosure 1 of Enclosure 10 at 6.

20 Shift B--See id., Enclosure 1 of Enclosure 9 at 1.

	CRO-in-training	Hemmila, E.[21]	
C[22]	Shift Supervisor	Mehler, B.	No change
	Shift Foreman	Adams, C.	after December
	CRO	Congdon, J.	1978
	CRO	Cooper, M.	
	CRO-in-training	Phillippe, M.	
D[23]	Shift Supervisor	Hitz, G.	No change
	Shift Foreman	Miller, A.	after December
	CRO	Olson, D.	1978
	CRO	Wright, L.	
	CRO	Coleman, M.	
E[24]	Shift Supervisor	Smith, B.	Smith, B.
	Shift Foreman	Hoyt, K.	Hoyt, K.
	CRO	Booher, R.	Booher, R.
	CRO	Hartman, H.	Hartman, H.
	CRO-in-training	Blessing, J.	Blessing, J.
	CRO-in-training	Germer, L.	

Shift	Position	September - December 1978	January - March 1979
F[25]	Shift Supervisor	"F" Shift	Bryan, K.
	Shift Foreman	did not	Guthrie, C.
	CRO	exist	Hemmila, E.
	CRO		McGovern, H.

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2. Hemmila was in training until receiving his RO license in December, 1978. See id., Enclosure 16 at 2; Board Exh. 1-A, Stier Report, Vol. V(A) at Tab 4 (8/15/78 Shift Assignment Sheet).

22 Shift C--See Board Exh. 5-A, NRR Report, Vol. 1, Enclosure 1 of Enclosure 5 at 1.

23 Shift D--See id., Enclosure 1 of Enclosure 12 at 1.

24 Shift E--See id., Enclosure 15 at 2; id., Enclosure 1 of Enclosure 3 at 1.

25 Shift F--See id., Enclosure 1 of Enclosure 10 at 6.

CRO-in-training Germer, L.

C. Bodies Outside of the Chain of Command

"42. The Plant Operations Review Committee was an advisory group that reported to the Unit Superintendent. It was an interdisciplinary committee consisting mostly of department heads and key individuals from the plant. PORC was responsible for review of procedure changes and plant modifications, as well as activities directly affecting the nuclear safety of the operating unit. Tech Spec 6.5.1.6 set forth the specific charges of PORC. One such charge was investigating violations of Tech Specs, including preparing reports covering evaluations and recommendations to prevent recurrence to the Station Superintendent and the GRC. PORC also was responsible for reviewing events requiring 24-hour notification to the NRC. The Tech Specs required PORC to provide written notification within 24 hours to the Station Superintendent and the GRC Chairman of disagreement between PORC and the Unit Superintendent. The Unit Superintendent, however, had responsibility for resolving the disagreements. Board Exh. 1-A, Stier Report, Vol. V(B) at Tab 14 (Tech Specs 6.5.1.6 and 6.5.1.7); Kunder, ff. Tr. 4800 at 3-4; Tr. 4817-20 (Kunder); Herbein, ff. Tr. 5268 at 8."

"43. The General Office Review Board was an advisory group that reported directly to the President of Met-Ed. GORB reports provided the President, who was not involved in the day-to-day operational activities

of the station, with the broad perspective of maintaining nuclear safety and appropriate radiation protection. Herbein, ff. Tr. 5268 at 8."

"44. The Generation Review Committee was a group organized to provide an independent review and audit of activities important to nuclear safety, which included procedural changes, plant modifications, and violations of regulations. Id."

"45. The Quality Assurance organization audited and inspected safety-related activities, including operations, maintenance, engineering, and licensing, to ensure compliance with procedures developed by the functional groups. Id. at 9. QA had a specific responsibility to oversee surveillance testing. Board Exh. 1-A, Stier Report, Vol I at 138."

II. TECHNICAL SPECIFICATIONS, TRAINING AND CHRONOLOGY OF EVENTS DURING OCTOBER 1978 NRC INSPECTION

A. Technical Specifications and Procedures Relevant to Leak Rate Testing

In this section the Board generally adopts the GPUN Proposed Findings set forth in their Section IIB. Such findings not modified by the Board are enclosed in quotation marks.

"1. The TMI-2 Operating License incorporated Tech Specs that established limiting conditions for operation. Two sections of the Tech Specs addressed the requirements for pressure boundary leakage detection, Sections 3.4.6.1 and 3.4.6.2. Each of these sections was divided into four parts: (1) limiting conditions for operation establishing minimum requirements for plant operation; (2) an "Action" section, generally referred to as the "Action Statement," describing the steps to be taken if a limiting condition for operation was exceeded; (3) surveillance requirements, designed to assure compliance with limiting conditions for operation; and (4) "bases" describing the background or purpose of the limiting conditions for operation. Board Ex. 1-A, Stier Report, Vol. 1 at 36; Id., Vol. V(B) at Tab 14 (Tech Specs 3.4.6.1 and 3.4.6.2)."

2. Tech Spec 3.4.6.1 follows the provisions of Reg. Guide 1.45 by requiring the three leakage detection systems recommended in that Guide. The Tech Spec required radioactive particulate and sump monitoring systems in addition to either an air cooler condensate or a gaseous radioactivity monitoring system. The Action Statement of this

Tech Spec described the steps to be taken in the event these systems were not continuously in operation. Its corresponding surveillance requirements specified how plant personnel were to demonstrate that these systems were operable. The "bases" of this Tech Spec explained that it was intended to be consistent with Reg. Guide 1.45. Tech Spec 3.4.6.1, however, did not specify the leakage limits that it was intended to monitor, and it did not require an inventory balance test. Id., Vol. I at 36-37; Id., Vol. V(B) at Tab 12 (Reg. Guide 1.45).

3. Tech Spec 3.4.6.2 established the following leakage limits as the limiting conditions for operation:

a. no pressure boundary leakage;

b. 1 gpm of unidentified leakage;

c. 1 gpm of primary-to-secondary leakage through the steam generators;

d. 10 gpm of identified leakage from the Reactor Coolant System;

e. 8 gpm controlled leakage at a Reactor Coolant System pressure of 2155 ± 50 psig.

Board Ex. 1-A, Stier Report, Vol. V(B) at Tab 14 (Tech Spec 3.4.6.2).

4. The corresponding Action Statement to Tech Spec 3.4.6.2 required that if any pressure boundary leakage were found, the plant had to be in "hot standby" within six hours and in "cold shutdown" within the next thirty hours. For any other leakage, including unidentified leakage, in excess of a limiting condition for operation, leakage was to be reduced to within Tech Spec limits within four hours or the plant had

to be in hot standby within the next six hours and in cold shutdown within the next 30 hours.

5. Tech Spec 4.4.6.2, which provided the corresponding surveillance requirements, stated:

> 4.4.6.2 Reactor Coolant System leakages shall be demonstrated to be within each of the above limits by:
>
> a. Monitoring the containment atmosphere particulate radioactivity monitor at least once per 12 hours.
>
> b. Monitoring the containment sump inventory and discharge at least once per 12 hours.
>
> c. Measurement of the CONTROLLED LEAKAGE from the reactor coolant pump seals when the Reactor Coolant System pressure is 2155 ± 50 psig at least once per 31 days.
>
> d. Performance of a Reactor Coolant System water inventory balance at least once per 72 hours during steady state operation.

As the Board reads this language, all four of these surveillances were required. Id., Vol. I at 37-38; Id., Vol. V(B) at Tab 14 (Tech Spec 4.4.6.2).

"6. Tech Specs 1.14 through 1.17 defined the categories of leakage referred to in Tech Spec 3.4.6.2 as follows (Board Ex. 1-A, Stier Report, Vol. I at 38-9; Id., Vol. V (B) at Tab 14 (Tech Specs 1.14-1.17); see also Wermiel, ff. Tr. 376 at 5):

> IDENTIFIED LEAKAGE
>
> 1.14 IDENTIFIED LEAKAGE shall be:
>
> a. Leakage (except CONTROLLED LEAKAGE) into closed systems, such as pump seal or valve packing leaks that are captured and conducted to a sump or collecting tank.

b. Leakage into the containment atmosphere from sources that are both specifically located and known either not to interfere with the operation of leakage detection systems or not to be PRESSURE BOUNDARY LEAKAGE.

c. Reactor coolant system leakage through a steam generator to the secondary system.

UNIDENTIFIED LEAKAGE

1.15 UNIDENTIFIED LEAKAGE shall be all leakage which is not IDENTIFIED LEAKAGE or CONTROLLED LEAKAGE.

PRESSURE BOUNDARY LEAKAGE

1.16 PRESSURE BOUNDARY LEAKAGE shall be leakage (except steam generator tube leakage) through a non-isolable fault in a Reactor Coolant System component body, pipe wall or vessel wall.

CONTROLLED LEAKAGE

1.17 CONTROLLED LEAKAGE shall be that seal water flow supplied from the reactor coolant pump seals. . . ."

"7. The Tech Specs also established requirements for reporting to the NRC when a limiting condition for operation was exceeded. Tech Spec 6.9.1.8 provided that in such instances a report had to be made to the NRC within 24 hours. This had to be followed by a more detailed Licensee Event Report within 14 days describing the event, the corrective action taken, and the steps that the licensee intended to take to prevent recurrence. Board Ex. 1-A, Stier Report, Vol. I at 39; Id., Vol. V(B) at Tab 14 (Tech Spec 6.9.1.8); see also Wermiel, ff. Tr. 376 at 5, 11."

"8. Finally, Tech Spec 6.10 required "records of surveillance activities . . . required by these Technical Specifications" to be retained for at least five years. Board Ex. 1-A, Stier Report, Vol. I

at 40; Id., Vol. V(B) at Tab 14 (Tech Spec 6.10); see also Wermiel, ff. Tr. 376 at 11."

"9. The TMI-2 FSAR described the leak rate test as the "primary means of detecting reactor coolant system leakage." Board Ex. 1-A, Stier Report, Vol. I at 41; Id., Vol. V(C) at Tab 15 (FSAR); see also Wermiel, ff. Tr. 376 at 8-9; Board Ex. 22, FSAR Sections 5.2.7.3 and 5.2.7.4. It was in fact the only one of the tests prescribed in the Tech Specs that provided a quantifiable means of measuring unidentified leakage as defined in the Tech Specs. See Tr. 683 (Stier, Russell); Tr. 3865 (Mehler)."

"10. The following three interrelated procedures implemented Tech Spec requirements for leak rate testing: (1) SP2301-3D1, "RCS Inventory," controlling the performance of leak rate tests; (2) AP 1012, "Shift Relief and Log Entries," dealing with logging requirements; and (3) AP 1010, "Technical Specification Surveillance Program," covering reporting the results of surveillance tests.[26] Board Ex. 1-A, Stier

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26 The NRC Staff identified one additional procedure, AP 1036, "Instrument Out-of-Service Control" (Board Exs. 12-A and 12-B), as a relevant procedure to this proceeding. Tr. 1167-68 (Russell). Mr. Russell stated:

> The purpose of the procedure is to describe the method of control of readout devices which become inoperable or are strongly suspected of being inoperable, such that they are marked, documented and controlled until repair is effected. That's under section 1.1; purpose.
>
> Under section 2.1, responsibilities: "shift supervisors, shift

(Footnote Continued)

Report, Vol. I at 41; Id., Vol. V(C) at Tabs 17 (AP 1010), 18 (AP 1012), 19 (SP 2301-3D1)."

"11. SP 2301-3D1 stated that its purpose was to assure compliance with the leakage limits set forth in Tech Spec 3.4.6.2. It required performance of a leak rate test at least once every 72 hours during "steady state" in Modes 1, 2, 3, and 4, when, according to the Tech Spec definition of Modes, RCS temperature averaged greater than 200°F. Board Ex. 1-A, Stier Report, Vol. I at 42; see also Board Ex. 5-A, NRR Report, Vol. 1, Enclosure 1 at 2."

"12. The procedure prescribed the plant conditions required for the performance of a leak rate test. Certain "operations should not be conducted," for example, "(a) makeup or chemical addition to the makeup system, . . . (e) boration or deboration." "Operations such as adding water to the make-up tank or sampling the RCS [reactor coolant system]

(Footnote Continued)
foreman and control room operators. The shift supervisor and/or shift foreman and/or control room operators are responsible to assure out-of-service instruments are identified and logged out-of-service. They are also responsible to assure that work requests are submitted to effect repair and remove the out-of-service stickers from the instruments and close out the out-of-service instrument log entries."

This is the procedure which promulgates the log that we have been discussing, and I think the procedure is quite clear and it indicates that out-of-service instruments and suspected instruments are not to be used and they are to be tagged and indicated and those tags are to remain on them until such time as repairs are effected and they are again reliable for the purpose of operating the facility. Tr. 1803 (Russell).

may be accounted for [in the test calculation] . . ., however, these should be avoided if at all possible." The reactor coolant and make-up systems should be maintained in a "steady state condition." Valve line-ups should be maintained the same throughout the test, and reactor power and RCS temperature and pressure should not be altered. The procedure also directed use of the same instruments to obtain data at the beginning and end of the test. Board Ex. 1-A, Stier Report, Vol. I at 42."

"13. The procedure also provided for the performance of the test normally by means of the plant computer. Operators were alerted to the inability of the computer to perform leak rate test calculations when RCS temperature was below 520°F. At such times, operators were to perform the calculation manually, and the procedure provided a data sheet for that purpose. Id. at 43; Board Ex. 2, Faegre & Benson Report, Vol. 4 at Tab 2 (SP 2301-3D1, Rev. 3, Section 4.3); see also Board Ex. 5-A, NRR Report, Vol. 1, Enclosure 1 at 2."

"14. If an operator had to change the RCS inventory during the test, he had to account for the change in the calculation and complete a "Data Sheet 4" to indicate the quantity added to the RCS and the operation that caused the change. Board Ex. 1-A, Stier Report, Vol. I at 43."

"15. The procedure contained directions for responding to test results that exceeded limiting conditions for operation. The first requirement was that an operator begin a new leak rate test. Next, the operator was to determine whether unaccounted-for operator action had

affected the initial test. If such action had taken place, the operator was to invalidate the test. The procedure required that the operator record such action in the "remarks" section of the data sheet. Id.; see also Board Ex. 5-A, NRR Report, Vol. 1, Enclosure 1 at 2."

"16. Operators were then required to check for leakage. If an operator found such leakage, he was to document the leakage on a "Data Sheet 3" along with its flow rate and a description of the method used to determine the rate. The shift supervisor was then required to evaluate the safety significance of any such leakage that the operator had identified. Board Ex. 1-A, Stier Report, Vol. I at 43-44."

"17. If, after these steps were taken, test results remained in excess of acceptance criteria, the procedure required that the process of shutting down the plant should begin according to the Action Statement of Tech Spec 3.4.6.2. Id. at 44; see also Board Ex. 5-A, NRR Report, Vol. 1, Enclosure 1 at 1."

"18. AP 1012 set forth requirements for logging surveillance tests. A control Room Log, maintained by a CRO, was to include a record of the start and completion or suspension times of all tests required by Tech Specs. The Supervisor of Operations was required to review and sign the Control Room Log at least once per week, indicating that he was satisfied with the recording techniques and was familiar with any operating abnormalities. The procedure also required maintenance of a Shift Foreman's Log, but did not specify that the Log contain any information relating to leak rate tests. Board Ex. 1-A Stier Report,

Vol. I at 44; see also Board Ex. 5-A, NRR Report, Vol. 1, Enclosure 1 at 2."

"19. AP 1010 established a system for documenting the results of surveillance tests that could not be performed successfully or failed to meet acceptance criteria. Any surveillance test that had an unsatisfactory result had to be documented on an "Exception and Deficiency List" and filed. Filing an "Exception" was necessary in the event of a failure to obtain "required plant conditions" or an inability to use "an existing procedure (i.e., equipment out-of-service or a procedure which cannot be followed)." Filing a "Deficiency" was necessary when a test had been completed but acceptance criteria had not been met. Board Ex. 1-A, Stier Report, Vol. I at 45; see also Board Ex. 5-A, NRR Report, Vol. 1, Enclosure 1 at 2-3."

"20. A shift supervisor was required to review and initial all Exceptions and Deficiencies ("E&Ds") "as soon as possible." In the case of a Deficiency, he was to determine whether a reportable occurrence had taken place. If so, he had to bring the matter to the attention of the Unit Superintendent. The E&D List would then be attached to the test data package and filed with the GMS Coordinator. Board Ex. 1-A, Stier Report, Vol. I at 45."

"21. The GMS Coordinator, who was appointed by the Unit Superintendent to administer the GMS (Generation Maintenance System) program covering all plant maintenance and testing, would inform the PORC Chairman and the QC Supervisor when the maximum allowable time interval between surveillance tests had been exceeded. The GMS

Coordinator would forward any E&D to the PORC Chairman and QC Supervisor as soon as practicable. He would also maintain a follow-up action log of all E&Ds. Finally, the QC Supervisor was designated to provide general oversight for all surveillance testing. Id., at 45-46."

B. Training

The Board generally adopts the Proposed Findings of the Numerous Employees as set forth in their Sections V A and V B except as deletions are indicated by ". . . ." .

"22. The testimony of Mr. Dennis J. Boltz, who was a training instructor assigned to the licensed operator training group at TMI-2 during 1978-79, Tr. 2218-19, made apparent the fact that classroom training regarding the performance of leak rate tests was virtually non-existent. Mr. Boltz acknowledged that, in 1978-79, the TMI-2 training department focused exclusively on "textbook type" training consisting of little more than providing a copy of the Technical Specifications to the operators and supervisors to read, and thus it "had to rely heavily [on] the operations and on-the-job training aspects of [the CROs'] training programs with qualified personnel on shift." Tr. 2225, 2226; see Tr. 2582, 2714, 2799, 2839."

"23. Mr. Boltz searched training records from 1978-79 and found only one document that referred to leak rate testing; it merely states that a CRO must be "[c]apable of using [the] computer for calculations

of leak rate, heat balance, Reactivity Balance, etc." Exhibit 16; see Tr. 2220, 2226."

"24. Mr. Boltz's testimony before this Board also highlighted the important information concerning leak rate testing that was omitted from the TMI-2 classroom training program. The training program did not include a discussion of the requirement of Administrative Procedure 1012 to log the start and completion (or suspension) of each leak rate test performed, Tr. 2224-25, nor did it include a discussion of the Administrative Procedure 1010 requirement that leak rate tests not performed successfully or that failed to meet the acceptance criteria should be documented through the use of an exception or a deficiency. Tr. 2224. The classroom training program at TMI-2 also failed to provide any instructions regarding the performance of leak rate tests by hand. Tr. 2229. Nor were such instructions provided during the three-week course at the B&W simulator taken by all CRO trainees prior to becoming licensed. Tr. 2231."

"25. The only instruction as to how to perform leak rate tests was provided as part of an operator's on-the-job training (Tr. 2225; see, e.g., Mell Prep. St., pp. 1-2, ff. Tr. 3239), but the TMI-2 training department took no action to assure that the on-the-job leak rate test training was consistent among the shifts. Tr. 2224. The Board thus finds that classroom training concerning leak rate testing at TMI-2 was essentially non-existent during 1978-79, and failed to teach the TMI-2 operators and supervisors the requirements pertaining to, and proper procedures for, leak rate testing."

"26. The evidence of record is that the on-the-job instruction received by the TMI-2 operators concerning leak rate testing was confined to a basic demonstration of the steps necessary to conduct the leak rate test. As Mr. McGovern testified before this Board, "[a]ll I remember about performing leak rates and learning how to do them was what I was taught by the CROs. This is how you punch it out and make the leak rate test come out. That's what I remember about leak rate training." Tr. 3207; see Mell Prep. St., pp. 1-2, ff. Tr. 3239."

"27. Mr. McGovern's recollection was echoed by the testimony of several other operators. Mr. Coleman testified that the on-the-job instruction he received concerning leak rate testing was not "very extensive." Tr. 2583. Mr. Cooper testified that apart from being shown how to perform a leak rate test, his only instruction concerned the prescribed limits for plant leakage. Tr. 2916. Thus, there is ample testimony illustrating the limited nature of the on-the-job training received by the TMI-2 operators in 1978-79. In essence, there was no training on the meaning or purpose of the test. Tr. 523-24."

"28. The TMI-2 operators and shift foremen were unanimous in testifying that their on-the-job training on leak rate testing never included any discussion of the relationship between the test and the potential safety significance of a critical crack in RCS piping. Mr. Illjes, a CRO, could not recall having received "any specific training on leak rates or the [safety] implications" of performing them. Tr. 3082. Nor could Mr. Mehler (a shift supervisor) (Tr. 3859-60) or Mr. Adam Miller (a shift foreman) (Tr. 3628) recall any such training.

Other operators who testified to this void in their training include Mr. Cooper (Tr. 2916), Mr. Wright (Tr. 2672), Mr. Hitz (Tr. 3707), Mr. Guthrie (Tr. 4126), Mr. Olson (Tr. 4009-11) and Mr. Conaway (Tr. 3105)."

"29. The on-the-job training at TMI-2 was also deficient in that it failed to instruct operators to take the prescribed actions in response to unsatisfactory leak rate test results. Numerous operators testified that they were never taught to apply Administrative Procedure 1010, the Exception and Deficiency procedure, to unsatisfactory leak rate test results. Mr. Wright's testimony is typical in this regard. He stated that the requirement to apply the Exception and Deficiency Administrative Procedure to unsatisfactory leak rate test results was never "impressed upon me, either in training or anything else." Tr. 2672. The testimony of Messrs. Coleman (Tr. 2636), Conaway (Tr. 3108), Hitz (Tr. 3669), Miller (Tr. 3648), Smith (Tr. 4344), and Scheimann (Tr. 2795) supports Mr. Wright's recollection. . . .

"30. It is also clear that the on-the-job training never conveyed the proper interpretation of the "72-hour" rule and the "Action Statement" requirement. The TMI-2 operators believed that they were obligated to enter the Action Statement only upon failing to obtain one satisfactory leak rate test result within a 72-hour period. E.g., Illjes Prep. St., pp. 2-3, ff. Tr. 3010; Scheimann Prep. St., p. 2, ff. Tr. 2831; Cooper Prep. St., p. 5, ff. Tr. 2835. Only a few TMI-2 operators and supervisors seemed to have correctly understood that the requirement to invoke the "4-hour clock" in the "Action Statement" applied whenever a valid leak rate test depicted unidentified leakage in

excess of 1 gpm. Frederick Prep. St., p. 2, ff. Tr. 2447; Zewe Prep. St., p. 2, ff. Tr. 2946."

"31. The Board finds that on-the-job training at TMI-2 essentially consisted of a demonstration of the manner in which to perform the leak rate test, with virtually no guidance as to the significance of the test or the actions to be taken if test results were unsatisfactory. See Tr. 4967-71 (Board summary of testimony). The conclusion is inescapable that the lack of meaningful training was a major cause . . . of the problems with leak rate testing at TMI-2."

C. Chronology of Events During October 1978 NRC Inspection

The following section is based largely upon Section IIC(iii) of the GPUN proposed findings. However, the Board's numerous departures from those proposals make it impracticable to identify the source of particular language.

32. In October 1978 NRC Inspector Donald Haverkamp discovered that certain inappropriate leak rate test practices were being followed. The record indicates that on October 15, 1978, at 7:27 p.m., a leak rate of -0.3504 gpm was obtained.[27] See NRR Test No. 12. On October 16, 1978,

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27 For purposes of this discussion, the Board assumes that such a relatively small negative leak rate might reasonably be considered valid, taking into account the normal ranges of instrument error. See Tr. 4901 (Floyd). Our assumption is supported by the record,
(Footnote Continued)

at 7:35 p.m., a leak rate of 2.5645 gpm was obtained, substantially above the 1 gpm limit set by the Tech Specs. See NRR Test No. 12A. On October 17, 1978, at 1:27 p.m., a leak rate of 2.0738 gpm was obtained, again substantially above the Tech Spec limit. See NRR Test No 12B. On October 18, 1978, at 5:13 a.m., a leak rate of 1.7754 gpm was obtained, again well above the Tech Spec limit. See NRR Test No. 12C.

33. The shift supervisor turnover note from the midnight to morning shift on October 18 stated, "Still could not get a leak rate -- 1900 today is deadline doing hand calculations." Board Ex. 1-A, Stier Report Vol. V(B) at Tab 10 (10/18/78 Daily Plant Status Report, p. 104, Item 11). Brian Mehler, shift supervisor of the shift that was on duty that morning, said he was aware of the need for a good leak rate and the fact that the 72-hour clock was running out. Tr. 3893 (Mehler). At 7:35 a.m., a leak rate of 1.2939 gpm was obtained. See NRR Test No. 12D. Charles Adams, the shift foreman on Mehler's shift, testified that James Floyd, TMI-2 Supervisor of Operations, usually came into the Control Room around 6:00 a.m., and, though he did not recall exactly what time Floyd arrived on October 18, he recalled Floyd sitting at the computer console, where leak rate tests were run. Tr. 3797 (Adams). Floyd claimed not to recollect the morning events of October 18, but he

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(Footnote Continued)
which indicates that small negative leak rates were considered acceptable. See, e.g., Tr. 2797-98 (Scheimann); Tr. 4901 (Floyd); Tr. 2529-32 (Faust); Coleman, ff. Tr. 2579 at 5; Tr. 2652-53 (Coleman).

did note that he frequently sat at the computer console and sometimes started a test for an operator by typing "RCSL." Tr. 4898-99 (Floyd). Mehler did not recall Floyd's presence in the Control Room "immediately in the morning, early" but implied that Floyd was there before Haverkamp arrived. Tr. 3893-94 (Mehler). At 8:59 a.m., a leak rate of 1.3219 gpm was obtained. See NRR Test No. 12E.

34. At approximately 9:00 a.m. on October 18, Haverkamp, who was on-site conducting a routine inspection of plant operations, arrived in or near the Control Room and overheard a discussion by a CRO, shift foreman, and shift supervisor about bad tests. Board Ex. 20, Haverkamp Testimony at 2-3. Haverkamp joined the discussion and saw several leak rate tests results which exceeded the 1 gpm LCO. Id. Haverkamp interrupted his routine operations inspection schedule to question Mehler and/or Floyd about the tests. Id. at 4. He then learned of the interpretation being given to the Tech Specs and left the Control Room to discuss this with James Seelinger, the Unit 2 Superintendent of Technical Support, in his trailer. Id. Haverkamp went directly to Seelinger because Seelinger was Haverkamp's "primary point of contact for TMI-2." Tr. 2113 (Haverkamp). Discussing the type of day in, day out relationship he had with Met-Ed, Haverkamp testified that "when it came to plant operations, technical questions about engineer-related questions, I spoke frequently with Mr. Seelinger, probably . . . during each inspection." Id.

35. Haverkamp recalled that, shortly after he began his meeting with Seelinger, Floyd entered Seelinger's trailer office and joined the

discussion. Board Ex. 20, Haverkamp Testimony at 4-5. Haverkamp clearly recalled Floyd telling him, in effect, that unidentified leakage test results must be calculated to be under 1 gpm only once every 72 hours to be in legal compliance with the Tech Spec surveillance requirements. Id. In Floyd's view, any number of test results could be greater than 1 gpm as long as acceptable results were obtained once every 72 hours. Id. Haverkamp informed Floyd that his interpretation was clearly incorrect and stated that the Tech Spec limiting conditions for operation limits must always be met, in accordance with the applicable Tech Spec facility operating modes, including the results of leak rate tests that were conducted more often than required by the 72-hour Tech Spec surveillance frequency. Id. Floyd claimed not to recall this conversation, but said that he had no reason to believe Haverkamp's recollection was incorrect. Tr. 4926-27 (Floyd).

36. In the discussion with Seelinger and Floyd, Haverkamp was informed that plant operators were attempting to identify any leakage sources to reduce unidentified leakage to less than 1 gpm. Board Ex. 20, Haverkamp Testimony at 6. Seelinger assured Haverkamp that the plant would be operated in accordance with the applicable Tech Spec Action Statements and informed him that the matter would be referred to PORC for its review as a potentially reportable occurrence. Id.; see also Tr. 2050-51 (Haverkamp); Tr. 4630-32 (Seelinger). Also during this discussion, the possibility of rounding off test results was discussed after Haverkamp raised some questions about the specified limit being

"1" gpm as opposed to "1.0" gpm.[28] Board Ex. 20, Haverkamp Testimony at 8-9; Tr. 2111-13 (Haverkamp); Seelinger, ff. Tr. 4623 at 7; Tr. 4770-72 (Seelinger).

37. Sometime on the morning of the 18th, Seelinger met with Gary Miller, TMI Station Superintendent and Unit 2 Superintendent, and informed him of the Haverkamp-related events. Tr. 4722-27 (Seelinger). Seelinger recalled that during this meeting, a telephone conversation took place with a Met-Ed manager in Reading about how to handle the situation. Id. Although Seelinger is the only member of either on-site or off-site management who remembered such a telephone conversation, no one disputes that it took place. The message Seelinger recalls receiving during that conversation was to review the item for reportability and act appropriately. Id.

38. At 10:16 a.m., a leak rate of 1.0246 gpm was obtained. See NRR Test No. 13. At approximately noon, Mark Bezilla, the procedure coordinator and PORC secretary for TMI-2 (Board Ex. 1-A, Stier Report, Vol. VI(A), Bezilla 2/22/85 Interview at 1) at Seelinger's request brought Floyd three tests, NRR Test Nos. 12C-E, to analyze. Tr. 4913-20 (Floyd). On Test No. 12C, which indicated a leak rate of 1.7754 gpm at 5:13 a.m., Floyd wrote that "rounds off high but is corrected by leak

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28 Although the short-term practice of rounding off test results to one significant figure is of some interest in understanding this sequence of events, evidence bearing on the question of who initiated a discussion of rounding off is in conflict and the conflict need not be resolved.

rate 10/18/78. 7:35:27 start time i.e. into action statement at 5:13:02 out of it at 7:35:27." Tr. 4913-14 (Floyd). On Test No. 12D, which indicated a leakage of 1.2939 gpm at 7:35 a.m., Floyd wrote, "OK by roundoff, JRF, 1200, 10/18/78." Tr. 4914 (Floyd). On Test No. 12E, which indicated a leakage of 1.3219 gpm at 8:59 a.m., Floyd again wrote, "OK by roundoff." These tests indicate that by noon on October 18, a practice of rounding off test results was in effect. Mehler specifically recalled that at some point in time Floyd came to him and advised him that he was going to be able to round off leak rates as a result of a discussion Floyd had had with Haverkamp, whose opinion allowed rounding off to the nearest whole number. Board Ex. 1-A, Stier Report, Vol. VI(I), Mehler 3/15/85 Interview at 18. Mehler then rounded off Test No. 13, which had been run that morning, and wrote on the test "Net Unidentified Leak Rate rounded off To Nears whole Number 1 GPM." See Id. at 19, 37-39; see also id., Vol. VI(A), Adams 3/13/85 Interview at 44-48.

39. At 12:21 p.m., a leak rate of 0.1081 gpm was obtained, later corrected by William Fels[29] to indicate a leak rate of -.283 gpm. See NRR Test No. 14; Tr. 4520-31 (Fels). Probably in the early afternoon, Haverkamp was shown this test, with an acceptable leak rate of 0.1081

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29 Between March 1978 and March 1979, Fels was the engineer assigned to start up and check the TMI-2 computer systems. Board Ex. 1-A, Stier Report, Vol. II(A), Fels Summary at 1. He was the individual who installed the computerized leak rate test program at TMI-2. Id., Vol. VI(C), Fels 2/25/85 Interview at 2.

gpm, and was informed that some amount of leakage had been identified and a computer input error found and corrected, both reducing unidentified leakage. Board Ex. 20, Haverkamp Testimony at 6-7; Tr. 2054-57, 2131 (Haverkamp). Statements about an identification of leakage and a correction of a computer input error were repeated in the subsequent Licensee Event Report (LER) and are addressed below.

III. COMMISSION QUESTIONS CONCERNING TECHNICAL SPECIFICATIONS AND RESPONSES TO OCTOBER 1978 INSPECTION

A. Incorrect Interpretations of Technical Specifications and Inadequate Corrective Actions

The first group of issues the Commission requested the Board to address is separated into three parts for clarity. We quote and address them, below.

> "How were the Technical Specification 3.4.6.2 requirements for reactor coolant system unidentified leakage interpreted and implemented by control room operators (CROs), shift foremen, shift supervisors and on-site and off-site management?"

1. From the period of time when leak rate testing began in March 1978 to October 1978, virtually all Operations Department personnel, including CROs, shift foremen, shift supervisors, and the Superintendent of Operations, Mr. Floyd, generally worked under an interpretation that Tech Spec 3.4.6.2 and its corresponding surveillance requirement, Tech Spec 4.4.6.2, required entry into the Action Statement only if they were unable to obtain a leak rate test result of 1 gpm or less once in a 72-hour period. If such a result were obtained, any other tests run during the same period and showing excessive leakage were not considered to require entry into the action statement. See, e.g., Congdon, ff. Tr. 2709 at 2; Board Ex. 1-A, Stier Report, Vol. VI(G), Illjes 2/7/85 Interview at 14; Cooper, ff. Tr. 2835 at 5; Hitz, ff. Tr. 3644 at 3; Bryan, ff. Tr. 4540 at 2; McGovern, ff. Tr. 3148 at 3; Tr. 3151-52 (McGovern). Floyd, ff. Tr. 4894 at 3; Tr. 4753-57 (Seelinger). This erroneous interpretation contributed to a practice whereby tests

greater than 1 gpm were discarded and tests of 1 gpm or less were filed. See, e.g., Tr. 2715-16 (Congdon); Hitz, ff. Tr. 3664 at 3; Adams, ff. Tr. 3776 at 2; Tr. 3614-15 (A. Miller); see also Board Ex. 1-A, Stier Report, Vol. I at 58-59.

2. Some operators at times would search for leakage or "eyeball" plant parameters for indications of excessive leakage after obtaining a test greater than 1 gpm, but most of them would not make any efforts to determine the validity of a test before discarding it. The lack of such efforts was particularly true during the last three months of operation. See, e.g., Tr. 2714-16 (Congdon); Tr. 2522-24 (Faust); Tr. 3109-11 (Conaway); Tr. 4117-18 (Guthrie); Tr. 4241-47, 4252-3 (Hoyt); Smith, ff. Tr. 4331 at 4; Tr. 4359-62 (Smith); Tr. 4545-46 (Bryan). Virtually all of the operators, in effect, were simply going through the motions of conducting leak rate tests to satisfy a procedural requirement, without regard to the validity of the test.

3. The responsibilities of management above the level of TMI-2 Superintendent of Operations for interpretation of Tech Specs and other issues in this proceeding are discussed in pp. 110-121, below.

B. "Following the discovery by an NRC inspector in October 1978 that Technical Specification 3.4.6.2 requirements were not properly interpreted or implemented, what corrective action was taken by management personnel?"

4. Late on October 18 PORC met and determined that a reportable occurrence had occurred when the limiting condition for operation for

Tech Spec 3.4.6.2 was not invoked at 7:35 p.m. on October 16 when a leak rate of 2.6 gpm was obtained. Tr. 4780-81 (Seelinger); see also Board Ex. 1-A, Stier Report, Vol. V(C) at Tab 31 (Seelinger 10/19/78 Letter to Grier ("Grier Letter")).

5. In the afternoon of October 19, Seelinger informed Haverkamp, who was still on site, that PORC had met to review operation of the facility during October 16-18 with unidentified leakage greater than 1 gpm and that PORC had determined the matter to be a reportable occurrence. Board Ex. 20, Haverkamp Testimony at 6-7.

6. Later in the day on October 19, Seelinger sent a letter to Boyce Grier, Director of Regulatory Operations at NRC's Region I, informing him of the reportable occurrence. Board Ex. 1-A, Stier Report, Vol. V(C) at Tab 31 (Grier Letter). Bezilla, TMI-2 Procedure Coordinator and PORC secretary, wrote the body of the Grier letter; Seelinger probably made corrections to it. Id., Vol. VI(A), Bezilla 2/22/85 Interview at 15-22.

7. The Grier letter also contains the statement that "[u]nidentified leakage was reduced to [Tech Spec] limits at 0735 on 10-18-78" but does not state that rounding off was the method of reduction. We find that the statement is misleading.

8. On October 20, Floyd issued an Operations Memorandum to the TMI-2 shift foremen and supervisors explaining in the first two paragraphs, respectively, that (1) the leak rate computer program had been modified to round off and (2) "If the unidentified leakage is equal to or greater than 2 gpm, then the 4-hour time clock commences with the

output time of the printout i.e., the time the final data was taken." Board Ex. 1-A, Stier Report, Vol. V(C) at Tab 34 (Floyd 10/28/78 Operations Memorandum); see also Tr. 4934-44 (Floyd). The Board finds that the second paragraph was a poorly phrased and under the circumstances, completely inadequate attempt by Floyd to instruct the operators about the need to enter the Action Statement immediately on obtaining a valid test equal to or greater than 2 gpm.[30] The Board also finds that Floyd, as the member of on-site management responsible for the memorandum and the overall supervision of the operators, had the duty to take whatever follow-up actions were necessary to implement the memorandum, including specific discussions of the subject with shift supervisors. Such actions were never taken.

9. During the week following the October 18 inspection, Haverkamp telephoned NRR to determine the acceptability of rounding off. Board Ex. 20, Haverkamp Testimony at 8-9. Haverkamp was informed that the rounding off of test data was not an allowable practice and conveyed this conclusion by phone to Seelinger, who stated that the rounding off practice would not be employed. Id. Seelinger admitted that in this conversation between Haverkamp and him, which Seelinger estimated occurred 10 days after the inspection, or approximately on October 28,

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30 Floyd's reference to 2 gpm is appropriate because reprogramming the computer to round off meant that leak rates of 1.01-1.49 gpm would round off to 1, an acceptable number, whereas leak rates of 1.50-2.49 gpm would round off to 2, an unacceptable number.

he "wasn't terribly straight-forward" with Haverkamp about the extent to which the rounding off practice has been relied on to achieve acceptable results. Tr. 4772-74 (Seelinger). The record indicates that the rounding off practice was actually terminated beginning on October 27. See Board Ex. 1-A, Stier Report, Vol. I at 143.

10. Sometime after the decision by PORC that a reportable occurrence had occurred, Seelinger asked Bezilla and James Stair, the licensing engineer responsible for writing up LERs (Board Ex. 1-A, Stier Report, Vol. VI(K), Stair 3/1/85 Interview at 2), to assist him in drafting the 14-day follow-up LER. Id., Vol. VI(A), Bezilla 2/22/85 Interview at 19. Stair spent a total of about 1-1/2 hours on work related to the LER, including talking with the cognizant engineer, on whom he relied for factual information, drafting the original words of the LER, and attending the PORC meeting where the LER was reviewed and edited. Id., Vol. VI(K), Stair 3/1/85 Interview at 11-20; see also Tr. 4641 (Seelinger); Board Ex. 1-A, Stier Report, Vol. VI(A), Bezilla 2/22/85 Interview at 24. PORC met and provided input to the LER on October 31, when a final draft LER was prepared and submitted to typing by Stair. Board Ex. 1-A, Stier Report, Vol. V(C) at Tab 32 (Accountability Checksheet).

