DRAFTS OF REPORTS AND INTERVIEWS

D-1 Draft of discussion on interview with Hugh McGovern.

D-2 Draft of interview with John Blessing by Christopher.

D-3 Draft of interview with John Blessing by Christopher and Martin.

D-4 Draft of interview with Raymond Booher by Cummings, Martin and Christopher.

D-5 Draft of interview with Raymond Booher by Christopher.

D-6 Draft of interview with Raymond Booher by Christopher and Martin.

D-7 Draft of interview with Joseph Congton by Sinclair.

D-8 Earlier Draft of interview with Joseph Congdon by Sinclair.

D-9 Prospective list of interviewees.

D-10 Early draft of Table 9 from investigation feeder report by Kirkpatrick.

D-11 1980 draft of investigation feeder report on Leak Rate Review by Kirkpatrick.

D-12 Draft feeder report on allegation concerning estimated critical position written by J. W. Chung.

D-1

I assisted in interviewing three TMI Unit 2 Control Room Operators (CRO's), Hugh McGovern, Earl Hemmila and Mark Coleman, on April 10, 1980, at the NRC trailers at the site. Also participating in the interview was ~~Dave~~ David H. Gamble of the Office of Inspector and Auditor. As part of the interview, I asked each of the operators a series of questions. The substance of these questions and the operator's answers derived from my memory and sparse notes, are briefly listed ~~below~~ in the two attached sheets. Each operator was asked to sign a written statement which Mr. McGovern and Mr. Hemmila did. Mr. Coleman participated in the formulation and editing of a statement, but decided not to sign it. Where the answer to a question appears in the statement it is not included ~~below~~.

Donald C. Kirkpatrick

I assisted in interviewing three TMI Unit 2 Control Room Operators (CROs), Hugh McGovern, Earl Hemmila and Mark Coleman, on April 10, 1980 at the NRC trailers at the site. Also participating in the interview was Dave Gamble of the Office of Inspector Auditors. As part of the interview, I asked each of the operators a series of questions. The substance of these questions and ~~the~~ operator's answers, derived from my memory and sparse notes, are briefly listed below. Each operator was asked to sign a written statement which Mr McGovern and Mr Hemmila did. Mr Coleman participated in the formulation and editing of a statement but decided not to sign it. Where the answer to a question appears in the statement it is not included below. ~~In Mr Coleman's~~ ~~case a detailed report of the~~ ~~[illegible] was written and signed~~ ~~[illegible]~~

Don Kirkpatrick

Operator — Hugh McGovern

Q What is your understanding of the purpose of the leak rate test?

A To prevent the release or minimize the release of radiation to the environment. ~~To determine leaks from the reactor to adjoining systems.~~ To prevent loss of coolant from the reactor coolant inventory. ~~[illegible]~~

Q Have you every recieved training on the connection between the unidentified leak rate and a crack in the reactor pressure boundary as discussed in the SAR?

A — No

Q - Describe the leak rate test including all of the elements that go into the calculation of the leak rate.

A. Gave a knowledgeable discussion of the test including the changes in the RCS density, Pressurizer level, Makeup tank and RC drain tank. Discussed the addition of water during the test and the necessity for entering this in the computer.

Q Did you ever have difficulty getting good leak rate test results. ~~[illegible]~~ and what were the main reasons for the difficulty?

A - Yes and No The main cause of inaccuracy was the variation in the indicated level in the makeup tank (false level change) This amounted to a inch or so which would cause a variation of about 30 gallons.

~~The RC [illegible] tank [illegible]~~

Q Were you aware of problems with the Leak Rate test computer program and the inaccuracies in the program?

A - Yes. Did know that there was a change in the computer program between ~~[illegible]~~ December 1978 and January 1979

Q What was normally done with a computer test record that gave unacceptable results

A - It was discarded.

Q In what ways can the leak rate test results be changed by operator actions?

A. See Statement

Q Did you ever use any of these methods to effect the results of a leak rate test.?

See statement

(Subsequently Mr Mcgovern was shown documentation showing that water had been added during the performance of one of his tests with out entry into the computer. This is discussed in the statement

Q Did you know of any one else who used these methods to effect the leak rate test results?

A - See statement

Q Did any of your superiors ever ~~ex~~ tell you to do anything to change the results of a leak rate test?

See statement

D-2

REPORT OF INTERVIEW WITH JOHN [redacted]
BLESSING [redacted] AS RECORDED BY [redacted]
R. KEITH CHRISTOPHER, INVESTIGATOR
US NUCLEAR REGULATORY COMMISSION

On 4-10-1980 Mr. John Blessing [redacted], a Unit 2 Control Room Operator for the [redacted] Metropolitan Edison Company was interviewed commencing at 0810 [redacted]. The interview was conducted at the Nuclear Regulatory Commission offices at the Three Mile Island Nuclear Power Station By: R. Keith Christopher and Thomas T. Martin from NRC Region I and Mr. Jim Cummings, of the Office of Inspector and Auditor, NRC headquarters. Also present was a representative for Metropolitan Edison Company -- attorney at law Harry [redacted] Glasspiegel.

John Blessing was questioned regarding the falsification of leak rate [redacted] Readings in the Reactor Coolant Inventory Surveillance tests for TMI-2. (next page)

~~Mr. Blessing was asked~~ "When asked if the aforementioned attorney was present at his request Mr. Blessing indicated the presence of Mr. Glasspiegel was desired.

Blessey denied knowing of any specific instances in which the leak rate records were intentionally falsified. He acknowledged that it was common practice by a large portion of the Control Room operators, to add hydrogen to the makeup tank, while running the leak rate surveillance tests, in order to assist in getting good leak rate results (i.e. results that met technical specification requirements). At this time, Blessey did not specify or identify individuals who had actually added hydrogen to the makeup tank, but reiterated that it was common practice and well-known to personnel at least up to the shift foreman level of management. Blessey was also asked to relate ways that he was personally aware of for falsifying leak rate test results. He responded by stating that in addition to adding hydrogen, an operator could add water to the makeup tank without telling the computer ~~...~~ THIS WOULD RESULT IN an incorrect computer calculation ~~of the leak rate~~ showing less leakage in the Reactor coolant inventory which could cause the leakrate to fall within the technical specification requirements. Blessing said he was not aware of any instance where water was intentionally added to the makeup tank without telling the computer for the purposes of falsifying leakrate test results. He continued with the statement [illegible]. and there was no management indication that it was a forbidden practice to add hydrogen to the makeup tank while the RC Inventory Surveillance tests was being run

The second area of questioning concerned the destruction of ~~leakrate test records with~~ the Reactor Coolant Inventory Surveillance test records that ~~did not meet the~~ failed to meet the technical specification requirements of one gallon per minute (GPM) for unidentified leakage. During questioning Blessing acknowledged that he routinely destroyed leakrate test records which were bad (i.e. did not meet technical specification requirements) and acknowledged this was a common Practice among the Control Room Operators. Blessing was asked ------------------- more orders passed down through the ranks.

(BNMP PAGE 1)

He cited what he thought was the origination of this Policy when, on one occasion (date unknown) a bad leak rate calculation was left lying out in the Control Room. Blessing said shortly after that he overheard two foremen (whom he could not/would not identify) talking in the Control Room. He said, that to the best of his recollection, he heard them say that they (the foremen) didn't want the bad leak rate records laying out where the NRC could see them and then ask why they (the Plant) were not shut down. Haagens stated ------------- learned on the shift

at this time Blessing was questioned regarding the addition of hydrogen to the makeup tank in order to get good leak rate results for the Surveillance test.
He again stated - see attached
____ ____ ____ ____ All of them should have known about the Practice

Blessing was then questioned about his understanding of the technical specifications that gave him three days (72 hrs) in which to get a good leak rate calculation from the Reactor coolant Inventory Surveillance test. He stated that it was his understanding that he only had to have a good leakrate result once every 72 hours, irregardless of the fact that he might get subsequent unexplained "bad ones" during the period before getting the next satisfactory leak rate result. He said the bad leak rates ____ ____ ____ ____

____ He also stated that he felt the computer program was wrong because the computer would show a ~~[illegible]~~

large amount of leage in the Reactor Coolant Inventory and yet the sump Pump which collects the leakage from the various Reactor Coolant System mechanisms wouldn't come on, so that it was his opinion that there was no way that much water could be leaking from the reactor coolant system. He said these were the primary reasons.

---- ---- ---- would fail on an average of 4 - to five times Per shift and that all of those test results would have to be thrown away.

finish without further changes.

When specifically asked what foremen were aware of the hydrogen addition he stated he was confident that Ned Hoyt, his shift foreman was well aware of the hydrogen addition during the leak rate test. When asked about the other shift foremen and supervisors in the plant he stated it was his opinion that because it was such common knowledge, all of the foremen should have known about this practice. In referring to an operations dept. personnel roster he ~~specifically~~ identified ~~[illegible]~~ F. Scheimann, W.T. Conaway, C.S. Adams, A.W. Miller ~~Miller~~ and C.Z. Guthrie who are the Unit #2 shift foremen. Blessing did not provide ~~[illegible]~~ any supportive information as a basis for this assertion.

WHEN ASKED, "IS LAWYER HERE AT YOUR REQUEST,"

nterview of Mr. John BLESSING

The following [redacted] IS the results of an interview with Mr. John BLESSING, a Control Room Operator employed by the Metropolitan Edison Company. This interview was conducted on 4/10/80 at 0810 in Trailer No. 2 at the Nuclear Regulatory Commission [redacted] OFFICE, Three Mile Island Nuclear Power Station. This interview was conducted by Mr. RK Christopher AND Mr. T. T. Martin of the Region I Office, Nuclear Regulatory Commission and Mr. JIM CUMMINGS of the Office of Inspection and Auditor. ALSO PRESENT IS A representative for Metropolitan Edison Company, [redacted] Attorney at Law, Harry [redacted] GLASSPIEGEL. [redacted] MR Blessing [redacted] INDICATED THE ~~no objection to the~~ presence of Mr. GLASSPIEGEL WAS DESIRED.

John [redacted] BLESSING WAS QUESTIONED regarding the [redacted] FALSIFICATION OF leak rate TESTS [redacted] IN the reactor ~~core~~ COOLANT system for TMI-2. [redacted] BLESSING DENIED knowing any specific instances in which [redacted] LEAK RATE records WERE intentionally falsified. He acknowledged that it was common practice, by A large portion of the control room operators, to add hydrogen to the makeup ~~test~~ tank, while running the test, in order to assist in getting good [redacted] leak rates. At this time, BLESSING did not specify or identify individuals who had added hydrogen, but reiterated that it was common practice and well known to [redacted] individuals [redacted], AT LEAST UP TO THE FOREMAN LEVEL. [redacted]

I recorded to here but that did not end the paragraph. Tape is really bad

HE INDICATED THIS WAS BECAUSE OTHER OPERATORS WHO HE COULD NOT ... HAD TOLD HIM THAT HYDROGEN WOULD AFFECT THE LEAK RATE TEST CALCULATION

BLESSING ~~[illegible]~~ was also asked to Relate any ways that he was personally aware of for falsifying leak rate tests. He responded by stating THAT besides adding hydrogen, that YOU COULD add water to the makeup tank without telling the computer. He stated he was not aware of any INSTANCES where water was knowingly added without telling the computer FOR PURPOSES OF falsifying leak rates. He continued with the statement that he did not feel the addition of hydrogen was a falsification of the leak rate records because IT ~~[illegible]~~ "Didn't do anything to the makeup tank level". He did acknowledge that on numerous occasions he had in fact added hydrogen to the makeup tank while running leak rates. ~~[illegible]~~ ~~passed on to [illegible] from other operators who he said he was unable to identify that adding hydrogen would affect the leak rate~~. He emphasized that ON 9 out of 10 occasions the addition of HYDROGEN TO THE MAKE UP TANK DID NOT WORK AND THERE ~~hydrogen to the leak rate tank did not work and there~~ was no management indication that it was a forbidden practice.

The next area of questioning involved the destruction of leak rate tests RECORDS which did not meet the one gallon per minute specification FOR UNIDENTIFIED LEAKAGE. ~~Blessing~~ During questioning BLESSING acknowledged that he routinely destroyed leak rate tests which were bad and acknowledged this was a common practice among the control room operators. BLESSING WAS ASKED IF HE WAS DIRECTED to destroy the bad leak rate calculations and he responded by stating that the PRACTICE OF throwing away of BAD leak rates TESTS ~~was~~ "filtered down from the management people ~~by~~ shift foremans." BLESSING SAID he was unable to specifically identify any one foreman or supervisor who specifically told him to destroy the bad leak rate calculations, and reiterated that it was more or less passed down through THE ranks.

He cited what he thought was the origination of this policy when on one occasion (date unknown) a bad leak rate was left out in the control room. Blessing said that shortly after that he overheard TWO FOREMEN talking in the control room. He said to the best of his recollection he heard them say that they didn't want the bad leak rate records laying out where the NRC would see them and would ask why they were not shutdown. He again stated that he could not specifically identify any one particular management individual who directed HIM to throw away the leak rates, STATES that it was just something he learned on the shift. At this time BLESSING WAS questioned regarding the addition of hydrogen to the makeup tank in order to get good leak rate records. He AGAIN stated that he has in the past added hydrogen to the makeup tank and STATED that adding this was something he would do as a last resort to get a good leak rate. He again stated he picked up this suggestion (to add hydrogen) from other operators, but could not specify any particular individual. HE INDICATED THAT HE KNEW AT LEAST ONE OTHER OPERATOR (NAME FORGOTTEN) ADDED HYDROGEN DURING A LEAK RATE TEST. He emphasized that it was not a secret that hydrogen was being added to the makeup tank during the running of the leak rate tests and it was a totally common practice. He said it was HIS OPINION supervisors and foremen WERE well aware of this practice. He again reiterated that 9 out of 10 times the hydrogen addition did not work and therefore was not pertinent to the issue. When specifically asked what foreman were aware of the hydrogen additions, he stated that he was confident that Dick Hoyt his shift foreman was well aware of the hydrogen additions during the leak rate tests. When asked about the other shift foreman and supervisors in the plant, he again stated that it was his opinion that because it was such common knowledge all of them should have known about the practice.

~~In further questioning~~ John BLESSING was then questioned about his understanding of the technical specifications that gave him ~~the~~ A three day (72 hour period) in which to get a good leak rate. He stated that IT WAS IN FACT HIS [redacted] understanding that he only had to have a good leak rate every 72 hours [redacted] irregardless of the fact that he ~~had~~ MIGHT GET [redacted] BAD ONES [redacted] DURING THE PERIOD BEFORE THE NEXT GOOD ONE. [redacted] He said the bad leak rates were largely disregarded because he and the other operators felt the computer was not accurate. HE SAID Particularly in the later stages, just prior to the accident, it became harder and harder to get good leak rates because the computer program errors made it difficult to get acceptable leak rates. He also stated that he felt that the computer program was wrong because the computer would show a large amount of leakage and yet the sump pump wouldn't come on so that it was his opinion THAT there was no way there could be that much water leaking. He said these were the primary reasons why the ~~LAS~~ RO operators disregarded the bad leak rate data. He also stated that along with the COMPUTER CALCULATED leak rates, he ~~also~~ ~~made~~ DID many hand calculations and that he got "better ones" then the computer. He also stated HE and Hal Hartman had made quite a few of these hand calculated leak rates. BLESSING SAID THESE COMPUTER PROBLEMS WERE RELAYED TO [redacted] A MR. FELL FOR CORRECTION, BUT NO IMMEDIATE CORRECTIVE ACTION WAS TAKEN. He continued that [redacted] AS THE approach to the accident drew nearer it was more difficult to get good leak rates and there was increasing pressure to get them, although he did not specify management PERSONNEL OR WAYS PRESSURE WAS EXERTED. [redacted]. He said he felt the computer was not picking up the increased leakage in the valves LEADING to the RC drain tank and for this reason it was causing bad calculations. He said it was also his opinion that leak rate tests would fail on an average of 4 to 5 times per shift and that all those would have to thrown away.

HE STATED HE COULD NOT REMEMBER A TIME WHEN THE HAND CALCULATION DIDN'T GET A GOOD ONE.