11. Sometime after the October 31 PORC meeting, Seelinger in his capacity as PORC Chairman sent the LER with a one paragraph Narrative to George Troffer, Manager of Quality Assurance, in Reading. See Id. at Tab 28 (Seelinger Memorandum to Troffer); Tr. 4647-51 (Seelinger). On November 1, 1978, Herbein formally submitted the completed LER with a

revised three-paragraph Narrative to Grier at the NRC. See Board Ex. 1-A, Stier Report, Vol. V(C) at Tab 29 (Herbein 11/1/78 Letter to Grier). These two versions of the LER Narrative (i.e., the one-paragraph version drafted at the site and forwarded to management at Reading after PORC approval and the three-paragraph version that ultimately accompanied the LER forwarded to NRC by Herbein) contained several erroneous or questionable statements in common: (1) the reference to 10:00 a.m. on October 19 when a determination was made that the Tech Specs had been violated; (2) the statement that reduction of unidentified leakage to within allowable limits was accomplished at 7:35 a.m. on October 18; (3) two statements concerning discovery and correction of errors in inputting data to the computer; and (4) the statement that appropriate personnel would be instructed on the relevant requirements of the Tech Specs and surveillance procedures. These statements are discussed, seriatim.

12. The first phrase of both Narratives repeats the inaccurate time and date that appeared in the Grier letter -- 10:00 a.m. on October 19 -- when Seelinger stated the determination was made that the Tech Specs had been violated. Although either Stair or Bezilla may have written this phrase, the source of the phrase was Seelinger. Mr. Seelinger's best recollection of why the time and date were misreported was that although the PORC had met on the 18th (late in the day) Mr. Floyd did not attend the meeting, and he was not "brought on board" until 10 o'clock on the 19th. Tr. 4780-82 (Seelinger). Inasmuch as NRC Inspector Haverkamp, to Seelinger's knowledge, was already aware of the

situation since his discovery of it on the 18th, the Board finds that this error was probably innocent and was, in any event, inconsequential.

13. Both "narrative" versions state that action was being taken to reduce the unidentified leakage to within allowable limits and that that was accomplished at 7:35 a.m. on October 18. Seelinger was aware, however, that the only action then being taken to reduce unidentified leakage was simply to round off, not to identify or correct leakage. See Tr. 4685-4701 (Seelinger). Furthermore, even the rounding off was done retroactively, since Floyd approved of the 7:35 a.m. test at noon. See II ¶ 38. Thus the "accomplishment" at 7:35 a.m. of reducing leakage to within allowable limits was merely a retroactive paper change, not a real change in the leak rate. The Board does find, however, that unidentified leakage was reduced to below 1 gpm around noon on October 18, not by rounding off, but by identifying leakage. See NRR Tests 12E, 13, 14.

14. After the transmittal of the one-paragraph Narrative to Troffer in Reading, the format of the Narrative was changed to three paragraphs, minor changes were made, and, of significance, the phrase "by determining a portion of this to be identified leakage from the Reactor Coolant System and to be well within the limits of Tech. Spec. 3.4.6.2c" was added to describe, purportedly, how reduction of unidentified leakage was accomplished at 7:35 a.m. on October 18. See Board Ex. 1-A, Stier Report, Vol. V(C) at Tab 29 (Herbein 11/1/78 Letter to Grier); Tr. 4685-88 (Seelinger). As discussed above, the only "reduction" at that time appears to have been by retroactive rounding

off, a fact that was not disclosed to the NRC, nor apparently to Met-Ed management including Miller and Herbein. Although the Board has been unable to determine the source and reason for this erroneous language, Seelinger testified that it is unlikely that someone in Reading changed the Narrative without first checking with someone at TMI. Tr. 4651-61 (Seelinger).

15. The Narratives also contain two incorrect statements concerning the input of data to the computer: (1) "In addition, it was discovered that errors in inputting data to computer caused indicated leakage to be greater than actually was occurring" and (2) "Input data for the computer program which calculates unidentified leakage has also been clarified." See Board Ex. 1-A, Stier Report, Vol. V(C) at Tab 28 (One-paragraph Narrative). Fels testified that input data had not been clarified as of November 1. Tr. 4529 (Fels); see generally Tr. 4512-31 (Fels). In fact, the only involvement Fels had with any generic computer problem associated with the leak rate test occurred sometime between November 9 and November 22, well after the LER had been drafted, approved, and sent to the NRC. Tr. 4514-17, 4528-29 (Fels). In that period of time, Fels discussed the possibility of program errors and decided to add a note to the program heading stating that a decimal point must be entered with leakage values. Tr. 4515 (Fels); compare NRR Test No. 40 (11/9/78) with NRR Test No. 41 (11/22/78). The only involvement prior to November 9 Fels could recall having was limited to a specific test, NRR Test No. 14 conducted on October 18, where Fels may have told the operators involved to redo the calculation using the

correct sign because the leakage sign convention looked wrong. Tr. 4520-31 (Fels); see NRR Test No. 14.

16. Seelinger testified that he partially drafted the first computer-related sentence and that he entirely drafted the second one. Tr. 4640-44, 4407 (Seelinger). In any event, he obviously approved both sentences at the time of the drafting of the one-paragraph Narrative. Seelinger stated that his practice was to rely on Fels for computer matters. Tr. 4704 (Seelinger). Seelinger also stated that, having heard the testimony by Fels, he believed that "Fels and I may have been on a different wave-length" when they discussed a possible program problem, with Fels stating something specific and Seelinger hearing something generic. Tr. 4705-07 (Seelinger). Finally, Seelinger stated that he vaguely recalled that within the few weeks following October 18, he went to Bezilla, the PORC Secretary, and asked him to request a write-up from Fels on the supposed clarification of computer input data, but Bezilla was "unsuccessful" in obtaining such a write-up. Tr. 4706-07 (Seelinger). Seelinger felt "some sense of resistance" but did not understand why and did not pursue the matter. Id. The request for a write-up was apparently withdrawn at Seelinger's request. See Board Ex. 1-A, Stier Report, Vol. V(C) at Tab 30 (TMI-2 PORC Action Items, Section III).

17. The Board finds the LER to be flawed in several respects. Given the numerous errors concerning times, dates and circumstances, it falls short as a straightforward description of the event. Indeed, the Board strongly suspects that at least some of the errors were not

inadvertent, but reflected a conscious attempt to put the best light possible on the incident. Given the collective authorship of the document, however, it is not possible to assign responsibility for such an attempt to any specific person. More importantly, however, the LER conveyed no clear explanation to the operating personnel that their interpretation of the Tech Specs had been wrong, and that they were required to enter the action statement whenever a leak rate test reflected leakage in excess of 1 gpm and there was no valid basis for declaring the particular test invalid. The only information in that regard was the statement in the Narrative that "The appropriate personnel will be instructed on the requirements of the applicable sections of the Tech Specs and the requirements to immediately invoke applicable action statements when the provisions of limiting conditions for operation are not met". This was, at most, a present promise of a future instruction which, as we next discuss, was never effectively carried out.

18. Walter J. Marshall, one of two operations engineers assigned to Floyd, was given the responsibility for implementing and following up on the LER; in particular, the PORC Action Item specified that Marshall was to insure that the Narrative sentence on instruction of appropriate personnel was "documented by Ops review" of the LER. See Board Ex. 1-A, Stier Report, Vol. V(C) at Tab 30 (TMI-2 PORC Action Items, Section III; see also Tr. 4389-96 (Marshall)). The PORC Action Item initially was given a due date of November 20 and was signed by Seelinger; however, the "Document Review" form (i.e, "signature sheet") required review of

the LER by November 10. See Board Ex. 1-A, Stier Report, Vol. V(C) at Tab 30 (PORC Action Item Sheet and Document Review Form). Someone other than Marshall filled in the signature sheet requiring the 10-day turnaround. Tr. 4396-97 (Marshall).

19. Marshall stated that the phrase "documented by Ops review" meant "that the document went to the Control Room with the cover sheet and that the operators had the opportunity to initial and read it." Tr. 4398 (Marshall). Marshall explained that he fulfilled his follow-up responsibility simply by making sure the LER and a signature sheet were placed in the three-ring notebook in the Control Room with other LERs and by reviewing the binder periodically to see if any CROs, shift foremen, and shift supervisors had still not signed the sheet indicating their review. Tr. 4397-4400, 4408-09, 4414-16 (Marshall); see also Tr. 4713-14, 4664-68 (Seelinger); Tr. 4943-44 (Floyd). If someone had not signed the signature sheet, Marshall "would tell the group to take a look at it and sign it." Tr. 4409 (Marshall). No one has claimed that Marshall had any further responsibilities concerning this Action Item.

C. "Was the corrective action taken sufficient to insure compliance with the Technical Specification 3.4.6.2 by the personnel performing and reviewing the leak rate surveillance tests?"

20. The signature sheet attached to the LER indicates that all the CROs, shift foremen, and shift supervisors (with the exception of Bryan) signed the signature sheet indicating their review. See Board Ex.1-A, Stier Report, Vol. V(C) at Tab 30 (Document Review Form); Tr. 4574-80,

4608-09 (Bryan). However, mere placement of the LER in the Control Room binder evidently did not constitute sufficient instruction of appropriate personnel. Operator after operator testified that he never received any clear instruction on the correct interpretation of the Tech Spec following the LER. See e.g., Tr. 3699-3700 (Hitz); Tr. 3619-20 (A. Miller); Tr. 4455 (Phillippe); Tr. 4573-80 (Bryan); Tr. 2718-19 (Congdon); Tr. 2967-69 (Zewe); Tr. 3858-59 (Mehler); Tr. 3818-19 (Adams); Tr. 3244-46 (Mell); Tr. 3083-84 (Illjes); Tr. 3115-16 (Conaway); Cooper, ff. Tr. 2835 at 6-7; Bryan, ff. Tr. 4540 at 5.

21. Only one operator, Dennis Olson, testified that he changed his practice in some respects following the LER. See Tr. 4007-09 (Olson); Olson, ff. Tr. 3911 at 3-4. Olson stated that he was "pretty sure" that out of the LER came the word not to discard bad tests and not to accept negative tests. Tr. 4007-09 (Olson). Even Olson, however, nowhere suggests that he received instructions on the requirements to enter the Action Statement whenever a test showed unidentified leakage over 1 gpm.

22. In sum, operators had at least three possible ways of receiving instruction on the requirements of the Tech Specs and surveillance procedures pertaining to leak rate testing. First, superiors like Floyd, and to a lesser extent Seelinger, who were aware of the need for such instruction following Haverkamp's inspection, could have directly communicated with the Operations Department personnel. The record is clear, however, that effective direct communications never took place. Second, Floyd's October 20 Operations Memorandum to shift foremen and supervisors was an attempt to ensure that operators were

instructed on proper leak rate practice. The cryptic language of the critical second paragraph of the Memorandum, however, led to the failure of this attempt also. The record indicates no further efforts by Floyd to elucidate the meaning of the Memorandum. (Seelinger even speculated that operators may have interpreted Floyd's putting an "X" through his October 20 memo after learning that the rounding off practice should be terminated to mean cancellation of the entire memo, not only the first paragraph, which dealt with rounding off, and a return to the practice prior to the LER. See Tr. 4680-81 (Seelinger); Board Ex. 1-A, Stier Report, Vol. V(C) at Tab 34 (Floyd 10/20/78 Operations Memorandum)). Third, placement of the LER itself in a required reading book gave the operators potential notice of the problem but resulted in virtually no instruction to them or change in practices. The record does not indicate any further meeting or memorandum to fulfill the promise of instructing appropriate personnel. The record is clear that operators did not receive adequate instruction by any means on the requirements of the Tech Specs and leak rate test surveillance procedures growing out of the October 18 inspection.

23. The Board concludes that, despite the apparent review of the LER and the October 20 Floyd Operations Memorandum by the operators, the operators following the Haverkamp inspection did not change their general practice of repeatedly running tests and discarding bad tests based on misunderstanding the Tech Specs only to require one "good" test every 72 hours.

24. Initially scheduled for completion by November 20, 1978, the PORC Action Item had its due date extended to "no later than December 15, 1978" because "plant problems and test program" had "overshadowed" the item. See Board Ex. 1-A, Stier Report, Vol. V(C) at Tab 30 (TMI-2 PORC Action Item Extension). Despite the force of the language "no later than December 15, 1978," action relating to this item inexplicably was not completed until March 5, 1979. See Id. (PORC Action Items). See also Tr. 4397-98, 4404-05 (Marshall).

25. Seelinger testified that he made the following personal efforts to implement the corrective actions described in the Narrative:

> "In any event, I attempted to implement the coorective actions described in the Narrative by assuring myself that Mr. Floyd followed Mr. Haverkamp's interpretation (which he appears to have done by issuing his Operations Memorandum dated October 20, 1978), by instructing Mr. Walter Marshall (by memorandum) to inform the operators of the correct interpretation, by discussing the matter in a plan-of-the-day (POD) meeting and again at a later date on second shift with Shift Supervisor, by satisfying myself that ppropriate computer changes had been made, by advising Mr. O'Hanlon (the then-Unit 1 Superintendent), in October 1978, of the NRC's interpretation of the Action Statement requirement, and by assuring myself (after I became Unit 1 Superintendent) that Unit 1 operators would also take comparable action if unidentified leakage was greater than 1 gpm".

Seelinger, ff. Tr. 4623 at 8; see Tr. 4669-79 (Seelinger); see also Board Ex. 1-A, Stier Report, Vol. V(C) at Tab 36 (Seelinger 8/9/84 Letter to Palladino). The Board finds that, based on the record cited in these findings, these personal efforts, while well-meant, were not adequate to correct the situation.

26. As we have already indicated (see III ¶ 22) what was needed in this situation was a sustained effort to make certain that the operators and their immediate supervisors understood that they had been misinterpreting a tech spec, and that they must change their interpretation and their practices with respect to leak rate tests indicating excessive leakage. In our judgment, two basic steps should have been taken: first, the problem area -- including a description of the previously prevailing misinterpretation of the tech specs, the correct interpretation, and the action statement requirement -- should have been put in memorandum form in simple English, with a copy to each CRO, foreman and supervisor. Floyd's single, cryptic sentence in his operations memorandum was no substitute for a full and clear informational message. Second, all of the CROs, foremen and supervisors should have been told, in face to face meetings, about the informational memorandum and given an opportunity to ask questions about the matter.

27. In sum, the Board finds that the efforts to implement the corrective actions articulated in the LER Narrative were totally inadequate. The members of management responsible for these efforts were primarily Floyd and to a lesser extent Seelinger. There is no indication in the record that any members of management above Seelinger and Floyd had any direct responsibility for the implementation of any corrective actions arising out of the LER.

IV. DIFFICULTIES IN PERFORMING LEAK RATE TESTS; SENIOR SUPERVISOR AND MANAGEMENT KNOWLEDGE AND RESPONSIBILITIES; PRESSURE TO OBTAIN "GOOD" TESTS

The Commission's questions in this area are quoted and discussed below.

> "What difficulties, if any, were operators experiencing when conducting leak rate surveillance tests required by Technical Specification 4.4.6.2.d? Who knew about these difficulties? What corrective actions were taken? Did operators feel pressure to obtain leak rate surveillance test results which did not exceed technical specification limits? If so, what type of pressure was perceived or exerted and who was responsible? (CLI-85-18, 22 N.R.C. at 880, Issue (b))"

A. Difficulties the Operators Were Experiencing

1. The surveillance requirements of Tech Spec 4.4.6.2.d required that RCS leakages be demonstrated to be within prescribed limits by "[p]erformance of a Reactor Coolant System water inventory balance at least once per 72 hours during steady state operation.", as well as by the other three required surveillances in this Tech Spec. Stier Report, Vol. V(B) at Tab 14 (Tech Spec 4.4.6.2).

2. The TMI-2 operators typically performed a leak rate test on each eight-hour shift, in contrast to the technical specification required frequency. Stier Report, Vol. I, p. 51; Exhibit 5-A, Enclosure 1, p. 9. A test was performed by every shift if the computer was available and if the performance of other shift evolutions and responsibilities did not interfere. The practice of performing a leak

rate test on every eight-hour shift was established at TMI-1 and was subsequently implemented at TMI-2. Stier Report, Vol. I, p. 52.

3. TMI-2 Surveillance Procedure 2301-3D1 governed the performance of the leak rate test and is set out at Stier Report, Vol. V(C), Tab 19. The actual performance of a leak rate test was rather routine and uncomplicated. It was usually performed (although not always) by the "switching and tagging" CRO, that is, the CRO who was not manipulating the controls of the plant (i.e., "assigned to the panel"). If there were three CROs or more on shift, one would be assigned to the panels, one to "switching and tagging", and one to surveillance tests. E.g., Olson Prep. St., pp. 2-3, ff. Tr. 3911. The CRO performing the test would instruct the computer, which was located in the TMI-2 control room, to calculate the RCS leakage by entering the appropriate code ("RCSL"). E.g., Cooper Prep. St., pp. 3-4, ff. Tr. 2835. At the same time, the CRO would specify the time interval in which the test was to be performed (which, in practice, was always one hour). The computer would then conduct the leak rate test and at the end of the hour would request certain information of the CRO to complete the test. The CRO was asked to enter any identified leakage and any operator-caused change to the volumes of the RCDT or RCS. With that information, the computer would print the initial and final values of the parameters used in the leak rate test and the calculated values for the gross leakage, identified leakage, and unidentified leakage. Stier Report, Vol. 1, pp. 52-53; Exhibit 5-A, Enclosure 1, p. 2.

4. Generally, although not always, the CRO who performed the test signed the sheet printed out by the computer; on occasion, however, a licensed operator other than the CRO who performed the test signed it. Stier Report, Vol. I, p. 54; e.g. NRR Test Nos. 96, 98, 108, 154, Tr. 3986-87. The test was then approved by an SRO, usually the shift foreman on duty during the performance of the leak rate test. Exhibit 5-A, Enclosure 1, p. 2.

5. Generally, the CRO performing the leak rate test would inform the CRO assigned to the panel that the computer was being instructed to conduct a leak rate test. On occasion, however, the CRO performing the test failed to so alert the CRO at the panel. This lack of communication led to occasional mistakes in the performance of the test, since the panel operator might manipulate the reactor controls to violate the "steady state" conditions required by procedure or add water to the make-up tank without informing the operator who was performing the test. The Board infers that, since tests with such mistakes were approved, the foremen that approved the surveillance test results did not examine either the log or the make-up tank strip chart to confirm the absence of such mistakes.

6. The difficulty that the operators were experiencing was that the test results were quite variable. Successive tests during a shift or from shift to shift showed computer-calculated leak rates that were inconsistent and, therefore, unbelievable, i.e. a large leak does not spontaneously become smaller. There is near unanimity in the record that there was a lack of confidence in the computer-calculated result of

this Tech Spec required surveillance test. Tr. 2097, 2904, 2988, 3017, 3196, 3249, 3487, 3526, 3528, 3826, 3924, 4134, 4341, 4362, 4462. The reasons for the difficulty (below) were not known to anyone in the operations department but were generally thought to be in the computer program.

7. The Board finds that the general knowledge that the computer-based surveillance was unreliable and erroneous should have led the operators, with concurrence from the shift foremen and shift supervisors, to use the manual procedure that also is part of the TMI-2 Surveillance Procedure 2301-3D1.

8. The operators were not obliged to file or foremen to approve these many dubious test results. They failed to follow Administrative Procedure 1010 to conclude that the tests were not satisfactory and classify them as either an exception or deficiency (see II ¶ 19). During the hearing, the Board inquired of a sufficient number of the Operations Department personnel to find the Exception and Deficiency mechanism was well known to them and used in other Surveillance tests. Tr. 2177, 2194, 2222, 2268, 2545, 2672, 2795, 3524, 3648, 4077, 4345, 4587 and 4992.

9. The causes of the difficulties the operators were experiencing when conducting the leak rate tests generally fall into one of three categories: (a) procedure errors, (b) instrument inaccuracies, and (c) oscillations in plant conditions. The effects in each of these categories had some potential to cause the test to reflect a result other than actual unidentified leakage. In addition to the difficulties

the operators were experiencing in conducting the leak rate test, there were certain idiosyncrasies associated with the implementation of the leak rate test that contributed to the operating personnel's negative or confused reaction to the test performance.

10. The record indicates that the degree of error caused by each of the difficulties was not necessarily cumulative. In some instances the errors cancelled each other out (Tr. 888 (Kirkpatrick)) or a particular error was not present because of plant conditions at the time of the test. (Tr. 891 (Russell)).

Procedure Errors

11. The technical experts identified thirteen procedure errors that could have produced leak rate test results at variance from the true values. The degree of variance would have been dependent on the conditions existing at the time each test was performed, Board Exh. 1-A, Stier Report, Vol. IV(A) at III.3-III.4; Kirkpatrick, ff. Tr. 376 at 18-20 and Attachment 4. Four of these errors were quantitatively important.

1. Lack of RCDT Density Compensation.

12. The leak rate test procedure failed to correct f a difference in density that existed between RCS leakage collected in the Reactor Coolant Drain Tank ("RCDT") and the water in the RCS itself.

The difference in density was caused by the different temperatures of the water in the RCDT and in the reactor. This defect in the leak rate test procedure produced a significant error in the test calculation and seriously compromised the accuracy of the test. Faegre & Benson Report, Vol. 1, pp. 21-22; Stier Report, Vol. IV(A), Section III, Table III-2; id., Appendix A, pp. A.16-18; Kirkpatrick & Wermiel Prep. St., Attachment 4, ff. Tr. 376.

13. Average RCS temperature was approximately 581°F. Stier Report, Vol. IV(A), Section VI, p. VI.4. The RCS leakage collected in the RCDT was cooled to approximately 85°F. The failure of the leak rate test procedure to account for this difference produced an error that was typically about 40 percent of the total RCS leakage added to the RCDT during a leak rate test. Tr. 853-54; Faegre & Benson Report, Vol. 1, p. 21. "The temperature compensation error was significant and affected virtually every leak rate test." Faegre & Benson Report, Vol. 1, p. 22. The impact of the error on calculated unidentified leakage ranged between 0.07-2.10 gpm. Stier Report, Vol. IV(A), Section III, Table III-2; Tr. 843. This was "a very significant error." Tr. 843. For example, if the actual unidentified leakage was zero but the identified leakage collected in the RCDT was 2 gpm, the value for unidentified leakage increased by 1 gpm due solely to this error. Tr. 844. From mid-February 1979 to March 16, 1979, identified leakage exceeded 2 gpm. Tr. 844-45, 848; Stier Report, Vol. IV(A), Section IV, Figure IV-14 (RCDT collection rate and other identified leakage).

14. This defect in the TMI-2 leak rate test procedure was corrected by a Temporary Change Notice ("TCN") that became effective on March 16, 1979, 12 days before the TMI-2 accident. Stier Report, Vol. V(C), Tab 21. The TCN required that each leak rate test be corrected by a hand calculation to compensate for the failure of the test procedure to correct the temperature of the RCS leakage to the average temperature of the RCS. Tr. 857; Faegre & Benson Report, Vol. 1, p. 22. There is no evidence in the record that explains how this defect was discovered or why it took so long to discover it. Tr. 858.

2. Lack of Density Correction for Additions to the MUT

15. The leak rate test procedure failed to account for the difference in density between water in the MUT and in the reactor because of the difference between the temperature of the water added to the MUT and the average temperature of the RCS. Stier Report, Vol. IV(B), Appendix A, pp. A.16-18; id., Vol. IV(A), Section III, Table III-2; Faegre & Benson Report, Vol. 1, pp. 21-22. This defect produced an error in a leak rate test results if water was added to the MUT during a test.

16. According to the Stier report, there were 31 leak rate tests during which water was added. Stier Report, Vol. IV(A), Section VI, Table VI-1 (listing 31 of 222 tests evaluated). Therefore, the failure to correct for the difference in density between water added to the MUT and water in the reactor did not affect every leak rate test. In any

event, this error would have offset (in whole or in part, depending upon the amount of water added) the corresponding error in the leakage to the RCDT, if both occurred during a leak rate test, until the TCN was adopted on March 16, 1979. Tr. 1958 (Stier).

17. The failure to account for the difference in density between additions to the MUT and in the reactor was not discovered and corrected until August 21, 1979, after the TMI-2 accident. Tr. 878-79. No technical witness could explain why this defect was not discovered when the RCDT temperature compensation error was corrected by the March 16, 1979 TCN. Tr. 881. It is clear that the TCN should have corrected the leak rate test procedure for both the MUT and RCDT density differences (and, to be precise, the difference in density between identified leakage other than that collected in the RCDT and the density of RCS inventory at average RCS temperature).

3. RCS Temperature Was Not Correctly Entered If Temperature Exceeded 582°F.

18. The TMI-2 leak rate test procedure failed to account for changes in the RCS temperature when it exceeded 582°F. Stier Report, Vol. IV(B), Appendix A, pp. A.18-A.19. An RCS temperature of 582°F was used in the leak rate test procedure when the RCS temperature exceeded 582°F. This defect produced an error of 2.49 gpm in the test calculation for every degree of change in the temperature above 582°F. Tr. 885; Stier Report, Vol. IV(B), Appendix A, p. A.18. There is no explanation in the record for the failure of the test procedure to

account for changes in the RCS temperature when it exceeded 582°F. Tr. 803, 882. Mr. Kirkpatrick suggested that the test was based on the TMI-1 leak rate test procedure and that 582°F was "an acceptable limit [at TMI-1] because the plant hardly ever got above 582 degrees Fahrenheit." Tr. 882. But at TMI-2, the evidence indicates that the RCS temperature exceeded 582°F in approximately 50 filed leak rate tests (Tr. 803, 883-86 (49 out of 161 tests); Tr. 885-86 (54 out of 170 tests); Stier Report, Vol. IV(B), Appendix A, p. A.18 (54 tests).

19. The failure of the leak rate test procedure to account for changes in RCS temperature when it exceeded 582°F frequently produced errors in the leak rate test results of up to 1 gpm. Tr. 803, 883-86; Stier Report, Vol. IV(B), Appendix A, p. A.18; id., Vol. IV(A), Section III, Table III-2; Kirkpatrick & Wermiel Prep. St., Attachment 4, Table 1, ff. Tr. 376. An error of approximately 1 gpm occurred if temperature changed 0.5°F. Tr. 805, 883. However, in one test, on September 22, 1978, RCS temperature changed 1.5°F, which caused an error in the test result of several gpm. Tr. 885; Stier Report, Vol. IV(B), Appendix A, p. A.19.

4. RCS Pressure Differences Were Not Accurately Taken Into Account.

20. The TMI-2 leak rate test procedure failed to consider accurately the changes in the RCS pressure. Stier Report, Vol. IV(B), Appendix A, pp. A.7, A.11; Faegre & Benson Report Vol. 1, pp. 22-23. If the RCS was maintained in steady state (with respect to pressure), there

would be no impact on the leak rate test as a result of this error. However, RCS pressure was not a variable that was within the control of the TMI-2 operators. Tr. 760-61.

21. Changes in RCS pressure often had a "significant impact on the leak rate test" Tr. 761. A change in the RCS pressure of plus or minus 50 pounds per square inch "was typical of the test", Tr. 762, and produced an error of 1.08 gpm in the test result. Stier Report, Vol. IV(B), Appendix A, p. A-11.

22. Staff witnesses Kirkpatrick and Wermiel agreed that the failure of the TMI-2 leak rate test procedure to account for the changes in the RCS pressure "had a very significant effect on the error in the leak rate calculation." Tr. 771, 786-87. The Faegre & Benson analysis (based on an RCS pressure change of 15 pounds per square inch) and the Stier analysis (based on an RCS pressure change of 50 pounds per square inch) are in substantial agreement. Tr. 785. There is no systematic analysis of the changes in the RCS pressure at TMI-2 in 1978 and 1979. However, the technical experts indicated that the typical change ranged from 20 to 50 pounds per square inch during a leak rate test. Tr. 802-03. On at least one occasion, during January 4-5, 1979, a change in the RCS pressure of 60 to 65 pounds per square inch produced an error in a leak rate test result of two gpm. Tr. 778-80, 785.

Instrument Errors

23. The normal instrument errors associated with the TMI-2 leak rate test procedure naturally affect the accuracy of the measurements used in the test. These measurements included the temperature in the two RCS hot legs, the temperature in two of the four cold legs, the pressurizer level, the MUT level, and the RCDT level. Stier Report, Vol. IV(B), Appendix A, pp. A.6-7. The impact of these normal instrument errors was estimated by the technical witnesses. Id., Vol. IV(A), Section III, pp. III.8-III.10; id., Vol. IV(B), Appendix A, pp. A.19-27. Kirkpatrick & Wermiel Prep. St., Attachment 4, Table 2, ff. Tr. 376; Faegre & Benson Report, Vol. 1, pp. 24-26. The cumulative impact of these normal instrument errors might have produced an error in a leak rate test of between 0.7 and 1.24 gpm, with a probability of 1 in 20, i.e. these values correspond to approximately two standard deviations. Tr. 894 (1 gpm) (Kirkpatrick); Tr. 895 (1.24 gpm)(Rockwell); Tr. 896 (0.7 gpm)(Stier).

24. These normal instrument errors were, according to Mr. Kirkpatrick, "the kind of instrument error that you would expect in any kind of installation like this." Tr. 897. The effect of these errors could have been reduced by the performance of a leak rate test for more than the one-hour test interval that was always used at TMI-2. Tr. 897. Mr. Moore testified that "we've learned a lot in these last few years and that, today, people are running longer tests. . . ." Tr. 936. Mr.

Kirkpatrick testified that Regulatory Guide 1.45 fails to discuss normal instrument errors. Tr. 934.

25. In June 1983, the NRC published NUREG-0986, entitled "RCSLK8: Reactor Coolant System Leak Rate Determination For PWRs." In that report, the NRC Staff recommended a test interval of 4 hours. Tr. 950. Prior to the publication of NUREG-0986, there was no recommendation on the part of the NRC concerning the leak rate test interval. Tr. 951. Mr. Kirkpatrick testified that the random error would be approximately 0.1 gpm if the test were performed over an eight-hour interval, 0.2 gpm over a four-hour interval, and 0.34 gpm in a two-hour interval. Tr. 953-54. Given that it was not until June 1983 that the NRC recognized in print the advantage of performing the leak rate test over these longer intervals, we do not fault the TMI-2 operators for failing to do so.

26. In addition to the above "normal" instrument errors, the technical witnesses agreed on the existence of a defect in the MUT level sensor that produced errors. This defect may have been the result of a loop in the dry reference leg of that instrument, which on occasion, it is hypothesized, became filled with water from the MUT. This could produce a "loop seal" effect in that the pressure in the MUT tank gas phase would not be accurately transmitted to the sensor. Stier Report, Vol. IV(A), Section III, pp. III.10-III.12; id., Vol. IV(B), Appendix A, pp. A.27-32, id., Figure A-4; Kirkpatrick & Wermiel Prep. St., pp. 25-29 and Attachment 5, ff. Tr. 376; Faegre & Benson Report, Vol. 2, pp. 68-69; id. Vol. 3 A, Exh. 22-31, Vol. 1, pp. 23-24; id.

27. The defect in the MUT level sensor was not conclusively established in the record to be the result of a "loop seal" effect. Tr. 960, 963-65, 972, 995-96. A defect in the MUT level sensor existed, and the existence of the "loop seal" effect is "a reasonable hypothesis." Tr. 965 (Stier). However, we agree with Mr. Stier that it is not critical to understand whether the defect was caused by the "loop seal" effect or by something else. Id. The important point is that some operators were aware of the defect and used it to affect tests, as discussed below.

28. The existence of a "loop seal" in the dry reference leg of the TMI-2 MUT level sensor could have had "a very significant effect under certain circumstances." Tr. 968 (Kirkpatrick). A positive bias might occur if water or hydrogen was added to the MUT, or a negative bias might exist as the MUT level decreased during a leak rate test. Tr. 968-69. The existence of a "loop seal" in the MUT dry reference leg could have resulted in an overstatement in the change in the MUT level during a leak rate test. Stier Report, Vol. IV(B), Appendix A, p. 27; Tr. 975. According to Stier, the effect of the overstatement in MUT level could have been as high as 30 percent. Tr. 991 (Stier); see also Tr. 992-94 (Kirkpatrick).

29. The operators were not aware of the "loop seal" but rather some operators became aware that a water addition might be over indicated by the MUT level sensor and cause an erroneous "bonus" that would effect the computed leak rate. The technical experts also postulated that the "loop seal" was the cause of the spurious increase

in the MUT level signal that sometimes occurred when hydrogen was added to the MUT. Kirkpatrick & Wermeil, ff. Tr. 376, at 26. These defects provided an opportunity for operators to manipulate the leak rate tests by adding either water or hydrogen to the MUT during the tests. We review the record to ascertain the evidence for individual responsibility in Section F below.

30. The "loop seal" effect was not discovered by the NRC until 1980, during the initial investigation of the allegations raised by Mr. Hartman. Tr. 983. There is evidence in the record to suggest that Met Ed should have discovered the problem prior to 1980:

> "B&W anticipated the possibility of certain problems with a dry-reference-leg system and suggested measures to minimize those problems. In particular, B&W suggested a reference leg with a condensate loop and draining capabilities. The suggestion was not incorporated in the actual modification as identified in the vendor's instruction manual. Incorporating the vendor's suggestion probably would have avoided the physical condition which may have allowed hydrogen additions to the make-up tank to affect level instrumentations."

Faegre & Benson Report, Vol. 2, p. 63 n.* (footnotes omitted).

31. Met Ed should have discovered and corrected this leak rate test defect well in advance of its discovery by the NRC in 1980. Tr. 1066 (Kirkpatrick) ("there were several indications of the loop seal problem which Met Ed should have investigated but did not"); Tr. 1068 (Rockwell) ("any engineer looking at the configuration would recognize the potential for a problem"). As Mr. Kirkpatrick observed, "any competent instrument design engineer should have realized that accumulation of water in this -- in a low spot would have caused

instrument problems." Tr. 1079. We note that Mr. Chwastyk, Shift B Supervisor, testified that the reference was frequently "blown out", Tr. 3477, and that he had asked I&C to check the reference leg, Tr. 3473-75. Even so, the problem was not corrected.

Oscillations in Plant Conditions

32. Another defect in the TMI-2 leak rate tests was the impact of RCS oscillations on the calculation of the RCS leakage by the computer during the performance of a test. Stier Report, Vol. IV(A), pp. III.13-III.15; id., Vol. IV(B), Appendix A, pp. A.34-36; Faegre & Benson Report, Vol. I, p. 25; id., Vol. II, pp. 93-108; id., Vol. III(B), Exhibits 37-42; Kirkpatrick and Wermiel Prep. St., pp. 17-18, ff. Tr. 376. The oscillations occurred in the RCS temperature and pressure, the pressurizer level, and the MUT level. The impact of these oscillations produced "a significant effect on the leak rate test results." Faegre & Benson Report, Vol. 1, p. 25.

33. Mr. Moore testified that the oscillations were the result of a problem with the integrated control system. Tr. 1095-96. These oscillations caused similar oscillations in the RCS, thereby affecting the leak rate test and compromising its ability to quantify RCS leakage. Tr. 1097 (Russell)("the oscillations caused high variability in the computed unidentified leak rate"), 1098 (Rockwell)("there was a direct correlation between the oscillation in these plant parameters and the oscillation in the leak rate test results.").

34. If the oscillations in these parameters took place simultaneously or in phase, the leak rate procedure would have compensated for small changes in the values, which is the purpose of recording the magnitude of all these parameters three times at the beginning and end of the test. However, the analysis by Faegre and Benson found that these parameters did not vary in phase. Ex. 2, Faegre and Benson, Vol. 2, p. 99. They used some reactimeter data for January 4-5, 1979 that recorded the plant parameters every 3 seconds to calculate a large series of leak rates, starting the calculations 3 seconds later on each successive calculation. Figure 1 shows a sample of the results. Faegre and Benson, Vol. 3B, Ex. 38-1. As may be seen for this particular data set, an operator could have obtained a gross leak rate test result ranging from 0.7 gpm to 3.3 gpm for gross or total leakage. The identified leakage was approximately 0.6 gpm, so that unidentified leakage would have ranged from 2.7 gpm to 0.1 gpm. This example may represent a time of near maximum oscillations but clearly shows that variable test results would have been obtained by the operator and that <u>any</u> single test was not a reliable measurement of leakage due to this problem.

35. The GPU Nuclear Proposed Finding 152 quotes the MPR report as stating:

> At worst, the effect of the oscillation would cause an additional error of the same magnitude as the instrument errors. On a 'typical' basis the additional error would be less. Since it is independent of the instrument errors, it would combine with them on a random basis, producing only a minor increase on the overall expected error.

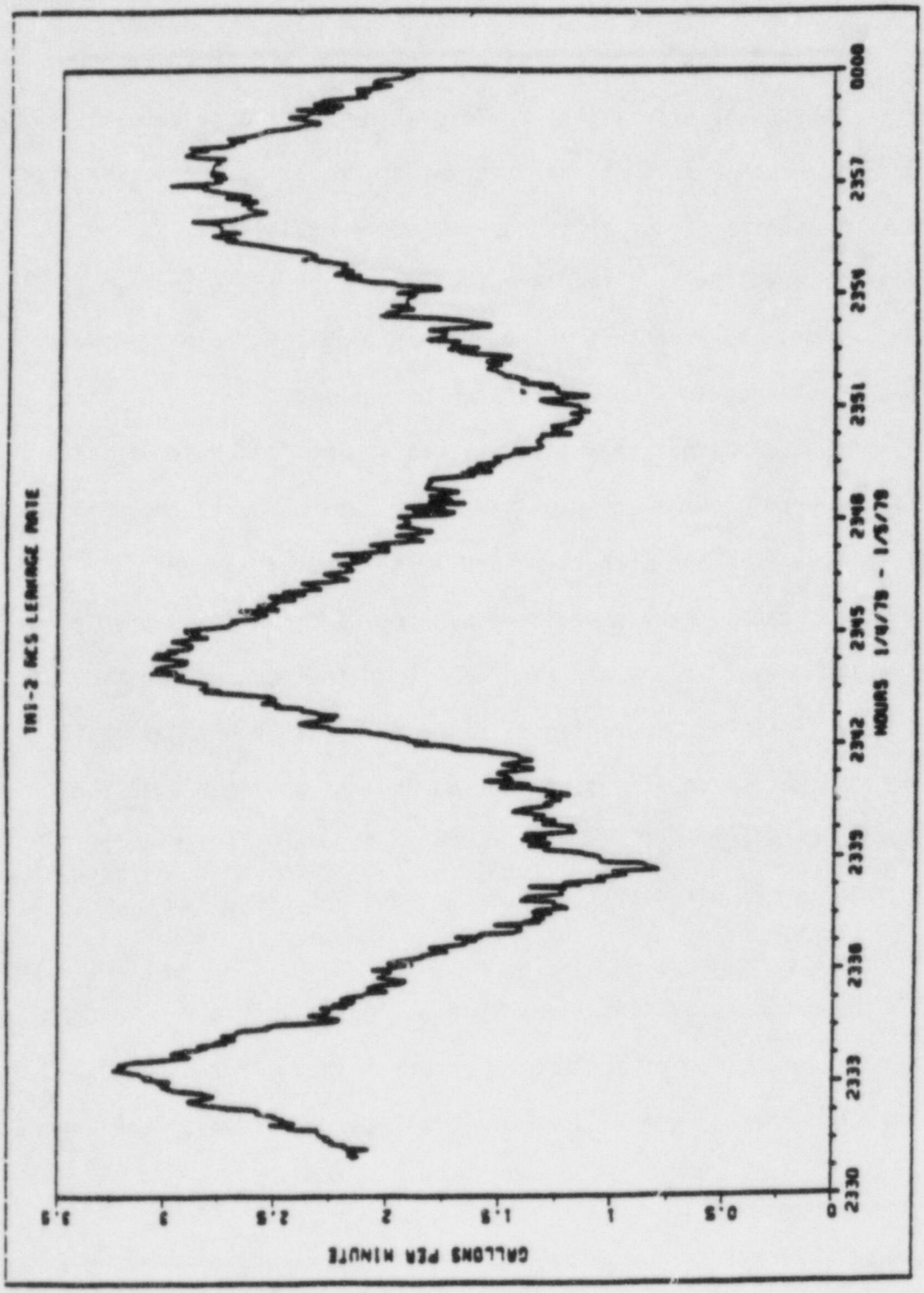

Figure 1. Gross Leakage Calculations, from Exhibit 38 in Board Exhibit 2. See IV para. 34.