Blessing also related at this time that it was his personal knowledge that Hal Hartman had IN FACT added hydrogen to the makeup tanks during this period to get good leak rates. WHEN questioned regarding the other operator ON HIS SHIFT, RAY BOOHER, he stated that he could not say for a fact whether or not BOOHER had in fact added hydrogen or water or in any other way falsified leak rates.

BLESSING WAS THEN QUESTIONED regarding management pressure that was being exerted in order to get GOOD leak rates. He stated that he did not feel there was any direct upper management pressure but there was a strong desire to keep the plant on the ON-LINE and that no one wanted to be the shift that was responsible for the plant coming down. HE INDICATED THE PRESSURE RESULTED FROM HIS PERSONAL SENSE OF DUTY TO KEEP THE PLANT ON THE LINE. Again he stated that he did not feel the hydrogen was a falsification of leak rates because it did not work MOST OF THE TIME. This time he acknowledged that adding water to the tank would be a falsification, BUT stated that he would not knowingly add water without telling the computer. He DID indicate that this could happen FOR several reasons; for one, THE OPERATOR WOULD just forget to add it TO THE COMPUTER. He ALSO explained that the operator doing the leak rate was not responsible for inputting the water additions to the computer and that IN THE DIALOGUE between the two it VERY WELL could happen that the operator RUNNING THIS COMPUTER PROGRAM did not know the water was added. At this time, Mr. Martin showed John Blessing a leak rate calculation for 2/2/79, which reflected that during the period of the leak rate test, water was added to the makeup tank. It was noted by Blessing that the LOG ENTRY WAS MADE BY RAY BOOHER and he also acknowledged that he had in fact AND signed the computer calculations FOR THE leak rate tests. He denied intentionally adding water to the makeup tank in order to get a good leak rate.

He stated that he probably did not know that Ray BOSHER had added water and for that reason he punched 0 into the computer calculation for operator INDUCED CHANGE. He said that normally he would tell the panel operator not to add water when the leak rate tests would be run, but then on some occasions IT WOULD BE FORGOTTEN. He said in all probably IT WAS HIS own error that resulted in water being added WITHOUT THE computer being told. He again denied that he intentionally NEGLECTED TO THE WATER ADDITION in order to falsify the leak rates RECORD CALCULATION. At this time, BLESSING was shown another leak rate calculation dated 1-13-79, which also indicated an addition of water during the leak rate test. He again stated that his only explanation for the water addition without telling the computer was operator error. He concluded by denying that he intentionally falsified any leak rate calculations by the addition of water or by any other means. Blessing was then asked to provide a written sworn statement regarding the details of this interview; however Blessing declined to provide a sworn statement and the interview was terminated at 0945.

RK CHRISTOPHER

T. T. MARTIN

D-4

0715
4-10-80
RKC

RAYMOND BOOHER, CRO

INDIVIDUALS PRESENT

JOHN CODY - UNION REP IBEW
HARRY GLASS PIEGEL - ATTORNEY MET-ED
J. CUMMING
TED MARTIN
R. K CHRISTOPHER

says he can't remember the BCP incident. ~~dump~~ was not instructed to fudge any BCP. Brian Mehler and Hal Hartman had a working relations ship problem.

RCS leak Rate test
had problems getting leak rate (good ones)
recalled one day getting goods ones and the next time not getting them
Q - How could leak rates be fudge-
B. easy could Put down a wrong number. - used to take number off the makeup tank gauges
& pulls out the millivolt reading.

RAY BOOHER

ways to fudge (other)

recently heard about H_2 additions

- not aware of the fact that H_2 addition would cause a rise in the tank.

(2) run unacceptable leak rates

(1) not sure, says he can't remember

- doesn't remember the policy of what to do with leak rate tests (the unacceptable rates)

once they got acceptable leak rate

- if they get a bad one within a few hrs. after a good one - (A) says it is his understanding that he had 72 hrs to get a good leak rate from the time of the last one.

WHO INTERPRETED TECH SPECS - (A) it was

SOP - shift supervisor is normally responsible for interpreting tech specs.

0740 - Union rep requests a meeting with Booher.

0742 - returned

Re BOEHRE 4-10-80

reiterates - he doesn't remember what he did w/ bad leak rate tests

supervisors / Foremans - in general tell them to go back and get good leak rates

FOREMEN / SUPERVISOR - HOYT / SMITH

But he doesn't remember a specific instance of these supervisors telling him to get the leak rates when couldn't get good leak rates

- guys as a routine will just run another

H2 ADDITIONS

leak rate - ~~10-2~~ 10-20-78 - added H_2

states it was not his intent to falsify

1-13-79 - water added - not entered in the computer

- states this is his handwriting on this log.

Pressure - to get rates by adding ~~water~~

- says he doesn't ~~reme~~ remember if Hal asked him to fudge leak rates

-~~w~~CRO's add water when necessary.

state he can't remember if Hartman ever ~~so~~ asked him to fudge leak rates by adding water

JIM.

4

R B00482

2-23-79 - H2O 150 · logged in
by Booher - acknowledges it is his handwriting
in on the ~~to~~ log.
Booher - on panel - says he doesn't
necessarily know why. Someone else
is punching out leak rates
denies any knowledge of intentional
falsification / or even of actually falsifying
leak rates
states ~~he~~ he has no feeling for
Pressure from the management.
interview completed at 0800.

RKC
4-15-80

RAY BOOHER

RCP INCIDENT -4-23-80

FUDGING

10-20-78 ld test } H_2
1-13-79 logged in } H_2O
2-2-79 logged } H_2O
2-23-79 -logged in } H_2O

D-5

REPORT OF INTERVIEW WITH RAYMOND BOOHER AS RECORDED BY R. KEITH CHRISTOPHER, INVESTIGATOR, US NUCLEAR REGULATORY COMMISSION

On 4-10-80 Mr. Raymond Booher, a ~~[illegible]~~ control Room Operator for the Metropolitan Edison Company was interviewed commencing at 0715. The interview was conducted at the Nuclear Regulatory Commission Offices at the Three Mile Island Nuclear Power Station by R. Keith Christopher and Thomas T. Martin from NRC Region I and Mr. Jim Cummings of the Office of Inspector and Auditor, NRC Headquarters. Also present at the request of Booher ---- ---- ---- related essentially the following information.

Booher was asked to relate any information he had regarding an allegation made by Harold Hartman that during a Unit #2 startup the reactor went critical below the allowable band around the calculated "Estimated Critical

Position (ECP), the reactor was not shutdown as required by procedure for the event, and that a new ECP was fudged. Booker acknowledged - - - - - - - - - - - - unable to confirm or deny that this incident had taken place.

Booker was then questioned with regards to the reactor coolant Inventory Surveillance tests and he confirmed that there ~~had~~ had been problems in getting good leak rate results (I.E. results that met technical specification requirements). He indicated ~~that~~ that on some days they would get good leak rate results right away, while on other days they (the operators) could not get an acceptable one.

Booker was asked how leak rates could be falsified. He ~~[illegible]~~ [indicated that that could very easy] said the operator used to take a number off the reactor coolant drain tank gauges, and all the operator had to do was enter a wrong reading. Booker said he had no personal knowledge of any individual doing this and denied that he ever did it. - - - - - -

He said since the inception - - -
______________________ or if they were
kept.

Booker was then questioned as to his understanding of the technical specification requirements for the ~~[illegible]~~ performance of leak rates ~~[illegible]~~ in the Reactor Coolant Inventory surveillance tests. He said it was his interpretation that once they (the operators) got an acceptable leak rate it was 72 hours before they needed another one to meet the technical specification requirements. He said it was his interpretation - - - ______
______________________ until you got one (an acceptable leak rate calculation)

Finish what no further changes.

D-6

Results of Interview with Raymond ~~Bore~~ BOOHER

Raymond ~~Bore~~ BOOHER, control room operator for the Metropolitan Edison Company, was interviewed on 4/10/80 commencing at 0715. THE Interview was conducted at the Nuclear Regulatory Commission offices, Three Mile Island. The interview was conducted by R. K. Christopher and T. T. Martin ~~of~~ FROM NRC Region I and Mr. Jim Cummings of the Office of Inspection and Auditor, NRC headquarters. Also present at the request of ~~Bore~~ BOOHER was Mr. John Cody his union representative from the International Brotherhood of Electrical Workers and Mr. Harry ~~Galasspigel~~ CLASSPIBGEL, an attorney representing Metropolitan Edison Company. When interviewed ~~Bore~~ BOOHER related essentially the following information.

BOOHER was asked to relate ~~key~~ any information he had regarding an allegation made by Harold Hartman ~~during a startup~~ [illegible] ~~recalculated after~~ [illegible] ~~continuation of the startup and that there was~~ no shutdown [illegible] (see insert 1)

BOOHER acknowledged that he ~~was working~~ worked the same shift with Harold Hartman and recalled that on several occasions ~~working~~ he worked on a shift in which Brian Mehler was the shift supervisor. It [illegible] WITH NRC [illegible]. BOOHER stated that he could not remember [illegible] the incident in questions and [illegible] did insert ①

that during a ~~plant~~ plant startup, the reactor went critical below the allowable band around the calculated ECP, the reactor was not shutdown as required by procedure for this event, and that a new ECP was fudged.

not recall being asked to recalculate an ECP after the startup. He stated that he was never instructed by any supervisor to fudge AN ECP [redacted] calculation. He also noted that Harold Hartman and Mehler had a personality conflict that impaired their ability to work on the same shift. IN conclusion, Booher said he was unable to confirm or deny that this INCIDENT HAD [redacted] taken place.

BOOHBR [redacted] was then questioned regarding the reactor COOLANT [redacted] system leak rate tests and he confirmed that there had been problems in getting good leak rates. He INDICATED ~~said that he recalled the instability of the system in~~ that SOME DAYS ~~one day or in one hour~~ THEY would get good leak rate RESULTS RIGHT AWAY WHILE [redacted] and ~~during the~~ ON OTHER DAYS ~~next time period or over several time periods~~ they could not get AN [redacted] ACCEPTABLE ONE[redacted].

BOOHBR [redacted] was asked HOW ~~what were some of the ways that the~~ leak rates could be fudged. [redacted] He INDICATED THAT THE TESTS ~~responded that they~~ could very easily be fudged [redacted]. He said all an operator had to do was put down a wrong number. He said they [redacted] used to take a number off the REACTOR COOLANT DRAIN TANK ~~makeup tank~~ gauges [redacted] and all the operators had to do was enter a wrong reading ~~if they wanted to~~. He said he had no personal knowledge of any individual doing this and denied that he ever did it. He said [redacted] [redacted] since the inception of this investigation HE HAD HEARD that addition of hydrogen to the makeup tank was a way of getting good leak rates. He said he wasn't aware of this fact until recently AND [redacted] that he did not understand how hydrogen addition could cause a rise in the tank. Booher [redacted] was then questioned regarding the DISPOSITION of leak rate tests which had failed. ~~and questioned as to whether or not they were thrown away or what their disposition was~~. BOOHBR [redacted] stated that he was not sure and could not remember what the policy was and could not remember if he threw AWAY [redacted] bad leak rate tests or if they were [redacted] kept [redacted].

He was then questioned as to [redacted] his understanding of the technical specification [redacted] for the taking of leak rates. He said that it was his understanding and interpretation that once they got an acceptable leak rate it was 72 hours before they needed another one. He said it was his interpretation that if they had subsequent unacceptable leak rates, after a good one, it did not matter as long as it was within the 72 hour time period. He stated [redacted] this [redacted] interpretation was drawn [redacted] from his observation [redacted]

~~pretation that he had~~ and [redacted] of everyone else doing the same thing. [redacted] This interpretation was never related specifically to him in training or by any [redacted] supervisor. [redacted]

He did state that the technical specifications would normally be interpreted [redacted] by the shift supervisor, who would have been Bernie Smith, had there been any questions. Booher said [redacted] he could not recall this particular area being discussed by anyone. [redacted] Mr. Cody, union representative, then requested a private meeting with Booher. [redacted] They subsequently returned and the interview continued. At this time, Booher [redacted] reiterated that he did not remember what was done with a bad leak rate test record. [redacted] When questioned regarding the getting of good leak rates, he said that supervisors, [redacted] foremen, and other operators would, in general, tell each other [redacted] to get good leak rates, but that he did not feel that it was direct management pressure. He also stated that he did not remember any specific incident where either his supervisor Dick Hoyt or Bernie Smith specifically ordered him to get a leak rate at any cost. Booher said that the standing routine was that if you could not get a good leak rate, [redacted] you kept running it hourly until you got one.

At this time Mr. Martin showed Booher a leak rate calculation dated 10/20/78, which according to the control room operator's log, indicated hdyrogen had been added to the makeup tank during the leak rate test. Booher was at a loss to explain the hydrogen addition, or its effect, and denied that he had any intention to falsify the records.

~~10/20/78 which according to the operator's log indicated hydrogen had been added to the makeup tank during the test. [illegible] explain the hydrogen addition or its effect~~ _____ ~~denied that he had any intention to falsify the records.~~ Booher was also shown a leak rate calculation dated 1/13/79 in which water was added to the makeup tank and not entered into the computer. Booher reviewed the leak rate calculation and the copy of the control room log sheet pertaining to this incident. He confirmed that it was his handwriting in the log recording the entry, but had no explanation for it not being added to the computer. At this time, Booher again stated that it was not his intention that leak rates be falsified and that he felt no management pressure to do these type of things to get good leak rates. Booher acknowledged being a good friend of Harold Hartman and stated that he could not recall if Harold Hartman had ever asked him to specifically help him fudge leak rates. He specifically stated that he could neither confirm nor deny if Hartman ever asked him to fudge the leak rates by adding water. Booher was again shown another leak rate calculation dated 2/23/79 which reflected that water was again added during the time of the leak rate test.

BOOHER reviewed the leak rate RECORD and the operator's log and confirmed that it was his handwriting entering the water into SYSTEM. BOOHER continued to explain that on the panel he doesn't necessarily know if someone else is CONDUCTING a leak rate POST during TAK time and HB may not necessarily know that he should not add water if there was NO dialogue between the operators. He denied intentionally falsifying the records and ADMIN stated that he was at a loss to explain how the water was added and not recorded except for operator error. He concluded by stating that he had no feeling of pressure from management LEVEL PERSONNEL to get good leak rates. He stated that everyone wanted to keep the plant on line, if possible. At this time, BOOHER added nothing FURTHER to the interview and IT WAS terminated at 0806.

K. Christopher

T. Martin

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REPORT OF INTERVIEW WITH JOSEPH CONGDON
AS RECORDED BY JOHN R. SINCLAIR, INVESTIGATOR
U.S. NUCLEAR REGULATORY COMMISSION

On April 10, 1980 Joseph Raymond Congdon, Control Room Operator, Unit 2, Three Mile Island nuclear power facility was interviewed at the Three Mile Island site by NRC personnel concerning his knowledge of alterations of "leak rate tests" pertaining to the reactor coolant system inventory surveillance. Congdon began by explaining that he was not certain that the addition of hydrogen would effect the leak rate test results, however, he was aware that it did effect the level in the makeup tank (MUT). Despite this he (Congdon) stated that one "would not necessarily want to do it". He also indicated that the MUT level was one of the critical parameters in the leak rate calculations and if hydrogen was added during the test it would have an effect on the leak rate. Congdon also explained that although he could not recall specific conversations with other operators on his shift, or with supervisors, he believed that Cooper and Adams had the "depth of knowledge" to know that hydrogen would have an effect. Congdon did not remember any specific conversations relating to the addition of hydrogen.

When questioned about the discarding of leak rate test data which was considered unacceptable Congdon replied that it was "common practice to throw away leak rate tests" that were unacceptable. Congdon explained that procedurally he would show the test results to the shift foreman if they were acceptable. He continued by explaining that if he (Congdon) believed he had made a procedural error, or there was a logical reason for invalidating the results, he would personally make the decision to throw the test results away and rerun the test. Congdon stated, however, that he never threw one away that was done properly, and did not recall if he had run any tests, excluding mistakes, that were not acceptable.

According to Congdon his shift ran the tests at least once a shift to comply with the 72 hour requirement. Congdon then explained that he did not recall how many tests were run and then conceded that there may have been as many as two or three tests conducted per shift. After additional queries, Congdon also stated that there may have been one entire shift completed where operators did not get an acceptable leak rate. In response to a question about whether there was a policy or established practice to discard unacceptable leak rates Congdon replied that the only requirement was that they "were required to take a test every 72 hours".