Ex. 1-A, Stier Report, Vol. IV(B) at A.36.

36. The Board does not agree with this quote. If there are two independent sources of error, they would combine to produce a total variability (expressed as a standard deviation) equal to the square root of the sum of squares of the individual standard deviations.[31] For equal sized errors, the resulting error would be 1.4 times the individual error. We find this to be a minor technical point. However, there is a more important aspect that can be seen in the data plotted in Figure 1. The data do not show a time variation or frequency of values that correspond to a normal or Gaussian distribution, i.e., frequent small deviations from the mean value and less frequent larger deviations. In fact, the visual impression of Figure 1 is that extremely high or low values are as probable as the mean or, in fact, somewhat more probable. Conventional error analysis techniques that assume the "normal" frequency distribution are not applicable to these errors due to oscillations. We note further that the plant was in "steady state" as required by the procedure and was steadily oscillating.

37. The rapid variations (less than a minute) in Figure 1 appear to us to be a reflection of instrument errors. They are roughly 0.3-0.4 gpm rather than the 0.7 gpm to 1.24 gpm estimates provided by the expert

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31 We take official notice of the textbook "The Mathematics of Physics and Chemistry", Margenan and Murphy, D. VanNostrand Co., Inc., 1943, p. 498 to support this generally recognized fact.

witnesses. The Board notes that instrument errors in general at other plants may not be as great as this record would otherwise indicate. See IV ¶ 23.

38. The Board finds that the oscillations caused by the Integrated Control System at TMI-2 were a major contributor to the difficulty that the operators experienced in attempting to carry out the inventory balance surveillance test. It is clear to us that one of the reasons for specifying four surveillances in Tech Spec 4.4.6.2 is to provide redundancy or "defense-in-depth" and the problems with the inventory balance test should have led the Operations Department to utilize the containment sump inventory (required each 12 hours) to monitor leakage into containment until the ICS was adjusted properly. However, the Unit 2 Superintendent Mr. Logan testified "I don't think anybody ever tried to quantify by use of the sump pump or whatever a leakage". Tr. 5115.

39. The technical witnesses also testified that the sump surveillance was not properly carried out. Tr. 475-491. The failure to perform this sump inventory surveillance (4.4.6.2.a) was another violation of the Tech Spec requirements.

40. In addition to the difficulties induced by methodology and instrument errors, certain other aspects made it more difficult for the operators to obtain unidentified leak rate results smaller than the Tech Spec limit of 1 gpm. The difficulties in this class reflect the following idiosyncrasies in the TMI-2 leak rate test:

a. Both GPU in PF 153 and Numerous Employees in PF 138-145 point out that there were inconsistencies between Reg. Guide 1.45 and the

TMI-2 Tech Specs. The water inventory balance test is mentioned only once in Reg. Guide 1.45 as a means "of obtaining indications of uncontrolled or undesirable intersystem flow", p. 1.45-2; whereas, Tech Spec 4.4.6.2 calls for the water inventory balance test without restricting it to intersystem leakage. We agree that this definitional inconsistency would have made it more difficult for the operators to obtain test results lower than the 1 gpm LCO, since both pressure boundary leakage and intersystem leakage contributed to the measured values. The fact remains that the reactor water inventory balance surveillance was the only procedure that the operations department used to quantify unidentified leakage.

b. TMI-2 Tech Specs and surveillance procedures did not incorporate Reg. Guide 1.45 latitude to compare values of unidentified leakage obtained by different detection methods, e.g., sump pump. Reg. Guide 1.45 states monitoring sump data is a reliable and sensitive way to measure unidentified leakage (Board Exh. 2, Faegre & Benson Report, Vol. 1 at 29-30), yet the TMI-2 Tech Specs provided no guidance on how to reconcile differences between detection methods (Board Exh. 1-A, Stier Report, Vol. I at 40). Tech Spec bases would seem to indicate a need for comparison to determine "effectiveness" of different methods of detecting leakage. Faegre & Benson Report, Vol. 2 at 18-21.

c. Unidentified leakage was based upon a volume rate of one gallon per minute determined at RCS average temperature of 581°F rather than reactor building temperature (room temperature). When Reg. Guide 1.45 refers to 1 gpm as being measureable in sumps as an industry

experience, it seems clear that room temperature is implied. Use of the 1 gpm number at the reactor temperature meant that effectively the LCO was 0.72 gpm rather than the 1 gpm described in Reg. Guide 1.45. The Tech Specification 4.4.6.2b required that the containment sump inventory and discharge be monitored at least once per 12 hours. An LCO of 1 gpm for the sump surveillances should have corresponded to a LCO of 1.4 gpm for the inventory balance surveillance because of the temperature difference, but the Tech Specs make no mention of this aspect of the leak rate detection systems.

d. While the foregoing differences between the TMI-2 Tech Specs and Reg. Guide 1.45 made it more difficult, as a technical matter, to obtain the required 1 gpm result, we reject the premise put forward by the Numerous Employees (PF 145) that the differences and ambiguities arising when the two documents are read together actually caused confusion among the operators. Reg. Guide 1.45, standing alone, was, of course, not binding on the operators, any more than any other regulatory guide. Furthermore, we disagree with the assertions of GPUN (PF 75) and the Employees (PF 145) that the Tech Specs "incorporated" Reg. Guide 1.45. That suggests that the Reg. Guide in its entirety was binding on the operators, and overstates the case. Although the "Bases" section of Tech Spec 3.4.6.1 does make an explicit reference to the Reg. Guide, that reference, in its context, does not reflect an intention to "incorporate" the entire Reg. Guide into the Tech Specs. Legal analysis to one side, there is no evidence in this record that any of the

operators had ever read Reg. Guide 1.45, let alone been confused by the differences and ambiguities we have discussed.

e. The TMI-2 leak rate test procedure failed to include an "evaporative loss factor" for losses from the RCS. Tr. 1134. Other Babcock & Wilcox power reactors were allowed to include an evaporative loss factor in their leak rate test procedures. For example, TMI-1, Rancho Seco, and Oconee all include evaporative loss factors in their leak rate test procedures. Tr. 1135. The evaporative loss factor for TMI-1 was 0.51 gpm; for Oconee-1, 0.68 gpm; for Oconee-2, 0.73 gpm; and for Oconee-3, 0.52 gpm. Faegre & Benson Report, Vol. 1, p. 19, n.*. Assuming that evaporative losses at TMI-2 were comparable to those at TMI-1, the failure of the TMI-2 leak rate test procedure to include such a factor resulted in the increased estimates of unidentified leakage in the calculation of the TMI-2 unidentified leakage of as much as 0.5 gpm. Id. Mr. Stier concluded that this was a primary problem in the performance of the leak rate test at TMI-2:

> "There were several major causes of the difficulty experienced at TMI-2. First, the TMI-1 leak rate calculation permitted the subtraction of 0.5 gpm from gross leakage to account for 'evaporative losses.' AT TMI-1, this helped offset the variability of test results caused by such factors as instrument error and oscillation within the reactor coolant system. The TMI-2 procedure contained no similar provision, thereby increasing the frequency with which calculated unidentified leakage exceeded 1.0 gpm due to inherent test variability."

Stier Report, Vol. I, p. 21.

41. The Staff witnesses contended that the use of an evaporative loss factor at TMI-2 was inappropriate. Tr. 1138. Staff's position, as

we understand it, is that such a factor is not appropriate because, as plant operations continue, "frequently the amount of evaporative loss would be reduced so that you didn't know what it was." Tr. 1139. That may be true, but the basis of Staff's position might not apply to TMI-2 because it had not yet become a mature plant. Tr. 1121.

42. Staff witness Russell testified with respect to the evaporative loss factor that "it would have been an error to include it, since the maximum reactor coolant pressure boundary flaw size assumed in the safety analysis is that associated with a 1 gpm leak, not a 1 gpm plus an evaporative loss factor." Tr. 1138. In contrast to Mr. Russell's statement, the FSAR stated:

> "Based upon the above analysis the critical parameter would be a crack in the cold leg piping of approximately 9 gpm. In establishing a maximum unidentified leakage, the following criteria are considered:
>
> 1. The magnitude of the leakage should be well below the leakage associated with a crack of critical size.
>
> 2. The magnitude should be well within the capability of the normal makeup system.
>
> 3. The magnitude should be sufficiently large to allow for ease of detection within a reasonable period of time.
>
> 4. Offsite releases should be within 10 CFR 20 limits.
>
> Accordingly, a 1 gpm leak was selected as the maximum allowable unidentified leakage rate. This value is well below the leakage associated with a crack of critical size. It can be detected within a reasonable period of time as discussed previously. . . ."

Exhibit 22, p. 5.2-25; see also Stier Report, Vol. V(B), Tab 12 Regulatory Guide 1.45, pp. 1.45-1 to 1.45-2 (basis for selection of 1

gpm (instead of some higher number less than 9 gpm) as the LCO for unidentified leakage is "industry practice"). We take the view that the 1 gpm LCO is essentially an ALARA number, having no bright-line safety significance -- i.e., it is not the case that 0.9 is "safe" and 1.1 is "unsafe." Be that as it may, the Board finds the TMI-2 operators were faced with a new plant that probably had an evaporative RCS loss of 0.5-0.7 gpm.

43. The Board concludes that the aggregate effect of the errors and idiosyncracies discussed above would have produced erratic and usually inaccurate results in leak rate tests at TMI-2. The experts expressed a similar conclusion. Tr. 450, 1230-37. Indeed, those effects would have been such that should the test have produced an occasional result that happened to correspond with actual unidentified leakage, such a result would have been attributable more to a random confluence of errors than to any residual technical merit in the test -- in the vernacular, a "happy accident." Having viewed erratic tests results over time, the operators skepticism of the test as a source of useful information was fully justified.

B. Managers Who Knew of the Leak Rate Test Difficulties

44. The difficulties with the leak rate test that the operators were experiencing manifested themselves over a long period of time in an inability to run two tests back to back, with no power changes or operator-caused changes, and obtain the same results. The test results

were described as "unpredictable," and "quite erratic." Adams, ff. Tr. 3776 at 3; Cooper, ff. Tr. 2835 at 6; Guthrie, ff. Tr. 4113 at 2; Board Exh. 1-A, Stier Report, Vol. VI(F), Hitz 4/24/84 Interview at 31; Hitz, ff. Tr. 3664 at 4. But see Frederick, ff. Tr. 2447 at 4. All of the CROs, their foremen and shift supervisors knew of these difficulties in some degree, as shown below in our discussion of individuals. In response to the Commission's next question, we discuss in this section the knowledge of management personnel about leak rate test difficulties.

45. James Floyd, Supervisor of Operations, characterized himself as a "crisis fighter." He allowed his shift supervisors to run the plant on a day to day basis and, as long as something had not come to the crisis level, it rarely came to his attention. Tr. 4969 (Floyd). With regard to leak rate testing in particular, Floyd stated that "[a]s soon as this plant would have been shut down for a leak rate test I'm sure I would have been acutely aware of the problem." Tr. 4969 (Floyd). It was his testimony, however, that he has "no recollection of knowing about any of these problems" and that he was "basically . . . ignorant of what was going on here [TMI-2]." Tr. 4976 [Floyd].

46. Despite Floyd's recollection, the weight of the evidence is that Floyd was aware of operator problems with leak rate tests. Floyd had a discussion in early October 1978 with Seelinger concerning the interpretation of the leak rate test procedure and was aware of and involved in many of the events of October 18, 1978. He expected difficulties with erratic leak rates during initial operation of the unit. Floyd, ff. Tr. 4894 at 5-6. Fels believed he discussed leak rate

problems with Floyd; Chwastyk recalled a Floyd briefing on leak rates after the events on October 18; Haverkamp had a very strong recollection of Floyd being present when he spoke to Seelinger on October 18th; Cooper was aware Floyd was getting feedback from shift supervisors concerning leak rate problems; and Guthrie was "sure" Floyd knew the operators had problems with the leak rate. Tr. 4509-10 (Fels); Tr. 3502 (Chwastyk); Tr. 2050 (Haverkamp); Tr. 2903 (Cooper); Board Exh. 6, OI Report, Exh. 30, Guthrie Interview at 17. Also the NRC inspector, Mr. Haverkamp, testified that "Mr. Floyd expressed a lack of confidence in the computer calculated results of the RCS unidentified leakage" in October, 1978. Tr. 2097.

47. Floyd generally portrayed himself as a "hands on" manager who spent a lot of time in the control room working directly with the CROs. For example, on the morning of October 18, a foreman testified that Floyd was in the control room sitting at the leak rate computer console. Tr. 3797. Given Floyd's style of operation, we think it highly probable that Floyd was quite familiar with the difficulties CROs were experiencing with leak rate tests. We reject Floyd's claim that he was basically ignorant of those problems.

48. James Seelinger, Superintendent of Technical Support at TMI-2, while knowledgeable of the fact that getting an acceptable leak rate test was difficult, had little in-depth knowledge of the various factors that were at play in those difficulties. As he revealed in his testimony:

> [Judge Carpenter] With respect to Unit 2 and its

> interpretation, did you sit down with Mr. Floyd and ask yourself the question: What are the parameters that control this test, that are significant in the test? And how much variation do we have in those parameters? And what is the numerical effect of that variation? Did you do an analysis, is what I'm asking you?
>
> A. No, sir, not at that time. And not at any time that I recall that I participated in. Tr. 4749 (Seelinger).

49. Mr. Seelinger first learned of the practice of discarding leak rate tests that were greater than 1 gpm about 2½ weeks before the Haverkamp incident. He found at the same time that the action statement was not being entered if a high leak rate was measured, as long as a "good" leak rate was obtained within 72 hours of obtaining a previous "good" leak rate. At the time, he did not think that either action was permissible. Tr. 4745 (Seelinger).

50. Two incidents which occurred shortly thereafter persuaded Seelinger to change his attitude, at least temporarily. The shift supervisor who had told him about discarding tests informed him that his interpretation of the Tech Specs would result in shutting down TMI-1. Seelinger resolved to meet with the TMI-1 PORC and straighten out the situation, but had to go to an offsite meeting for several days. When he returned, the plant was shut down, and continued to be shut down for the next 7 to 10 days. Other matters occupied his attention, and he did not confer with the TMI-1 PORC before the Haverkamp incident. Tr. 4746-47 (Seelinger).

51. As to the second incident, he and Mr. Floyd conferred about the proper interpretation of the Tech Specs. The result of the discussion was, in Seelinger's words:

> We came out of that conversation with an interpretation that I agreed to for a period of time -- that the leak rate test was to be set aside if it exceeded the criteria on the basis of the fact that the plant was not in steady state operation and would allow the running of another, or another, and we didn't specify the number, of leak rate tests. Tr. 4746 (Seelinger).

This meant, as a practical matter, that any test over 1 gpm would be disregarded (set aside) and tests would continue to be run until a "good" test emerged from the computer.

52. After the Haverkamp incident, the resulting LER indicated that the action statement would be entered after any leak rate test result over 1 gpm was obtained. However, this interpretation was never implemented by the operations personnel, as we have seen. See pp. 81-85, infra.

53. Against this factual backdrop, the Board finds that Mr. Seelinger was guilty of culpable neglect as described in GPUN's Proposed Findings 212-213, which we adopt:

> 212 . . . In early October 1978, the record is clear that James Seelinger learned of the practice of discarding tests. The fact that a shift supervisor subsequently told him that TMI-1 would shut down if Seelinger's interpretation of the Tech Specs were adopted and that Seelinger then intended to raise this issue with the TMI-1 PORC does not excuse Seelinger from the affirmative duty to act and follow through after gaining actual knowledge of a potentially improper practice. Furthermore, the meeting with Floyd at which Seelinger claims they reached a common ground of interpretation does not justify following an interpretation when Seelinger had actual knowledge that adherence to such an interpretation in practice

> meant the repeated running of tests and the discarding of all tests greater than 1 gpm.
>
> 213. . . The Board believes that Seelinger's awareness in early October 1978 of the practice of repeated running and discarding of tests in and of itself is sufficient evidence for the Board to find that Seelinger by dereliction or culpable neglect allowed improper operator actions. Seelinger, however, allowed a bad situation to get worse. He had admitted that he was the source of an instruction to shift supervisors not to leave tests lying around to prevent the NRC from seeing them and becoming aware of an interpretation of the Tech Specs with which he was uncomfortable. Tr. 4756 (Seelinger). Seelinger's concern about the NRC's possibly finding bad tests lying around was realized on October 18 with Haverkamp's arrival in the Control Room; at the same time, the interpretation with which Seelinger was uncomfortable and which led him to advise the shift supervisors to keep bad tests out of sight was replaced by the immediate Action Statement entry interpretation insisted on by Haverkamp. See Tr. 4757-60 (Seelinger). Despite the relatively short duration of Seelinger's concern, the Board does not view his decision to keep information from the NRC as either reasonable or tolerable.

As we have previously indicated the board believes that Mr. Seelinger could have exercised more vigor in following up the corrective action after the Haverkamp incident.[32] We do find that he did what he

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[32] One aspect of Mr. Seelinger's testimony was very puzzling to the Board. Gary Miller, at the time in question both Station Superintendent and TMI-2 Superintendent, testified that he depended on Mr. Seelinger for the day-to-day supervision of TMI-2 operation. Tr. 5050-53 (G. Miller). Mr. Seelinger, however, did not believe that he had any authority outside his own chain of command (which did not include Mr. Floyd and the Operations Department). Tr. 4627-28. It becomes even more puzzling if we examine a relevant portion of the job description of the Unit 2 Superintendent of Technical Support.

> "The overall scope of the responsibility of the Unit

(Footnote Continued)

thought was within his authority. He directed Mr. Marshall to see that the LER was read by all shift personnel and assured himself that Mr. Floyd wrote an Operations Memorandum to be read by all shift personnel which supposedly would explain the new procedures to be used in carrying out leak rate tests, among other things. See p. 84, infra. That the actions taken did not produce the desired results cannot be directly laid at Mr. Seelinger's doorstep. In the Board's view, he had every reason to believe that Mr. Floyd, who did not report to

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(Footnote Continued)
Superintendent Technical Support is to assist the Unit Superintendent in the integrated operation, maintenance and administration of a generating unit at the Three Mile Island facility to ensure that the unit is operated and maintained in a safe, efficient manner and that all applicable regulatory requirements are adhered to. This means that not only does the incumbent act as the Unit Superintendent during the Superintendent's absence, but actually assumes many of the normal duties of the Unit Superintendent with the same kind of authority as the Superintendent when such authority is so delegated and is not in conflict with established management policy as outlined in the Technical Specification." Stier Report, Vol. V(A), Tab 6.

It would be highly speculative of the Board to assert that if Mr. Seelinger had been aware of the responsibility that Mr. Miller thought he had and that his job description reinforces, the situation during the time in question here would have been improved. Nor do we intend to imply that this apparent misunderstanding was totally Mr. Seelinger's fault; it was clearly Mr. Miller's responsibility to adequately inform his subordinates as to what was expected of them. Mr. Miller never made clear to Mr. Seelinger just what his standing was. Tr. 5047-50 (G. Miller). In any event, we do believe that this is an illustration of an overall management situation gone awry.

Mr. Seelinger,[33] would follow up with the Operations Department personnel. We also note that on or about December 1, 1987 Mr. Seelinger was promoted to Unit Superintendent at TMI-1 and was not present at TMI-2 during the time of greatest difficulties in performing the leak rate tests. The Board, in considering the entire record on the adequacy of these corrective actions, finds that Mr. Seelinger's actions, while imperfect, do not constitute culpable neglect.

54. The Board found Mr. Seelinger to be an unusually forthright and candid witness. His admission that he had instructed shift supervisors not to leave tests lying around for the NRC to see was volunteered by Mr. Seelinger and may not have come to light at all but for his admission.

55. George Kunder succeeded Seelinger as the Unit 2 Superintendent of Technical Support in early December, 1978. Although Seelinger was uncertain whether he had informed his successor of the difficulties with the leak rate test (Tr. 7783-84 (Seelinger)), Kunder had some limited knowledge of the difficulties with the tests. He also was aware that some effort was being undertaken to correct the difficulties.

56. Sometime in 1979, Kunder became aware that there was some question whether leak rate test results accurately reflected plant conditions. Kunder believed the question was whether the calculation

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33 He was explicitly informed of this during his job interview with Messrs. Herbein, Miller and Colitz. Prepared Testimony, ff. Tr. 4623, at 3.

used to determine leakage was in error so that erroneously high readings were being obtained. Kunder was also aware that his department was requested to look at the leak rate test procedure or calculation to determine if a problem actually existed, and if so, to resolve it. Kunder, ff. Tr. 4800 at 2-3. Kunder had only limited recall of how he became aware of the difficulties and no recollection of what was accomplished to correct them. Tr. 4811-12, 4834-35, 4840-41 (Kunder). During this time, Kunder worked considerable overtime and had a very heavy work load, "attempting to not only take over the reins of . . . managing the engineering organization but also take care of the collateral duties of PORC chairmanship, beginning some preparations for the refueling outages which [he] was responsible to coordinate the planning for, and . . . in particular, deal with a myriad of issues and problems that existed at the time to attempt to get [himself] up to speed on the details of the Unit 2 systems; that is, to prepare for senior reactor operators license . . . ." Tr. 4803 (Kunder). We believe Kunder's inability to recall details with respect to his awareness of difficulties reflects his actual limited knowledge of these difficulties during the period of operation of TMI-2. We find no excuse for his failure to pursue this ongoing problem, and that such failure constitutes culpable neglect.

57. Joseph Logan, Unit 2 Superintendent, also had some knowledge of the difficulties operators were experiencing. Logan thought the problem was with the computer because the leak rate test results were inconsistent. Although he does not know when he became aware of the

difficulties, Logan does recall having had discussions with shift supervisors, Kunder, and Floyd. Tr. 5117, 5123-24 (Logan). Logan considered negative leak rate test results as an indication that there were computer program errors associated with this test. Tr. 5143, 5145 (Logan). However, Logan felt that the problem was recognized and the work being done led him to believe that a solution to correct the problems would be found. Tr. 5119, 5133 (Logan). Logan does recall that a change was made, but has no recollection if it was effective. Tr. 5134 (Logan).

58. The Board reviewed several leak rate surveillances with Mr. Logan and Mr. Logan was able to recognize the several different kinds of operator errors that caused these tests to be invalid. Tr. 5153-76. The fact that Mr. Logan had been aware that there were problems with the leak rate tests but had never bothered to look at the test results reflects discredit on his discharge of his duties. While his subordinates, Mr. Floyd and Mr. Kunder, should have handled the leak rate test problems, their failure to do so should have led Mr. Logan to investigate the performance of the tests and to instruct them that the problems should be resolved without delay. Mr. Logan's inattention to the leak rate test records, coupled with the other circumstances we have noted, leads us to a finding of culpable neglect by Mr. Logan.

59. Gary Miller, TMI Station Manager and, until December 1978, Unit Superintendent of TMI-2 was aware to a limited extent of the difficulties the operators were experiencing. Miller was routinely exposed to several sources of information containing data that, if

analyzed (such as comparing leak rate test results day after day) might have raised a question in his mind to inquire further. See generally Board Ex. 1-A, Stier Report, (Vol. II(B), G. Miller Summary at 4-11. Miller, however, did not carry out such a comparison: "In short, I simply did not realize that such repetitive results were being recorded." G. Miller, ff. Tr. 5039 at 19. The primary source Miller depended on to raise operational problems was the morning conference call. Miller did not believe that the subject of continuing leak rate surveillance difficulties was ever discussed during these calls nor does he believe that anyone ever advised him about such difficulties on any other occasion. Id. The record supports this statement.

60. The extent of Miller's knowledge concerning the violation of the Tech Specs probably comes from Seelinger's conversation with Miller on October 18, 1978. While Miller has no current recollection of their conversation, he believes it well could have taken place.

61. By Seelinger's account of the conversation, Miller probably became aware that the operators had experienced some difficulty with the leak rate test at that time. Tr. 4723-27 (Seelinger). Miller also was aware that an LER was issued (Tr. 5056 (G. Miller)), but for the reasons previously discussed concerning the accuracy and completeness of the LER (see III ¶¶ 10-17, supra), it is doubtful that the LER expanded Miller's awareness. More likely the LER would have suggested to Miller that there was a one-time problem (not a consistent pattern of procedural abuse) and given Miller confidence that the matter was being resolved. Tr. 5085-86 (G. Miller).

62. Mr. Miller was not aware of any of the questionable practices concerning the leak rate tests performed at TMI-2. As he testified:

> "I did not know that unacceptable leak rate surveillance test results were being discarded. I have testified before that this is something I would have expected to have been brought to my attention. I do not recall, however, that that was ever done. In my view, the discarding of leak rate tests on the scale on which it was apparently done was improper, and I would not have condoned it.

63. Mr. Miller's testimony is uncontroverted in the record. Although we have to some extent questioned his and others management style (See IV ¶ 53, n.32) we find no evidence of any wrongdoing therein. He clearly had no direct responsibility for or knowledge of improper leak rate practices at TMI-2. The Board finds that Mr. Miller exhibited neither dereliction nor culpable neglect in the performance of his duties.

64. John Herbein, Vice President of Generation, had no knowledge of the difficulties. The strongest potential source of information that might have alerted Herbein of the difficulties was the Licensee Event Report 78-62/IT. On November 1, 1978, Herbein signed the transmittal letter sending the LER to the NRC. Herbein, however, has no independent recollections of the LER or surrounding events. Herbein, ff. Tr. 5268 at 10-11. The circumstances surrounding the preparation of the LER and Herbein's signing of the transmittal letter are covered at III ¶¶ 10-14, supra.

65. The LER failed to identify that the sources of the problem were repetitive test results exceeding acceptance criteria, and the Operations Department's lack of confidence in leak rate test results.

The LER also failed to point out that the solution to the problem had been the decision to round off test results. Board Exh. 1-A, Stier Report Vol. I at 143. Given these inaccuracies and inadequacies in the LER, the Board cannot impute knowledge of the difficulties operators were experiencing to Herbein. In fact, to the extent Herbein would have had any question of the existence and subsequent resolution of operators' difficulties, his questions might have disappeared the following January when the NRC notified him that the LER had been selected for onsite follow-up. The notification stated that "the inspector verified that the reporting requirements . . . had been met, that appropriate corrective action has been taken, that the event was reviewed by the licensee as required by Tech Specs, and that continued operation of the facility was conducted in conformance with Tech Spec limits." Board Exh. 20, Haverkamp Testimony, Enclosure to Exhibit E at 10-11.

66. While we conclude that Herbein and Miller are not chargeable with "culpable neglect" on the specific issues before us, neither do we wish to imply any determination that their conduct with respect to the leak rate fiasco was all that it should have been. The record indicates that there was insufficient depth of senior management capability at TMI during much of Unit 2's operation. For many months, the post of Superintendent of Unit 2 was vacant, this at a time when the unit was in its initial "shakedown" phase of operation. No one was ever formally designated as "Acting" Unit Superintendent and the record reflects differences in the minds of Miller and Seelinger as to the scope of the

latter's responsibilities. Seelinger Prep. St. ff. Tr. 4623, at 6; G. Miller Prep. St. ff. Tr. 5039, at 6. In any event, apparently Seelinger was overworked and it is clear that Miller was grossly overworked. Miller testified that he worked an average of eighty hours per week, far more than should have been required of a person in a senior management position potentially affecting public health and safety. Herbein knew (or clearly should have known) that his senior managers were stretched too thin at TMI, and that this might compromise their ability to do their jobs properly. Yet no effective efforts were made to remedy this situation.

C. Corrective Actions for Technical Errors

67. Despite the fact that there were many difficulties associated with the leak rate test, only limited corrective actions for the technical errors were taken to cure the fundamental deficiencies that caused the difficulties. Two such corrections are discussed below. That more corrections were not made or attention paid to the host of deficiencies with the leak rate test was explored by the Board with a number of witnesses. One explanation is that operators felt it was being cured. Chwastyk, ff. Tr. 3407 at 3; Faust, ff. Tr. 2511 at 3; Frederick, ff. Tr. 2447 at 4. Another was that the plant was still new. Adams, ff. Tr. 3776 at 2-3. Virtually no one seemed overly concerned with the problems.

68. An attempt to correct leak rate test problems was prompted when in February 1979, the collection rate of the RCDT began to increase. This high rate of collection had not been experienced before at TMI-2 for any extended period of time. Stier Report, Vol. I at p. 91. The leak rate test calculation failed to convert RCDT collection from room temperature to RCS temperature before it was subtracted from gross leakage. A volume of a given mass of water is 1.4 times greater at reactor coolant temperature than it is at room temperature. Id.

69. Because of this error, the calculated unidentified leak rate was overstated by an amount equal to 40 percent of the RCDT collection rate. Thus, when RCDT collection reached a rate of 2.5 gpm at room temperature, the unidentified leak rate calculated at RCS temperature would be greater than the actual unidentified leakage by 1.0 gpm, even if the actual unidentified leak rate had not changed. This rate of drain tank collection (2.5 gpm) was reached around February 25. Id. at 92.

70. Having recognized that RCDT collection was driving up the unidentified leak rate measurements, on March 16 a procedural change was made to correct the calculation error that was causing RCDT collection to be understated. Thereafter, each test calculation was supposed to be corrected for this error by hand. This change, however, did not produce the desired result. Operators continued to experience difficulty in obtaining satisfactory leak rate test results. The apparent reason is that an inaccuracy in the make-up tank level transmitter continued to cause a 20 to 50 percent exaggeration in the drop in make-up tank level.

Therefore, if RCDT collection were 4.0 gpm, the error in make-up tank level measurement would overstate the calculated unidentified leak rate by 1.1 to 2.8 gpm. Id. at 100.

71. The second, but largely insignificant, attempted cure to leak rate test difficulties occurred in the Fall of 1978. On October 31, 1978, the Instrument and Control Department reported a problem. The instruments for both the wet reference leg and the dry variable leg of the make-up tank were connected to a common set of sensing lines. This arrangement made it impossible to perform maintenance on one instrument without affecting the other. By November 9, 1978, installation was completed of separate sensing lines with a common penetration on the make-up tank. Faegre & Benson Report, Vol. 2 at 65; Stier Report, Vol. V(D) at Tab 53 (Field Questionnaire). There was no apparent overall benefit from this change with respect to the subsequent accuracy of the make-up tank level measurement.

D. Pressure to Obtain Leak Rate Test Results Which Did Not Exceed Technical Specification Limits

72. This Board examined the issue of whether operators felt pressure to obtain leak rate test results that did not exceed the Tech Spec limit.

73. CROs felt pressured by shift supervisors and shift foremen to obtain test results under 1.0 gpm. Shift foremen felt similar pressure from their shift supervisors. The evidence does not indicate that shift

supervisors experienced similar pressure from their superiors. Board Exh. 1-A, Stier Report, Vol. I at 124-25.

74. The pressure felt by the CROs was depicted as a general sense to keep the plant on line (Id., Vol. VI(G), Illjes 2/7/85 Interview at 57-58); being asked questions about the status of the leak rate test (Board Exh. 6, OI Report, Exh. 10, Cooper Interview at 24; Chwastyk, ff. Tr. 3407 at 6); and being told to get a good leak rate (Coleman, ff. Tr. 2579 at 2-3; Tr. 2586 (Coleman); Booher, ff. Tr. 4175 at 3; Stier Report, Vol. VI(B), Congdon 4/10/80 Interview at 2). Despite the fact that some CROs felt pressure, that pressure did not translate into a sense that adverse action would be taken against them if they failed to obtain a good leak rate test result (Booher, ff. Tr. 4175 at 3; Board Exh. 6, OI Report, Exh. 18, Wright Interview at 109-10). Some shift foremen felt pressure to keep the plant on line as much as possible. Board Exh. 1-A, Stier Report, Vol. VI(B), Conaway 2/21/85 Interview at 37-38; Board Exh. 6, OI Report, Exh. 30, Guthrie Interview at 45-46.

V. DISCARDING LEAK RATE TESTS

> Were unacceptable leak rate surveillance test results required by Technical Specification 4.4.6.2.d discarded? If so, who knew of, condoned or directed this practice? Were unacceptable leak rate surveillance test results discarded in an attempt to hide them from the NRC? (CLI-85-18, 22 N.R.C. at 880, Issue (c))

The Board adopts and sets forth below GPUN's proposed findings 180-191, except as changes are indicated by ". . ."'s or by brackets.

"1. The third issue specified by the Commission in this proceeding concerns whether unacceptable leak rate surveillance test results required by Tech Spec 4.4.6.2.d were discarded. If the Board found that records were discarded, it was supposed to determine who condoned or directed this practice and whether there was an attempt to hide unacceptable leak rate surveillance test results from the NRC. CLI-85-18, 22 N.R.C. at 880. In connection with this issue of documentation, we also explored the operators' compliance with related paperwork requirements, including logging and filing of E&Ds."

"2. The administrative procedures applicable to the documentation of leak rate testing are discussed at ¶¶ 81, 91-94, supra. [Summarizing the key requirements, records of "surveillance activities" -- including the results of leak rate tests -- were required by Tech Spec 6.10 to be retained for five years. Furthermore, AP 1010 required that any surveillance test which had an unsatisfactory result -- e.g., a leak rate test showing unidentified leakage in excess of 1 gpm -- had to be

documented on an "Exception and Deficiency List" and filed.] The plant records at TMI-2 show that the only leak rate tests ever "filed" were those showing unidentified leakage under 1 gpm. Board Exh. 1-A, Stier Report, Vol. I at 60; id., Vol. III(A) at Table 1. Stier estimated that at least 50 percent of all the tests performed were discarded because the results showed unidentified leakage exceeding 1 gpm. Id., Vol. I at 60. MPR Associates performed two statistical analyses of recorded tests. Id. First, they determined that the variability of the frequency with which tests were filed was high, indicating that tests were filed at irregular intervals and raising the possibility that significant numbers were discarded. Id. Second, MPR plotted test results as histograms, and from the apparent truncation of the resulting distributions, estimated that about half or more of the expected results would have exceeded 1 gpm but were not filed. Id.; id., Vol. IV(A) at V.2-V.8. Testimony obtained from TMI-2 personnel indicated that as many as two or three leak rate tests may have been discarded for every one that was filed. Id., Vol. I at 61 (citing the Interviews of Smith, 2/8/85 at 70; McGovern, 2/6/85 at 15; Illjes, 2/7/85 at 10-11, 114; Faust, 2/19/85 at 138; Adams 3/8/85 at 81)."

"3. The practice of discarding leak rate test results greater than 1 gpm began at TMI-1 and carried over to TMI-2. Tr. 4325 (Smith); Floyd, ff. Tr. 4894 at 2; Board Exh. 1-A, Stier Report, Vol. I at 58. Every CRO, shift foreman, and shift supervisor who appeared before the

Board, except Frederick,[34] testified that he was either aware of the practice of discarding tests or personally discarded tests. Tr. 2250 (Hartman); Tr. 2544 (Faust); Coleman, ff. Tr. 2579 at 2; Tr. 2673 (Wright); Congdon, ff. Tr. 2709 at 4; Tr. 2795 (Scheimann); Cooper, ff. Tr. 2835 at 4; Tr. 2958 (Zewe); Illjes, ff. Tr. 3010 at 2; Tr. 3110 (Conaway); Tr. 3204 (McGovern); Tr. 3243 (Mell); Kidwell, ff. Tr. 3285 at 3; Tr. 3487 (Chwastyk); A. Miller, ff. Tr. 3608 at 3; Hitz, ff. Tr. at 3; Adams, ff. Tr. 3776 at 2; Mehler, ff. Tr. 3842 at 5; Tr. 4007-08 (Olson); Hemmila, ff. Tr. 4039 at 3; Tr. 4115 (Guthrie); Booher, ff. Tr. 4175 at 2; Hoyt, ff. Tr. 4233 at 3; Tr. 4325 (Smith); Phillippe, ff. Tr. 4432 at 2-3; Bryan, ff. Tr. 4540 at 2."

"4. Descriptions of the practice of discarding tests differed somewhat among the witnesses. Some witnesses testified that CROs or auxiliary operators were dispatched to search for leaks before a test was invalidated and discarded. Tr. 2250 (Hartman); Tr. 3109-10 (Conaway); Booher, ff. Tr. 4175 at 2; Smith, ff. Tr. 4331 at 4. Other witnesses testified that they compared the leak rate test to plant parameters. If they found that the leak rate test results were inconsistent with the plant parameters, they discarded the leak rate test results greater than 1 gpm. Tr. 2817 (Scheimann); Zewe, ff. Tr.

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34 Frederick testified that he gave the leak rate tests to his shift foreman and was unaware that the tests were being discarded. Frederick, ff. Tr. 2447 at 6.

2946 at 3. Some operators testified that results over 1 gpm were given to the shift foreman to discard. Faust, ff. Tr. 2511 at 3; Congdon, ff. Tr. 2709 at 4. Most operators, shift foremen, and shift supervisors testified that leak rate test results above 1 gpm were retained until a leak rate test result below 1 gpm was obtained; and then the tests above 1 gpm were discarded. Coleman, ff. Tr. 2579 at 2;[35] Congdon, ff. Tr. 2709 at 4; Cooper, ff. Tr. 2835 at 4; Illjes, ff. Tr. 3010 at 2; Tr. 3243 (Mell); Kidwell, ff. Tr. 3285 at 3; Tr. 3487 (Chwastyk); A. Miller, ff. Tr. 3608 at 3; Adams, ff. Tr. 3776 at 2."

"5. James Floyd, the Unit 2 Supervisor of Operations, was aware that . . . leak rate tests were being discarded. Floyd, ff. Tr. 4894 at 2. Floyd maintained that he never directed that leak rate tests be discarded, but the practice of discarding tests carried over from TMI-1. Id. Floyd was also of the "opinion that blatantly bad leak rates (for example, excessively negative ones) had no connection with reality; consequently, it was permissible to discard them." Id. at 2-3." [Be that as it may, Floyd was in charge of operations at Unit 2 and he probably knew, or certainly should have known, that many of his

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35 Coleman testified that on one occasion he obtained a leak rate test in excess of 1 gpm, signed the test, put it on his shift foreman's desk, and a short time later, three people came out of the shift supervisor's office and one told him that they did not want to see leak rates that exceeded the Tech Specs. After that incident, Coleman began throwing away leak rate test results over 1 gpm. Coleman, ff. Tr. 2519 at 3.

subordinates were systematically throwing out tests showing unidentified leakage over 1 gpm, without regard to their validity.]