Congdon continued by stating if there was a situation where they got two "bad" (unacceptable) ones then someone should have had to go and identify the problem. In the event that an "Action Statement" was required, Congdon stated that initiation of Action Statements "was not on his shoulders". Congdon added that he believed that "we had discussions about the leak rate and it was an area getting proper attention".

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Congdon replied to a question about difficulty in obtaining acceptable leak rates, as time progressed toward the accident date (March 28, 1979), by stating that they had a lot of leakages in the drain tank but did not recall any specific problems with leak rate tests. Congdon then stated that there was pressure as "we got into a position that you had to go into an Action Statement" "company knows you have to shut down so general feeling was do what was necessary" within interpretations. As Congdon proceeded he stated that generally, "yes there was pressure to obtain a "good" leak rate". The supervisors would say "we need a good leak rate, we're approaching 72 hours". Following this statement Congdon did state, however, that nobody directed him to falsify records. Congden also explained that some of the pressure was to keep running the tests as often as necessary to see what the actual leak condition was.

Following questioning about whether he (Congdon) either intentionally altered leak rates or was instructed to falsify leak rate tests, Congdon stated that he never intentionally altered a leak rate test or received directions to falsify leak rate tests. Congdon stated that when a leak rate test was conducted properly and still exceeded limits it would be kept to watch for adverse trends until they got a good one and then the old test was discarded. Congdon also stated that he believed that in instances where leak rates appeared to be procedurally correct but were still outside the limits (technical specifications) the results were forwarded to supervisors.

Congdon was shown leak rate test records for the dates November 5, 1978, November 9, 1978 and February 15, 1979 containing information implying hydrogen was added during a leak rate test conducted on Congdon's shift ("C" shift). Congdon observed the stipulated documents and confirmed that they disclosed the addition of hydrogen during the test procedures. Congdon then replied to a question regarding what effect the addition of hydrogen would have on the leak rate test by stating "it would look like less leakage".

In addition, Congdon was provided the opportunity to review a Makeup Tank Level chart for the leak rate test on February 15, 1979. Specifically, he was questioned on a notation on the chart "Pressurized MUT" during the period of the leak rate test. He stated it was not his handwriting and he didn't recognize it.

Congdon was apprised that a record review of leak rate tests for the period of April 1978 through March 1979 disclosed that hydrogen was added during the performance of 8 tests, were attributed to "C" shift. Congdon responded that he had no explanation of why the majority of these tests identified his shift. When asked if it was the intent to alter leak rate tests Congdon stated that he did not know what his intent was, however, he was not trying to cover up unsafe conditions or cover up leakage. Congdon, added, he probably was attempting to "get a good leak rate". Congdon reiterated that it "was not done to hide a safety issue but was done to comply with administrative requirements. According to Congdon the addition of hydrogen "probably was to satisfy the surveillance requirement and not jeopardize the safety of the plant". He then stated that he would not have done it if it was to jeopardize the safety of the plant.

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Congdon subsequently indicated hydrogen was added for the purpose of effecting the leak rate calculation. According to Congdon the entire shift including the shift foreman knew the hydrogen effected the leak rate and that it was his belief it was a group decision to satisfy surveillance requirements. Congdon then stated that there was no intention to falsify records.

One reason that hydrogen additions were utilized, according to Congdon, was that the operators did not have faith in the leak rate test program. As Congdon continued he explained that they did not believe that they should be going through problems to satisfy a surveillance. Congdon further explained that the nature of the problems were brought up to people, but CRO's were not getting information or responses to correct the problem. As Congdon recalls the problem was brought to the attention of Bill Fells in Programming, Brian Mehler, Shift Supervisor and Chuck Adams, Shift Foreman. The extent that each individual was informed of the leak rate problem, Congdon could not be certain. Congdon explained that a possible program deficiency was brought to Fells' attention but he could not say if Fell was aware that hydrogen additions were made to attempt to obtain acceptable leak rates.

Condgon concluded by stating that he had no personal knowledge of water being added to the make up tank during test procedures.

REPORT OF INTERVIEW WITH JOSEPH CONGDEN

AS RECORDED BY JOHN R. SINCLAIR, INVESTIGATOR

U. S. NUCLEAR REGULATORY COMMISSION

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Congden continued by stating if there was a situation where they got two "bad" (unacceptable) ones then someone should have had to go and identify the problem. In the event that an "Action Statement" was required Congden stated that initiation of Action Statements "was not on his shoulders". Congden added that he believed that "we had discussions about the leak rate and it was an area getting proper attention".

Congden replied to a question about difficulty in obtaining acceptable leak rates as time progressed toward the accident date (March 28, 1979) by stating that they had a lot of leakages in the drain tank but did not recall any specific problems with leak rate tests. Congden then stated that there was pressure as "we got into a position that you had to go into an Action Statement" - "company knows you have to shut down so general feeling was do what was necessary" within interpretations. As Congden proceeded he stated that generally, "yes there was pressure to obtain a "good" leak rate". The supervisors would say "we need a good leak rate, we're approaching 72 hours". Following this statement Congden did state, however, that nobody directed him to falsify records. Congden also explained that some of the pressure was to keep running the tests as often as necessary to see what the actual leak condition was.

Following questioning about whether he (Congden) either intentionally altered leak rates or was instructed to falsify leak rate tests, Congden stated that he never intentionally altered a leak rate test or received directions to falsify leak rate tests. Congden stated that when a leak rate test was conducted properly and still exceeded limits it would be kept to watch for adverse trend until they got a good one and then the old test was discarded. Congden also stated that he believed that in instances where leak rates appeared to be procedurally correct but were still outside the limits (technical specifications) the results were forwarded to supervisors.

Congden was shown leak rate test ~~data~~ record for the dates November 5, 1978, November 9, 1978 and February 15, 1979, containing [redacted] information ~~respectively which illustrated that~~ implying hydrogen was added during a leak rate test [redacted] conducted on Congden's shift ("C" shift). Congden observed the stipulated documents and confirmed that they disclosed the addition of hydrogen during the test procedures. Congden then replied to a question regarding what effect the addition of hydrogen would have on the leak rate test by stating "it would look like less leakage".

When specifically questioned on the [redacted] on the Makeup Tank

INSERT NEW PARAGRAPH

In addition, Condon was provided the opportunity to review a Makeup Tank Level chart for the leak rate test on February 15, 1979. Specifically, he was questioned on the notation "Pressurized MUT" on the chart during the period of the leak rate test. ~~which~~ He stated ~~that~~ it was not his handwriting and he didn't recognize it.

for the period of April 1978 through March 1979

Congden was apprised that a record review of leak rate tests disclosed that 7 of 8 tests, 7 of which ~~in which hydrogen was added~~ were attributed to "C" shift. Congden responded that he had no explanation of why the majority of these tests identified his shift. When asked if it was the intent to alter leak rate tests Congden stated that he did not know what his intent was, however, he was not trying to cover up unsafe conditions or cover up leakage. Congden, added, he probably was attempting to "get a good leak rate". Congden reiterated that it "was not done to hide a safety issue but was done to comply with administrative requirements. According to Congden the addition of hydrogen "probably was to satisfy the surveillance requirement and not jeopardize the safety of the plant". He then stated that he would not have done it if it was to jeopardize the safety of the plant.

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Condgon concluded by stating that he had no personal knowledge of water being added to the make up tank during test procedures.

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METROPOLITAN EDISON CO. CONTACTS

(1) JOHN WILSON ATTORNEY METROPOLITAN EDISON CO.

✓(2) x MARTIN COOPER SHIFT FOREMAN

(3) THEODORE (TED) ILLJES - SHIFT FOREMAN

(4) LYNN WRIGHT - CONTROL ROOM OPERATOR

(5) x HUGH McGOVERN - SHIFT FOREMAN

(6) CRAIG FAUST - CONTROL ROOM OPERATOR

(7) MARK PHILLIPPE - CONTROL ROOM OPERATOR

(8) x MARK COLEMAN - CONTROL ROOM OPERATOR

(9) [illegible] - CONTROL ROOM OPERATOR

(10) x EARL D. HEMMILA - SHIFT FOREMAN.

(11) [illegible] - SHIFT FOREMAN

(12) DENNIS OLSON - CONTROL ROOM OPERATOR

(13) EDWARD FREDERICK - CONTROL ROOM OPERATOR (TRAINING)

(14) LEONARD GERMER - FORMER CONTROL ROOM OPERATOR *

(15) x JOSEPH CONGDON - CONTROL ROOM OPERATOR

(16) x JOHN BLESSING - CONTROL ROOM OPERATOR

(17) x RAYMOND BOOHER - CONTROL ROOM OPERATOR

(18) JOHN KIDWELL - CONTROL ROOM OPERATOR

(19) BERNIE SMITH - SHIFT SUPERVISOR

(20) BRIAN MEHLER - SHIFT SUPERVISOR

(21) [illegible] - SHIFT FOREMAN

(22) JAMES FLOYD - OPERATIONS SUPERVISOR (FORMER)

(23) JOSEPH (JOE) CHWASTYK - OPERATIONS SUPERVISOR

✓(24) WILLIAM [illegible]

(25) [illegible] - DIR. OF PERSONNEL

(26) ROBERT ARNOLD - VICE PRESIDENT

([illegible] [illegible]) → NOT YET CONTACTED [illegible] SUBPOENA

✓ (27) HAROLD HARTMAN - EX-CONTROL ROOM OPERATOR

RD#1 COLUMBIA, PA.

NRC PERSONNEL

(1) LARRY VANDENBERG OMPA

(2) HAROLD ORNSTEIN EDO

(3) ROBERT MARSH IE

(4) DENNIS P. ALLISON SEPB

(5) OWEN SHACKLETON IE

(6) NORM MOSELEY IE

(7) VIC STELLO DIR. IE

(8) JIM CUMMINGS O.IA

(9) J. OHN SINCLAIR OIA

10. DAVE GAMBLE OIA

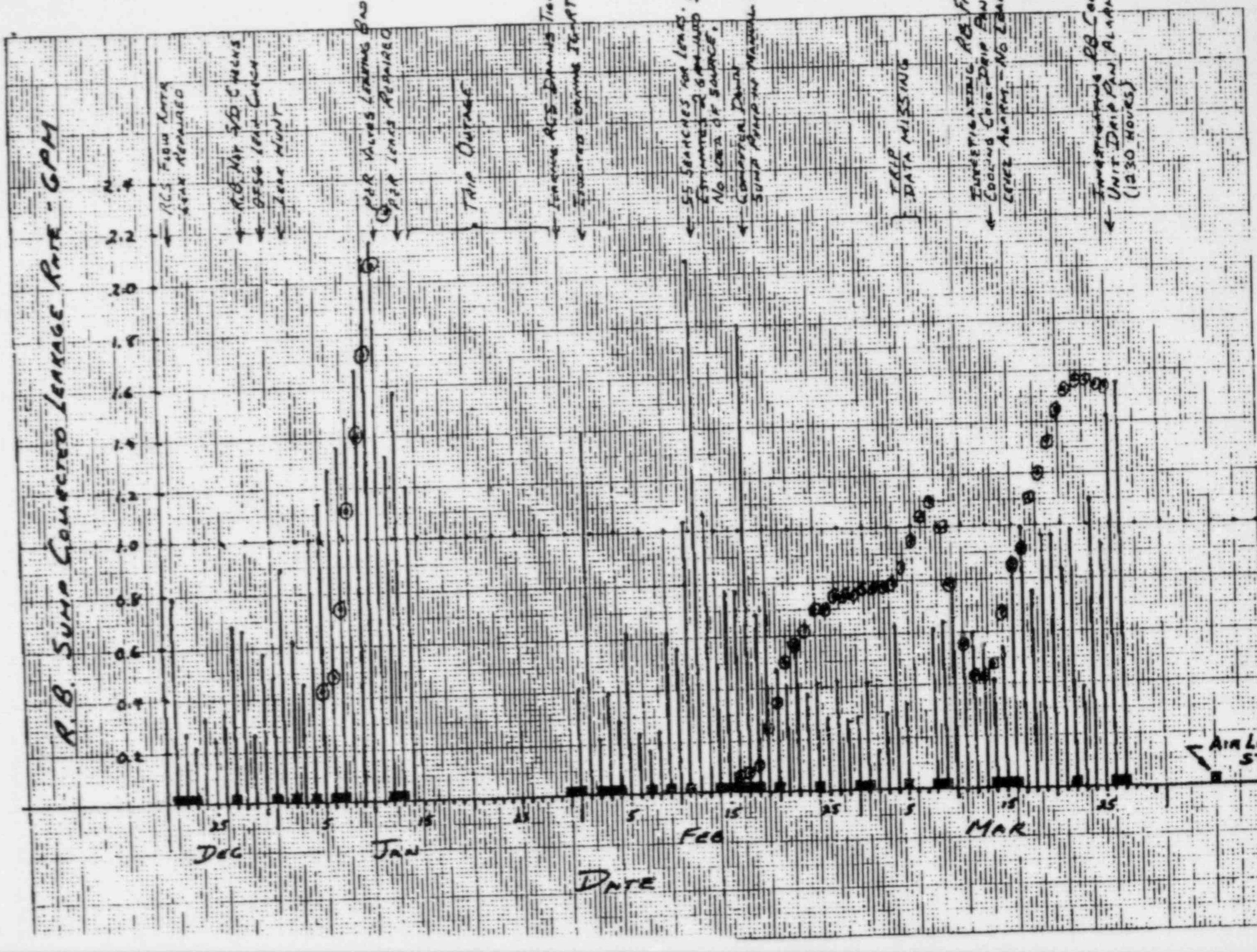
11 DON KIRKPATRICK IE

ADDITIONAL MET ED

GEORGE KUNDER

MIKE BENSON

K•E 10 X 10 TO THE CENTIMETER 46 1510
KEUFFEL & ESSER CO.



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REPORT DETAILS

1. PERSONS CONTACTED (CHRISTOPHER)

2. INTRODUCTION (MARTIN)

3. EFW SURV
   - ALLEGATION (MARTIN)
   - FINDINGS (REXITO

4. ECP
   - ALLEGATION (MARTIN)
   - INVESTIGATION (MARTIN)
   - FINDINGS (MARTIN)

5. TERMINATION
   - ALLEGATION (CHRISTOPHER)
   - FINDINGS (CHRISTOPHER)

6. SAFETY CONCERNS
   - ALLEGATION (CHRISTOPHER)
   - FINDINGS (MARTIN)

7. RCS INVENTORY

	ALLEGATION	(CHRISTOPHER)
(1) ✓✓	PROCEDURE	(KIRKPATRICK)
(2) ✓✓	COMPUTER PROGRAM → Calculator program	(KIRKPATRICK)
(3) ✓✓	HAND CALCULATION	(KIRKPATRICK)
(4) ✓	PROBABLE CALC ERROR	(KIRKPATRICK)
	OPERATOR CONCERNS	(MARTIN)
	STRESS TO FALSIFY	(MARTIN)
	T/S INTERPRETATION [TW 72HR]	(MARTIN)
	RECORDS PRACTICE	(MARTIN)
	PORC ACTIONS	(HAVERKAMP)
	H_2 ADDITIONS EFFECT	(MARTIN)
	H_2 ADDITION PURPOSE & LOCATION	(MARTIN)
(5) ✓✓	H_2O ADDITION EFFECT	(KIRKPATRICK)
(6) ✓	H_2O ADDITION PURPOSE & HISTORY	(KIRKPATRICK)
	RECORDS FALSIFICATIONS	(MARTIN)
(7) ✓	ACTUAL IDENTIFIED LEAKAGE 3 Parts (Gross) (Corrected) (actual)	(KIRKPATRICK)
	ACTUAL UNIDENTIFIED LEAKAGE	(MARTIN)
	OPERATOR KNOWLEDGE CONTROLLED LEAK OTHER EFFECTS	(MARTIN)
	ADDITIONS OUTSIDE WINDOW	(CHRISTOPHER)
	CONCLUSION	(MARTIN)

8. UNIT 1 RCS INVENTORY (CHRISTOPHER)

9. S/D REQUEST (HAVERKAMP - CHRISTOPHER

10. SAFETY CONCERNS
    ALLEGATION (CHRISTOPHER)
    FINDINGS (MARTIN)

11. UNRESOLVED ITEMS (MARTIN)

12. ENTRANCE/EXIT (MARTIN)

ENCLOSURES (CHRISTOPHER)