"6. In early October of 1978, James Seelinger, the Unit 2 Superintendent of Technical Support, became aware of the practice of discarding [seemingly][36] valid tests above 1 gpm and running another test. Tr. 4745 (Seelinger). The extent of Seelinger's knowledge of the practice of discarding tests, and the actions he took when he discovered the practice are discussed at [GPUN'S] ¶¶ 103-105, 108-113, supra. In

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36 We say "seemingly" valid because, as we have found (see IV ¶ 44 above) the errors built into the leak rate test made it inherently unreliable. The test at TMI-2 never was "valid" in the sense of consistently giving an accurate measurement of unidentified leakage. On the other hand, the operators did not understand the technical defects in the test and had to deal with the test results as they appeared. Thus, for example, when an operator ran a test showing 1.2 gpm and there was nothing he could point to (such as operator error) to invalidate the test, he was required to go into the action statement.

Stier and MPR attempted to determine through sump pump data times during which actual identified leakage probably did exceed the 1 gpm LCO. See Stier Report, Vol. IV (A). The Numerous Employees dispute the Stier findings, arguing that excessive unidentified leakage only occurred during a brief period in October. PF 225-236. We are making no findings on actual unidentified leakage partly because it would be extremely difficult to do so on the record before us but, more fundamentally, because such findings are not necessary to resolve the issues before us. Even if it were possible now to determine historic unidentified leakage, the fact remains that the employees did not know what it was at the time, except for the erratic data being given them by the leak rate test. They nevertheless continued to run the reactor without any reliable basis for believing that its operation was in continuing conformity with the 1 gpm LCO.

sum, Seelinger testified that after a meeting with Floyd in early October, he (Seelinger) agreed that the Tech Specs required one leak rate test under 1 gpm every 72 hours and entry into the Action Statement only at the end of such a 72-hour period. Tr. 4764-65 (Seelinger). Because Seelinger "did not particularly care for the interpretation" and he "was not particularly crazy on having the NRC involved with that interpretation or finding out about that interpretation," he subsequently advised one or more shift supervisors "that the tests were not to be left out and lying around," where the NRC might find them. Tr. 4756 (Seelinger). After Haverkamp's visit, Seelinger stated that he interpreted the Tech Specs to require immediate Action Statement entry on obtaining a test result greater than 1 gpm. Tr. 4758-59 (Seelinger). Such an interpretation should have ended the practice of discarding tests. Id. Seelinger acknowledged, however, that he never effectively put the word out to the shift supervisors to adopt the new interpretation of the Tech Specs. Id. Therefore, the practice of discarding leak rate tests apparently continued up to the accident at TMI-2."

"7. Operators did not log the starting time of the leak rate test, [as required by AP 1012.] See e.g., Tr. 2496 (Frederick); Congdon, ff. Tr. 2709 at 3; McGovern, ff. Tr. 3148 at 3; Hitz, ff. Tr. 3664 at 5; Tr. 4116 (Guthrie); Bryan, ff. Tr. 4540 at 3. Some operators did log the completion time of leak rate test results below 1 gpm. See, e.g., Chwastyk, ff. Tr. 3407 at 3; Smith, ff. Tr. 4331 at 3."

"8. No E&Ds were ever filed with any of the leak rate test results at TMI-2. Tr. 2268 (Hartman); Board Exh. 1-A, Stier Report, Vol. I at 60. Most witnesses testified that they just did not think about using E&Ds with the leak rate test or had no explanation for why E&Ds were not used with the leak rate test. Tr. 2452 (Frederick); Tr. 2671 (Wright); Congdon, ff. Tr. 2709 at 3; Tr. 2794 (Scheimann); Tr. 2988-89 (Zewe); Tr. 3668-69 (Hitz); Mehler, ff. Tr. 3842 at 4; Tr. 4078 (Hemmila); Tr. 4742 (Seelinger). Some witnesses testified they thought that the E&D procedure may have been inapplicable to the leak rate test because the test was conducted on the computer. Tr. 2911 (Cooper); Tr. 3018 (Illjes); McGovern, ff. Tr. 3148 at 4; Tr. 3524 (Chwastyk); Tr. 4346 (Smith); Bryan, ff. Tr. 4540 at 5. Finally, some witnesses claimed that the E&D procedure did not apply to the leak rate test because the test was a routine surveillance. Tr. 2545 (Faust); Tr. 3018 (Illjes); Floyd, ff. Tr. 4894 at 3."

"9. Based on the evidence in the record, it is clear that TMI-2 personnel uniformly failed to document leak rate testing properly . . . . Leak rate tests were routinely discarded by CROs and shift foremen, [if they registered more than 1 gpm without regard to their validity.] Shift supervisors were aware of this practice . . . Further, James Seelinger, at one point, told TMI-2 personnel not to leave leak rate tests lying around. This instruction may have led at least some TMI-2 personnel to discard leak rate tests so that the NRC would not discover them."

"10. In addition, TMI-2 personnel failed to log the start times of leak rate tests and failed to file E&Ds. Board Exh. 1-A, Stier Report, Vol. I at 60. Floyd failed to enforce the application of the E&D procedure to the leak rate test. Floyd, ff. Tr. 4894 at 3. He claimed that E&Ds were not filed because the leak rate test was run more frequently than required by the Tech Specs. Id." [While true, that factor is irrelevant. The practice of discarding seemingly valid tests only because they showed unidentified leakage in excess of 1 gpm -- engaged in by virtually all the CROs with the knowledge (and some participation) of the shift foremen and supervisors -- was, in the Board's view, much more than a mere administrative default. The individuals knew or should have known that the tests were supposed to have some safety significance. Detection of "unidentified leakage" is a red flag of that. When coupled with the practice, by the same individuals, of keeping all tests that registered unidentified leakage of less than 1 gpm (but for which there was no technical basis for the differentiation) this pattern of conduct borders on falsification of test results.[37] It is no answer to say that the discarding of tests

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37 There are indications in the record that some operators in signing tests they ran, and some foremen signing their approval thought they were merely certifying that the result was less than 1 gpm. See Stier Report, Vol. I, p. 54. That is an impermissibly narrow, indeed, fatuous, view of the significance of these signatures. As to all filed tests, it is clear from the face of the computer-generated test result that the result was less than 1 gpm. No signatures were necessary for that determination. Although the

(Footnote Continued)

"came over from Unit 1." The people involved should have known better and many of them surely did.]

"11. No members of management above Floyd and Seelinger apparently knew that tests were being discarded where unidentified leak rate results exceeded 1 gpm. Floyd was the most senior person who admitted E&Ds were not filed when leak rate tests failed to meet acceptance criteria. See Board Exh. 1-A, Stier Report, Vol. I at 133; Tr. 4745 (Seelinger); Floyd, ff. Tr. 4894 at 3. By their very nature, the practices of discarding tests and failing to follow procedures for documenting test results tended to conceal such conduct. Board Exh. 1-A, Stier Report, Vol. I at 135. Although the CROs and shift foremen openly followed these practices, the evidence does not show that any management officials participated in their activities, and, other than Floyd and Seelinger, observed their conduct."

(Footnote Continued)
significance of these signatures apparently was not spelled out in company directives, we believe that any reasonable operator should have known that, by his signature, he was warranting that he had conducted the test in accordance with prescribed procedures and that, at a minimum, he had no specific bases (as distinguished from general skepticism) to believe that the particular test was not accurate. Similarly, in our view, a foreman by his signature was warranting that the results, at least on their face, appeared to be valid and that he too had no specific bases to believe that the particular test was not accurate.

"12. Both Kunder and Logan testified that they did not know that operators were discarding leak rate tests. Tr. 4839 (Kunder); Tr. 5138 (Logan). G. Miller also had no knowledge operators were discarding leak rate tests. As Station Superintendent, G. Miller had no direct involvement in leak rate testing. Miller testified that he depended primarily on the morning conference call as a means of identifying operational problems. G. Miller, ff. Tr. 5039 at 19. Miller did not believe that the subject of continuing leak rate surveillance difficulties was ever discussed during those calls. Id. It was his belief that surveillance records were retained and collected by the Surveillance Coordinator. Board Exh. 1-A, Stier Report, Vol. II(B), G. Miller Summary at 1. Herbein was informed of the daily status of the plant through subordinates. Herbein, ff. Tr. 5268 at 7. Herbein's subordinates never informed him that CROs or others were discarding or failing to document unsatisfactory leak rate tests. Id. at 13."

VI. INDIVIDUAL RESPONSIBILITY OF CROs, THEIR FOREMEN AND SUPERVISORS AND THE SUPERVISOR OF OPERATIONS FOR LEAK RATE DATA MANIPULATION AND KNOWING CERTIFICATION OF FALSE TESTS AND FOR OTHER VIOLATIONS OF LEAK RATE TEST PROCEDURES

A. Introduction.

1. In this section, we make findings with respect to the individual involvement of each CRO, Shift Foreman and Shift Supervisor in leak rate testing at TMI-2 in 1978-79, in response to the following Commission question:

> Did operators manipulate data or take other actions during leak rate surveillance testing in an attempt to improperly influence test results? Who performed, condoned, directed or was knowledgeable of data manipulation or other improper actions during leak rate surveillance testing?

Our findings cover thirty individuals, twenty-eight of whom appeared as witnesses in the proceeding. We also make further findings concerning the responsibility of the Supervisor of Operations, Mr. Floyd.

2. Our findings on individual responsibility are grouped according to the shift on which each person served. The individual CROs and Shift Foremen (and to some extent, the Shift Supervisors) cannot be viewed realistically in isolation, for several reasons. The performance of a leak rate test was often a "joint enterprise" involving two, and sometimes more, people on a shift. Thus if water were added during a test, that would normally be done by the CRO assigned to the panel, who should then inform the surveillance CRO -- the person who took the

computer readings and signed the test. Alternatively, the surveillance CRO might ask the panel CRO if he had added water during the test. See, e.g., Stier, Vol. IV, interviews with Olson (10/22/84, p. 8); McGovern (2/6/85, p. 96); Coleman (2/5/85, p. 5). Tr. 2843-46 (Cooper). The surveillance CRO would, in turn, present the test to the Shift Foreman for approval. The point is well illustrated by Stier's discussion of water manipulation by Shift D, as follows:

"On January 11, 1979, the first accounted-for water addition during the course of a leak rate test occurred on Coleman's shift. He was the test performer while Olson was the Control Room Operator operating the control room panel. Testimony from numerous members of the Operations Department makes it clear that water was usually added to the system by the Control Room Operator controlling the panel."

"The next water addition appears on February 16, 1979. On that occasion, Olson was performing the test while Coleman was controlling the panel."

"Thereafter, 11 tests containing logged water additions in February and March were performed on as many of Coleman's consecutive assigned shifts. In each case, the water addition was made near the end of the test, suggesting some degree of collaboration between the operator assigned to the panel and the operator performing the test. Coleman and Olson performed all of these tests, sometimes with assistance from Wright. . . .

"This test data makes it clear that it is unlikely Coleman acted alone when making logged water additions during the course of the leak

rate test in an effort to manipulate results. The evidence also makes it clear that Coleman had to be aware of the participation of others during this period, although he insists he does not recall at this time." Stier, Vol. II(A), Coleman Assessment pp. 12-13.

3. Pointing to testimony that the roles of the CROs in leak rate testing varied from time to time and/or that tests were often performed in a perfunctory or sloppy manner, Tr. 3024, 3079, 3306, 3995, the Numerous Employees propose that the Board "cannot conclude that any given leak rate test that may have been falsified or that violated procedures was necessarily the responsibility of any particular CRO or SRO." Employees' Proposed Finding 275. We emphatically reject that conclusion, a conclusion that would render this proceeding largely futile. While the roles of shift member's varied from time to time, it is equally clear that there were routine ways of doing things, and that such routines were generally followed. Such routines provide some basis for an inference that the routine was followed in the particular case.[38]

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38 Apart from the "joint enterprise" aspect that is most relevant here some CROs even testified that they may have signed tests as "operator" when they had not themselves run the test. For example, John Kidwell testified that he might simply have taken a test printout from the computer and signed it if it reflected less than 1 gpm. Tr. 3305-07. Given the cynicism of the operators toward the test, that may sometimes have occurred. However, we think it fair to assume that the person listed as "operator" on the test (1) was primarily responsible for its performance (2) performed the calculations required, and (3) certifies the test as accurate. The individual operators were given an opportunity to deny the attributions of test performance by NRR and MPR. Such denials were not made.

Thus, if there is evidence that a particular water addition was made in order to manipulate a test result, the "joint enterprise" aspect of the test procedure would usually provide some independent evidence that the surveillance CRO, the panel CRO, and perhaps the shift foreman knew about the manipulation.

4. An inference of shared knowledge of manipulation may also be supported by direct testimony of a CRO concerning his shiftmates, or by an apparent pattern of manipulation involving a single shift, based upon expert analysis of test records. In the latter regard, the clear pattern of manipulation by underrecording water additions by all three CROs on Shift D -- discussed in detail below -- constitutes the strongest evidence in the record of manipulation by an entire shift.

5. We stress, however, that merely because we may have found evidence of manipulation of a test by a particular person, we did not automatically impute knowledge of or participation in such manipulation to other members of that shift. Rather, we looked at all the facts and circumstances surrounding that test and other tests run by that shift, including the testimony of the CROs, levels of communication among that shift, and other relevant factors.

6. We use the terms "manipulate" and "falsify" in a similar sense. Both terms connote an intent to deceive and to produce a false result. We generally use the term "manipulate" with reference to data --e.g., by adding water, knowing it will be underrecorded, an operator "manipulates" a test result from one value to another. We generally use the term "falsify" to mean the act of certifying a test as accurate when

the CRO making the certification knows that the test data have been manipulated. We believe that our use of these terms is consistent with the Commission's use of the same terms. We reject the Numerous Employees' argument to the contrary. See PF 394.

7. In general, the operators are directly responsible for their own violations of procedure. The concept of "dereliction" or "culpable neglect" -- the terms used by the Commission -- came into play at the foreman level and above. In some respects, however, the foreman may be personally chargeable with a procedural violation -- e.g., where he was personally involved. In other respects, most notably manipulation, the foreman's responsibility may be based entirely upon culpable neglect. Again speaking generally, the shift supervisors were one step removed from the leak rate test process and were not usually involved in particular tests. Although circumstances vary, the shift supervisors are responsible only on a "culpable neglect" basis.

8. The Commission did not define the words "dereliction" or "culpable neglect," nor is a dictionary definition particularly helpful in the circumstances of this case. We reject the Numerous Employees' suggestion that the words "connote and element of scienter, or knowledge." PF 49. That suggestion would place too high a premium on ignorance and effectively immunize from responsibility supervisors who exhibited a disregard for the conduct of their subordinates. We agree with the following language proposed by GPUN:

> The Board has not applied a standard whereby a managerial position alone carries with it a basis for finding fault in this proceeding. We do not interpret the Commission order as

> requiring a standard of vicarious or imputed responsibility, but rather one of negligence that considers the particular tasks and duties of a position and what the individual knew or reasonably should have known. PF 195.

9. Mr. Hartman had alleged, among other things, that leak rate tests had been manipulated by "taking advantage of discrepancies between the level indication read by the two make-up tank level indicators." Faegre & Benson, Report, Vol. I, p. 48. All of the investigators attempted to document this allegation in the test records. Similarly, there were concerns that operators might have used "feed and bleed" operations as a cover for test manipulation, and this possibility was fully investigated. Although several tests raise questions along these lines, there is no solid evidence in the record that any operator either switched level indicators or used a "feed and bleed" operation to manipulate a test. In view of that conclusion, it is not necessary for us to address the numerous findings proposed to us in those areas concerning particular test records. We may refer to such tests, not as evidence of manipulation, but for other purposes, such as to illustrate sloppy performance.

Shift A

10. Shift A was made up of the Shift Supervisor, William H. Zewe, the Shift Foreman, Frederick J. Scheimann and two CROs, Craig C. Faust and Edward R. Frederick. The record shows that there were no communications problems among its members.

11. The shift had some of the problems common to most of the shifts in that neither of the CROs followed Administrative Procedures 1010 and 1012 (filing exceptions and deficiencies and logging start and stop time of leak rate tests), and neither supervisor required them to do so. Tr. 2460 (Frederick); Faust Prep. Stat. ff. Tr. 2511, p. 4; Tr. 2544 (Faust); Tr. 2794 (Scheimann); Tr. 2988-89 (Zewe).

12. Insofar as manipulating or falsifying leak rate tests or test results is concerned, the NRR and Stier investigators could find no evidence that any such manipulations or falsifications ever occurred. We discuss that subject and that of discarding leak rate tests below.

Craig C. Faust

13. In 1973, Mr. Faust began employment with Met Ed as an AO. He became a CRO at TMI-2 in 1977. He is currently employed in the GPU nuclear training department as an Instructor IV, and he maintains an SRO license. Faust Prep. Stat., p. 1, ff. Tr. 2511. Mr. Faust was assigned to "A" shift during the 1978-79 period.

14. Mr. Faust's shift generally divided its responsibilities by assigning one CRO to operate the plant and maintain the CRO log and the other CRO to perform surveillance tests. Tr. 2559-61. If Mr. Faust were assigned to perform surveillances, he would usually conduct a leak rate test within the first hour of his shift. Tr. 2526. He tried to obtain a leak rate test on a shiftly basis, if plant conditions

permitted. Tr. 2542. He did recall that he performed leak rate tests on the day shift, if the computer was available. Tr. 2543.

15. Mr. Faust regarded the leak rate test as the principal way to satisfy the 1 gpm LCO for unidentified leakage. Tr. 2533. He did not question the accuracy of the leak rate test and he believed that the test had some relationship to actual plant leakage. Tr. 2533-34.

16. If a leak rate test result was under 1 gpm of unidentified leakage, or within a fairly narrow range of negative values, Mr. Faust would sign the test without detailed analysis. Tr. 2534. If Mr. Faust obtained a leak rate test result in excess of 1 gpm, he attempted to determine whether the result was valid. Tr. 2522. If he could invalidate the leak rate test result, he threw it away and started another test. Id. He did not need supervisory approval to discard the test. Faust Prep. Stat., p. 3; Also see Tr. 2959 (Zewe).

17. Mr. Faust discarded leak rate test results regardless of the value for unidentified leakage if he had either conducted the test improperly, added water but inadvertently failed to account for it, or encountered a change in power level. Tr. 2524, 2571. If Mr. Faust could not invalidate a leak rate test result, he discussed it with the shift foreman or placed it on the shift foreman's desk. Tr. 2524-25. At times, he would be ordered to check the test result further for inaccuracies or to search for leakage. Stier Report, Vol. VI(C), Tab F, 2/19/85 Faust Interview, pp. 122-23; Tr. 2524. Mr. Faust presumed that either he or the shift foreman found a reason to invalidate all leak rate test results not meeting the 1 gpm LCO, because excessive leak rate

tests did not cause his shift to enter the Action Statement of Technical Specification 3.4.6.2. Faust Prep. Stat., pp. 3-4.

18. The record contains four negative leak rate tests signed and filed by Mr. Faust. They are NRR Test No. 98 (Stier Test No. 60); NRR Test No. 102 (Stier Test No. 56); NRR Test No. 118 (Stier Test No. 40); and NRR Test No. 149 (Stier Test No. 9). Exhibit 5-b, Attachment 5, Table 11; Stier Report, Vol. III(A), Table 2 (Faust). All of these Tests were within the range of -0.1 gpm to -0.9 gpm. Stier Report, Vol. IV(E) (Test Nos. 56 and 60); Id., Vol. IV(D) (Test No. 40); Id., Vol IV(C) (Test No. 9). In light of Mr. Faust's awareness, in 1978-79, that instrument errors and plant oscillations could result in negative leak rate test results, we find that Mr. Faust acted reasonably in treating such tests as valid. Tr. 2529, 2532 (Faust).

19. Mr. Faust never manipulated or falsified a leak rate test. Tr. 2547. The record is devoid of any allegations that he did so. Tr. 1486-87 (Mr. Russell exonerated Mr. Faust of any involvement in intentional leak rate test manipulation); Stier Report, Vol. II(A), Tab F, Faust Assessment, pp. 9-13.

20. Mr. Faust did not know, during 1978-79, that the addition of water could cause the MUT level strip chart to record a greater addition than the amount of water actually added. Faust Prep. Stat., p. 5. While he heard a rumor that hydrogen added to the MUT could affect the leak rate test, he did not believe the theory and he never added hydrogen to the MUT during a leak rate test to determine its effect. Id., pp. 5-6.

21. Mr. Faust is aware of LER 78-62/IT only through subsequent investigations. Id., p. 6. He would not have changed his interpretation of Technical Specification 3.4.6.2 because of that LER, because he knew during 1978-79 that his shift would have to enter the Action Statement if they could not invalidate a leak rate test result in excess of the 1 gpm LCO. Faust Prep. Stat., p. 7.

22. In summary, we found Mr. Faust to be "a forthcoming and candid witness." Tr. 2577 (Kelley, J.). It is clear from the record that Mr. Faust never attempted to manipulate or falsify a leak rate test.

Edward R. Frederick

23. Mr. Frederick began employment with Met Ed in 1973 as an AO. He obtained his TMI-2 RO license in 1977. He is currently an Instructor V for GPU Nuclear in its training department, and he holds an SRO license. Frederick Prep. Stat., p. 1, ff. Tr. 2447; Ex. 5-B, Attachment 5, Table 1. In 1978-79, Mr. Frederick was assigned to "A" shift in TMI-2 as a CRO.

24. As a licensed operator, Mr. Frederick realized that he had an obligation to ensure that TMI-2 was operated safely. He believed that one part of this obligation was to obtain a leak rate test result depicting unidentified leakage less than 1 gpm once every 72 hours while the plant was in operation. Frederick Prep. Stat., p. 2. He understood that to perform the leak rate test properly, he had to establish the appropriate conditions for the test. Id. While running a leak rate

test, he habitually monitored pressurizer level, MUT level, RCS average temperature, and other plant parameters, so that there was no disruption of steady state conditions. Tr. 2471. Mr. Frederick recalled knowing that the purpose of the leak rate test was to give the operator an indication of a developing leak which might propagate and thereby lead to a more hazardous condition. Tr. 2462.

25. After Mr. Frederick obtained a leak rate test result, he examined the printout for obvious inaccuracies. Tr. 2476. In examining a leak rate test result, Mr. Frederick went beyond merely verifying that the value for unidentified leakage was less than 1 gpm, because he regarded the test as a valid indicator of leakage. Tr. 2478.

26. Mr. Frederick gave all leak test results to his shift foreman (including any depicting negative unidentified leakage), Tr. 2459, although he did hold the belief that negative leak rate test results were attributable to normal instrument errors. Tr. 2458.

27. If Mr. Frederick determined that the leak rate test result was inaccurate, he gave it to the shift foreman, along with an explanation of the inaccuracy. Tr. 2477. He did not recall discarding any leak rate test, Frederick Prep. Stat., p. 9, because he gave all the tests that he completed to the shift foreman, and left the ultimate decision about the validity of the test to him. Tr. 2475. Mr. Frederick presumed that his shift foreman must have discarded leak rate tests that he invalidated. Frederick Prep. Stat., p. 6. Although Mr. Scheimann could not corroborate Mr. Frederick's recollection that he (Frederick) gave Mr. Scheimann all of his completed leak rate tests, Mr. Scheimann

did acknowledge that he reviewed leak rate tests given to him by his shift, and that he (Scheimann) discarded tests he determined to be invalid. Tr. 2785, 2787, 2820 (Scheimann).

28. Mr. Frederick was neither aware of, nor involved in, leak rate test manipulation at TMI-2. Mr. Frederick has testified that he never manipulated leak rate tests in any fashion. Frederick Prep. Stat., pp. 8-10; see also Stier Report, Vol. II(A) Frederick Assessment, p. 1 (insufficient evidence that Mr. Frederick intentionally manipulated leak rate tests through either water or hydrogen additions to the MUT); Exhibit 5-A, Enclosure 7, p. 2 (Mr. Frederick's "testimony regarding his lack of personal involvement in leak rate test manipulation or falsification is consistent with NRR's technical analysis."). He was not aware that leak rate tests could be manipulated through either hydrogen additions to the MUT (Frederick Prep. Stat., p. 7; Stier Report, Vol. VI(D), Tab F, 3/12/85 Frederick Interview, pp. 31-32, 68-69), or "underrecorded" water additions to the MUT (Frederick Prep. Stat., p. 7; Stier Report, Vol. VI(D), Tab F, 3/12/85 Frederick Interview, p. 33).

29. Mr. Frederick tried to avoid water additions to the MUT during a leak rate test. Tr. 2498. If he added water during a leak rate test, he did so only for legitimate operational reasons such as to maintain proper MUT water inventory or RCS boron concentration. Tr. 2497-98.

30. Mr. Frederick took precautions in setting up a leak rate test because he doubted that the test was perfectly accurate. Id., p. 3. We find that Mr. Frederick's diligence did produce a high percentage of

valid results; in fact, of the twelve Shift A tests labeled "questionable" in Exhibit 5-B, Attachment 5, Table 8, only five were signed by Mr. Frederick and none involved manipulation. Exhibit 5-A, Enclosure 7, p. 5; Tr. 1486-87, 1493 (Russell).

31. Mr. Frederick did sign two tests during which the plant might have, arguably, been in nonsteady state condition, but these are disputed; the first by Mr. Frederick, the second by MPR. The first test, NRR Test No. 10, occurred while the shift began a reactor start-up. Exhibit 5-B, Attachment 5, Table 11; Stier Report, Vol. III(A), Table 2 (Frederick). Mr. Frederick disputed the contention that the start-up made conditions unstable. Tr. 2463. He emphasized that the start-up to criticality did not affect temperature or pressure, and that the numbers printed out at the beginning and end of the Test were steady. Id. According to MPR, the second Test, NRR Test No. 108, was also not performed during a period when plant conditions were unstable. Exhibit 1-B (Green Volume), Stier Test No. 50.

32. NRR agreed that Mr. Frederick did not sign any tests involving a hydrogen addition to the MUT; however, NRR alleged that two of the tests signed by Mr. Frederick involved an unrecorded or "underrecorded" water addition to the MUT. Exhibit 5-B, Attachment 5, Tables 7 and 11. As to the unrecorded water addition attributed to him by NRR (NRR Test No. 98), MPR refuted NRR's conclusion that there was a water addition during the test. Exhibit 1-B (Green Volume), Stier Test No. 60. As to the test allegedly involving an underrecorded water addition to the MUT according to NRR, (Exhibit 5-B, Attachment 5, Table 11, NRR Test No.

149), MPR concluded that there was a legitimate reason to add water to the MUT during that test. Stier Report, Vol. III(A), Table 2 (Frederick).

33. Mr. Frederick stated that he was aware, during 1978-79, of the need to enter the Action Statement of Technical Specification 3.4.6.2 if his shift obtained a valid leak rate test with unidentified leakage in excess of 1 gpm. Frederick Prep. Stat., pp. 9-10. Mr. Faust had a similar understanding prior to the accident. Faust Prep. Stat., p. 7, ff. Tr. 2511. However, both Messrs. Frederick and Faust agreed that it was the shift foreman's decision whether to enter the Action Statement. Tr. 2475 (Frederick); Tr. 2524-25, 2556 (Faust).

34. We agree with Mr. Frederick's assessment of his leak rate tests: He had a good record, with a relatively high percentage of valid leak rate tests. Frederick Prep. Stat., p. 10. He obviously tried to perform the leak rate tests with a degree of care, and the arguably invalid tests he performed are remarkably few, given the defects in the test procedure. Accordingly, we agree with Mr. Russell's and Mr. Stier's exoneration of Mr. Frederick of any involvement in the intentional manipulation of leak rate tests at TMI-2. Tr. 1486-87; Stier Report, Vol. II(A), Tab F, Frederick Assessment, p. 1.

Frederick J. Scheimann, Jr.

35. During 1978-79, Mr. Scheimann was the shift foreman assigned to "A" shift. Mr. Scheimann currently is employed as a training

consultant by Mechanical Equipment Consultants, and he is stationed at the Crystal River Nuclear Power Plant. Id., p. 1. He does not maintain a license to operate a nuclear power plant. Exhibit 5-B, Attachment 5, Table 1; Tr. 2790.

36. Mr. Scheimann's view of compliance with Tech Spec 3.4.6.2 was that if one leak rate test meeting the 1 gpm LCO was obtained during a 72 hour period, Mr. Scheimann believed that he did not have to enter the Action Statement of Technical Specification 3.4.6.2, even if another leak rate test result exceeded the 1 gpm LCO during that period. Tr. 2802-03, 2805. However, Mr. Scheimann testified that he responded to leak rate test results depicting unidentified leakage in excess of 1 gpm by checking for operator error or searching for leakage. Tr. 2803.

37. Mr. Scheimann viewed the leak rate test as a tool to aid in the detection of RCS leakage. Tr. 2792-93. He did not recall that the leak rate test had inherent problems, or that satisfactory leak rate test results became increasingly difficult to obtain during February-March 1979. Tr. 2789. Presumably, Mr. Scheimann was not aware of problems with the leak rate test because he did not have to perform it, id., and because his shift encountered fewer difficulties than other shifts in obtaining leak rate test results meeting the 1 gpm LCO. Scheimann Prep. Stat., ff. Tr. 2831, p. 5; Tr. 1493 (Mr. Russell concluded that "shift A did not have the high percentage of invalid or questionable tests that the other shifts had.").

38. Mr. Scheimann directed his shift to perform the leak rate test during every shift if conditions permitted. Scheimann Prep. Stat., pp.

2-3. As a general rule, if the CROs on his shift obtained a leak rate test result over 1 gpm, they gave it to Mr. Scheimann if they could not invalidate it. Tr. 2787. Mr. Scheimann did not dispute Mr. Frederick's assertion that he gave Mr. Scheimann all of his completed leak rate test results. Tr. 2785. Mr. Scheimann also agreed with Mr. Faust's recollection that Mr. Faust invalidated and discarded some leak rate test results on his own. Tr. 2818. Mr. Scheimann was most likely to review test results sometime after they had been performed because he was frequently out of the control room. Tr. 2787-88. He claimed that he never ignored leak rate test results (Tr. 2822), and he discarded only those test results that he deemed invalid. Tr. 2820. As part of his validation process, Mr. Scheimann reviewed MUT level and, on occasion, pressurizer level. Tr. 2788, 2830. Since Shift A never entered the action statement, Mr. Scheimann claimed, in effect, to have "invalidated" every test reflecting leakage in excess of 1 gpm. The Board is somewhat skeptical of this claim because of the erratic results the test produced and the consequent likelihood that some tests could not have been invalidated by the methods Mr. Scheimann described. However, in the absence of other evidence, we accept Mr. Scheimann's description of his actions.

39. It is also clear that Mr. Scheimann himself was unaware, during 1978-79, that leak rate tests could be manipulated by either "jogging" water into the MUT (Scheimann Prep. Stat., p. 4), adding water to the MUT and obtaining a "bonus" effect (Tr. 2809), or adding hydrogen to the MUT (Scheimann Prep. Stat., p. 4).

40. Mr. Scheimann did not receive classroom training on the performance of leak rate tests. Tr. 2799. He learned how to perform the leak rate test on shift as a TMI-2 CRO. Scheimann Prep. Stat., p. 1; Tr. 2799. It is apparent to the Board that Mr. Scheimann's knowledge was no more adequate than the operator's. As a shift foreman, Mr. Scheimann generally did not participate in the training process. Id. If he had been asked to supervise a trainee, Mr. Scheimann would have directed his CROs to assume responsibility for leak rate test instruction. Tr. 2801.

41. Although Mr. Scheimann knew that the existence of a negative rate of leakage was theoretically impossible, Tr. 2798, he did approve negative leak rate test results for filing. Tr. 2789. Mr. Scheimann believed that negative leak rate test results were caused by normal changes in plant parameters, such as slight temperature increases, and as such were not aberrant. See Tr. 2788-89, 2798. However, he did not approve negative leak rate test results in excess of -1.0 gpm of unidentified leakage. Tr. 2798; see Stier Report, Vol. III(A), Table 1 (Stier Test Nos. 9, 40, 56, 60, 75, and 152) (all between 0 and -1 gpm).

42. Mr. Scheimann did not approve any tests involving manipulation through either hydrogen or water additions to the MUT. Tr. 1484-94 (Russell); Tr. 1494-98 (Stier). According to NRR, Mr. Scheimann approved two tests involving "questionable" water additions to the MUT: NRR Test No. 98 (Stier Test No. 60) and NRR Test No. 149 (Stier Test No.

9). Exhibit 5-B, Attachment 5, Tables 9 and 11; Stier Report, Vol. III(A), Table 1.

43. NRR claimed that its Test No. 98 had a possible water addition to the MUT six minutes before the end of the leak rate test. Exhibit 5-B, Attachment 5, Table 11, p. 14. MPR did not agree that water was added during that test because it appeared the trace deflections during the test were similar to others around the time of the test, and the level trace had a uniform overall slope before and after the end of the test. Exhibit 1-B (Green Volume), Stier Test No. 60.

44. NRR Test No. 149 involved an alleged water addition to the MUT nineteen minutes before the end of the leak rate test which caused a 36 gallon differential between the amount of water recorded and the amount shown on the MUT level strip chart; nevertheless, we accept MPR's conclusion that a legitimate operational reason existed for that water addition. Accordingly, we find no basis to agree with NRR's allegations about its test nos. 98 and 149.

45. NRR found that Mr. Scheimann's shift did not add hydrogen to the MUT during leak rate tests (Exhibit 5-A, Table 10) and Mr. Stier agreed. Tr. 1494-98 (Stier).

46. During 1978-79, Mr. Scheimann never realized that he was not complying with Administrative Procedure 1010, the "Exceptions and Deficiencies" Procedure, by not applying that procedure to invalid leak rate tests. Tr. 2794. His noncompliance did not result from management pressure to refrain from applying that procedure, but rather, it

resulted from the fact that no one informed him that the procedure applied to leak rate tests. Tr. 2795.

47. Mr. Scheimann did not require that his operators log the start or the stop time of leak rate tests in accordance with Administrative Procedure 1012. See Frederick Prep. Stat. ff. Tr. 2447, p. 5. Mr. Scheimann was following the consistent practice at TMI in not applying AP 1010 and AP 1012 to leak rate tests. See Floyd Prep. Stat., pp. 2-3, ff. Tr. 4894. The Board does not accept this as an excuse for not following proper procedures.

48. Mr. Scheimann agreed that it was his responsibility to communicate the meaning of an LER to his CROs. Tr. 2812. He was unable to recall whether he analyzed LER 78-62/1T, or instructed his shift about the interpretation of the Technical Specifications that it reported. Tr. 2807. Mr. Scheimann was unsure whether he ever changed his interpretation that only one leak rate test result depicting unidentified leakage of less than 1 gpm was required every 72 hours. Tr. 2804-05.

49. In summary, we find that Mr. Scheimann was an accessible, conscientious shift foreman. Tr. 2557 (Faust). As we have found, the majority of the leak rate tests he approved for filing were valid (Exhibit 5-B, Attachment 5, Table 9); none of the leak rate tests he approved involved manipulation. Tr. 1484-94 (Russell); Tr. 1494-98 (Stier).

50. The investigators were unanimous in concluding that "A" shift did not falsify or manipulate leak rate tests. Tr. 1486-87 (Russell),

1494-98 (Stier); see Stier Report, Vol. II(A), Tab F, Assessments of Messrs. Faust and Frederick. The Board agrees. However, as shift foreman, we find that Mr. Scheimann failed to meet his responsibilities to insure that the performance of leak rate tests by his CROs followed the applicable Tech Specs and administrative procedures. The record shows that Mr. Scheimann did little or nothing to adequately inform his people, and in that regard the Board finds him to be culpably negligent.

William H. Zewe

51. Mr. Zewe began employment with Met Ed in 1972 as an AO. In 1973, he was promoted to shift foreman, and in 1976 he was promoted to shift supervisor. At Unit 2, he supervised "A" shift. Zewe Prep. Stat., p. 1, ff. Tr. 2946. Mr. Zewe is still employed by Met Ed as Manager of Titus Generating Station. Id. He no longer holds a license to operate a nuclear power plant. Exhibit 5-B, Attachment 5, Table 1.

52. Mr. Zewe acknowledged that, as shift supervisor, it was his ultimate responsibility to ensure that unidentified leakage was below the 1 gpm LCO prescribed by the Tech Specs. Tr. 2951. The shift foreman directed actual compliance with leak rate testing practices, however. Zewe Prep. Stat., p. 2. Mr. Zewe could not recall ever performing a leak rate test (Tr. 2949), and he never formally approved a test for filing from September 30, 1978 to March 28, 1979. Exhibit 5-B, Attachment 5, Tables 9 and 11.

53. Mr. Zewe knew that to comply with the Technical Specification requirement that unidentified leakage be kept within the 1 gpm LCO, his shift sought a leak rate test depicting unidentified leakage of less than 1 gpm during a 72-hour period while the plant was in operation. He recalled that his shift tried to perform a leak rate test at least every day and sometimes every shift. Zewe Prep. Stat., p. 2. He, unlike Scheimann, thought that his shift would have entered the Action Statement of Technical Specification 3.4.6.2 in response to a valid leak rate test result over 1 gpm (Id., Tr. 2972-73, 2979), although he does not recall his shift ever doing so. Tr. 2961, 2974.

54. Mr. Zewe testified that his operators were not authorized to discard leak rate tests in excess of the 1 gpm LCO, unless they had made a determination that the test was invalid. Tr. 2958; Zewe Prep. Stat., p. 3. Mr. Zewe expected his operators to make this determination on their own. Id. They did not have to explain their decision to Mr. Zewe or to his shift foreman, Mr. Scheimann. Tr. 2959. Mr. Zewe does not recall ever discarding a leak rate test. Tr. 2995.

55. The record does demonstrate that members of "A" shift were conscientious in evaluating leak rate test results against other plant parameters. Tr. 2817 (Scheimann); Tr. 2524-25, 2533 (Faust); Tr. 2475-78 (Frederick). Indeed, Mr. Zewe recalls that he personally investigated for, and inspected, leaks in the plant on many occasions. Zewe Prep. Stat., pp. 2-3.

56. Mr. Zewe thought that the 1 gpm standard for unidentified leakage was "too conservative", because of Unit 2's oscillation problems

and because of the large volume of water in the RCS. Tr. 2955-56. He recalls believing that it would be merely a matter of time until the oscillations and inaccuracies in the leak rate test procedure were resolved, and the leak rate program and the new plant became compatible. Tr. 2953, 2957.

57. During 1978-79, Mr. Zewe was not aware of leak rate tests being manipulated through any method. Tr. 2691. Specifically, he had no awareness of leak rate test manipulation through the addition of either hydrogen or water to the MUT (Zewe Prep. Stat., p. 6; Stier Report, Vol. VI(K), Tab Z, 3/29/84 Zewe Interview, pp. 43-45). Prior to the TMI-2 accident, Mr. Zewe was not aware of the effect that hydrogen additions to the MUT could have on leak rate test results. Zewe Prep. Stat., p. 6; Stier Report, Vol. VI(K), Tab Z, 3/29/84 Zewe Interview, p. 50.

58. Mr. Zewe could not recall any of the circumstances leading to the issuance of the November 1, 1978 LER concerning leak rate testing, although he does recall that leak rate test results were rounded to whole numbers for a short period of time. Zewe Prep. Stat., pp. 6-7; Tr. 2969-70. He did try to read all documents on the required reading list. Tr. 2969. He understood that it was his responsibility to see that his shift received and understood the information contained in the LER. Tr. 2968. Neither Mr. Faust nor Mr. Frederick recall being given any instruction on the implication of the LER. Faust Prep. Stat., pp. 6-7, ff. Tr. 2511; Frederick Prep. Stat., p. 8, ff. Tr. 2447. Inasmuch as Mr. Zewe had the responsibility to insure that his shift was aware of

the actions which resulted from the LER, but evidently did nothing substantive about it, we must find Mr. Zewe guilty of culpable negligence.