TRANSCRIPTS
SWORN STATEMENTS
REPORT OF INTERVIEWS

Table 2

EXPECTED VARIATION LEAK RATE CALCULATION DUE TO NORMAL VARIATION IN MEASUREMENT

PARAMETER	BASIS FOR ESTIMATE OF VARIATION	VAR. IN MEASURE	N/O TIMES VAL/USED	CALCULATION OF VARIATION FOR ONE HOUR TEST	VAR. IN LEAK RATE (gpm)
RCS avg.Temp.	Repeatability=.2%/range Range=520°F to 620°F Variation=.2%x100/$\sqrt{3}$	.115°F	Note(6) 8	Note(6) Note(4) $\sqrt{8(.115)^{2}}$ [illegible] (2587ft^3)(.1612 gal/#) ——— 60 min.	.18
Pressurizer Level	Oscillation of 2.5" during measurement Variation=2.5"/$\sqrt{3}$	1.44"	2	$\sqrt{2(1.44)^{2}}$ in (102#/in)(.1612gal/#) ——— 60 min.	.56
Makeup Tank Level	Oscillation of 1.5" during measurement Variation=1.5"/ $\sqrt{3}$	.87"	2	$\sqrt{2(.87)^{2}}$ in (257#/in)(.1612gal/#) ——— 60 min.	.73
RC Drain Tank Level	Repeat.=.2%ofrange Range=0 to 92" Variation=.2%x92/$\sqrt{3}$	.11"	2	Note (1) $\sqrt{2(.11)^{2}}$ in (1.343)(73.33gal/in) ——— 60 min	.26
Combined	Square root of sum of squares of individual Variations	-	-	$\sqrt{(.18)^2+(.56)^2+(.73)^2+(.26)^2}$	.97

Table 1

Effect of Computer Program Errors on Leak Rate Determination

Error Type	Largest Change Recorded	Calculation of Error for one hour test	Error in Leak Rate (gpm)
Failure to account for density change in water added	300 gal of Water added	note (1) 300 gal (1.343 − 1)/60 min	1.71
Failure to account for density change in RC drain tank	3 inches (Prior to 3/16/79)	note (1) 3 in (73.33 gal/in)(1.343 − 1)/60 min	1.26
Failure to extend RCS density correction above 582°F	0.5°F in Tavg above 582°F	note (2) 0.5°F (2.21 gpm/°F)	1.11
Incorrect RC drain tank level to volume table	4 inches in RCDT (From 74" to 78")	note (3) note (1) (302 gal − 290 gal)(4)(1.343)/60 min	0.27
Failure to account for effect of pressure change	80 psi in RCS pressure	note (4) 0.884#/psi (80 psi)(.1612 gal/#)	0.19
Incorrect RCS volume (327 cu ft error)	one deg F in RCS Tavg	note (2) (327 ft³/10346 ft³)(2.21 gpm/°F)	0.07
Incorrect make up tank mass change rate	5 inches in MUT level	note (4) 5(257#/in − 255#/in)(.1612 gal/#)/60 min	0.03

PROCEDURE (ATTACHMENT 1)

The TMI Unit 2 RCS inventory procedure, ~~(No.~~ 2301-3 D1 ~~copy attached)~~ is intended to ensure compliance with technical specification 3.4.6.2 which limits identified leakage to 10 GPM and unidentified leakage to 1 GPM, (as well as other limits). The technical specifications required the procedure to be performed at least once per 72 hours during steady state operation.

The procedure accounts for water inventory changes in the RCS (from expansion and contraction), the pressurizer and the makeup tank, to determine gross leakage. Water additions by the operators are also accounted for by the procedure in the determination of gross leakage. The data used in the gross leakage determination are initial and final RCS temperatures, pressurizer levels and make-up tank levels, as well as the water addition totalizer changes. Identified leakage is determined by level changes in the reactor coolant drain tank (RCDT), which collects primary water from various sources in the containment. Identified and measured primary water leakage that is not normally collected in the RCDT, quantified steam generator leaks and operator changes to the RCDT are also included in the identified leakage calculation. Unidentified leakage is defined as the difference between gross leakage and identified leakage.

The precautions in the procedure include a warning to avoid the addition and removal of water from the reactor coolant and makeup systems during the test. The procedures also contain the warning that, for the most accurate leak rate determination, the initial and final power, RCS temperature, pressure and pressurizer level should be identical. The procedure required the test to be run for for a period from one hour to eight hours.

The test results were reviewed for the period from 12/20/78 to 3/5/79. Despite the precautions identified above, water was added frequently during the test (and sometimes not included in the calculation.) This was particularly true after 2/14/80, when water was added during almost every test. The initial and final RCS temperature, pressure and pressurizer levels were seldom equal. The pressure sometimes oscillated continually over a wide range (as much as 80 psi). None of the tests reviewed were conducted for a period exceeding one hour. As shown below these practices added significantly to the probable calculational error in the leak rate determinations.

The procedure provides a set of steps to be taken if the RCS leakage is excessive.

The first step is to perform another leak rate determination. The second is to check for operator actions affecting the inventory and, finally, to initiate action to determine the source of the leakage. Partly as a result of the large variations discussed below, the test results frequently indicated an excessive unidentified leak rate. According to operator testimony (see transcripts of operator statements) the operators made a practice of attempting a leak rate test once each shift. Those test records that showed unacceptable results were systematically discarded.

Computer Program (attachment 2)

The RCS inventory procedure instructs the operator to use the computer to run the leak rate test if this is available (Item 6.1 of procedure). In fact, all of the tests conducted during the period reviewed were done using the computer. All that is required of the operator is to type the program code letters, "RC", into computer and press a start key ("Return" key). The computer then prompts the operator to enter the test interval, (1-8 hours) operator water changes (both to the primary system and to the RCDT), identified uncollected leakage and steam generator leakage.

The computer then automatically gathers all of the initial and final readings described above, makes all of the necessary calculations and prints out the three leak rates (gross, identified and unidentified). ~~(See sample computer sheet attachment 1).~~

The computer program was reviewed in detail. The program gathers three data sets, at one minute intervals, for the initial conditions and three similar sets for the final conditions. The three values for each parameter are averaged to provide the initial and final values that go into the calculations. These data sets are not read directly from the measuring instruments, but are gathered from values already entered into the data logging locations of the computer memory. Since these values are up-dated at varying frequencies, the data in a given set are measured at different times. As shown in Table 2, this can cause significant variations in the leak rate results because some of the values in the calculation were continually ocsillating. Several errors in the computer calculations that cause significant errors in the leak rate results were identified. These errors and their effect on the leak rate are listed in Table 1 and described as follows:

1. The use of inconsistent densities to convert mass of water to gallons of leakage. The gross leakage from the RCS is determined by summing the mass changes, calculated in pounds, in the various primary spaces and multiplying by a gallons-per pound factor, based on the water density at RCS temperatures (5.86#/gallon at 582°F). The identified leakage, however, was derived from the leakage collection tank level change converted to gallons by use of a table in the computer. The calibration for this level measurement was based on cold water density (8.29#/gallon at 70°F). Since the unidentified leakage is defined as gross leakage less identified leakage, this inconsistency leads to an erronerous increase in the unidentified leak rate of about 40% of the identified leak rate.

2. The similar failure to correct the volume of water added by the operators to the RCS for expansion to reactor density. This omission results in an erroneous decrease in the unidentified leak rate of the same magnitude.

3. The tables in the program used to convert temperature to density, terminate at 582°F. When the RCS temperature exceeds this value, the density corresponding to 582°F is selected. Twenty two of the tests reviewed had temperatures above 582°F and resulting errors as high as one gpm.

4. Lack of a correction for pressure changes in the RCS during the test. The pressure affects the leak rate determination in two ways, by reducing the pressurizer density (as the saturation temperature increases) and by increasing the RCS density. Although these are opposing affects, the net result can cause a significant change in the measured leak rate.

5. An incorrect RCS volume used in the calculation of the mass change in the RCS. The computer uses a value of 10,673 ft., whereas the SAR gives a value of 10,346 ft.