59. The investigators have agreed that Mr. Zewe's shift did not manipulate leak rate tests. Tr. 1486-87 (Mr. Russell stated that "there was insufficient evidence to support a conclusion that they [Messrs. Faust, Frederick, et al.] engaged in intentional leak rate manipulation."); see Stier Report, Vol. II(B), Tab Z, Zewe Assessment, p. 1; Tr. 1494-98 (Stier). Accordingly, we find that there is no evidence that Mr. Zewe was aware of, or involved in, leak rate test falsification or manipulation at TMI-2. We do find, however, that it was Mr. Zewe's responsibility in his capacity as shift supervisor to make sure that all the people on the shift were properly applying the relevant Tech Specs and administrative procedures. This he did not do. We therefore find that Mr. Zewe was guilty of culpable neglect of this part of his duties.

Shift B

60. This shift included CROs Theodore F. Illjes and John M. Kidwell and a trainee, Mr. Charles F. Mell. The shift foreman was William T. Conaway, II, and the shift supervisor was Joseph J. Chwastyk.

61. Shift B misinterpreted the Tech Spec requirements and considered it sufficient to obtain at least one leak rate test below the 1 gpm LCO during a 72 hour period. ff. Tr. 3010, at 2-3 (Illjes), ff.

Tr. 3285, at 1 (Kidwell), ff. Tr. 3239, at 2 (Mell), Tr. 3128-29, (Conaway), ff. Tr. 3407, at 2 (Chwastyk). They regularly discarded tests that showed exceedance of the one gpm limit and regarded the tests as a meaningless administrative requirement, rather than as an accurate measure of leakage. ff. Tr. 3010, at 2 (Illjes), ff. Tr. 3285, at 3 (Kidwell), ff. Tr. 3239, at 2 (Mell), Tr. 3104, (Conaway), ff. Tr. 3407, at 3 (Chwastyk).

62. The shift members had not been given adequate training with respect to the leak rate test and its safety implications. TR. 3019, (Illjes), Tr. 3288-89 (Kidwell), Tr. 3247, 3274 (Mell), Tr. 3105 (Conaway), ff. Tr. 3407 (Chwastyk). The shift did not follow administrative procedures 1010 and 1012 that required the filing of exception and deficiency statements and the logging of start and completion times for surveillances. Tr. 3018 (Illjes), Tr. 3293 (Kidwell), Tr. 3108 (Conaway), ff. Tr. 3407, at 3 (Chwastyk).

Theodore F. Illjes

63. Mr. Illjes began employment with Met Ed in 1971 and became a CRO at TMI-2 in 1976. Mr. Illjes is still employed at TMI-2 by GPU Nuclear as a licensed shift supervisor. Illjes Prep. St., p. 1, ff. Tr. 3010.

64. Mr. Illjes testified that "it would appear, now, that the leak rate test procedures I followed were not always in strict compliance with the requirements imposed on us, in that I usually discarded test

results showing unidentified leakage greater than 1 gpm." Id. at 2. He also admitted that he did not understand the Tech Specs by testifying that "during 1978 and 1979, I thought it sufficient to obtain at least one leak rate test result below one gpm during a 72-hour period." Id. at 2-3. The Board has reviewed the ten tests signed by Mr. Illjes and we find many other kinds of noncompliance with procedural requirements and that 70 percent of his surveillances were not valid.

65. On October 31, 1978, Mr. Illjes carried out and signed a leak rate test in blatant disregard for the procedural requirement that the test only be performed during steady state conditions. This test was carried out with primary plant testing in progress and large changes in pressurizer level (+ 10.5 inches) and MUT Level (-7 inches) occurred. Ex. 5-A, Enc. 9, at p. 3 of Enc. 1.

66. On December 5, 11 and 20, 1978 and January 7, 1979, Mr. Illjes conducted leak rate tests with an unstable and erroneous level sensor connected to the computer. Mr. Illjes testified that "I do not recall a problem with a fluctuating transmitter, . . .". Prep. St., p. 4, ff. Tr. 3010. Mr. Stier noted in his evaluation of Mr. Illjes that:

> There is testimony that the makeup tank level instrumentation problem was well known in the Operations Department. This testimony is corroborated by plant records that demonstrate an awareness of the problem, particularly on the shift to which Illjes was assigned. During the relevant period, Illjes' shift submitted two work requests to repair the level transmitter and filed a Shift Supervisor turnover note indicating that the transmitter was out-of-service. Stier Report, Vol. II(B) at Tab I, p. 7.

67. The Board cannot understand how Mr. Illjes could have been unaware of level transmitter malfunctions. The implication is that he was very inattentive to the control room situation and, thus, incompetent.

68. On February 12, 1979, a leak rate test was conducted while Mr. Illjes was the control panel operator. The MUT strip chart shows that ca. 150 gallons of water were added to the MUT, but Mr. Illjes did not record this addition in his log. While this behavior could reflect deliberate falsification of the test, it may also be a careless mistake by Mr. Illjes. Also the RCDT was pumped down in violation of procedural controls. At any rate, the Board finds this test reflects discredit on his performance as an operator.

69. On February 17, 1979, Mr. Illjes conducted a leak rate test and was also the operator assigned to the control panels. According to the Auxiliary Operator's log, hydrogen was added at 0500. The hydrogen addition was not logged by Mr. Illjes. The strip chart (see Figure 2) shows an upward offset of the MUT level coincident with the hydrogen addition and which biased the unidentified leak rate toward a falsely lower value than would have been otherwise obtained. If there were additional tests implicating Mr. Illjes in hydrogen manipulation, this test might be viewed as "clear and convincing" evidence that Mr. Illjes carried out such manipulation. Since this test may represent inadvertence with the hydrogen added to the MUT for legitimate purposes, we regard this test as inconclusive evidence of manipulation.

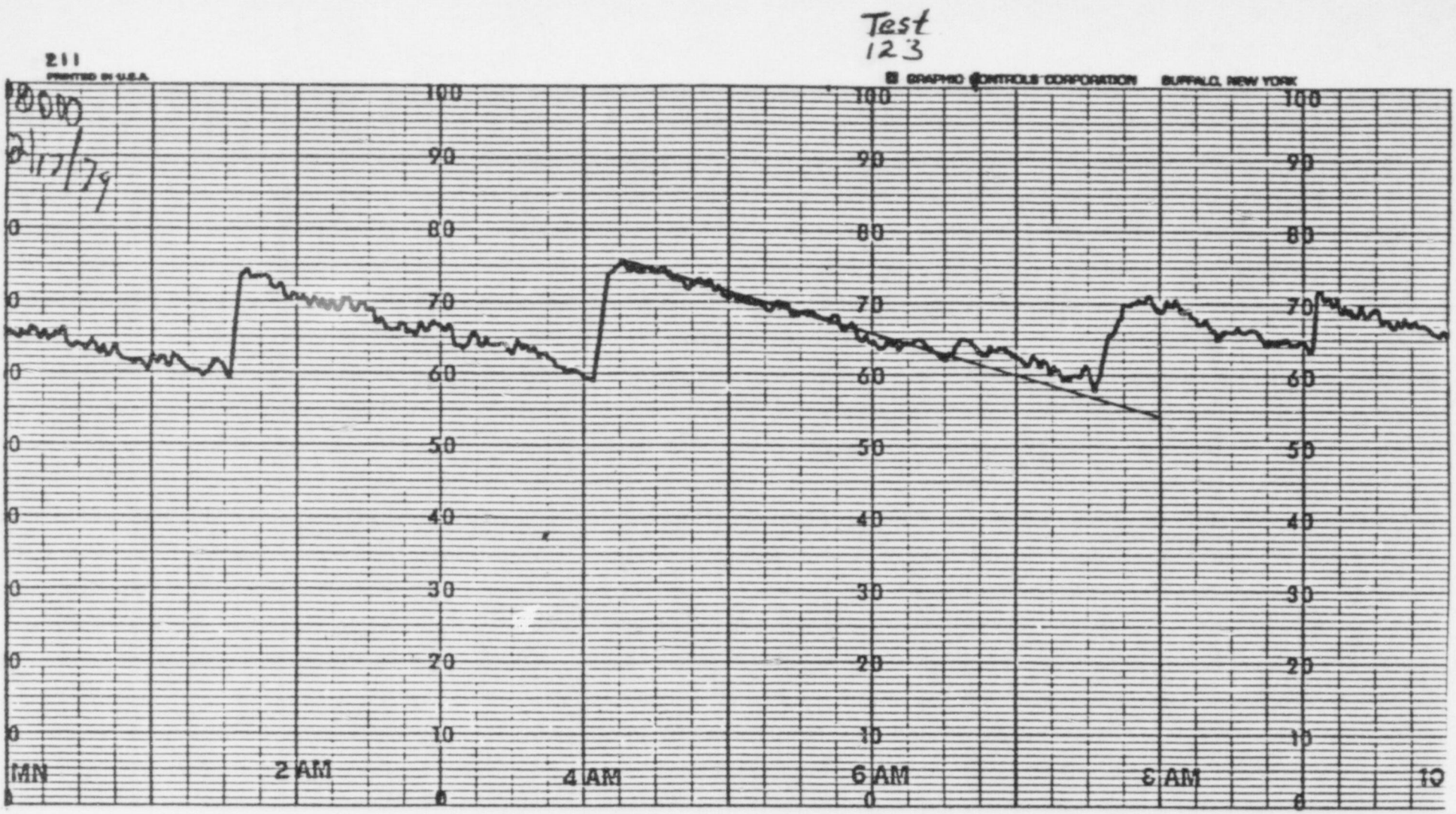

Figure 2. MUT strip chart record on February 17, 1979 showing the upward offset in the level indicator associated with the addition of hydrogen. There was a 1 hour and 30 minute difference between actual time and the preprinted chart time. Thus, the hydrogen addition at 0500 a.m. corresponds to a chart time of 0630 a.m.

70. Two leak rate tests were conducted on February 19, 1979 when Mr. Illjes was the panel operator. (NRR tests 124 and 125). Mr. Kidwell signed as the operator on these surveillances, and both Mr. Stier and NRR have taken the posture that these tests represent manipulation with hydrogen and that Mr. Illjes would have been involved in the postulated hydrogen additions. Stier Report, Vol. II (B), Tab I, at 8 to 13; Ex. 5A, Test Evaluation Worksheets for tests 124 and 125. These tests merit careful scrutiny because of the potential implications concerning Mr. Illjes, and also Mr. Kidwell, with regard to test manipulation by hydrogen additions.

71. The Board finds these tests (NRR 124 and 125) represent ambiguous evidence for the following reasons:

a. There was no logging of any hydrogen addition. The experts' allegations of hydrogen additions during these tests represent speculations: Mr. Stier imputes hydrogen additions and NRR alleges either water or hydrogen. Id.

b. Figure 3 is a copy of the MUT water level strip chart record for part of February 18 and 19, 1979 that includes the time interval when the tests were conducted. As may be seen, this strip chart record displays numerous anomalies before, during and after the times of the tests. We do not see anything distinctive or diagnostic in this strip chart, except that the level sensing system was providing erratic data. The clear upward offset associated with a logged hydrogen addition two days previously (Figure 2) is not apparent and the absence of this

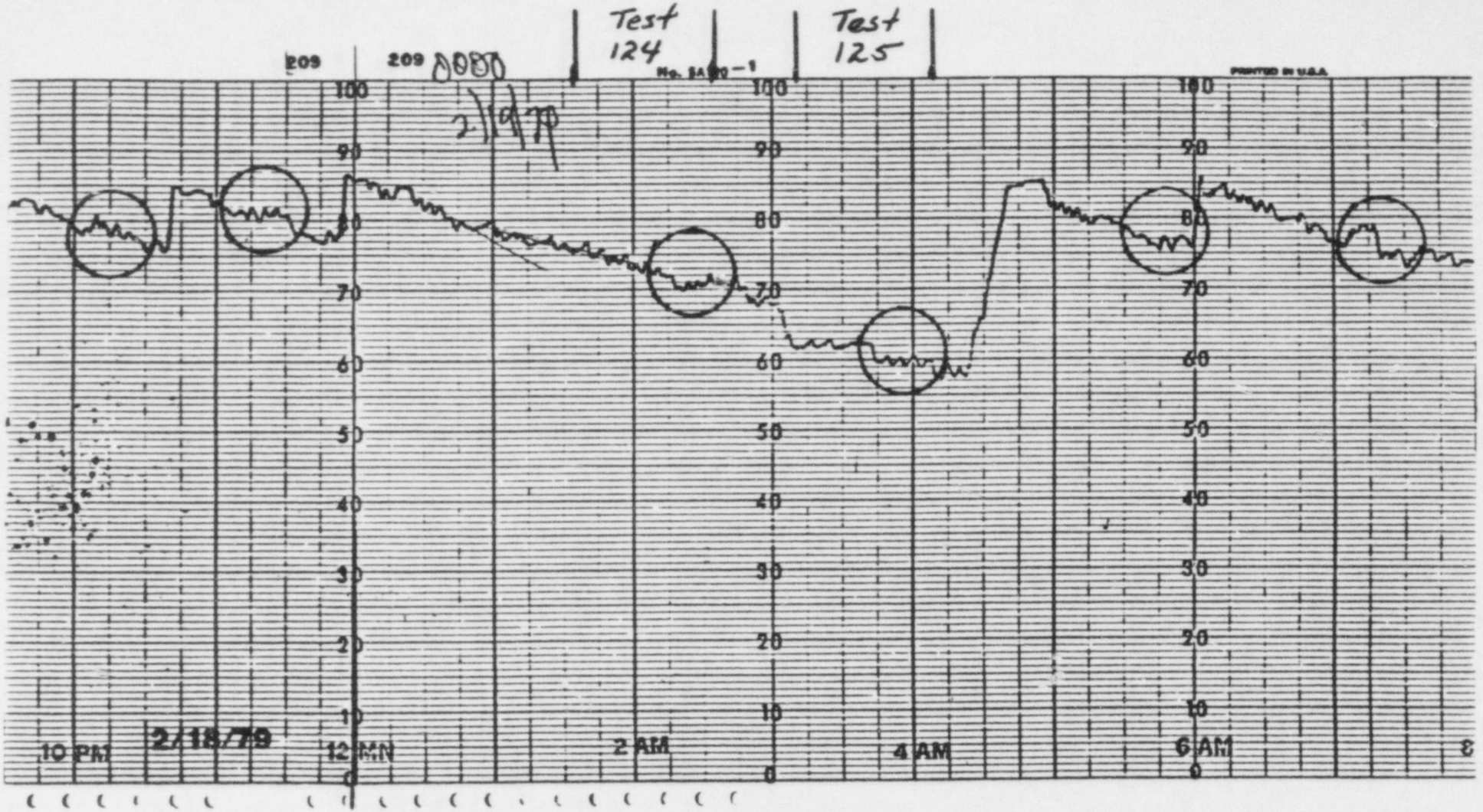

Figure 3. MUT strip chart record for February 18 and 19, 1979 showing anomalous traces before, during and after two leak rate tests. Lack of persistent upward offset suggests hydrogen additions were not made during these tests.

potentially diagnostic pattern precludes a conclusion that these tests reflect manipulation by hydrogen additions.

72. In a September 30, 1986 letter that was served on all parties, Mr. Stier provided copies of strip chart records showing the effects of hydrogen additions at times when leak rate tests do not appear to have been performed. At 1540 and 2235 hours on February 21, 1979, there were logged hydrogen additions and the strip chart record shows clearly, for both of these additions, an upward, persistent offset that closely resembles the pattern of hydrogen effect that is shown in Figure 4 for February 17, 1979. The fact that the strip chart hydrogen response was plainly observable both 2 days before and 2 days after the tests on February 19, 1979, contributes strongly to our view that hydrogen additions did not influence the tests on February 19, 1979 because the expectable effect is not present in the strip chart for that date.

73. Mr. Stier's opinion is that these tests (NRR 124 and 125) represent some experimentation carried out by Mr. Chwastyk, the shift supervisor. Mr. Chwastyk had stated that he had become aware that adding hydrogen could affect the leak rate test and he had observed it. Stier Report, Vol. VI(B), Chwastyk 4/24/84, at 25-27. Mr. Chwastyk stated that he was not sure when he became aware of the problem but he believed that it was some time in the latter half of 1978. Id. NRR has cited this interview and noted that test NRR 69 conducted by Mr. Illjes on December 20, 1978 might have involved a hydrogen addition which would be in a time frame consistent with Mr. Chwastyk's testimony. Ex. 5-A,

Enc. 9 at 11. We find that a hydrogen addition cannot be reliably ascribed to this test.

74. However, Mr. Stier reports a turnover note as indicating this experiment was conducted on February 19, 1979. Mr. Stier quotes the note and expresses his view as follows:

> The Shift Supervisor turnover notes for February 19, 1979, written by Chwastyk, contain the following, "At 60" level in MUT & 5-6 psig H_2 overpressure we get good LR."43/ The clear implication of this is that the experimental hydrogen addition was made during the course of the second leak rate test on February 19, 1979. A review of the makeup tank level strip chart reveals an elevation in the trace close to the 60 inch level at a point corresponding to the running of the test.44/ In light of the foregoing, we have concluded that the offsets in the strip chart for that date were caused by hydrogen additions." Stier Report, Vol. II(B), Tab I, at 11.
>
> 43/ Shift Turnover Notes, February 19, 1979 (Tab 10)
> 44/ Vol. IV (MPR Report), App. K, Test No. 33" Id., at 21.

75. The Board questioned Mr. Chwastyk at length concerning this turnover note and NRR Tests 124 and 125. Tr. 3412-3461. Mr. Chwastyk was unable to determine unequivocally from the test records that these corresponded to the time when he did hydrogen experiments. Tr. 3459. As the Board reads the total turnover note - not just the Stier excerpt - the thrust relates to "Leakage out of RCS looks Like is due to MU-RI (outlet relief from MUT)". The last part of the note reads "may want to break flange downstream of MU-RI to check for leakage." Stier Report, Vol. V(B), Tab 10 at 00325. Mr. Chwastyk appears to be reporting a suspected leak, rather than the results of experimentation with hydrogen - whether or not tests 124 and 125 represent attempts to estimate the magnitude of the suspected leak would be conjecture that cannot be

resolved on this record. Since there is an alternative view to Mr. Stier's opinion that seems quite plausible, we conclude that manipulation with hydrogen in these tests is not established in this record.

76. On March 14, 1979, Mr. Illjes conducted a leak rate test. The test results are blatantly invalid, because Mr. Illjes added a large amount of water during the test and then included the addition in the wrong step in the computer program. This simple mistake is not remarkable. What is remarkable is that Mr. Illjes would run a test that produced a calculated gross leak rate of minus 6.7 gpm and then sign it as a valid work product.

77. NRR evaluation of Mr. Illjes concluded that:

> The weight of available evidence, including statements by his former Shift Supervisor (Mr. Chwastyk) and the technical analysis, strongly suggests that Mr. Illjes was either not truthful in answering questions regarding his role in or knowledge of leak rate test manipulation or he was grossly negligent in performing leak rate tests." Ex. 5-A, Enc. 9. at 6.

78. At the hearing, Mr. Illjes stated that "I did not have the motivation or inclination in 1978 or 1979 to manipulate leak rate tests." Illjes Prep. St. ff. Tr. 3010, at 4. The Board finds the seven invalid tests signed by Mr. Illjes demonstrate a careless and unprofessional performance of his duties. While one test was influenced by a hydrogen addition, we do not see a "clear and convincing" pattern of test manipulations, and, therefore, agree with the NRR view that he was grossly negligent.

John M. Kidwell

79. Mr. Kidwell began employment with Met Ed in 1974 as an auxiliary operator at TMI-1. In 1978, he was promoted to CRO at TMI-2. He left Three Mile Island in 1980. Kidwell Prep. St., ff. Tr. 3285, at 1.

80. From October, 1978 through March, 1979, Mr. Kidwell conducted eight leak rate tests that he signed. Ex. 5-A, Table 11. While an unstable sensor was used in one test and he failed to account for added water in another test, we find no evidence of manipulation or falsification in these tests. In a test on February 14, 1979, hydrogen was added near the end of the leak rate test; but Kidwell came on watch only 5 minutes before the hydrogen was added by the auxiliary operator. It seems improbable that this hydrogen addition represents deliberate manipulation.

81. Mr. Kidwell testified that:

> Prior to Harold Hartman's allegations, I had no knowledge whatsoever of operators deliberately adding hydrogen or water to the makeup tank for the purpose of manipulating the end result of the leak rate calculation. I do not recall receiving instruction in any form that provided me with guidance that I was to refrain from adding hydrogen during leak rate tests. Kidwell Prep. St., ff. Tr. 3285, at 4.

82. The two leak rate tests on February 19, 1979 that we have discussed in detail in our above review of Mr. Illjes were signed by Mr. Kidwell. We do not find reliable evidence that these represent

manipulation by adding hydrogen. We find that this record substantiates Mr. Kidwell's claim that he did not manipulate the tests.

Charles F. Mell

83. Mr. Mell became employed by Met Ed as an auxiliary operator in 1976. He became a CRO trainee in 1978 and received his RO license in the summer of 1979. Mell Prep. St., ff. Tr. 3239, at 1; Tr. 3263.

84. From October, 1978 through February, 1979, Mr. Mell carried out seven leak rate tests that he signed. Only two of the tests are not questionable and the several questionable tests reflect the woefully inadequate training program with respect to this surveillance. Mr. Mell testified that he did not get a feeling that the test was a useful tool and that it would make a contribution to the safe operation of the plant. Tr. 3275.

85. On October 29, 1978 and February 11, 1979, Mr. Mell's surveillances were invalid because water had been added to the MUT and was not included in the computer calculation. These appear to be examples of careless conduct.

86. On October 13, Mr. Mell performed and signed a leak rate test that showed an unidentified leak rate of minus 8.5 gpm, which is a result without any possible physical reality. This test reflects great discredit on the CRO's training of Mr. Mell and the shift foreman for approving such nonsense, but also demonstrates that Mr. Mell did not

take his duties in running this surveillance in a properly serious manner.

87. Mr. Mell carried out two tests using a malfunctioning MUT level sensor. His behavior appears to have been in accord with the general lack of professionalism with which this shift conducted the leak rate tests.

88. Mr. Mell testified that he was unaware that adding "hydrogen could effect the leak rate test or that anyone was deliberately trying to do this." He also testified that he did not remember "the performance of an experiment with hydrogen on his shift. I do not remember Joseph Chwastyk cautioning us not to add hydrogen during a leak rate: in my opinion, if he had noticed a problem with hydrogen, he would have kept it close to his chest until he had so fully checked it out that he could explain it. I recall that I first discussed the hydrogen phenomenon with my crew after the Hartman allegations were made known, and we were all surprised by Hartman's claims." Mell Prep. St., ff. Tr. 3239, at 3 and 4.

89. The Board finds no evidence of manipulation or falsification of leak rate tests by Mr. Mell.

William T. Conaway II

90. In 1973, Mr. Conaway began employment with Met Ed. He was an AO at TMI-1 until he was promoted to CRO at TMI-2 in 1975. In 1978, he

was promoted to shift foreman at TMI-2. He is currently a Radioactive Waste Support Manager at TMI-2, and he no longer holds an NRC license. Conaway Prep. St., ff. Tr. 3097, at 1.

91. Mr. Conaway testified that "we did not have a lot of faith in the leak rate test itself. The Operations Department in general had little confidence in the validity of the leak rate test. A lot of the tests were not valid. For example, we got a lot of high negative leak rates." Conaway Prep. St., ff. Tr. 3097, at 3. Mr. Conaway approved the October 13, 1978 test that showed unidentified leakage of minus 8.5 gpm and the March 14, 1979 test that showed gross leakage of minus 6.7 gpm. The Board finds that Mr. Conaway could have easily ascertained that these tests were due to non-steady state plant operation and a computational error. His failure to do so is a clear case of culpable neglect.

92. The many invalid tests that he approved reflect the perfunctory way in which the tests were reviewed and approved by him. Mr. Conaway testified that:

> We were primarily concerned with the safe operation of Unit 2 in 1978-79. We were not as concerned with the administrative requirement of demonstrating that the plant was operating within the limiting conditions for operation for RCS leakage. We regarded the actual plant safety as more important than the leak rate tests, the pieces of paper, that were often invalid." Conaway Prep. St., ff. Tr. 3097, at 3.

93. Mr. Conaway was guilty of culpable neglect in his attitude toward the test and in allowing the CRO's under his supervision to treat the test in a casual manner.

94. Mr. Conaway testified that the safety implications of the leak rate surveillance had never been explained to him. Tr. 3105. The Board finds his profound lack of knowledge and understanding to be a egregious example of the poor training at TMI-2.

95. With respect to the hydrogen experiment that Mr. Chwastyk carried out, Mr. Conaway testified that " I have no recollection of being involved in that test and I do not recall any discussion by the CRO's of the effect of hydrogen additions on leak rate tests. Nobody ever brought it to my attention as far as I know, with the exception of Marty Cooper, after the accident." Conaway Prep. St., ff. Tr. 3097, at 5-6. While Mr. Chwastyk has testified that he issued a brief oral instruction that hydrogen should not be added during a leak rate test, Tr. 3451, we accept Mr. Conaway's assertion that Mr. Chwastyk's brief statement did not make any impression on him. The Board does not find any evidence that Mr. Conaway was aware of or involved in any manipulation of leak rate tests.

Joseph J. Chwastyk

96. Mr. Chwastyk began employment with Met Ed in 1968. In 1969 he became a CRO at TMI-1. In approximately 1973, he became a shift foreman at TMI-1, and shortly thereafter a Unit 1 shift supervisor. In 1977, he became a dual-licensed shift supervisor for both TMI-1 and TMI-2. Chwastyk Prep. St., ff. Tr. 3407, at 1.

97. If his shift obtained a leak rate test result over 1 gpm, they would run another leak rate test; if the next one was under 1 gpm, they would discard the first one. Id. at 3. At the time, Mr. Chwastyk approved the discarding of leak rate tests because he thought that once a test had been declared invalid, there was no reason to keep it. Tr. 3490. Mr. Chwastyk believed that if the test result was not discarded, and it was later reviewed, it could not be determined at that later time if the test was in fact a valid test or not. Tr. 3490. Mr. Chwastyk now recognizes that recordkeeping practices at TMI-2 were deficient. Tr. 3535-36.

98. Mr. Chwastyk has stated that he was aware in the latter half of 1978 that the addition of hydrogen might have an effect on the leak rate test results. Stier Report, Vol. VI(B), 4/24/84 Chwastyk Interview, at 26. When asked who brought this to his attention, Mr. Chwastyk replied "I believe it was my CROs. And I think I remember, specifically, it was Ted Illjes. Id. at 27. Mr. Chwastyk did not identify Mr. Illjes specifically before this Board when asked if "sitting here today do you have any independent recollection of Illjes or anybody else telling you that?" Tr. 3411. We give little weight to the fact that Mr. Chwastyk was unable to confirm his previous identification of Mr. Illjes. On the other hand, in view of the repeated denials of Mr. Illjes that he had knowledge of the hydrogen addition's effect on the leak rate test and in the absence of any corroboratory evidence, the Board finds this reference to Mr. Illjes

falls short of a "clear and convincing" implication of leak rate test manipulation by Mr. Illjes.

99. As we have described above, Mr. Chwastyk has testified that he gave attention to the rumors that hydrogen additions had an effect on the leak rate test. In his GPU interview, Mr. Chwastyk stated that "it was right after commercial operation had started", which further reinforces our view that February 19, 1979 was not the time when he carried out the experiments. Stier report, Vol. VI(B), Tab C, 4/24/84, at 27. Be that as it may, Mr. Chwastyk testified that, as a result of his observations, he requested the I and C to "go look at it". Id. at 27. However, there is not any evidence in this record that Mr. Chwastyk's verbal request produced any resolution to the leak rate test problem.

100. Mr. Chwastyk does not remember his shift being aware of his experiment, but he does remember later ordering that hydrogen not be added to the MUT during leak rate tests, and recalls that Messrs. Illjes and Conaway were in the room when he gave that directive. Tr. 3451, 3456.

101. Mr. Chwastyk acknowledged that Messrs. Illjes and Conaway might not have recalled his directive to refrain from adding hydrogen to the MUT during leak rate tests, because he did not involve them in the experiment (Tr. 3451-52), and when he gave them the direction to refrain from adding hydrogen during leak rate tests, it was extremely brief and was not followed-up with additional instructions or discussion. Tr. 3537, 3551.

102. Mr. Chwastyk recalled receiving some instruction on the meaning of LER 78-62/1T. Tr. 3502. He was told by the TMI-2 Supervisor of Operations, Mr. Floyd, that he was to enter the "Action Statement" of the Tech Specs if his shift obtained a valid leak rate test result with unidentified leakage greater than 1 gpm. Tr. 3502-04. The LER did not change Mr. Chwastyk's interpretation of the Action Statement requirement. Tr. 3509. Therefore, Mr. Chwastyk did not instruct the operators on his shift on the meaning of the LER, because he assumed they already knew how to interpret the Tech Specs. Id. As the record shows, his assumption that the shift properly understood the Tech Specs was in error and we find Mr. Chwastyk is guilty of culpable neglect because he failed to properly instruct Shift B.

103. We found Mr. Chwastyk to be a candid and knowledgeable witness who made a sincere effort to recall the facts concerning leak rate testing at TMI-2. We found no evidence that he had knowledge of involvement in test manipulations or falsifications. We do find that, in view of the numerous sloppy and invalid tests filed by his shift, his performance in supervising Mr. Conaway reflects culpable neglect.

Shift C

104. Shift C was made up of 2 CROs, Joseph Congdon and Martin Cooper; one CRO-in-training, Mark Phillippe; the Shift Foreman, Charles Adams; and the Shift Supervisor, Brian Mehler. The record shows that

this was a "friendly" shift, with good personal relationships and no communications problems.

105. This shift exhibited many of the problems and practices in leak rate testing observed in other shifts:

-- they misinterpreted the Tech Specs to require only one "good" test, i.e., not over 1 gpm, every 72 hours, regardless of the results of other tests. Cooper Prep. Stat. ff. Tr. 2835, p. 5; Tr. 2718 (Congdon). Phillippe Prep. Stat. ff. Tr. 4432, p. 2; Adams Prep. Stat. ff. Tr. 3776, p. 2; Tr. 3848 (Mehler).

-- tests reflecting excessive leakage were routinely discarded; "good" tests were routinely filed. This was a direct violation of the TMI-2 Tech Specs. Tr. 2715-16, 2780 (Congdon); Cooper Prep. Stat., p. 4; Phillippe Prep. Stat., p. 3; Adams Prep. Stat., p. 2; Mehler Prep. Stat. ff. Tr. 3842, pp. 3-6.

-- the operators did not receive any significant training in leak rate testing. Tr. 2713-14 (Congdon); Tr. 4485 (Phillippe); Tr. 2839-40 (Cooper).

-- the operators did not follow administrative procedures 1010 and 1012 requiring the filing of exception and deficiency statements and the logging of start and stop times for the leak rate tests. Tr. 2911-15 (Cooper); Congdon Prep. Stat., p. 3; Tr. 4439 (Phillippe; Stier Report, Vol. VI(A), Tab A, 3/8/85 Adams Interview, pp. 123-24; Tr. 3870 (Mehler).

106. There are no disputes about the foregoing points. The operators and supervisors either conceded them in their testimony or

they are conclusively demonstrated by the record. Therefore, as to those points, there is no need to freight this opinion with detailed findings about each member of the shift, beyond the foregoing summary.

107. There is evidence of culpable negligence and test manipulation for Shift C. We discuss this evidence in the following findings for each member of the shift.

Mark D. Phillippe

108. Mr. Phillippe appeared at the Board's request; he waived the issuance of a subpoena. Mr. Phillippe is presently employed as a Quality Engineer-Nuclear at Waterford 3. Phillippe Prep. St., p.1, ff. Tr. 4432.

109. Mr. Phillippe began employment at TMI-2 in 1976 as an AO. He commenced training to become a CRO in May 1978 (Tr. 4435) and received his RO license in July 1979. During late 1978 and until March 28, 1979, Mr. Phillippe was assigned to "C" shift as a CRO trainee.

110. Mr. Phillippe testified that if a water addition was made to the MUT during a leak rate test or water was removed from inventory during the test, it was the practice of his shift to invalidate the results and discard them. Phillippe Prep. St., p. 3. He said that he was never aware of anyone on his shift adding water to the MUT during a leak rate test in order to falsify the test result. Id.

111. Mr. Phillippe had a general recollection of being informed that the addition of hydrogen to the MUT during a leak rate test could improve the test result. Tr. 4440-42. He did not recall who informed him of this phenomenon. Id. Questioned specifically about whether he had discussed the effect of hydrogen additions with his co-workers, Messrs. Congdon and Cooper, he denied having done so. Tr. 4443-55. Mr. Phillippe stated that he did not learn about the effect of a hydrogen addition through participation in an experiment conducted on his shift to determine the effect of adding hydrogen to the MUT during a leak rate test. Phillippe Prep. St., p. 3. It appears from the CRO logs and plant daily attendance records that Mr. Phillippe was not on shift following February 11, 1979, and consequently was not present when a hydrogen experiment was performed on his shift on February 15, 1979. Tr. 4445, 4451-53.

112. Mr. Phillippe stated that he never added hydrogen to the MUT during a leak rate test for purposes of falsifying the test result. His testimony is borne out by the fact that the experts found no evidence of hydrogen additions to the MUT during any of the six tests that he submitted. See Ex. 5-B, Attachment 5, Table 11. Mr. Phillippe further stated that he had no knowledge that others on his shift added hydrogen to the MUT during a leak rate test for the purpose of falsifying the result. Tr. 4440.

113. The Board accepts Mr. Phillippe's testimony as candid and truthful, and finds that he was not involved in leak rate test falsification through the addition of hydrogen to the MUT, and that he

was unaware that others on his shift might have been purposely adding hydrogen during leak rate tests.

Joseph R. Congdon

114. Mr. Congdon became employed by Met Ed in 1974 as an AO in Unit 1 after seven years of service in the United States Navy. He obtained his RO license in 1977 and was a CRO in TMI-2 throughout 1978-79. Congdon Prep. St., p. 1, ff. Tr. 2709. Mr. Congdon is a shift foreman at TMI-2, and he maintains an NRC license in that position. Ex. 5-B, Attachment 5, Table 1.

115. The Board finds that the record does not support any claim that Mr. Congdon added water to the system in order to manipulate the results of leak rate tests. He denies that he knew of any water effect, and states that he made every effort not to add water to the makeup tank during a leak rate test. Board. Ex. 1, Stier Report, Congdon Interview 2/13/85, pp. 77-81. Both NRR and Stier agree that no tests by Mr. Congdon involved other than incidental water additions. Tr. 1585 (Russell); Board Ex. 1, Stier Report, Vol. 3, Tables 1 and 2.

116. Although we find no evidence that tests were manipulated by water additions, the record shows a situation concerning the addition of hydrogen to the MUT to affect leak rate test results. At some point during 1978-79, Mr. Congdon became aware that hydrogen additions to the MUT sometimes affected the MUT level indicator. Tr. 2725, Stier Report, Vol. VI(B), Tab C, 2/13/85 Congdon Interview, p. 52. His best

recollection was that he heard about this effect from operators on another shift. Id., p. 53.

117. In order to determine if such an effect existed, Mr. Congdon participated in an experiment during a leak rate test (NRR No. 120) in which the MUT level strip chart was deliberately marked at the time the hydrogen was added. He cannot remember what the effect on the leak rate test result was, but does recollect adding hydrogen to other tests in an effort to enhance the results. Id., p. 56, 57. He went on to testify.:

> Q "You did know at that time that, in fact, the make-up tank would be reflecting an inaccurate level?
>
> A I knew that it could. Not always did the make-up tank level go up when you added hydrogen. Sometimes it did and sometimes it did not. Sometimes it didn't have any change at all. I couldn't really explain that in my own mind why it should have any affect on it due to the type of level transmitters we had. The level transmitter is supposed to compensate for the over pressure, but I did observe that sometimes it did affect the level indicator.
>
> Q And you would file the test if it was a successful test?
>
> A That's correct".

Id., pp. 57, 58.

118. It is clear, from his own admission, that Mr. Congdon was aware of the potential effect of hydrogen additions to the MUT. He also admits that he deliberately added hydrogen during leak tests in order to "enhance" the results. He also admits that, after adding hydrogen, the test would be accepted if the result was under 1 gpm. The Board accepts his admission that he both manipulated and falsified leak rate tests and test results.

119. The Board found Mr. Congdon to be a candid and cooperative witness.

Martin V. Cooper

120. Mr. Cooper became employed by Met Ed at TMI-2 following six years of Naval service and employment with Stone & Webster Corporation as an engineering aide. Cooper Prep. St., p. 1-2, ff. Tr. 2835. His first position at TMI-2 was as an AO; he became a CRO in 1977 and obtained his RO license in 1978. Id., p. 2. In 1980, he obtained an SRO license and became a shift foreman. Subsequently, he became a shift supervisor. He left the employ of Met Ed in 1982. He is now employed by Southern California Edison Company at its San Onofre nuclear facility as a Shift Supervisor. Id., pp.1-2. He is not a party to the proceeding (Id., p. 2) but appeared as a Board witness under subpoena. At the Board's request, Mr. Cooper travelled to Bethesda to testify, although he had expressed a preference for testifying near his home or work. Tr. 2944.

121. Mr. Cooper's duties as a CRO included conducting the actual operation of the plant and performing the switching and tagging operations and necessary surveillance testing. Mr. Cooper recalled having difficulty with the leak rate test, including widely varying results from back-to-back tests despite there being no significant change in plant conditions. Mr. Cooper recalls that several changes were made to the computer program for leak rate testing "to improve the

leak rate calculations." Id., pp. 5-6. However, he continued to believe "that the tests were almost meaningless because we got such inconsistent results." Id., p. 6.

122. Mr. Cooper denied adding water during a leak rate test and not accounting for it, and he also denied adding water to manipulate leak rate tests. Tr. 2921. Mr. Capra testified that "[w]e did not conclude that Mr. Cooper was involved in manipulation of tests through the use of water additions." Tr. 1552. We conclude that Mr. Cooper did not manipulate leak rate tests through water additions.

123. Mr. Cooper recalled that he was aware that the addition of hydrogen during a leak rate test might affect the MUT level, but he denied that he ever added hydrogen to affect leak rate test results. Cooper Prep. St., pp. 6-7. However, in the course of the NRR and OI investigations, Mr. Cooper has also testified as follows:

> "MR. CHRISTOPHER: Your statement is that you personally deny that you ever initiated any action to intentionally manipulate leak rate test results.
>
> THE WITNESS: I told you that I did realize that if I added hydrogen during a leak rate, it could affect it, and it may very well give me the result but it wasn't done with the intent of getting a good result. If I got one, I accepted it.
>
> MR. CHRISTOPHER: But you are saying you did not specifically take the action of adding hydrogen for the purpose of affecting a leak rate test result?
>
> THE WITNESS: Yes.
>
> MR. McBRIDE: The answer --
>
> MR. CHRISTOPHER: It is a little unclear.
>
> MR. McBRIDE: Are you, or are you not saying that you ever added hydrogen to effect a leak rate test result?

Answer it in words rather than yes or no so the transcript will be clear of exactly what you are saying.

THE WITNESS: Okay. As I said, I wouldn't add hydrogen to affect the result of the leak rate, though I was aware that if I did add hydrogen while the leak rate was occurring, it could affect the result and did". Board Ex. 6. OI Report, 9/28/84 Cooper Interview, Ex. 6, pp. 82-83.

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"THE WITNESS: (Cooper): It may be splitting hairs. I think the final line is it wasn't okay, we are doing a leak rate, let's add hydrogen and maybe we'll get a good leak rate out of it. It is more like okay, we've got a leak rate in progress, the hydrogen is low, I've got to add hydrogen, let's see how that affects the result. If the result came out good, we accepted it". Id., p. 49; Also See Tr. 2895.

124. With these somewhat more complete statements, we can come to several conclusions. Mr. Cooper was aware that the addition of hydrogen could sometimes cause a reduction in the leak rate test results. Even though he knew this, when a leak rate test was being run he would add hydrogen if the over pressure indicator was low. If the test turned out to be a "good one", i.e., under 1 gpm, he would accept the results.

125. If Mr. Cooper had not known about the potential effect of adding hydrogen to the MUT, the Board would, in all probability, have found nothing culpable in this actions. Even if he had known about it, but had aborted the leak rate test if hydrogen needed to be added to the MUT, there would be no culpability. He did none of these things. The Board therefore must, and does, find that Mr. Cooper knowingly

manipulated and falsified the results of leak rate tests by the addition of hydrogen to the make-up tank.

Charles Adams

126. Mr. Adams served in the United States Navy for 8-1/2 years; upon his discharge he went to work for Carolina Power & Light Company in Southport, North Carolina. At Carolina Power he was a CRO and obtained his SRO license. He began employment with Met Ed in October 1975 as a shift foreman at TMI-2. Adams Prep. Stat., p. 1, ff. Tr. 3776. He was the only TMI-2 operator to have had prior experience at a nuclear facility other than TMI and the only foreman not to have been a CRO. Stier Report, Vol. VI(A), Tab A, 3/19/85 Adams Interview, p. 50; see Tr. 3656 (A. Miller). During 1978-79, he was assigned to "C" shift under the supervision of Mr. Mehler.

127. Mr. Adams stated that he was not aware, in 1978-79, that a hydrogen addition to the MUT could have an effect on MUT level. He testified that he does not recall any discussion about the hydrogen effect among the CROs or his supervisors. Stier Report, Vol. VI(A), Tab A, 3/19/85 Adams Interview, p. 36.

128. Mr. Adams was shown a copy of the MUT level strip chart for NRR Test No. 120 with the words "Pressurized MUT" written on it. See Ex. 18. He was unable to identify the person who wrote those words. Tr. 3805. He stated that it was possible that he had participated in an experiment involving that test and written those words on the MUT level

strip chart, but he could not recall doing so. Tr. 3808. Mr. Adams further testified that the first time he recalled being shown the MUT level strip chart for NRR Test No. 120 was in 1985, six years after the event, and that he could not recall anything about that test after that length of time. Tr. 3806.

129. Both Mr. Congdon and Mr. Cooper recall that Mr. Adams probably participated in an "experiment" to determine the effect on leak rate test results when hydrogen was added to the MUT.

Q "Do you remember personally participating in the addition of hydrogen during a leak rate test as an experiment? Do you have any personal recollection of your personally being involved in that?

A [Cooper] I don't personally recollect, like this leak rate test 120 or any specific test. But I believe that I did participate in some kind of experiment to see what kind of effect we could get for a hydrogen addition. And I think it happened more than once.

Q All right. In connection with that recollection, do you have any recollection as to who was working with you?

A Specifically, no. I would assume it would be my shiftmates: Joel Congdon, Mark Phillippe, and Chuck Adams." Tr. 2927 (Cooper).

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Q "Having been involved in this test, Mr. Congdon, can you explain those words?

A What I believe occurred is at that time frame I had heard something to the effect that hydrogen did have an effect on makeup tank level indication. I thought it might be good to attempt to pressurize it and note what effect it did have. In the course of doing that, to the best of my recollection, Chuck suggested why don't we mark the chart at that point, so we referenced what time we actually add the hydrogen. And I processed to log it in the book and, to my best recollection,

Chuck made that notation on that chart. I might be wrong on that.

Q The notation that we are looking at right now that says, "pressurized MUT"?

A That's correct, sir." Tr. 2730 (Congdon).

130. In view of Mr. Adams' lack of any recollection of such an event, but his refusal to deny that it happened, coupled with the apparent close working relationship on this shift, the Board believes, and so finds, that Mr. Adams was at least aware that adding hydrogen to the MUT could affect leak rate test results.

131. Both Mr. Congdon and Mr. Cooper gave testimony which indicated that they thought Mr. Adams was probably aware of their hydrogen additions during leak rate tests

Q "Okay. In terms of knowledge, you say Floyd -- speaking generally, at least -- knew about leak rate problems. Are you aware of whether the phenomenon of hydrogen added during a test when you were adding it to keep the band up, that phenomenon, do you know whether that was known to him?

A I don't know that.

Q It was known to Adams, I assume?

A Yes, sir". Tr. 2905 (Cooper)

- -

Q "Did other people on your shift know that from time to time you would do this?

A I think they probably did.

Q And, specifically, who would know?

A Probably Marty Cooper, probably Chuck [Adams]".

Stier Report, Vol. VI(B), Tab C, 2/13/85 Congdon Interview, pp. 58, 59.

132. When Mr. Adams was advised that there was testimony which implied that he was aware that the CROs on his shift were adding hydrogen in order to affect leak rate tests, Mr. Adams testified that this was possible, but that he had no recollection of being aware of it. Stier Report, Vol. VI(A), Tab A, 3/19/85 Adams Interview, pp. 43-44. However, he testified that, if he had been aware, in 1978-79, that a CRO was adding hydrogen to the MUT in an effort to affect leak rate test results, he would not have approved the practice. Id., p. 45.

133. There is no evidence that either Mr. Adams or Shift C was involved in leak rate test manipulations through any method other than hydrogen additions. Stier Report, Vol. II(A), Tab A, Adams Assessment, p. 16; see Tr. 1552, 1585 (Messrs. Congdon and Cooper did not manipulate leak rate test results through water additions).

134. The record shows that Mr. Adams tolerated and participated in the procedural violations cited in VI ¶ 105, above. We find that in his supervisory position as shift foreman, such violations clearly constitute culpable neglect of his duties. Additionally, the Board finds that the high probability that he knew of the potential effect of adding hydrogen to the MUT during a leak rate test and his allowance of this practice by his CROs constitutes culpable neglect.

Brian A. Mehler

135. Mr. Mehler commenced employment with Met Ed in 1967. From 1969 until 1975, he was a CRO at TMI-1. Thereafter, he became a shift foreman at TMI-2, and a dual-licensed shift supervisor in April 1978. Mehler Prep. Stat., p. 1, ff. Tr. 3842. In 1978-79, Mr. Mehler supervised "C" shift in both Units. Tr. 3861.

136. As a shift supervisor, Mr. Mehler generally had little direct involvement in leak rate testing: "it was very unusual for [him] to run a leak rate test [himself]." Mehler Prep. Stat. p. 2; see Tr. 3858. Only when he was advised of a particular problem with a specific leak rate test, would he get involved. He testified that he was unaware of significant problems with the leak rate test procedures and he believed the test was the only tool available to quantify unidentified RCS leakage. Tr. 3852-67. During January-March 1979, Mr. Mehler knew that CROs were having a difficult time obtaining satisfactory leak rate test results; he attributed the problem to unidentified leakage from the pressurizer valves. Tr. 3862-63.

137. Mr. Mehler expected his operators to determine the validity of leak rate test results exceeding 1 gpm of unidentified leakage. Mehler Prep. Stat., p. 3. He testified that the operators did this by running another leak rate test, and by evaluating the leak rate test result against other plant indications. Id. Mr. Mehler was aware of the practice of discarding leak rate tests considered to be invalid. He relied upon the CROs under his supervision to determine the validity of

a given test. Id., pp. 3-6. He believed that his operators would have known to enter the Action Statement if a leak rate test exceeding the 1 gpm LCO appeared valid. Id.; Tr. 3854.

138. At Unit 1, Mr. Mehler had observed that an addition of hydrogen to the MUT produced a slight increase or decrease in the MUT level indication. This negligible change convinced him that adding hydrogen to the MUT would have no significant effect on leak rate test results. Mehler Prep. Stat., p. 7. During 1978-79, he had no knowledge of anyone adding hydrogen or water to the MUT to manipulate a leak rate test. Tr. 3845.

139. Mr. Mehler also was unaware that the MUT level strip chart could depict a water addition greater in volume than that actually added. Mehler Prep. Stat., p. 7. No one on Mr. Mehler's shift manipulated leak rate tests through water additions to the MUT. E.g., Tr. 1485, 1552.

140. Mr. Mehler could not recall whether he was on duty on February 15, 1979, when the words "Pressurized MUT" were written on the MUT level strip chart. Tr. 3898. (Given his dual responsibilities for the two units, and our observation that TMI-2 shift supervisors had little direct involvement in leak rate testing (see Tr. 3844) it is not surprising that Mr. Mehler would be unaware of the notation.) Mr. Mehler testified that the handwriting was not his. Tr. 3899. He could not identify the handwriting as that of his shift foreman, Mr. Adams. Mr. Mehler was not familiar enough with the handwriting of Mr. Congdon,

Mr. Cooper or Mr. Phillippe to say whether the handwriting was theirs. Tr. 3899.

141. Mr. Mehler did not recall LER 78/62 IT, although he thought that he read it because his initials were on the cover sheet. Tr. 3858 (Mehler). The only action he thought was necessary was the placing of the LER in the required reading file. Tr. 3858-59 (Mehler). Neither Mr. Cooper nor Mr. Congdon recall the LER, and do not remember that any instruction from Mr. Mehler on a change in the 72-hour interpretation of the Tech Spec was to be made. It is clear that it was never adequately explained to them, as they continued their previous interpretation of the Tech Spec. Cooper Prep. Stat. ff. Tr. 2835, p. 6; Tr. 2717-18 (Congdon). The Board finds that Mr. Mehler did not adequately carry out his supervisory duties and was therefore guilty of culpable neglect.

142. Mr. Mehler could not recall receiving any specific training on the safety significance of the leak rate test. Tr. 3859-60. He did recall that he had general training on the Technical Specifications and their bases. Tr. 3860. However, most of his knowledge about the leak rate test came from his experience as a CRO in Unit 1. Tr. 3853.

143. Other than NRR Test No. 13, (Stier Test No. 144) the only leak rate test in which Mr. Mehler appears to have been involved is NRR Test No. 68 (Stier Test No. 90). Exhibit 5-B, Attachment 5, Table 9. No investigator has alleged that it was manipulated. Exhibit 5-B, Attachment 1; Stier Report, Vol. IV(F), Test No. 90. Accordingly, we find that Mr. Mehler had virtually no direct involvement with leak rate

testing at TMI-2, and we exonerate Mr. Mehler of any awareness of, or involvement in, leak rate test falsification or manipulation at TMI-2.

144. Mr. Mehler did, however, have knowledge of procedural violations of the Tech specs and administrative procedures in force at TMI-2, as we see in VI ¶ 105, above. He did nothing to correct these practices, which was a clear dereliction of his duties as a shift supervisor. The Board therefore finds Mr. Mehler to be culpably negligent in this matter.

Shift D

145. Three CROs were assigned to Shift D -- Mark Coleman, Dennis Olson and Lynn Wright. The Shift Foreman was Adam Miller and the Shift Supervisor was Gregory Hitz.

146. Shift D's understanding and handling of leak rate tests was typical of other shifts in the following respects:

-- they misinterpreted the Tech Specs to require only one "good" test in 72 hours, regardless of the results of other tests. Tr. 2588 (Coleman); Olson Prepared Statement ff. Tr. 3911, at 2; Wright OI Interview of 3/27/85 at p. 45; Miller Prepared Statement ff. Tr. 3608, p. 2; Tr. 3718-3719 (Hitz).

tests reflecting excessive leakage were routinely discarded. "Good" tests were filed, without regard to their validity. Thus, leak rate tests were regarded as a meaningless

so-called "loop seal" phenomenon, and he denied any intent to falsify the test. Tr. 2862; OI Interview 93, 104.

175. Mr. Wright claimed that his purpose in adding water at the end of leak rate tests "was to bring the make-up tank back up to its original level so as to minimize instrument error." Tr. 2678; OI Interview at 78. Wright claimed he had been concerned at the time that the make up tank level sensor might introduce inaccuracies into the leak rate calculation because of "calibration" problems, and that such problems could be minimized, in his view, by returning the level in the tank to the point it had been at the start of the test. He would then include the amount of water he had added in the computation of the leak rate. In that connection, Wright claimed that there were problems with the batch controller at times, and that when that happened he would derive the amount of the water addition by eyeballing the strip chart. Tr. 2685-87; Wright OI Interview, pp. 74, 103. Wright's claim that he added water to enhance the accuracy of the test is not supported by the record. For the reasons that follow, we reject that claim and find that Wright was manipulating and falsifying leak rate tests in the same manner and for the same reasons as Coleman and Olson.

176. The Board agrees that, in theory, Wright's claimed approach might have enhanced the accuracy of the test, provided he had applied his approach consistently and provided he had used an accurate method to measure water additions. However, the evidence indicates inconsistencies in his approach and raises questions about his water addition computations.

his foreman, and stated that he did not know what became of them. Tr. 4007-08. His testimony in the latter regard is inconsistent with the testimony of his shiftmates, Coleman and Wright. Tr. 2583, 2673. However, the Board gives Olson the benefit of the doubt on this point.

Lynn O. Wright

172. Mr. Wright began employment with Met Ed as an AO at TMI-1. Exhibit 6, OI Report, Exhibit 18, 3/27/85 Wright Interview, p. 4 (hereafter "OI Interview"). In 1975, he began training for his CRO license at TMI-2, and was assigned to "D" shift. Id., at 5. Mr. Wright left TMI-2 in 1984 to open his own business. Id. He no longer holds a license to operate a nuclear power plant. Exhibit 5-B, Attachment 5, Table 1.

173. Mr. Wright recalled that it was always difficult to obtain a leak rate test result meeting the 1 gpm LCO. Tr. 2704. He had little faith in the computer-generated leak rate test. Tr. 2670. He believed management personnel were aware that it was difficult to obtain reliable leak rate test results from the computer. Tr. 2676.

174. Mr. Wright testified that he sometimes added water toward the end of a leak rate test. That much is clear from our earlier discussion of tests in which Wright was involved. See VI 149, above. To repeat, Wright was surveillance CRO in NRR tests 140 and 142 and the panel CRO in NRR tests 129, 133, 139 and 141 -- in each of which water was added in the final minutes of the test. However, he denied knowledge of the

conclude that Mr. Olson's claim that he may have added water to keep the control rods in position is not credible.

169. We note in this connection the letter of February 17, 1987 from Counsel for GPUN to the Board confirming the existence of hourly recordings of rod positions taken by a plant computer, information we were not aware of during the hearing and which, of course, is not in the record. It is possible that information of this type could be useful in determining whether a particular water addition might have been made in order to change boron concentration and move control rods. It is also possible, however, that such hourly data would not be close enough in time to the water addition to shed much light on that issue. In any event, there is nothing to indicate that Stier, Rockwell or the NRC investigators used this data in their test analyses. We do not find it necessary to consider this data in resolving Olson's (or any other operator's) claim that they added water for the purpose of moving control rods. While we appreciate Mr. Blake's bringing this data to our attention, we see no need to call for its addition to the record. None of the parties has done so.

170. According to NRR's analysis, Mr. Olson was not involved in hydrogen additions during leak rate tests. Exhibit 5-13, Attachment 5, Tables 7 and 10.

171. Mr. Olson recalled discarding leak rate tests until the Havercamp incident of October 18, 1979, but that thereafter he did not discard excessive leak rate tests. Olson Prepared Statement ff. Tr. 3911, at 3; Tr. 4007. He recalled giving all leak rate test sheets to

demineralized water tank. Such an addition would not significantly affect rod position. Furthermore, in Olson tests 133, 141 and 146, Olson filled out a "Data Sheet 4" which required him to "identify operation that caused change." In each case, the cause Olson gave was "increase MUT tank level." He gave no indication that the water addition had anything to do with boron concentration or rod position. In two of the three tests -- 133 and 141 -- there was not even an arguable operational justification for adding water before the end of the test to raise the MUT level -- the reason Olson gave for the addition. The MUT level at the time of the addition was well above the prescribed 60 inch minimum. Even in the third test, 146, the MUT level was slightly above the 60 inch level and the water addition could have readily been postponed five minutes until the end of the test to raise the MUT level -- the reason Olson gave for the addition.

168. Finally, while the addition of small quantities of demineralized water, as occurred in several of Olson's tests (122, 131, 139, 141, 142, 146) could alter boron concentration and reactivity levels (Tr. 1210-11) an addition of demineralized water alone was not the usual or most efficient method for altering boron concentrations to the degree that rod positions would be changed. As stated in the NRR Report, "feed and bleed operations were used routinely to increase or decrease the boron concentration in the RCJ." NRR Report, Enclosure 1, p. 7. See also Tr. 1312-16. According to NRR's analysis, only one of the eleven tests which involved manipulation by Shift D (141) also involved a feed and bleed operation. For all of these reasons, we

additions, Tr. 3919, 3928, while the surveillance CRO "ran the test." Tr. 4003. Given the pervasive pattern of manipulation reflected in the record, the suggestion that Olson was an innocent bystander on Shift D is not credible.

165. Mr. Olson was asked about the distinctive pattern whereby Shift D CRO's consistently added water at the end of leak rate tests. Tr. 1368-71. Coleman has testified, it will be recalled, that he believed his manipulation technique only worked when performed at the end of the test. See VI ¶ 155 above. As shown in VI ¶ 149 above, the nine manipulated tests in which Olson participated all involved additions at the end of the test. Olson failed to offer any explanation for this pattern in his tests. Tr. 3971. Olson suggested that he may have added water to change the boron concentration in the reactor coolant system in order to keep the control rods from moving out of the prescribed band. Tr. 3918, 3973, 4018-22. We find this suggestion unpersuasive, for several reasons.

166. First, while it may have been occasionally necessary to change the boron concentration to affect rod position it is not credible to suggest that such a need would have arisen consistently a few minutes before the end of each in a long series of leak rate tests. That asks too much of coincidence.

167. Second, while the records of the individual tests are not conclusive on this claim, several record indications are inconsistent with it. Thus, in Olson's tests 137 and 140, the CRO log indicates that the water was added from reactor coolant bleed tank, not the

explain its addition based on available plant records." Prepared testimony ff. Tr. 3911, p. 5. He further testified that he "never falsified leak rate test results . . . ." Id. The Board does not believe Mr. Olson's denials. For the reasons summarized below, we find that he manipulated test results with underrecorded water additions and certified test results knowing them to be false.

163. As shown in VI ¶ 149, above, of the three CRO's on D Shift, Olson was the most heavily involved in the water manipulations of February 10 to March 13, 1979 tests. Specifically, Olson was involved in three such tests -- as the panel CRO in NRR test nos. 31, 137, 140, 142, and as the surveillance CRO in NRR test nos. 122, 133, 137, 139, 141 and 146. Had he been involved in only one or two of these tests, he might have been able to convince us that his involvement was innocent, that any manipulation was being done by Coleman or Wright without his knowledge. But that claim is simply not credible, in light of his very extensive involvement in highly suspect tests. Indeed, on the basis of test record analysis, Olson's involvement in such manipulation was more extensive than any other CRO at TMI-2.

164. In the proposed findings for Mr. Olson, an attempt is made to persuade us that Mr. Olson did not know what Coleman and Wright were up to in manipulating tests. See Numerous Employees PFs 797-799. This attempt is not persuasive. Of course it is true that communications among CRO's were not perfect, and that normal assignments of responsibilities were not rigid and unvarying. Nevertheless, even according to Olson, the CRO assigned to the panel generally made water

that that change would not be related to any actual change in unidentified leakage from the plant. In that sense, Coleman intended to and did falsify leak rate tests. Indeed, under examination by the Board, Coleman admitted that several tests he had manipulated with water were false. Tr. 2629.

Dennis I. Olson

160. Mr. Olson is not a party to these proceedings; he testified under subpoena. Nevertheless, he filed a prepared statement discussing his involvement in leak rate testing at TMI-2. Olson Prep. St., ff. Tr. 3911.

161. Mr. Olson became employed by Met Ed at TMI as an AO in 1971, after 8 years of Naval service. After approximately five years as an AO, he became a CRO at TMI-2 in 1976. He received his RO license in 1978; during 1979, he was assigned to "D" shift. He left TMI in 1981. At that time, he became employed by Louisiana Power and Light Company at its Waterford III reactor, where he was a control room supervisor with an SRO license. He resigned from Waterford III in 1985. He no longer holds an NRC RO or SRO license. Id., pp. 1-2; Tr. 3914.

162. As discussed above, both the NRR and MPR experts found that a series of leak rate tests conducted by D shift between February 10 and March 13, 1979 were manipulated by underrecorded water additions at the end of the test. See VI ¶ 149, above. With reference to these tests, Olson testified that he could "no longer recall why water was added, or

which (so Coleman thought) had to be done at the end of the test. Coleman's testimony before us on this point was very evasive. Tr. 2601-04, 2607-12. While repeatedly failing to provide straight answers to the Board's questions, Mr. Coleman attempted to suggest that manipulation might have been accomplished by a CRO acting alone, a proposition that was not in question. Coleman finally agreed with a prior statement by shift-mate Olson that "the person assigned to the control panel was generally responsible for adding water, although this could be done by other operators." Tr. 2615.

158. Coleman did not flatly deny discussing test manipulation with other operators or his supervisors. He denied recollection of such discussions, except for one incident in which Olson allegedly walked away from a manipulation discussion Coleman had begun. Tr. 2604-07. Coleman's denial in that regard are not credible. Given the circumstances described above, the Board finds that Coleman did discuss and collaborate in manipulations with Olson and Wright.

159. In his prepared testimony, Mr. Coleman stated that at the time he was making hydrogen and water additions during leak rate tests, "I never thought I was falsifying leak rate tests." Coleman Prepared Statement at 3. Of course, Mr. Coleman's recollection of his subjective beliefs at the time, even if we were to credit it, would not be controlling on the issue of falsification. Mr. Coleman is responsible for the natural and foreseeable consequences of his own acts and he must be deemed to have intended those consequences. He intentionally added hydrogen and water for the purpose of changing a test result, knowing

146. As to NRR test 138, Coleman both ran the panel and signed the test, manipulating and falsifying it by himself.

156. While Coleman appears to have been candid with prior investigators and the Board about his own manipulations, the Board did not believe that he was candid before us with respect to his knowledge of his shiftmates involvement in manipulations, and their common knowledge and cooperation with one another in test manipulations. To begin with, the CRO's on all the shifts were facing a common problem -- how to get an erratic, seemingly arbitrary test procedure to produce a result under 1 gpm. We would think it perfectly natural for three people, working closely together over time, to share any helpful technique one of them might discover. This is particularly true if we are to believe Coleman's claim that he did not, at the time, think that he was doing anything wrong, that he just "took advantage of a glitch in the system." Tr. 2588.

157. More importantly, given the normal division of responsibilities among CRO's on a shift, we find that there was collaboration between the panel CRO and surveillance CRO on most if not all of the tests in which we have found manipulation by Shift D. As the Stier Report points out, "Testimony from numerous members of the Operations Department makes it clear that water was usually added to the system by the Control Room Operator controlling the panel." Stier, Vol., II(A), Coleman, p. 12. Yet the surveillance CRO was in overall charge of the test. Presumably, he would have to tell the panel CRO when to add water in order to take advantage of the "loop seal" effect

> another shift, I believe it was Harold Hartman, told me about it. I experimented myself and determined that sometimes if you added hydrogen, usually toward the end of the test, it could affect the makeup tank level indicator. Coleman Prepared Testimony ff. Tr. 2579, pp. 3-4.

The analyses by NRR and MPR of retained tests include no clear examples of hydrogen manipulation involving Coleman. (The references in Stier to MPR tests 39 and 122 are inaccurate because those tests did not involve Coleman. Stier Report, Vol. I, Coleman, pp. 9-10.) On the other hand, as his prepared testimony indicates, some of Coleman's attempts to manipulate with hydrogen would have been unsuccessful and the tests would have been thrown away. We find that Coleman at least attempted to manipulate leak rate tests with hydrogen, whether or not he was successful.

155. Mr. Coleman also admitted adding water to the makeup tank to manipulate leak rate tests, testifying as follows:

> I became aware that the water additions sometimes had the same effect on the level transmitter as did hydrogen additions. If water were added toward the end of a test, for a short period of time the level indicator would reflect a higher level in the makeup tank. Id. at 4.

With reference to specific tests, the Board finds that Coleman participated in manipulation of NRR leak rate test nos. 129 and 131 as the surveillance CRO and that he falsified those same tests when he signed and thereby certified them as accurate, knowing that the data had been manipulated. We further find that Coleman was the CRO assigned to the panel and that he participated in manipulating NRR test nos. 122 and

Mark S. Coleman

152. Mr. Coleman began his employment with Met Ed as an AO at TMI-1 in January 1974. In 1976, he became a CRO at TMI-2, and subsequently received his RO license. Coleman Prep. St., p. 1, ff. Tr. 2579. Mr. Coleman was a CRO in TMI-2 until the date of the accident. Stier Report, Vol. VI(B), Tab C, 2/5/85 Coleman Interview, pp. 3-4. During part of 1978 and through the 1979 accident, Mr. Coleman was assigned to "D" shift, under the supervision of Gregory Hitz and Adam Miller. The other CROs assigned to the shift were Messrs. Olson and Wright. Coleman Prep. St., p. 1.

153. Shortly after Mr. Coleman began performing leak rate tests at TMI-2, he signed and turned in a test result showing unidentified leakage of over 1 gpm. He was then told by a supervisor (whose identity he could not recall and whom we could not identify) that they did not want to see tests that exceeded the 1 gpm LCO for unidentified leakage. That incident prompted Mr. Coleman to discard leak rate test results exceeding the 1 gpm LCO. Coleman Prep. St., pp. 2-3; Tr. 2583-84. Mr. Coleman felt that he was under a lot of pressure to obtain a leak rate test result meeting the 1 gpm LCO when the 72-hour period since the last satisfactory leak rate test was about to expire. Tr. 2589-91.

154. Mr. Coleman admitted adding hydrogen to the makeup tank to manipulate leak rate tests, testifying as follows:

> When I was first interviewed by the NRC in April 1980, I informed the investigators that on some occasions I added hydrogen to the makeup tank during the performance of a leak rate test in order to get a good result. I first found out about this phenomenon when a control room operator from

The record indicates that normal levels of communication existed between these three CRO's. (Compare the conflicts among CRO's on Shift E, as described below.) Therefore, there is no reason to believe that information about manipulation would not have been shared by all three CRO's. While we would not expect the CRO's to recall details of such discussions, we find not credible their professed inability to remember anything about the knowledge of their fellow CRO's, particularly in light of the very striking pattern of their joint involvement in manipulation that emerges from the records analysis.

151. We note, in conclusion, other circumstances indicating common knowledge of manipulation by every member of Shift D, including Adam Miller, the Shift Foreman, and possibly including Gregory Hitz, the Shift Superintendent. As previously discussed, it was increasingly difficult to get a "good" leak rate during February and March 1979 because of increasing leakage from the pressurizer and code safety values. See IV ¶ 13, above. During the period between 2:30 a.m. on March 3 and 3:20 a.m. on March 9, 1979, Shift D was the only shift that was able to produce "good" leak rates at TMI-2. Shift D produced six consecutive "good" leak rate tests in that period, each of which was manipulated by an underrecorded water addition. Miller approved four of these tests (138-141) and Hitz approved two (137, 142). Under the circumstances, we think it unlikely that Shift D's unique ability to produce "good tests" can be attributed to coincidence or that that ability would have gone unnoticed by Miller and Hitz and perhaps other supervisory personnel.

146	Surveillance: Panel:	Olson Coleman	5	Miller

The additions of water in the last five minutes of most of these tests -- additions that were to be avoided "if at all possible" -- provide a distinctive signature of manipulation.[39] Although NRR and MPR differed in their technical analyses of some tests, there were no disagreements between them of these particular tests.

150. As to the roles of the three CRO's in these tests, the foregoing table shows:

CRO	Surveillance CRO	Panel CRO
Coleman	Tests 129, 131, 138	122, 138, 146
Wright	tests 140, 142	129, 133, 139, 141
Olson	tests 122, 133, 137, 139, 141, 146	131, 137, 140, 142

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39 There were frequent discrepancies in the times shown on leak rate test results and the times reflected on the leak rate strip charts. Thus it was necessary to adjust the chart times by reference to timed entries in the log books, in order to determine whether a particular evolution (such as a water addition) occurred during a leak rate test. It was not always possible to reconstruct the timing of evolutions and tests precisely and, in a few cases, one probably cannot say for certain whether a particular evaluation occurred during a test. In general, however, it was possible to reconstruct the time of evaluations and tests. There was good agreement between the times reconstructed by NRR and MPR. Tr. 1298-1299. None of the tests cited by the Employees as involving questionable timing (Employees' PF 286) is important to our findings. Finally, there was no dispute about the timing of the water additions in the series of tests under discussion here. Nor, except by Olson, could there be, since Coleman and Wright admitted adding water at the end of the tests.

underrecorded water additions to a far greater extent than any other CRO's. Furthermore, for an extended period of time -- February 10 to March 13, 1979 -- Shift D was the only shift involved in underrecorded water additions. There were eleven such tests during that period and each of Shift D's three CRO's -- Coleman, Olson and Wright -- had some role in several of these tests, as shown by the following table:

NRR Test No.		CRO	Water Added Minutes Before End of Test	Approved By
122	Surveillance: Panel:	Olson Coleman	13	Miller
129	Surveillance: Panel:	Coleman Wright	4	Miller
131	Surveillance: Panel:	Coleman Olson	17	Miller
133	Surveillance: Panel:	Olson Wright	4	Miller
137	Surveillance: Panel:	Olson Olson	3	Hitz
138	Surveillance: Panel:	Coleman Coleman	2	Miller
139	Surveillance: Panel	Olson Wright	10	Miller
140	Surveillance: Panel:	Wright Olson	1	Miller
141	Surveillance: Panel:	Olson Wright	3	Miller
142	Surveillance: Panel:	Wright Olson	3	Hitz

results by making water additions toward the end of leak rate tests for the purpose of influencing test results. Coleman admitted the practice. Wright admitted adding water during tests but claimed -- falsely, the Board finds -- that he did so to make the tests more accurate. The Board did not believe Olson's denials of manipulations through water additions.

148. Striking proof of these manipulations is provided by the NRR analyses of a series of tests performed by Shift D. According to NRR, all of these tests were manipulated by adding water toward the end of the test, with the knowledge that the level sensor in the make-up tank (MUT) would sometimes inaccurately register the addition of more water than was actually added. See IV ¶ 26, above, for more detailed discussion of the so-called "loop seal" effect. For example, if 200 gallons were added to the MUT by the batch controller and included in the leak rate test computation by the surveillance CRO, the level sensor might "tell" the computer that the MUT level had risen 260 gallons as a result of the 200 gallon addition. The extra 60 gallons, on a 1-hour test run, would decrease the unidentified leak rate by 1 gpm. Coleman testified that he knew about this "loop seal" effect and took advantage of it to manipulate data and falsify leak rate tests.

149. The repeated pattern evident from test analyses and involving not only Coleman, but Olson and Wright as well, virtually compels the conclusion that all three were involved in this method of manipulation. These patterns are clearly shown in NRR Tables 7 and 10. Thus, NRR Table 7 reflects that the CRO's on Shift D were involved in

administrative requirement, not as a real measure of leakage. Tr. 2589, 2592, 2637 (Coleman); NRR Table 5 (Olson); Tr. 2704 (Wright); Miller Prepared Statement supra, p. 3, 3611, 3615 (Miller); Tr. 3720, 3677-78 (Hitz).

-- the operators did not receive any significant training in leak rate testing. Tr. 2582 (Coleman); Tr. 4009 (Olson): Tr. 2672 (Wright); Tr. 3628 (Miller); Tr. 3707 (Hitz).

-- the operators did not follow administrative procedures 1010 and 1012 requiring the filing of exception and deficiency statements and logging of start and stop times. Tr. 2636 (Coleman); OI Interview pp. 42, 54 (Wright); Olson, Prepared Statement, supra p. 3; Stier Vol. VI (I) Interview of 3/20/85 at 76, Tr. 3611 (Miller); Tr. 3668-69 (Hitz).

There are no disputes about the foregoing points. Either the operators, foreman and supervisor conceded them in their testimony, or the point is irrefutably demonstrated by other record evidence. For example, almost all bad tests were discarded and no "E&D's" were ever filed. Therefore, as to those points, there is no need to freight this opinion with detailed findings about each member of Shift F, beyond the foregoing summary.

147. There is very clear and convincing evidence, and we find, that all three CRO's on Shift D manipulated test data and falsified test

177. In order to maximize the effectiveness of Wright's approach, it would have been necessary to restore the make-up tank water level to the same point at which the test began. In that regard, Wright did not claim a high degree of precision, only that the level was restored "approximately. Within, I'd say, you know, an inch or so." Tr. 2684. The records of the suspect tests in which Wright participated show that most of his end-of-test levels were more than an inch away from start-of-test levels.

NRR Test No.	Wright's role	Start of Test Level	End of Test Level	Net Change
140	Surveillance	79.2	77.8	-1.4
142	"	67.8	66.1	-1.6
129	panel	79.5	78.2	-1.3
133	"	74.6	72.9	-1.7
139	"	68.2	67.2	- .9
141	"	73.5	73.6	.1

Even employing an eyeball method, it should have been easy to return the make-up tank level to within half an inch or less of the starting point. Wright's failure to do that bespeaks a sloppiness inconsistent with his professed desire for greater instrument accuracy.

178. There are a number of other inconsistencies in Mr. Wright's asserted rationale for adding water. He claimed that there were problems with the batch controller (Tr. 2685) and that when those

problems arose, he computed amounts of water additions from the strip chart. The record does not support that claim. In each of the six tests in the table above, it is clear that the water addition included in the calculation was derived from the log and probably from the batch controller. For example, in two tests, the amount included in the test was given to single digits (test 142 -- "181" gallons; test 139 -- "128" gallons). In all six cases, had the size of the addition been derived from the strip chart, it would have been substantially larger. To be sure, the water addition amounts included in the leak rate computations in these tests appear to be accurate but, by virtue of the "loop seal" effects in the level sensor, the leak rate test result was artificially low. It seems very unlikely that an operator who watched strip charts as closely as Wright claimed he would not have been aware of the large errors being produced by the "loop seal" effect.

179. Assuming, contrary to the record, that Mr. Wright may have derived the size of some water additions from the strip chart, such a practice casts further doubt on his professed desire to minimize instrument inaccuracy. For one thing, it is difficult to derive a gallonage reading accurate to, say, 10 gallons or less, by eyeballing a strip chart. Yet Wright said he chose that method rather than trust a specific meter reading from the batch controller. More fundamentally, and assuming for the moment that Wright did derive some of his water addition amounts from the strip chart, he would have been building back into his calculation the very inaccuracy he claimed he was seeking to avoid in the first place. Tr. 2687-90.

180. Wright was aware of the fact that SP 2801-3D1 directed operators to avoid adding water to the make-up tank during leak rate tests "if at all possible." OI Interview, p. 74. He must have known that that direction had been given to provide accuracy in the test. Yet, if we are to believe Mr. Wright, he took it upon himself to implement a procedure of his own devising that was directly contrary to SP-2301-3D1, supposedly to enhance accuracy of the test.

181. One would think that if a CRO like Mr. Wright had devised a better way to run an erratic surveillance test, he would have at least shared it with his fellow CRO's. Wright claimed not to recall discussing his water additions with Coleman and Olson. Tr. 2678, 2682, 2703. On this record, that claim is not credible. Wright testified that the three CRO's -- himself, Coleman and Olson "communicated well" and that there were no serious antagonisms among them. Tr. 2698-99. The great weight of the evidence including our generally negative assessment of Wright's credibility, supports, clearly and convincingly, a finding that Wright's claimed reason for adding water to leak rate tests -- enhanced "instrument accuracy" -- was a fabricated cover story for test manipulation.

Adam W. Miller

182. Mr. Miller is currently Plant Operations Manager at TMI-2. He holds a SRO license. Exhibit 5-B, Attachment 5, Table 1. Mr. Miller

began employment with Met Ed in 1973 as an AO at Unit 1. He was promoted to CRO in August 1975 and shift foreman at TMI-2 in August 1978. Miller Prep. St., p. 1, ff. Tr. 3608. Between March and August 1978 he was a CRO at TMI-2. Tr. 3612. He appears to have been assigned to "C" shift during that period. Stier Report, Vol. III(A), Table 1.

183. Between August 1978-March 1979, Mr. Miller was the foreman on "D" shift in TMI-2. Miller Prep. St., p. 2. Mr. Miller was responsible for supervision of the monitoring of RCS leakage, including the leak rate test. Stier Report, Vol. VI(I), 3/20/85 Miller Interview, pp. 9, 34; Miller Prep. St., p. 2.

184. Mr. Miller learned how to perform the leak rate test as a CRO at TMI-1. Tr. 3614. He believes that he understood that the 1 gpm LCO for unidentified leakage was related to plant safety, but he was not trained on the safety significance of the leak rate test. Tr. 3628; Stier Report, Vol. VI(I), 3/20/85 Miller Interview, pp. 18-23. As a CRO, Mr. Miller discarded leak rate tests himself. Tr. 3611, 3615. When he became a shift foreman, he permitted his operators to discard leak rate test results reflecting unidentified leakage in excess of the 1 gpm, and he did not conduct a review of the tests that the operators discarded. Tr. 3615; Stier Report, Vol. VI(I), 3/20/85 Miller Interview, p. 98. He filed all leak rate tests reflecting unidentified leakage under 1 gpm, without regard to their validity. Tr. 3646. Stier Report, Vol. VI(I) Miller Interview of 3/20/85 at 53, 56. Indeed, according to Stier and the MPR Investigators, "almost two-thirds of the

tests that Miller approved should have been determined invalid." Stier Report Vol. IIB, Assessment of Adam Miller at 6.

185. Mr. Miller believed that the leak rate test was inaccurate because test results varied considerably despite no apparent changes in plant conditions, Tr. 3647. However, he did not further investigate those inaccuracies or take any other action to see that they were corrected.

186. On the contrary, as we have already indicated, Mr. Miller adopted -- and displayed to his subordinate CRO's -- an utterly cynical attitude toward the leak rate test. He did not treat the test as an important and the only quantified indication of unidentified leakage in the plant, but rather as a meaningless gesture required to be performed periodically. To repeat, he would perfunctorily approve any test reflecting leakage under 1 gpm, and he sanctioned his CRO's practice of automatically discarding any test result over 1 gpm. Miller's actions must have sent a clear message to Coleman, Olson and Wright: Foreman Adam Miller doesn't care how leak rate tests are performed, as long as the paper result from the computer reads less than 1 gpm.

187. The most serious issue involving Mr. Miller is whether he knew of or participated in the manipulations of tests engaged in by Coleman, Olson and Wright between February 10 and March 13, 1979. In that regard, Mr. Miller claimed that he "had absolutely no knowledge that the practice was going on, if it was." Prepared Statement ff. Tr. 3608, at 4. For their part, none of the CRO's could recall discussing water

additions with Miller. The other evidence on this point is indirect and conflicting.

188. Pointing toward knowledge of manipulation, if not participation, on Miller's part is the very striking and consistent pattern shown by the numerous suspect tests, especially as shown in the strip charts. Miller himself acknowledged that pattern when asked to review the test records. Tr. 3638, 3643. Furthermore, Shift D was the only shift that was consistently able to produce a "good" leak rate test during that period. When all the other shifts were having so much difficulty, one would think that foreman Miller would have at least been curious about his shift's secret of success. Mr. Miller was unable to offer a persuasive explanation why he simply signed the tests but made no inquiry at the time. Tr. 3644.

189. On the other hand, Mr. Miller's total lack of concern about the validity of leak rate tests constitutes the most persuasive indirect evidence that he did not know about manipulations by his CRO's. Again, the strip charts, viewed together, provided the clearest evidence of the manipulations in question. But Miller testified that he did not review the strip charts for trends, a claim we can readily credit in light of his cavalier attitude toward the test. Tr. 3639.

190. Part of the reason we found that the Shift D CRO's knew of and collaborated in one another's manipulations was that the normal operational performance of the test involved two CRO's working together. But a foreman, like Miller, had no operational role in the test. And if, like Miller, the foreman was indifferent to how the test was run,

there is little reason to believe that he would have known how tests were run.

191. We have no clear and convincing evidentiary basis for finding knowledge or collaboration by Miller in test manipulations. However, we do find that Miller was guilty of culpable neglect in his attitude toward the test, in his total failure to supervise his CRO's in performing the test, and in creating a work atmosphere where repeated manipulations could occur.

192. Mr. Miller did not apply or require his CRO's to apply Administrative Procedure 1010, the "Exceptions and Deficiencies" Procedure, to leak rate test printouts in excess of 1 gpm. Miller was unable to provide any substantial explanation for his consistent failure to follow an applicable and important procedure. Stier Report, Vol. VI(I), 3/20/85 Miller Interview, p. 76. Tr. 3648.

193. Mr. Miller did not require his CROs to log the start and completion times of all leak rate surveillance tests. Tr. 3611. He did recall that his shift logged the completion of "good" leak rate tests -- i.e. tests under 1 gpm -- to keep track of the 72-hour period. Stier Report, Vol. VI(I), 3/20/85 Miller Interview, p. 81. His shift did not log the start or finish of unsatisfactory leak rate tests i.e. tests over 1 gpm. No valid reason was offered for this violation of procedure. See Id. at 82-83 for an invalid reason.

194. Mr. Miller had no independent recollection of LER 78-62/1T, although he did initial the check-off sheet associated with it. Tr. 3618-19. He believes that the meaning of that LER was never made clear

to him, Tr. 3620, because he does not recall ever going into the Action Statement. Stier Report, Vol. VI(I), 3/20/85 Miller Interview, p. 55.

Gregory R. Hitz, Sr.

195. Mr. Hitz began employment with Met Ed in 1969. After working as an AO and CRO, he was promoted to shift foreman in 1975 at Unit 1. He became a dual-licensed shift supervisor in 1977. Hitz Prep. St., pp. 1-2, ff. Tr. 3664. Mr. Hitz was assigned to supervise "D" shift at TMI-2 during the latter part of 1978 and early 1979. Id. at 2.

196. Mr. Hitz had interpreted the leak rate Technical Specifications as requiring a leak rate test result depicting unidentified leakage below 1 gpm every 72 hours while the plant was in operation. Tr. 3718. If a satisfactory leak rate test result could not be obtained within that 72-hour period, they were required to invoke the Action Statement of Technical Specification 3.4.6.2. Tr. 3719.

197. It was Mr. Hitz' responsibility to see that leak rate tests were performed and that the plant was operating within specified leakage limits. Prep. Statement, at 3. Generally, however, leak rate tests did not go beyond Adam Miller, his Shift Foreman. Tr. 3630. Mr. Hitz understood that leak rate tests depicting unidentified leakage in excess of 1 gpm were discarded by his shift, without entry into the Action Statement. Tr. 3720. Mr. Hitz assumed that before the operators on his shift discarded a leak rate test they, but not the foreman, engaged in a determination whether the test was valid. Tr. 3677; Hitz Prep. St., at

3. Mr. Hitz acknowledged, however, that he never observed his operators engaging in that process. Tr. 3677-78. The record demonstrates that, in fact, the members of D Shift did not attempt to validate test results by reference to other plant parameters. On the contrary, Shift D accepted any test under 1 gpm and discarded any test over 1 gpm. See Tr. 3615, 3644 and VI ¶ 146, above. Mr. Hitz had no factual bases for his assumptions about validation.

198. In 1978-79, Mr. Hitz knew that his shift at TMI-2 was having problems obtaining leak rate test results meeting the 1 gpm LCO. Tr. 3666. He recalled seeing highly variable leak rate test results. Tr. 3667. At the time, Mr. Hitz did not blame these problems on inaccuracies in the computer program used to conduct leak rate tests. Id. Rather, he attributed the difficulties to plant oscillations and to secondary side plant problems which, be believed, would be corrected over time. Tr. 3670. He acknowledged that, in retrospect, these problems prevented anyone from knowing, with certainty, whether the 1 gpm LCO for unidentified leakage was being met. Tr. 3695.

199. The existence of plant oscillations prompted Mr. Hitz to accept as valid leak rate test results depicting small negative numbers for unidentified leakage. Tr. 3680-81. He was convinced that such negative results were likely to occur, and were therefore acceptable. Tr. 3682, 3686; see Exhibit 21, p. 3.

200. Mr. Hitz recalled receiving classroom training concerning the Technical Specifications, as well as the bases for those Specifications. Tr. 3707. When he became a shift supervisor, he received training by

observing other shift supervisors performing their administrative work. Hitz Prep St., p. 2. He testified that there was no on-the-job training focusing specifically on the leak rate test, however. Tr. 3707.

201. Mr. Hitz had no recollection of the incident described by his CRO Coleman, in which three individuals emerged from the shift supervisor's office and told Mr. Coleman they did not wish to see leak rate tests with unidentified leakage in excess of 1 gpm. Tr. 3678. Mr. Hitz believed that it was not a fair assumption that he was the shift supervisor involved, because Mr. Coleman's uncertainty about the timing of this occurrence other than that it was "early on", made it likely that he was not yet Mr. Coleman's shift supervisor. Tr. 3678. The Board believes that Mr. Coleman's recollection is too vague to support the conclusion that Mr. Hitz gave Mr. Coleman the instruction in question, especially in the face of Mr. Hitz's denial.

202. Mr. Hitz remembered hearing of the MUT "loop seal" phenomenon after the March 28, 1979 accident at Unit 2. Tr. 3712. Prior to learning of that phenomenon, he was unaware that a hydrogen addition to the MUT could affect the leak rate test. Id. As a Unit 1 CRO, Mr. Hitz had seen a brief, temporary effect on the MUT level caused by a hydrogen addition, but he believed that the effect was insignificant. Tr. 3690, 3692.

203. In retrospect, Mr. Hitz could not justify the practice of not applying the "Exceptions and Deficiencies" Procedure to invalid leak rate tests. Tr. 3668-69.

204. Mr. Hitz could not remember the November 1, 1978 Licensee Event Report (78-62/1T), but recognized that his initials were on the coversheet for the version sent to the control room. Hitz Prep. St., p. 6; Tr. 3698. Mr. Hitz presumed that the LER had no effect on operations at TMI-2. Tr. 3722. He agreed that it would have been his responsibility to ensure that all those under his supervision knew the importance of this LER, and he agreed that after the issuance of the LER, he should have verified that his shift was entering the Action Statement upon obtaining leak rate test results over 1 gpm. Tr. 3721, 3723.

205. Mr. Hitz had no knowledge of any operator falsifying or manipulating leak rate tests. Tr. 3725. He was convinced that his shift foreman, Mr. Adam Miller, was also unaware of any pattern of falsification or manipulation. Tr. 3728-29.

206. We know of no evidence that Mr. Hitz was aware of leak rate test falsification or manipulation. Mr. Coleman, for example, could not recall discussing his leak rate testing activities with Mr. Hitz. Tr. 2604. He was rarely involved even in the approval of leak rate tests, and signed only two tests (Stier Test Nos. 16 and 21); therefore, it is understandable that he would not have been aware of the practice of Messrs. Coleman, Olson and Wright, during February-March 1979, of adding water to the MUT during leak rate tests to affect test results. As Mr. Hitz explained, "once you [become] a shift supervisor, you kind of get removed from the Control Room Operator somewhat." Stier Report, Vol. VI(F), 3/29/84 Hitz Interview, p. 26.

207. We find, however, that Mr. Hitz must be charged with culpable neglect in two respects. First, he failed to keep himself adequately informed about the conduct of leak rate tests and to oversee Adam Miller's direct supervision of such tests, particularly in light of his knowledge that the test was presenting problems. Those failures, coupled with Miller's dereliction as direct supervisor of the Shift D CRO's, allowed those CROs to manipulate leak rate tests for a substantial period of time. Second, Hitz conceded that it should have been his responsibility to see to it that those under him understood and implemented the LER correcting the previous misinterpretation of the action statement requirement. Tr. 3721-3723. We agree, and make the same finding as to each shift supervisor, except Bryan.

Shift E

208. Three CROs were assigned to Shift E -- Harold W. Hartman, Jr., Raymond R. Booher, and John R. Blessing. Mr. Blessing was initially a trainee on this shift. The Shift Foreman was Kenneth P. Hoyt and the Shift Supervisor was Bernard G. Smith.

209. Mr. Hartman and Mr. Blessing had admitted previous to this proceeding manipulation of leak rate tests by adding hydrogen to the MUT. Mr. Booher denies involvement in manipulation or falsification of the tests. Mr. Hoyt and Mr. Smith denied any knowledge of Mr. Hartman's or Mr. Blessing's activities that produced falsification. In view of

Hartman's and Blessing's admissions, we make only limited findings with respect to them.

210. This shift, in common with others, misinterpreted the Tech Specs to require only one "good" leak rate test in 72 hours, regardless of the results of other "bad" tests. ff. Tr. 4175, at 2, (Booher); ff. Tr. 4233, at 3 (Hoyt); ff. Tr. 4331, at 3 (Smith). They routinely discarded tests that indicated leakage in excess of 1 gpm and they filed "good" tests, even though they had had serious doubts about the accuracy of the test results. ff. Tr. 4175, at 2 (Booher); Tr. 4236 (Hoyt); ff. Tr. 4331, at 3 (Smith).

211. The shift did not receive adequate training with regard to the potential safety significance of the leak rate test. Tr. 4229-30 (Booher), Tr. 4361-62 (Smith). Administrative procedures 1010 and 1012 requiring filing of exception and deficiency statements and the logging of all start times of surveillances were not followed. ff. Tr. 4175, at 3 (Booher); Tr. 4269 (Hoyt); Tr. 4344 (Smith).

Harold W. Hartman, Jr.

212. Mr. Hartman precipitated the several investigations that led to this proceeding by alleging in a television interview on March 24, 1980 that various methods had been used at TMI-2 by several personnel to obtain false leak rate test results. Stier Report, Vol. I, p. 1. Mr. Hartman did not become a party to this proceeding, but appeared voluntarily to respond to Board questions.

213. At the hearing, Mr. Hartman confirmed that he had used hydrogen additions during leak rate tests as a means of manipulating the test. He testified that he could not recall seeing anyone else using hydrogen but that he got the information on the hydrogen effect from other operators and he believed that there was common knowledge of the hydrogen effect among operators. Tr. 2240. Mr. Hartman was unable to specifically identify any operator who had told him of the hydrogen effect. Id. He could not recall any knowledge of hydrogen additions by Mr. Blessing, even though Blessing has admitted such actions. Tr. 2304. Mr. Hartman did not claim that his shift-mates were involved in manipulation by hydrogen additions.

214. With respect to Mr. Hoyt and Mr. Smith, he stated that ". . . I'd never do it during a day shift you know when there was a lot of people around, that's it, you know and I even kind of hide it from Shift Foreman, Shift Supervisor so that they didn't see me generally that was no problem." Stier Report, Vol. VI E, Hartman 3/26/80 Interview, p. 29.

215. With respect to the addition of water to the MUT for the purpose of manipulating the leak rate test, Mr. Hartman denied that he used this technique. Tr. 2242. However, he testified that he believed that he had observed Mr. Booher making slow (jogged) additions of water for the purpose of test manipulation on one occasion. Id. He thought the time frame might have been three months before the accident. He also stated, however, that the incident occurred during a period of considerable leakage through the pressurizer relief valves, which on this record probably was six weeks or less before the accident. Id.

Mr. Hartman could not identify the particular time when this occurred, which poses difficulties in confirming this allegation.

John R. Blessing

216. Mr. Blessing did not respond to the Board's invitation to participate in this proceeding and also disobeyed the Board's subsequent subpoena requiring an appearance. Board Chairman letters, dated August 6, 1986 and October 22, 1986. Since Mr. Blessing had admitted to having added hydrogen to the MUT on numerous occasions during leak rate tests in his April 10, 1980 interview by Mr. Christopher and Mr. Martin of the Region I office, the Board did not pursue Mr. Blessing. The Board finds his admission sufficient basis to conclude that Mr. Blessing manipulated tests and falsified the tests by signing the test result document. We find his excuse that on nine out of ten occasions the hydrogen addition did not work totally lacking as a justification. Indeed, on those nine unsuccessful attempts, Mr. Blessing was guilty of attempted manipulation which reflects as unfavorably on him as successful manipulation.

217. Mr. Blessing was interviewed by NRC Staff on April 10, 1980 and December 14, 1984 and summaries of these two interviews were admitted into the record of this inquiry as Exhibits 5 and 6 included in Exhibit 6 of our proceeding. Mr. Blessing was provided copies of these interview summaries in a Board mailing on August 6, 1986. Absent any response from Mr. Blessing, and noting that at the December 14, 1984 interview, he affirmed the correctness of the April 10, 1980 interview

summary, the Board accepts these two documents as reliable and probative.

Raymond R. Booher

218. Prior to joining Metropolitan Edison in 1971, Mr. Booher was in the United States Navy for six years. From 1971 to 1981, he was employed by Met Ed, first as an auxiliary operator in TMI Unit 1, then as a control room operator in TMI Unit 2. He obtained a TMI-2 license in 1977 and retained it until he terminated his employment with Met Ed in 1981. He then became employed by Louisiana Power & Light (LP&L) as a control room supervisor, licensed as a Senior Reactor Operator. In 1985, he terminated his employment with LP&L. He was then employed as Training Consultant at Palisades Nuclear Power Plant in Michigan.

219. Mr. Booher testified that he discarded tests that did not come out within the specified limit because he believed that he only needed one acceptable test with less than 1 gpm unidentified leakage during the 72 hour period. Booher Prep. St., ff. Tr. 4175, p. 2. He stated that ". . . I never felt that my job would be in jeopardy if I did not produce a successful test result." Id. at p. 3.

220. Mr. Booher testified that "although the NRC has accused me of deliberately adding water during the leak rate tests to affect the results, I never did this, and I believe that I have been unfairly accused." Id. at 5. He stated further that "I do not know why Harold Hartman stated I added water to falsify leak rate tests. According to

the NRC investigators, he believed that I was not a good operator; perhaps that is why he feels that I was involved in the conduct similar to his." Id. at 5.

221. The "Results of Joint NRR/OI Investigation and Evaluation of Raymond R. Booher" are found as Enclosure 3 of Exhibit 5-A of this inquiry. Mr. Russell concludes that "In summary, the weight of the evidence, including technical analysis and statements by other operators on Mr. Booher's shift, strongly suggest that Mr. Booher was not truthful in answering questions regarding his participation in or knowledge of leak rate test manipulation at TMI-2 during the period September 30, 1978 to March 28, 1979." The basis for this appears to be Items 6 and 7 on page 3 of this report.

222. Item 6 on page 3 reads "Mr. Booher stated that he was unaware that hydrogen additions to the make-up tank could affect make-up tank level indication, and, thus favorably influence leak rate test results." Ex. 5-A, Enc. 3, p. 3. In contrast to this characterization of the Booher interview on 11/15/84, page 46 of that interview reads in part:

"Q Were you aware that it could?

A I remember of hearing discussions. I don't remember when the discussions were. But I thought it was kind of ridiculous, to tell you the truth, to have some kind of a gas make a level change. I still believe that, to tell you the truth.

I don't understand how adding hydrogen to a tank would make the level change.

Q But you had heard about it back at that time?

A I heard that. I don't remember when."

The Board finds that Mr. Booher was aware that other operators thought adding hydrogen might have an effect. At any rate, the NRR technical analysis did not implicate Mr. Booher with respect to hydrogen additions. Also, Mr. Hartman at the September 25, 1986 hearing responded to a question "Is it a fact that you do not recall seeing any TMI-2 operator add hydrogen to the reactor coolant system to affect a leak rate test result?" with the response "That's correct." Tr. 2285-86. We do not find untruthfulness with respect to hydrogen additions.

223. Item 7 reads "Mr. Booher stated that he never added water to the make-up tank for the purpose of altering leak rate tests results." Id. at p. 3. It also states that "the technical analysis shows that during every leak rate test in which Mr. Booher took part from December 26, 1978 through the date of the accident (8 tests), all include water additions to the make-up tank that were not accounted for in the leak rate test calculation." Ex. 5-A, Enc. 3, p. 3.

224. Based on Table 11, Individual Test Synopsis, of Ex. 5-A, we take the referenced tests to be the following:

NRR Test No.	Date	CROs Surveillance/Panel
77	12/26	Booher/Hartman
94	1/13	Hartman/Booher
97	2/02	Blessing/Booher
128	2/23	Hartman/Booher
143	3/10	Hartman/Booher
144	3/12	Booher/Blessing
145	3/13	Hartman/Booher

225. The Board has reviewed the individual test records and we find that they all involve possible water additions but in different manners and to different degrees; i.e., a clear pattern is not apparent.

226. Test 77 was conducted under unstable plant conditions and it is clear that Mr. Booher violated the surveillance procedure requirement of "steady state conditions." Staff speculation that there was a possible water addition of 20 to 30 gallons is impossible to confirm since the strip chart record shows transient changes or oscillations during the test and both before and after the test time period that are larger than the postulated small addition.

227. Test 94 appears to be a situation where Mr. Booher as the panel operator added 117 gallons of water and logged the addition. Mr. Hartman did not include the water addition in the leak rate calculation. Since the water addition was logged, there was no hidden manipulation. Mr. Booher can be faulted for adding water and violating the procedures stricture that water additions should be avoided "if at all possible." Mr. Hartman can be faulted for not inquiring whether water had been added and for failing to check the log book. This appears to us to be simple carelessness in conducting the test primarily on the part of Mr. Hartman.

228. Test 97 is unusual in that Mr. Booher logged a 300 gallon water addition as having taken place at 0100, but there is no indication of such an addition on the strip chart record. It is conceivable that a

feed-and-bleed operation could have taken place and water removed at the same time and at the same rate that water was added but we consider it more probable that this represents a logging error. Be that as it may, this test does not represent manipulation by water addition. However, it clearly reflects an error by Mr. Booher.

229. Test 128 has a strip chart record that shows a feed-and-bleed operation was carried out during the test time interval. Water addition of 150 gallons was logged by Mr. Booher at 1135. However, an additional 150 gallons appears to have been added as part of a second feed-and-bleed and was not logged. Mr. Hartman did not include the logged water addition in the leak rate calculation. Mr. Hartman can be blamed for failing to check the log or learn from Mr. Booher that water nad been added. This erroneous test reflects sloppy performance by both Mr. Booher and Mr. Hartman with either a failure to communicate or a casual disregard for the test requirements.

230. Test 143 is regarded by NRR as displaying a jogged (added slowly) water addition. Figure 4 is a copy of the MUT strip chart for the time period that includes the test interval. MPR Associates reviewed the NRR conclusion and stated that the water addition was "not confirmed. Trace flattening appears typical of other times." Ex. No. 1-B. The Board agrees that the MUT strip chart record shows numerous slope flattenings (see Figure 4) and the change in slope near the end of the test may be only a chance occurrence. We note further that Hartman was conducting the surveillance and he has not alleged that he and

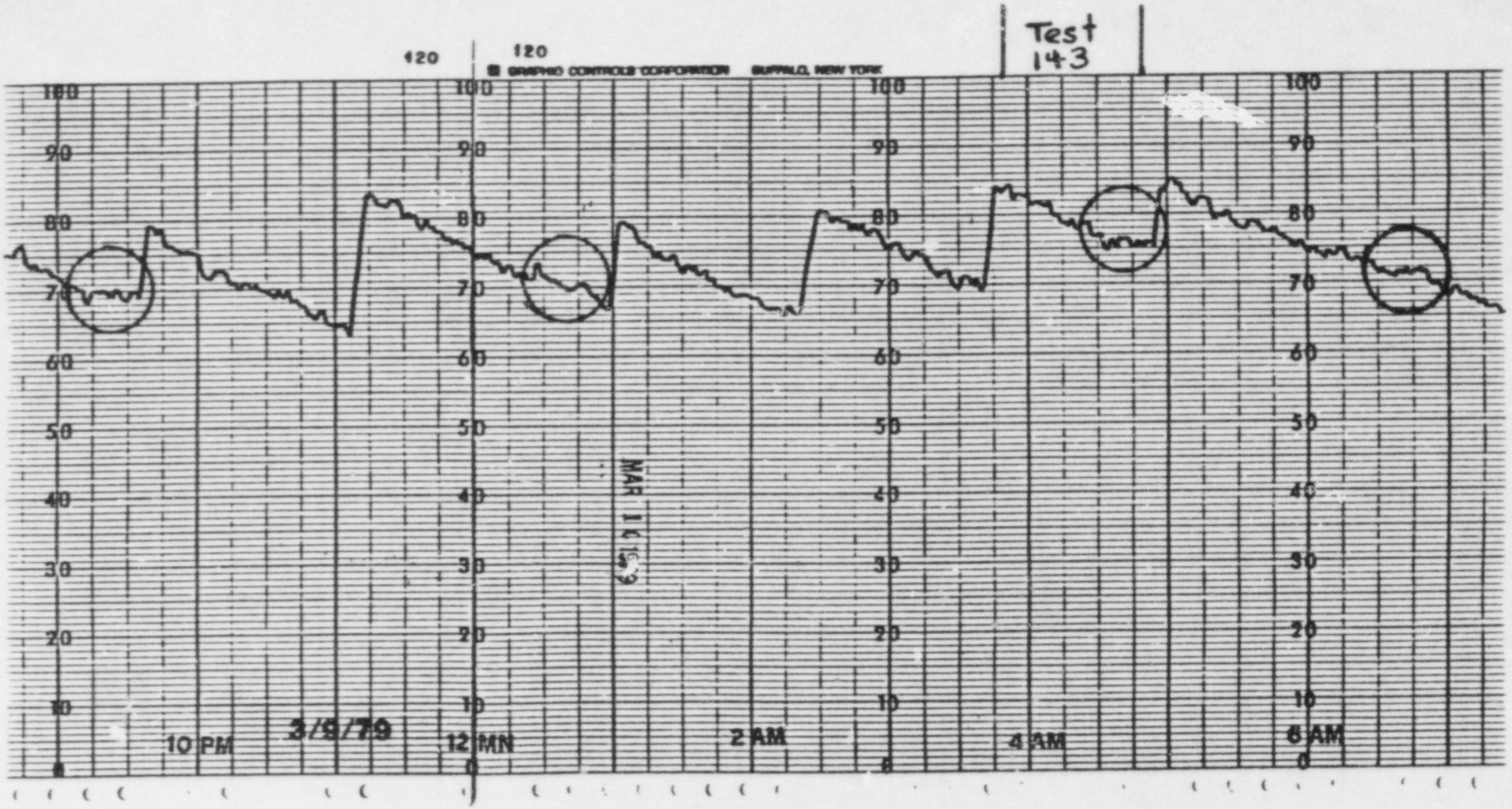

Figure 4. MUT strip chart record showing slope decrease near end of NRR test 143 and similar decreases at times when tests were not being conducted. Sharp, vertical increases associated with logged water additions.

Booher collaborated in manipulating tests by jogging water. We cannot reach a finding that this test is evidence for jogged water additions.

231. Test 144 was carried out by Mr. Booher and NRR ascribed a 100 gallon jogged water addition starting at 0150. MPR Associates reviewed the NRR conclusion and stated "not confirmed. No clear deflection at 0150, trace deflection appears typical of others during the day" and also noted that "from 0130 to 0315 overall slope is clearly less than before or after that period" and "the test may have started before the 300 gallon addition logged at 0130 was complete. Note initial MUT level may be appr. 2 in. low." Ex. No. 1-B.

232. Figure 5 is a copy of the MUT strip chart record for the time interval encompassing test 144. Mr. Russell testified that "NRR believes that the slope changes at 0150 and 0220 were caused by jogged water additions." Tr. 1716. The referenced slope changes are visible in Figure 5, but the Board finds such changes were not uncommon when the test was not being run. Transitory slope flattenings such as these or, for example, the more pronounced one at 1115 to 1130 on March 11, 1979 may be ascribed, in our view, to poor performance by the level sensing system or plant transients rather than slow and intermittent addition of water by the operators. Also, we note that the anomalous slope persists for 30 minutes after test 144 was completed--a very unlikely operator action.

233. Mr. Russell testified further that there were ". . . no logged evolutions in progress that would cause this change in slope unless it were operator-induced; . . . ." Tr. 1717. However, as seen in Figure

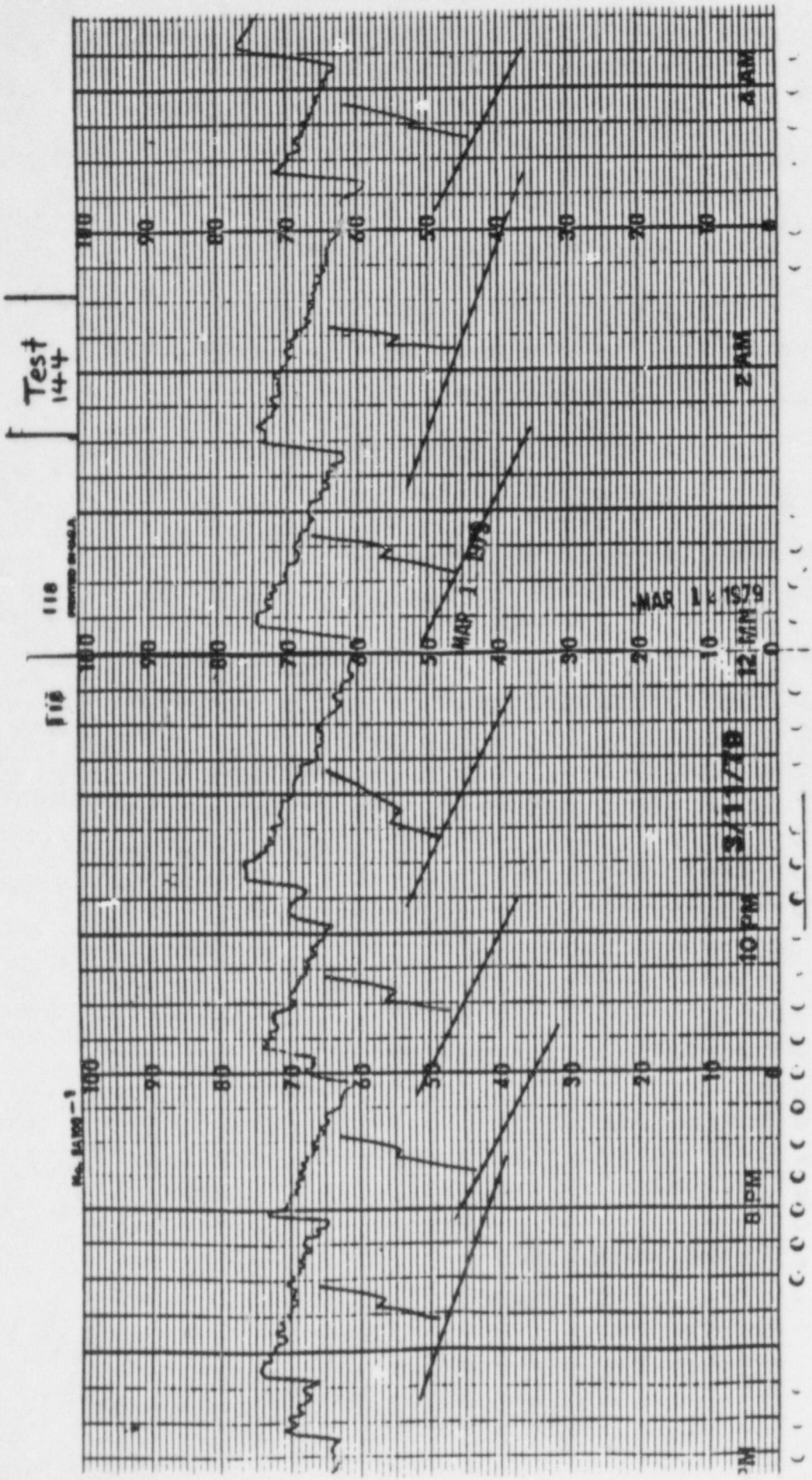

Figure 5. MUT strip chart record showing slope during test 144 and slopes during other times.

3, the level sensing system produced an apparent reduced slope from ca. 7 to 8 pm on March 11, 1979 and we do not see anything in the panel operator's log that would have caused that reduced slope either. We find that the slopes tend to be uniform but anomalies are to be found when no operator action would be postulated. The Board finds that test 144 does not demonstrate jogged water additions by Mr. Booher.

234. Test 145 was conducted by Mr. Hartman. NRR concluded that water was added (jogged) near the end of the test. However, MPR Associates review did not confirm this conclusion and the Board agrees with the testimony by Mr. Stier that "there is a trace deflection during the course of this test, but you can see from examining our copy of the strip chart that it is similar to trace deflections in other positions of the strip chart where leak rate tests are not on file." Tr. 1727. We note that a water addition should produce a persistent upward offset and this strip chart shows a temporary (15 minute) upward offset with a return to substantially lower values. The Board finds this test to be inconclusive with respect to manipulation.

235. Test 148 was executed by Mr. Booher while Mr. Blessing was the control panel operator. The MUT strip chart record shows a clear, persistent upward offset that starts near the middle of the test. NRR described this offset to a possible jogged water addition, but MPR Associates did not confirm this as a water addition and felt that "because of the similarity of this trace to a known hydrogen addition on February 15th, that it was a possible hydrogen addition." Tr. 1730. Mr. Blessing has stated during his April 10, 1980 interview that "he had

in fact added hydrogen to the makeup tank while running leak rates" and the Board finds that the possibility that hydrogen was added, as suggested by MPR, cannot be excluded. This is clearly a questionable test but, since a similar pattern can be found from midnight to 0030 when a leak rate test was not being run, there exists a question whether any clear conclusion can be reached.

236. In summary, the Board finds that the 8 tests (above) show careless and unprofessional performances by this shift. The several cases where water was added and not considered in the test calculations are either failures to communicate or sloppy errors. There does not appear to be collusion by these operators. Mr. Booher testified that his relationship with Mr. Hartman was not "extremely close." Tr. 4184. Mr. Hartman thought Mr. Booher was not a good operator. Ex. 5-A, Enc. 3, p. 11. Mr. Blessing testified that neither he nor Mr. Hartman were friendly with Mr. Booher, and communications were particularly bad. Ex. 5-A, Enc. 13, p. 3. As a result, his activities as a trainee were supervised by Mr. Hartman and not Mr. Booher. Id.

237. In contrast to Mr. Hartman's negative views, Mr. Hoyt, the Shift Foreman, testified that Mr. Booher was his "right-hand man" when Mr. Hoyt was not in the TMI-2 Control Room, and that Mr. Booher was the CRO that "really carried the shift." Tr. 4287. We find that resentment of Mr. Booher by Mr. Hartman is a reasonable conjecture. At any rate, the Board is unable to confirm Mr. Hartman's allegation of manipulation with water by Mr. Booher on this record.

Kenneth P. Hoyt

238. Following almost ten years in the United States Navy, Mr. Hoyt was employed by Metropolitan Edison in 1971 as an auxiliary operator at Unit 1. He became a CRO at Unit 2 in 1976 and a shift foreman in 1977. He is currently employed at GPU Nuclear Corporation as a Decontamination Supervisor in Recovery Operations. Hoyt Prep. St., p. 1, ff. Tr. 4331.

239. Mr. Hoyt testified that he did not feel the inputs to the computer were "totally accurate" and he doubted the results of the leak rate tests. Tr. 4260, 4262. He stated that "I believe that I could ensure that unidentified leakage did not present a safety problem by checking other monitoring methods, which I used routinely. These methods included observing makeup tank level, pressurizer level, system temperature and the sump pump." Hoyt Prep. St., p. 2, ff. Tr. 4331. He stated that he spent approximately one-half of his time touring and inspecting the plant. Id., at 1. Mr. Hoyt testified that he depended on these visual inspections to a substantial extent and, therefore, discarded all leak rate tests showing unidentified leakage in excess of 1 gpm "because in my judgement those tests were invalid." Id. at 3.

240. Mr. Hoyt testified that he talked about the problems in the test with his shift supervisor. Tr. 4265. He had the impression that the problems were being worked on and he had no control of the schedule. Tr. 4266.

241. The Board finds Mr. Hoyt's visual inspections were not a proper substitution for the Tech Spec required leak rate surveillance.

His failure to document the difficulties that Shift E had in conducting this surveillance and his written approval of unreliable tests constitute culpable neglect.

242. The Board found Mr. Hoyt to be straightforward and knowledgeable at the hearing. In contrast to many others, he understood the safety significance of leaks and the difference in importance between a valve stem leak and a pipe or weld crack. Tr. 4292-93. We find no evidence that he put pressure on the operators or was aware of any manipulation of the leak rate tests. As Mr. Hartman testified (see Finding VI ¶ 214), he would not carry out manipulations when he could be observed, which confirms Mr. Hoyt's posture that he had no reason to be suspicious of the operators.

Bernard G. Smith

243. Mr. Smith was a shift foreman at Unit 1 and then became a shift supervisor in both Units. During 1978-79, he supervised "E" Shift at TMI-2. Smith Prep. St., p. 1, ff. Tr. 4331.

244. Mr. Smith was aware that his shift encountered difficulties in obtaining leak rate test results that depicted unidentified leakage below 1 gpm. He attributed the problem primarily to the TMI-2 computer's software. Tr. 4341. Mr. Smith believed that those who were technically competent to do so were devoting time to correct the computer program. Tr. 4352-53; Smith Prep. St., p. 5.

245. Mr. Smith placed greater reliance on his ability to detect leakage through visual review of plant parameters than he did on the numbers reflected on the leak rate test computer printout. Tr. 4367; Smith Prep. St., p. 4. He recognizes now that his reliance on his own ability to visually detect leakage was misplaced. Tr. 4360.

246. Mr. Smith could not recall any training to comply with Administrative Procedure 1010 insofar as leak rate testing was concerned. Tr. 4344. Mr. Smith testified that, in retrospect, "[W]e didn't do things the right way at that time." Tr. 4347. Mr. Smith also testified that, in general, the training he received was very limited compared to present industry practices. Tr. 4361-62.

247. Mr. Smith was unaware of any falsification or manipulation of leak rate tests that may have occurred on his shift. Tr. 4374; Smith Prep. St., pp. 6-7. His lack of knowledge of such actions was confirmed by Mr. Hartman. Tr. 2241, 2286, 2292, 2303. Mr. Hartman has consistently testified that Mr. Smith was not necessarily aware of his leak rate test falsification. Stier Report, Vol. VI(F), 7/16/82 GPU v. B&W Deposition, pp. 1-2; id., 8/18/82 GPU v. B&W Deposition, p. 276. Mr. Smith testified that he was surprised by Mr. Hartman's and Mr. Blessing's admissions regarding leak rate test manipulation. Tr. 4374; Smith Prep. St., p. 7, ff. Tr. 4331, at 7.

248. The Board finds that Mr. Smith was tolerant of improper practices at TMI-2, which can be attributed to inadequate training and supervision. In common with other shift supervisors, he failed in his

duties to ensure that the technical specifications were properly understood and applied, which constitutes culpable neglect.

Shift F

249. Shift F was constituted in early January 1979. It was comprised of two CRO's -- Hugh A. McGovern and Earl D. Hemmila -- one CRO Trainee, Leonard P. Germer, Shift Foreman Carl L. Guthrie and Shift Supervisor Kenneth P. Bryan.

250. Shift F's understanding and handling of leak rate tests was typical of other shifts in the following respects:

-- they misinterpreted the Tech Specs to require only one "good" leak rate test in 72 hours, regardless of the results of other tests. Tr. 3219-3220 (McGovern); Hemmila Prepared St. ff. 4039, p. 2; Germer Prepared St. ff. 5236, p. 2; Tr. 4115, 4121 (Guthrie); cf. Tr. 4564 (Bryan).

-- tests reflecting excessive leakage were routinely discarded. "Good" tests were filed , without regard to their validity. Thus, leak rate tests were regarded as a meaningless administrative requirement, not as a real measure of leakage. Tr. 3199, 3204 (McGovern); Hemmila Prepared St. supra at 4; Germer Prepared St. supra at 2-3; VI ¶ 272, below (Guthrie).

-- the operators did not receive any significant training in leak rate testing. Tr. 3207 (McGovern); Germer Prepared St., supra at 2.

-- the operators did not follow administrative procedures 1010 and 1012 requiring the filing of exception and deficiency statements and logging of start and stop times. Tr. 3221 (McGovern); Tr. 4024 (Hemmila); Tr. 4116 (Guthrie); Tr. 4588 (Bryan); Bryan Prepared St. ff. 4540, pp. 3-4.

There are no disputes about the foregoing points. The operators, foreman and supervisor conceded them in their testimony; or they are conclusively demonstrated by the record. Therefore, as to those points, there is no need to freight this opinion with detailed findings about each member of Shift F, beyond the foregoing summary.

251. Shift F and its members can be discussed relatively briefly because we find that no manipulation occurred on that shift. There is no strong evidence of manipulation on Shift F, and none of the investigators believed that it had occurred. There is some indirect evidence of possible manipulation which we analyze below. Our negative conclusion about manipulation rested in part on our favorable impression of the Shift F members as witnesses, who came across as candid and responsible people.

Hugh A. McGovern

252. Mr. McGovern is currently employed by GPU Nuclear as Plant Operations Manager for TMI-2. McGovern Prep. St., p. 1, ff. Tr. 3148.

He maintains an SRO license in that position. Id., p. 2. He commenced his employment with Met Ed in 1976 as an AO at TMI-2, and he advanced to the position of licensed CRO at TMI-2 in late 1978. Id., p. 2. In January 1979, he was assigned to "F" shift in TMI-2.

253. Mr. McGovern's shift had the typical division of responsibilities. For example, water additions to the RCS typically would be made by the panel operator (Tr. 3164-65), and the individual assigned to perform surveillance tests typically would complete the questions that were part of the computer-generated leak rate procedure. Tr. 3165. His shift-mates attempted to communicate with each other concerning the commencement of a leak rate test, and Mr. McGovern could not remember having communication problems with respect to leak rate testing. Tr. 3165-66.

254. Mr. McGovern knew that he was to avoid adding water to the MUT during a leak rate test unless there was an operational need to do so. Tr. 3152. The typical operational reasons for adding water during a leak rate test were to maintain proper inventory and to adjust boron concentration. Tr. 3225. Mr. McGovern was unaware that the MUT level strip chart could reflect an amount of water higher than the amount actually added to the MUT. McGovern Prep. St., Id., p. 5.

255. Mr. McGovern signed four leak rate tests in which water was added during the course of the test, and the amount of water recorded in the log was different than the amount reflected on the MUT level strip chart. They are NRR Test No. 150 (Stier Test No. 8), NRR Test No. 151 (Stier Test No. 7), NRR Test No. 153 (Stier Test No. 5), and MPR Test 2

(which was not analyzed by NRR). These tests were performed between March 17-27, 1979. MPR found that these water additions, while carrying some indications of manipulation, could not be found "with certainty" to have been "made with the intention to influence the tests." Stier Report, Vol. I, p. 101. Stier and MPR analyzed these tests as follows.

> There are two factors that militate against a finding of intentional conduct. First, there is no direct evidence implicating any of the members of the two crews that performed all of the filed tests in this form of manipulation. Knowledge of the effect of water additions on the leak rate test does not appear to have circulated as widely as information about the effects of hydrogen. For example, Hartman stated that he was unaware that a water addition that was accounted for in the calculation could affect the leak rate test.
>
> Second, the pattern of water additions between mid-March and March 28 differed from the previous period. Water was not consistently added within the last few minutes of each test as had been the case from mid-February through mid-March. In addition, the reactor coolant drain tank collection rate became so high by mid-March that water additions were required at short intervals to compensate for the loss to the reactor coolant system. Operators may have added water to the makeup tank during tests out of necessity. Therefore, we cannot be certain that the water additions made between mid-March and March 28 were for the purpose of manipulating tests. Id. at 101-102.

The NRR analyses of these tests is generally consistent with the Stier-MPR analysis. See NRR Report, Vol. I, Enclosure 10, pp. 4-5.

256. These tests, particularly 151 and 153 (where water was added near the end) suggest manipulation. However, the addition during 151 could have been caused by a perceived need to maintain makeup tank inventory. More importantly, the increased rate of leakage during this time period made frequent water additions necessary. In the absence of

some other strong evidence of manipulation, we cannot find an intent to manipulate in these tests.

257. Mr. McGovern was unaware that the addition of hydrogen to the makeup tank could affect leak rate test results. Tr. 3167, 3202. He knew that hydrogen had to be added periodically to the makeup tank to maintain overpressure and to provide net positive suction head for the makeup pumps. Tr. 3201. NRR identified only one test involving Mr. McGovern (NRR Test No. 121) during which it alleges hydrogen may have been added to the MUT. Exhibit 5-B, Attachment 5, Table 11, p. 5. We reject NRR's analysis of its Test No. 121. MPR did not agree that there was a possible hydrogen addition during NRR Test No. 121, because the trace deflections on the makeup tank level strip chart did not show a definite offset similar to the confirmed hydrogen addition on February 15, 1979 (NRR Test No. 120, Stier Test No. 38). Exhibit 1-B (Green Volume), Stier Test No. 37. Rather, MPR concluded that the MUT level strip chart trace deflections during NRR Test No. 121 appeared typical of other deflections that occurred on the same day. The Board agrees.

Earl D. Hemmila

258. Mr. Hemmila appeared in response to a subpoena issued by the Board; he agreed to come to Bethesda to testify. He is currently employed as a contract consultant at Davis-Besse in the plant training department. Hemmila Prep. St., p. 1, ff. Tr. 4039. Mr. Hemmila was employed at TMI-2 from 1976 until 1982. Id., p. 2. In 1978, he was a

CRO in training. Id. He received his RO license on December 6, 1978. Tr. 4043. Beginning on January 1, 1979, he was assigned as a CRO on "F" shift. Tr. 4044.

259. Mr. Hemmila was aware that the leak rate procedure cautioned against the addition of water to the MUT. Tr. 4050. However, there were occasions when it became necessary to add water to the MUT during a leak rate test. Hemmila Prep. St., p. 4. For example, after mid-March 1979 water was being added with increasing frequency to keep the MUT level above the required minimum or to keep the control rods within the proper operating band. Tr. 4051-52. TMI-2 had a low level alarm on the MUT. Tr. 4140. The alarm would sound if the operator let the level go below 60 inches. Tr. 4148-49. Mr. Hemmila's shift foreman, Mr. Guthrie, testified that a prudent operator would endeavor to replenish the MUT Level before the alarm went off. Tr. 4151-52. The frequency of required water additions is illustrated by NRR Test No. 150, at which time water was added ten times to the MUT during an eight-hour shift. Tr. 4059. Similarly, in connection with NRR Test No. 153, water was added 12 times during an eight-hour shift. Tr. 4090-93.

260. In 1978-79, Mr. Hemmila was not aware of any phenomenon by which the volume of water added reflected in the makeup tank level strip chart was greater than the volume measured by the totalizer. Hemmila Prep. St., pp. 4-5; Tr. 4080. He testified that neither he, nor any other operator to his knowledge, deliberately falsified leak rate tests by making unrecorded or under-recorded water additions to the makeup tank. Hemmila Prep. St., p. 5. He felt that a lack of communication

between operators would account for any instances in which water was added during a test but not properly included in the test calculation. Id.

261. Mr. Hemmila was the CRO assigned to the panel during NRR tests 150-153. We have already discussed these tests in our consideration of Mr. McGovern. See VI ¶ 255, above. We reach the same conclusion here -- that Mr. Hemmila was not engaged in manipulation in these or any other tests.

262. During 1978-79, Mr. Hemmila was not aware that the addition of hydrogen to the MUT during a leak rate test could affect the test result. There was no explicit rule prohibiting the addition of hydrogen during a leak rate test. On the contrary, Mr. Hemmila was aware that Unit 2 Superintendent Logan checked hydrogen levels frequently, and so Mr. Hemmila believed that maintaining proper hydrogen pressure was very important. During 1979, when he was a licensed operator, it was not always possible to add hydrogen from the control room. When that happened, the addition had to be done manually by an AO. It is possible that an AO may have added hydrogen to the makeup tank during a leak test without the CROs knowing about it. Id.

263. Mr. Hemmila stated that he never added hydrogen to the makeup tank in an effort to falsify leak rate tests and that he had no knowledge that other operators had done so. Id., pp. 5-6. There is only one test (NRR Test No. 152) signed by Mr. Hemmila during which hydrogen was added. See Exhibit 5-B, Attachment 5, Table 11, p. 20. The hydrogen addition was duly noted in the CRO log, id., and there is

no evidence that it was made with intent to manipulate or that Mr. Hemmila even knew about it (he was not on the panel). See Stier Report, Vol. IV(C), Test No. 6, CRO log, p. 70.

Leonard P. Germer

264. In 1977, Mr. Germer began his employment with Met Ed as an AO at TMI-2. Germer Prep. St., p. 1, ff. Tr. 5236. Mr. Germer became a CRO trainee assigned to "E" shift in October or November of 1978, and was transferred to "F" shift in early January 1979. Id., pp. 1-2. As a trainee, Mr. Germer was permitted to perform leak rate tests only under the supervision of a licensed CRO. Id., p. 2.

265. In light of our finding that as a CRO trainee, Mr. Germer's involvement in leak rate testing at TMI-2 was minimal (Tr. 4169, Kelley, J.), we decided not to call Mr. Germer as a witness. Tr. 4541. Instead, we ordered that Mr. Germer's prefiled testimony be bound into the record as the testimony he would have given had he been called as a witness. Tr. 5236.

266. Mr. Germer had very minimal involvement in the logging of leak rate tests during 1978-79, because that typically was a function typically performed by a licensed CRO. Id., p. 3. He has no present recollection of ever being instructed to conceal the fact that a leak rate test had been performed by not logging it. Id., p. 3.

267. Mr. Germer did not any falsify any leak rate result during 1978-79, nor was he aware of any other operator who falsified any leak rate test during that time. Id., pp. 3-5.

268. Several findings of fact proposed for Mr. Germer, Numerous Employee's ¶¶ 536-540, seek to equate NRR's "questionable" label with deliberate manipulation of tests. That equation is not valid. When NRR classifies a test as "questionable," it is merely taking the position that the test appears to have been conducted in violation of procedures. That is not equivalent to charging the person or persons who conducted the test with manipulation. There is some basis for a finding of irregularity in each of the tests cited in NRR's Table 8 as involving Mr. Germer, either as surveillance CRO or panel operator.

Carl L. Guthrie

269. Mr. Guthrie was a shift foreman at TMI-2 during the 1978-79 period. He had been employed by Met Ed since 1971. His first assignment was as an AO at Unit 1, then as a Unit 1 shift foreman. In January 1979, he was assigned to "F" shift in Unit 2. Mr. Guthrie currently is a radwaste foreman at TMI-2. Guthrie Prep. St., p. 1, ff. Tr. 4413. He maintains an SRO license in that position. Exhibit 5-A, Enclosure 2, p. 11.

270. Leak rate tests were run by Mr. Guthrie's CROs. Stier Report, Vol. VI(D), Tab G, 2/12/85 Guthrie Interview, p. 7. Mr. Guthrie did not directly monitor their performance of leak rate tests. Moreover, he

might not have been in the TMI-2 control room when a leak rate test was performed, because the selection of the time for running the test was a decision left to the operator. Id. Mr. Guthrie did not personally perform a leak rate test at TMI-2. Id.

271. Mr. Guthrie recognized "his responsibility . . . to provide first line supervision of the control room operators." Prepared Statement ff. Tr. 4113 at 1. He further stated that "Generally, I directed the performance of various surveillance tests . . . and "had to ensure compliance with the Technical Specifications." Id. at 1-2. The record reflects, however, that Mr. Guthrie did not provide proper supervision of the control room operators in performing leak rate tests and in ensuring that the 1 gpm LCO in the Technical Specifications was being met. As previously noted, the Shift F CROs treated the leak rate test in a perfunctory manner. A test was considered valid or invalid depending entirely on its result, not upon the manner or conditions of its performance.

272. The Stier - MPR analyses of Shift F tests led them to conclude that:

> In addition to tolerating, and participating in, the discarding of all unsatisfactory test results obtained on his shift, Guthrie approved the filing of numerous satisfactory leak rate test results that were inaccurate or performed in violation of a test procedures. Almost half of the tests that Guthrie approved should have been determined to be invalid. Stier Vol. II(A), Guthrie Assessment, p. 6.

Similarly, the NRR investigation concluded that:

> Mr. Guthrie's review only involved looking at the "bottom line" test results. Thus, if a test result was greater than 1 gpm, it would be discarded and another test would be started.

> If a test was less than 1 gpm it would be retained with little or no review to ensure it was a valid test. NRR Report, Enclosure 8, p. 4.

The record underlying the quoted statements amply supports them.

273. Mr. Guthrie spent substantial time attempting to detect plant leakage. He measured leaks in accessible areas of the plant and estimated leakage in inaccessible areas. Tr. 4117-18. Mr. Guthrie often found that leakage depicted by the leak rate test was inconsistent with his own assessment of plant leakage. Id. His inability to corroborate leak rate test results caused him to question the accuracy of the test. Id. Mr. Guthrie was also skeptical of the leak rate test because it did not produce consistent results. Id.

274. In 1978-79, Mr. Guthrie heard a rumor, from a source he has since forgotten, that the addition of hydrogen to the MUT during a leak rate test could affect leak rate test results. Tr. 4116. While in Unit 1, he had observed the effect of a hydrogen addition to the MUT, but he thought that the very temporary, very slight increase he observed could not affect a leak rate test result. Guthrie Prep. St., p. 4; Tr. 4139. We find no substantial evidence to dispute Mr. Guthrie's statement that he was unaware of the fact that the addition of hydrogen to the MUT could affect leak rate test results.

275. Mr. Guthrie did not know until after the March 28, 1979 accident that a water addition to the MUT, even if accounted for in the leak rate test procedure, could produce a more favorable leak rate test result, nor was he aware of any operator who manipulated leak rate tests

in that fashion. Stier Report, Vol. VI(D), Tab G, 2/12/85 Guthrie Interview, pp. 74-75; Tr. 4145-46. Mr. Guthrie was not aware of any unrecorded water additions to the MUT made to falsify a leak rate test. See Tr. 4116. None of the operators on his shift talked about this phenomenon or acted as though this was a method they might use to manipulate leak rate tests. Id.

276. Mr. Guthrie approved NRR Test No. 150 (Stier Test No. 8); NRR Test No. 151 (Stier Test No. 7), and NRR Test No. 153 (Stier Test No. 5). We have previously discussed these tests and concluded that no manipulation occurred. See VI ¶ 255.

277. In conclusion, we find that, in addition to the procedural violations cited in VI ¶ 250 above in which he was personally involved (e.g., discarding tests, not filing E&D's), Mr. Guthrie was guilty of culpable neglect in his attitude toward the test and in allowing the CRO's under his supervision to treat the test in a perfunctory manner.

Kenneth P. Bryan.

278. Mr. Bryan began employment with Met Ed in 1967. He became a CRO at TMI-1 in 1974 and a shift foreman at TMI-1 in 1976. Between October 1978-June 1979 he was a dual-licensed shift supervisor. Bryan Prep. St., p. 1, ff. Tr. 4540.

279. Between October -December 1978, Mr. Bryan was a supervisor in training. Tr. 4573. He received a permanent assignment to "F" shift in

January 1979. Tr. 4571-72. Mr. Bryan currently is a non-licensed, self-employed nuclear consultant. Bryan Prep. St., p. 1.

280. Mr. Bryan testified as follows:

> Unit 2's technical specifications required that a successful leak rate test be performed every 72 hours. Company policy required us to perform one every shift. By obtaining a test with unidentified leakage less than 1 gpm, we extended the 72-hour time clock. If the computer printout indicated that the unidentified leakage was high or excessively low, it was my understanding that the operators would evaluate it based on plant parameters including makeup tank levels, radiation levels, and so forth. If nothing indicated why there was a change from previous leak rates, the test performer would discard that printout and initiate another. It was my understanding that we had to enter the action statement if we obtained a leak rate higher than 1 gpm that we could not invalidate. I did believe that if I had looked at everything else and did not think that I had obtained a valid leak rate, I did not have to start the time clock. Bryan Prep. St., pp. 2-3.

The foregoing testimony, viewed in the light of our findings on the other members of Shift F, shows that Mr. Bryan was out of touch with the performance of the leak rate test by his Shift. As we have seen, the CRO's made little or no attempt to "validate" tests. They simply filed all tests under 1 gpm and discarded all tests over 1 gpm. Although they ran many tests over 1 gpm, they never entered the action statement.

281. Mr. Bryan did not review leak rate test results. There are no tests from September 1978 through March 28, 1979 which he performed or approved. Exhibit 5-B, Attachment 5, Tables 9 and 11; Stier Report, Vol. III, Table 1. He did not recall any instance of Guthrie's bringing him a test for review. Tr. 4550. Nevertheless, he was aware that there

were problems with the leak rate test. As he testified, "Leak rates were hard to get." Tr. 4570.

282. Mr. Bryan realized that adding hydrogen to the MUT could affect the leak rate test. Tr. 4563-64. He candidly testified that while he hoped that he had instructed his operators not to add hydrogen to the MUT during a leak rate test, he could not specifically recall issuing such an order. Tr. 4564. There are only two leak rate tests (NRR Test Nos. 121 and 152) performed by his shift during which NRR alleged that hydrogen was added to the MUT. Exhibit 5-B, Attachment 5, Tables 5, 6 and 11; Stier Report, Vol. III(A), Table 1. We agree that neither of these Tests supports a conclusion that "F" shift's operators manipulated tests results through hydrogen additions to the MUT. Tr. 1660 (Capra).

283. Although Mr. Bryan witnessed the effect of hydrogen addition on MUT level, he did not observe that a water addition could produce a similar, false MUT reading. Tr. 4555. NRR found three instances where "F" shift "partially included" water additions during leak rate tests. Exhibit 5-B, Attachment 5, Tables 6 and 10, NRR Test Nos. 150, 151, 153. As previously discussed, see VI ¶ 255, we believe that these tests do not represent operator efforts to manipulate leak rate tests results, Tr. 1486-87 (Russell); Tr. 1847-49 (Stier).

284. Mr. Bryan permitted his shift to file a leak rate test result depicting negative unidentified leakage if the result was a small negative number. Tr. 4570. He could not remember the range of negative values he would accept or whether there was a specific rule concerning

an acceptable range. Tr. 4571. He considered that the status of Unit 2's development made it possible that negative leak rate tests would result. Tr. 4570. While he agreed that negative leak rate tests might not appear logical, he was convinced that the "swings" in instrumentation in the ICS made it just as likely to obtain a negative as well as a positive leak rate. Tr. 4596. We essentially agree with Mr. Bryan on this point.

285. Mr. Bryan recalled that the Technical Change Notification (TCN) to the leak rate Surveillance Procedure was implemented to correct an error in the leak rate test procedure and not to create an improper bias toward the production of favorable test results. Tr. 4597, 4605. He believed that he would not have noticed any problems in the TCN or objected to tests performed pursuant to it. Tr. 4596, 4605.

286. Mr. Bryan did not initial the sign-off sheet attached to LER 78-62/IT. Tr. 4608. Mr. Bryan believed that he did not read the LER, because someone else erroneously entered his initials alongside Mr. Bryan's name. Tr. 4609. Not surprisingly, therefore, Mr. Bryan had no recollection of that LER. Bryan Prepared St., p. 5. Although, arguably, Mr. Bryan should nevertheless have read the LER and seen to it that his foreman and shift corrected their interpretation of the Tech Specs, under these circumstances we do not charge him with culpable neglect with respect to the LER.

287. We find that Mr. Bryan must be charged with culpable neglect in that he failed to keep himself adequately informed about the conduct of leak rate tests and to oversee Mr. Guthrie's direct supervision of

such tests, particularly in light of Bryan's knowledge that the test was presenting problems. Tr. 4570, 4607-4608.

James R. Floyd, Supervisor of Operations

288. Mr. Floyd was the Supervisor of Operations of TMI-2 during the period relevant to this proceeding. Floyd Prep. St., p. 2, ff. Tr. 4894. Mr. Floyd reported to the Unit 2 Superintendent, Mr. Gary Miller, until December 1978, and Mr. Logan thereafter. Miller Prep. St., pp. 2-5, ff. Tr. 5039. He did not report at any time to Mr. Seelinger. Tr. 4625-26, 4769 (Seelinger), 5004-05 (Floyd).

289. We have already discussed Mr. Floyd in relation to (1) the events leading to the November 1, 1978 LER, (2) his knowledge of difficulties the operators were having with leak rate tests, and (3) his knowledge of the practice of discarding tests. We will not repeat those discussions in detail here. The findings in those discussions stand independently. The purpose of this section is to summarize and provide our overall assessment of Mr. Floyd's performance.

290. As the Supervisor of Operations, Mr. Floyd bears greater responsibility for what went wrong with leak rate tests at TMI-2 than any other single individual. He -- above the operators, foremen and shift supervisors -- had overall responsibility for seeing to it that the leak rate test was conducted correctly and that the unit was operated in accordance with the Tech Spec limit on unidentified leakage. He failed in that responsibility in several respects. Furthermore,

taking into account the many conflicts between Floyd's testimony and the evidence in the record and Floyd's demeanor before this Board, we find that Floyd was not fully forthcoming and candid. Indeed, Floyd was, in our judgment, the least candid witness to appear in this proceeding.

291. As discussed above (IV ¶ 46) there is considerable evidence, and we find, that Floyd knew about the difficulties the operators were having with the leak rate test. Apart from the specific evidence we have cited, that conclusion is compelled by Floyd's close relationship with the CRO's and the way he functioned on the job. It is inconceivable to us that a self-styled "crisis fighter" like Floyd who "lived out of the control room" (Tr. 4875) would not have been quite familiar within the difficulties we have described. We reject as incredible Floyd's claim that he had "no recollection of knowing any of these problems," that he was "basically...ignorant of what was going on." Tr. 4976.

292. The most striking lack of candor in Floyd's testimony relates to the misinterpretation of the Tech Specs under which seemingly valid tests reading over 1 gpm were not considered to trigger the action statement if one "good" test had been obtained in the preceding 72 hours. The great weight of the evidence shows that that was Floyd's interpretation until the Havercamp incident, and that it continued under Floyd when the "Havercamp correction" was not implemented. Mr. Seelinger, a believable witness, testified that that was the Floyd interpretation. Tr. 4745-4747, 4764-4765. Mr. Havercamp, also a believable witness, testified that:

> I clearly recall Mr. Floyd telling me, in effect, that RCS unidentified leakage test results must be calculated to be within acceptable limits (less than 1 gpm) only once every 72 hours in order to be in legal compliance with TS surveillance requirements. In his view, any number of RCS unidentified leakage measurement test results could be greater than 1 gpm, so long as every 72 hours acceptable leakage results were obtained. I did not attempt to determine whether this was a long-standing view or a hastily-formed justification or excuse that Mr. Floyd had argued to avoid a violation of the TS. However, I informed Mr. Floyd that in my view his interpretation was clearly incorrect.

Floyd himself, in his prefiled testimony, testified that:

> Until October of 1978, it was the general opinion that we had to get one valid leak rate of less than one gallon per minute unidentified leakage into the record every 72 hours to comply with the Unit's technical specifications. After October 20, 1978, if there was a bad leak rate and an operator could not convince himself that it was invalid, steps were to be taken to shut the Unit down.... I issued a memorandum in October of 1978 to explain the change in interpretation of Operations personnel.

At the hearing, however, Mr. Floyd apparently recognized that his long-standing Tech Spec interpretation was untenable. Accordingly, he engaged in some unconvincing backpedaling from his own prefiled testimony. Tr. 4903-4907. The Board credits the Seelinger and Havercamp testimony on this point and rejects Floyd's attempt to obfuscate the record.

293. In addition to the foregoing, we adopt the following quoted portions of findings proposed by GPUN:

> 208...Floyd admitted that he should have been aware of the failure by operators to record the start and stop times of leak rate tests in the CRO Log Book, as required by AP 1012, "because I was required to review the log book once a week." Floyd, ff, Tr. 4984 at 6. Floyd also admitted that he did not enforce the application of E&Ds to leak rate tests, as required by AP 1010. Id. at 3; see also

> Tr. 4991-93 (Floyd). Operators thus were "failing to take [actions] in violation of technical specification requirements." CLI-85-18, 22 NRC at 881. By failing to review the CRO Log and enforce the application of E&Ds to leak rate tests, Floyd through "dereliction or culpable neglect" was allowing such improper actions to occur. These very actions, if corrected, might well have highlighted the greater underlying problems with leak rate testing practices and led to their correction.
>
> 210...Floyd admitted that the analysis of plant status he provided on October 18, 1978, was invalid because he attempted to determine the "legality" of continuing to operate the plant without asking for all of the relevant information. Tr. 4919-20 (Floyd); see ¶ 115 supra. In response to the Board's inquiry concerning how Floyd could correctly answer Seelinger, who had sent Bezilla with three tests for analysis, NRR Test Nos. 12C-E, Floyd responded, "All I was asked for was to look at these three pieces of paper." Tr. 4919 (Floyd). The Board believes that the Supervisor of Operations must initiate and probe as well as receive and observe. By failing to demand the further information necessary for a valid analysis, Floyd lost a critical opportunity to discover that operators were again failing to take an action -- entry into the Action Station immediately upon obtaining a valid leak rate over 1 gpm -- in violation of Tech Spec 3.4.6.2. We therefore find that Floyd by his "dereliction or culpable neglect" allowed one of the improper actions enumerated by the Commission in its Order and Notice of Hearing.

294. Mr. Floyd testified that he was unaware, prior to the TMI-2 accident, that adding hydrogen to the MUT might affect leak rate test results. Floyd Prep. St., p. 6; Tr. 5026-27. Because of Mr. Floyd's understanding of differential MUT level transmitters, it is plausible that he would not believe that hydrogen additions would have had such an effect. See Faegre & Benson Report, Vol. One, pp. 42-43. We find that Mr. Floyd was not aware of hydrogen additions to the MUT made during leak rate tests for the purpose of manipulation. See Tr. 5027-28.

There is no evidence that Mr. Floyd had any knowledge of or participated in manipulation or falsification of leak rate tests by water or by any other means.[40]

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40 The Aamodts did not attend the hearing. As a matter of grace, not of right, the Board allowed the Aamodts to submit questions to the Board to be put to witnesses, subject to prior review by the Board and possible objections by the parties. We sustained an objection to a question proposed by the Aamodts for Mr. Floyd. Tr. 5008-09, 5034-35. The Aamodts subsequently filed a belated "Request for Relief" arguing that the objection to their question was invalid, accusing the counsel for Mr. Floyd who made the objection of "fraud", and urging us to put the question now to Mr. Floyd. Other counsel for Mr. Floyd responded to the Aamodt requests by letter dated April 3, 1987, objecting to them in various respects, but providing a response to the question in order to put the matter to rest.

The original objection was sustained on the basis of a stipulation described by counsel, a description which the Aamodts now question. This point is arguable. The literal language of the stipulation favors the Aamodts, but the purpose and likely intent of the stipulation favors counsel for Mr. Floyd. We need not resolve that issue because, in any event, the question is irrelevant to any issue in this proceeding. Furthermore, the question has now been answered. The Aamodt's personal attack on Mr. Floyd's counsel is baseless and is rejected. In view of our prior warning to the Aamodts about baseless personal attacks, and were this not the final chapter in this Board's proceeding, we might grant counsel's request to "terminate the Aamodts' disruptive participation in this proceeding." See Memorandum and Order of March 26, 1986, p. 5 note.

The Board trusts that the foregoing recommended decision is responsive to the Commission's requests.

Respectfully submitted,

James L. Kelley, Chairman
ADMINISTRATIVE JUDGE

Glenn O. Bright
ADMINISTRATIVE JUDGE

James H. Carpenter
ADMINISTRATIVE JUDGE

Bethesda, Maryland

APPENDIX A

List of
Exhibits
TMI-2 Leak Rate Proceeding

Exhibit No.	Description	Identified at Tr.Page	Received at Tr.Page
1-A	TMI-2 Reactor Coolant Inventory Balance Testing, Prepared for GPU Nuclear Corp. by Edwin H. Stier, September 5, 1985, all volumes.	388,391(as modified at 569)	388(as modified at 570), 5104,5221
1-B	Review of NRR and OI Reports on TMI-2 Reactor Coolant Inventory Balance Testing, Prepared for GPU Nuclear Corp. by Edwin H. Stier, August 28, 1986	388,391(as modified at 569)	388(as modified at 570), 5104,5221
1-C	Letter from Edwin H. Stier to Philip R. Clark, dated September 2, 1986	388,391(as modified at 569)	388(as modified at 570), 5104,5221
2	Results of Faegre & Benson Investigation of Allegations of Harold W. Hartman, Jr. Concerning Three Mile Island Unit 2, September 17, 1980, all volumes, but excluding Vol. 1, Sec. IV and Vol. 2, Ch. 9.	389-89	389, 5104,5221
3	Portion of Page 12 of Report of GPU Assessment Panel for Individuals Involved in TMI-2 Leak Rate Testing (in 1978-1979), January 6, 1986. (re Herbein)	389	389, 5104,5221
4	TMI-2 Computer Log (October 27, 1978).	389	389, 5104,5221
5-A	Results of NRR's Investigation and Evaluation of Ten Licensed Operators involved in TMI-2 Preaccident Leak Rate Testing Irregularities, including attachments and supporting documents. (per the Board's 6/24/86 Order, p. 7, undifferentiated references to "management" are to be disregarded.)	389(as modified at 569-71	389(as modified at 571), 5104,5221

Exhibit No.	Description	Identified at Tr.Page	Received at Tr.Page
5-B	Memorandum from William Russell to Harold Denton, dated September 20, 1985, with enclosed report.	389(as modified at 569-71	389(as modified at 571), 5104,5221
6	Office of Investigations Report entitled: Three Mile Island-2: Investigation of Individual Operator Actions Concerning the Falsification of Leak Rate Test Data, including all attachments.	389-90	390, 5104,5221
7	U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, TMI-1 Restart: An Evaluation of the Licensee's Management Integrity as It Affects Restart of Three Mile Island Nuclear Station Unit 1, Docket 50-289 (July 1984) (NUREG-0680, Supp. No. 5, Sec. 4.0.)	390	390, 5104,5221
8	Memorandum of Oct. 27, 1978	390	Withdrawn 5103,5221
9-A thru 9-F	Photographs of TMI-2 Control Room	377-381(as renumbered)	381(as renumbered at 391), 5104,5221
9-G	Photograph of the TMI-2 makeup storage tank level indicator, pressure indicator and temperature indicator.	1182	1183, 5104,5221
10-A	Sample SRO license	1025-26	1027,5104 5221
	Sample RO license	1026	1027,5104 5221
11-A and 11-B	J. Moore Charts, Effect of Oscillations	1025	5104,5221
12-A	Administrative Procedure (AP) 1036, Instrument Out-of-Service Control, Rev. 0, March 1978	1354-55	5104,5221

Exhibit No.	Description	Identified at Tr.Page	Received at Tr.Page
12-B	Administrative Procedure (AP) 1036, Instrument Out-of-Service Control, Rev. 1, August 1978	1354-55	5104,5221
13	Drawing of peak-to-peak v. slope offset calculation (included in Exhibit 24.)	1845(as modified at 5103-04)	5104,5221
14	Stier cover letter to Board with two strip charts showing hydrogen additions (included in Exhibit 24.)	1862(as modified at 5103-04)	1862
15-A and 15-B	Curriculum vitae of Dr. Harrison and Mr. Cole	2008	2008, 5104,5221
16	Training Department Administrative Memorandum Number 5, Change 2, dated October 8, 1976 (Subject-Category IV CRO Training Program.)	2219-20	2234,5104 5221
17	Excerpts from Instrument Out of Service Log	2400	2400,5104 5221
18	RCIB Test of 2/15/79, portion of CRO log and MUT Strip Chart	3470	3470,5104 5221
19	TMI-2 Control Room Layout diagram	3500-01	3501,5104 5221
20	D. Haverkamp prefiled testimony and attachments	4336	4337,5104 5221
21	Bettenhausen affidavit	4336	4337,5104 5221
22	TMI-2 FSAR Pages 9.3-26 thru 9.3-30 and 5.2-16 thru 5.2-27	4431	4431,5104 5221
23	TMI-2 FSAR Section 5.2.3.4, and Table 5.2-12	4431	4431,5104 5521
24	Stier letter to Judge Kelley, dated September 30, 1986, with attachments	5103-04	5221

Exhibit No.	Description	Identified at Tr.Page	Received at Tr.Page
25	MPR letter to Edwin Stier, dated September 30, 1986	5104	5221
26	Letter dated Nov. 3, 1986 from R. Gallo to Rochester Gas and Electric Corp., enclosing NRC Region I Inspection Report No. 50-244/86-16, and Numerous Employees Follow-up Questions for Donald R. Haverkamp	5266-67	Rejected 5267
27	Letter dated Oct. 21, 1986 from J.P. Moore to W.A. Rockwell, Subject: MUT Level Transmitter	Bd. Order 1/19/86	Bd.Order 1/19/86

APPENDIX B

LIST OF WITNESSES AND TESTIMONY

Witnesses	Written Testimony	Oral Testimony	Date
Adams, Charles D.	ff. Tr. 3776	3775 to 3841	10/15
Boltz, Dennis J.		2218 to 2234	9/25
Booher, Raymond R.	ff. Tr. 4175	4175 to 4232	10/28
Brummer, John A.*	ff. Tr. 5236		
Bryan, Kenneth P.	ff. Tr. 4540	4539 to 4610	10/31
Capra, Robert A.		374 to 1904, 2207 to 2209 2313 to 2439	9/8,9/9,9/10,9/11, 9/12,9/16,9/17, 9/18,9/25,9/30
Christopher, Keith		2314 to 2438	9/30
Chwastyk, Joseph J.	ff. Tr. 3407	3405 to 3600	10/10
Cole, Norman M., Jr.		374 to 2034	9/8,9/9,9/10,9/11, 9/12,9/16,9/17, 9/18,9/19
Coleman, Mark S.	ff. Tr. 2579	2578 to 2657	10/1
Conaway, William T., II	ff. Tr. 3097	3096 to 3141	10/7
Congdon, Joseph R.	ff. Tr. 2709	2708 to 2782	10/2,10/3
Cooper, Martin V.	ff. Tr. 2835	2835 to 2945	10/6
Faust, Craig C.	ff. Tr. 2511	2511 to 2577	9/30,10/1
Fels, William J.		4489 to 4535	10/30
Floyd, James R.	ff. Tr. 4894	4892 to 5036	11/4,11/5
Frederick, Edward R.	ff. Tr. 2447	2446 to 2510	9/30
Germer, Leonard P.*	ff. Tr. 5236		
Guthrie, Carl L.	ff. Tr. 4113	4112 to 4159	10/17

Witnesses	Written Testimony	Oral Testimony	Date
Harrison, Dwight H.		374 to 2034	9/8,9/9,9/10,9/11, 9/12,9/16,9/17, 9/18,9/19
Hartman, Harold W., Jr.		2239 to 2309	9/25
Haverkamp, Donald R.	Exhibit 20	2042 to 2210 5237 to 5267	9/24 11/12
Hemmila, Earl D.	ff. Tr. 4039	4038 to 4111	10/17
Herbein, John G.	ff. Tr. 5268	5267 to 5320	11/12
Hitz, Gregory R.	ff. Tr. 3664	3663 to 3732	10/14
Hoyt, Kenneth R.	ff. Tr. 4233	4233 to 4299	10/28
Illjes, Theodore F.	ff. Tr. 3010	3010 to 3096	10/7
Kidwell, John M.	ff. Tr. 3285	3285 to 3399	10/9
Kirkpatrick, Donald C.**	ff. Tr. 376	374 to 1243	9/8,9/9,9/10, 9/11,9/12
Kunder, George A.	ff. Tr. 4800	4799 to 4889	11/4
Logan, Joseph B.		5105 to 5220	11/6
Marshall, Walter J.	ff. Tr. 4380	4379 to 4424	10/29
McGovern, Hugh A., Jr.	ff. Tr. 3148	3147 to 3235	10/8
Mehler, Brian A.	ff. Tr. 3842	3841 to 3907	10/15
Mell, Charles F.	ff. Tr. 3239	3239 to 3282	10/9
Miller, Adam W.	ff. Tr. 3608	3607 to 3662	10/14
Miller, Gary P.	ff. Tr. 5039	5038 to 5096	11/5
Moore, James P.		374 to 1165	9/8,9/9,9/10,9/11
Olson, Dennis I.	ff. Tr. 3911	3911 to 4034	10/16
Phillippe, Mark D.	ff. Tr. 4432	4431 to 4489	10/30
Rockwell, Winthrop A.		374 to 1165	9/8,9/9,9/10,9/11

Witnesses	Written Testimony	Oral Testimony	Date
Russell, William T.		374 to 1904, 2313 to 2438	9/8,9/9,9/10,9/11 9/12,9/16,9/17, 9/18,9/30
Seelinger, James L.	ff. Tr. 4623	4614 to 4784	11/3
Scheimann, Frederick J., Jr.	ff. Tr. 2831	2783 to 2831	10/3
Stier, Edwin H.		374 to 2034	9/8,9/9,9/10,9/11, 9/12,9/16,9/17, 9/18,9/19
Smith, Bernard G.	ff. Tr. 4331	4330 to 4379	10/29
Wermiel, Jared S.**	ff. Tr. 376	374 to 801	9/8,9/9,9/10
Wright, Lynn O.***	ff. Tr. 2663	2661 to 2707	10/2
Zewe, William H.	ff. Tr. 2946	2945 to 3006	10/6

*The Board did not call Brummer and Germer as witnesses. Their prefiled testimony, however, was bound into the record and reflects what the witnesses would have sworn to had they appeared. Their statements could be referred to as if the witnesses had appeared to testify. Tr. 5236 (Kelley, J.).

**Joint prefiled - Kirkpatrick and Wermiel

***Because Wright did not adopt his prefiled testimony, it was bound into the record, not as substantive evidence, but as a brief accurate summary of a longer statement placed in the record (Board Exh. 6, OI Report, Exh. 18, Wright Interview) and regarded as substantive evidence. Tr. 2662-63 (Kelley, J.).

Documentary Material Bound into the Transcript

Description	Page	Date
Professional Qualifications of Robert A. Capra	ff Tr. 651	9/9
Surveillance Data Flow Chart	ff Tr. 731	9/9
Questions 5 thru 8 Submitted by Numerous Employees for D.R. Haverkamp	ff Tr. 2169	9/24
Personal Resume of Dennis J. Boltz	ff Tr. 2217	9/25
Paragraph from Page 7 of Prefiled Testimony of B. G. Smith	Tr. 2262	9/25
List of Exhibits	ff Tr. 5221	11/6

APPENDIX C*

CORRELATION OF NRR AND STIER TEST NUMBERS FOR EACH TMI-2 LEAK RATE SURVEILLANCE TEST PERFORMED BETWEEN 9/30/78 AND 3/28/79

NRR TEST No.	STIER TEST No.	NRR TEST No.	STIER TEST No.
SEPTEMBER 1978		NOVEMBER 1978	
1	161	32	126
OCTOBER 1978		33	125
		34	124
2	160	35	123
3	159	36	122
4	158	37	121
5	157	38	120
6	156	39	119
7	155	40	118
8	154	41	117
9	153		
10	152	DECEMBER 1978	
11	151		
12	150	42	116
12A	149	43	115
12B	148	44	114
12C	147	45	113
12D	146	46	112
12E	145	47	111
13	144	48	110
14	143	49	109
15	142	50	108
16	141	51	107
17	140	52	106
18	139	53	105
19	138	54	104
20	137	55	103
21	136	56	102
22	135	57	101
23	134	58	100
24	133	59	99
25	---	60	98
26	132	61	97
27	131	62	96
28	130	63	95
29	129		
30	128		
31	127		

* See Board Exh. 5-B, NRR Report, Attachment 1.

APPENDIX C (continued)

NRR TEST No.	STIER TEST No.
DECEMBER 1978	
64	94
65	93
66	92
67	91
68	90
69	89
70	88
71	87
72	86
73	85
74	84
75	83
76	82
77	81
78	80
79	79
80	78
81	77
82	76
JANUARY 1979	
83	75
84	74
85	73
86	72
87	71
88	70
89	69
90	68
91	67
92	66
93	65
94	64
95	63
96	62
FEBRUARY 1979	
97	61
98	60
99	59
100	58
101	57
102	56
103	55
104	54
105	53
106	52
107	51
108	50
109	49
110	48
111	47
112	46
113	45
114	44
115	43
116	42
117	41
118	40
119	39
120	38
121	37
122	36
123	35
124	34
125	33
126	32
127	31
128	30
129	29
130	28
131	27
132	26
133	25
MARCH 1979	
134	24
135	23
136	22
137	21
138	20
139	19
140	18
141	17
142	16
143	15
144	14
145	13
146	12
147	11
148	10
149	9
150	8
151	7
152	6
153	5
154	4
155	3
--- No Test	2
156	1