6. The table in the computer memory used to convert RC drain tank levels to gallons of water differed from the equivalent table used by the operators in the control room. As an example for an RCDT level of 76 inches, the table in the computer memory gave a value of 6,605 gallons, whereas, the valve use in the hand calculation was 6,411 gallons.

7. The computer value for make-up tank mass change with level change, differed slightly from a value based on the tank drawings and level calibration procedures.

The computer program had originally been written for TMI-1 by R. S. Sheng who was no longer employed at TMI. This program had been adapted for use on TMI-2 by Bill Felds, the current computer programmer employed by Metropolitan Edison at TMI. Felds said that the RCDT level versus volume table used in the hand calculation had been revised since the computer program was written and was believed to be correct. The revised values in the table, however, had never entered into the computer program.

Hand Calculation

Hartman alleged that hand calculations were done to achieve acceptable leak rate results when the computer results were out of limits. The procedure provides for a hand calculation to be used when the computer is unavailable. However, the hand calculation had most of the same errors as the computer and produced almost the same results. Also, during the period covered by the investigation, almost no hand calculations were performed.

It is likely that Hartman was referring to hand corrections that were made to the computer program beginning March 16, 1979. This was done to correct the first computer error identified above, which overstated the unidentified leakage by not correcting the density of the identified leakage back to reactor conditions. The procedure change was accompanied by a written evaluation signed by the unit superintendent. Copies of the hand written calculation sheets were provided to the operators (ATTACHMENT 3 IS EXAMPLE). This correction amounted to multiplying the computer derived identified leak rate by the ratio of the RCDT water density to the RCS water density. The corrected idenitified leak rate was then subtracted from the computer derived gross leak rate to provide a corrected unidentified leak rate. This procedure did provide a more accurate identified leak rate. However, the corresponding correction needed to adjust the water added to the RCS by the operators for expansion in the reactor was not made. During time period, in which the hand corrections were made, water was being added to the RCS during every test in amounts that were roughly equal to the identified leak rate. Therefore, the computer errors in the identified leakage and the computer errors in the water added, roughly cancelled each other. The new procedure, by correcting the identified leakage, but not the water added, had the effect of understating the more important unidentified leak rate.

Probable Calculational Error

In addition to the computer errors already described, a significant variation in the one hour leak rate test results can be expected due to the uncertainty in the data. The expected uncertainty in the various types of data used and its effect on the results is detailed in Table 2. Uncertainty is caused by the periodic oscillation of some of the parameters as well as the expected instrument uncertainty. The oscillation is significant because a beginning or end data set is gathered over a time span that is comparable to the period of oscillations. For the Table 2 parameters, the oscillation was chosen as the basis for the expected measurement uncertainty when its magnitude was large compared to the instrument uncertainty. The expected error, caused by these uncertainites ranged from 0.18 gpm for the temperature measurement to 0.73 gpm for the make up tank levels. The RMS combination of these errors results in a total expected measurement error of about one gpm.

The leak rate errors caused by the computer program could not be combined in any meaningful way due to their partially systematic nature. (See Table 1). The largest of these were the errors caused by the failures to account for the density changes in the water and the temperature changes above 582°F. The omission of RCDT density adjustments caused an error of about 34% of the leakage to the drain tank. Prior to the March 16 procedure correction, actual leakages to the drain tank (see discussion below) ranged up to about 5 gpm causing an error of 1.7 gpm. The similar omission in the water added to the RCS also caused an error of 34% of the added water. The largest water addition, recorded for a retained test record, was 300 gallons which also caused an error of one gpm. The largest temperature change recorded above 582°F was about 0.5°F resulting in an error of 1.1 gpm.

With these various errors and uncertainties it is estimated that the results of the one hour leak rate tests, done according to the procedure, will vary from the actual leak rates by several gpm.

Effect of Water Additions

doubly so
provide writeup

Water was added by the operators to the makeup tank in batches of up to 1000 gallons. The average addition was about 200 gallons. When this was done during a test it always caused an apparent reduction in the measured leak rate. As previously indicated the procedure provided for the entry of the water additions into the computer. However, due to the failure of the computer program to account for the expansion of the water as it heated up in the RCS, even a correctly entered addition caused an error. For example, a 200 gallon water entry is inventoried as 200 gallons by the computer, but expands to [illegible] gallons in the RCS. The result is a 1.1 gpm reduction in the calculated gross and unidentified leak rates for the usual 60 minute test. If (as discussed below) the operator fails to enter the 200 gallon addition into the computer, the full 268 gallon RCS increase is uncounted, resulting an an erroneous decrease of 4.5 gpm in the leak rates.

Purpose and History of the Water Additions

Hartman alleged that operators had added water to the RCS during leak rate tests, without entering the addition into the computer, in order to affect the leak rate test results. Operator actions, such as addition to the RCS are required to be entered in the Control Room Operators Log. This log was reviewed for the test period of each leak rate test conducted between 12/20/78 and 3/28/79. Six test periods were identified during which water addition had been logged, but had not been entered into the computer computation (copies of the computer test print outs and concurrent CRO log sheets are contained in Attachment 4 ~~attached~~). These are listed in Table 3, together with the effect of discrepency on the computer calculated unidentified leak rate. As shown by the table, each of the corrected leak rates are in excess of the technical specification limit of one gpm for unidentified leakage. Some cases of water addition could be verified by the examination of the make up tank recorder chart, which showed an upward shift in level when the water was added.

Actual Leakage

Needs additional work

Due to the large scatter in the leak rate test results combined with the licensee's practice of discarding leak rate test records that showed unacceptable results, the actual gross leak rates could not be determined from the licensee's leak rate test records. Over the long run, however, the gross leak rate must equal the amount of water added to the RCS by the operators.

The total amount of fluid added to the RCS could be derived by summing the water and boric acid additions recorded in the control operator's log. This was done for each day covered by the period of the investigation. The average daily gross leak rates were then calculated and the results were listed in Table 4. The variation from one day to the next is of the order of one gpm. The scatter is believed to be caused by the batch nature of the water additions which were as high as 1000 gallons. The data were smoothed further by calculating running 3-day averages. These are plotted on Figure 2. The highest leak rates occured during the week prior to the accident when they were running 7 to 8 gpm. At this time, water additions were being made approximately every hour. The identified leak rate calculation could be based entirely on the RCDT level change since no significant identified leakage was recorded during the time covered by the investigation. The measurement uncertainty in RCDT levels results in only about a 0.26 gpm variation in the one hour leakage calculation. (See Table 2). Therefore, reasonably accurate determinations of the identified leak rates could be calculated using the RCDT levels from the computer for all of the computer data sets. They are included in Table 4 and plotted on Figure 2. The results indicate that the identified leakage reached about 6 gpm during the period of March 24 to March 26, 1979.

The actual unidentified leakage could be estimated by drawing a smooth line through the two sets of data points on Figure 2, and measuring the distance between the two lines. The estimated unidentified leakage results are also plotted on Figure 2 and listed in Table 5. This plot indicates that the unidentified leak rate may have exceeded the allowable limit of one gpm prior to the shutdown on January 15. After the startup on January 29, the unidentified leak rate appears to have remained below or near the limit until around March 17. After this it increased to about 1.5 gpm prior to the accident.

Table 1

EFFECT OF COMPUTER PROGRAM ERRORS ON LEAK RATE DETERMINATION

ERROR TYPE	LARGEST CHANGE RECORDED	CALCULATION OF ERROR FOR ONE HOUR TEST	ERROR IN LEAK RATE (gpm)
Failure to account for density change in water added	300 gal of water added	Note (1) (300 gal.)(1.343-1) ~~/60min~~ 60 min	1.71
Failure to account for density change in RC drain tank	3 inches (prior to 3/16/79)	Note (1) (3 in.)(73.33 gal/in)(0.343) ~~(1.343-1)/60 min.~~ 60 min	1.26
Failure to extend RCS density correction	0.5°F in T avg above 582°F	Note (2) (0.5°F)(2.21gpm/°F)	1.11
Incorrect RC drain tank level to volume table	4 in. in RCDT (from 74"to 78")	Note (3) Note (1) (12 gal)(1.343) 60 min.	0.27
Failure to account for effect of pressure change	80 psi in RCS pressure	Note (4) (0.884#/psi)(80 psi) (.1612 gal/#) 60 min	0.19
Incorrect RCS volume (327 cu ft error)	one °F in RCS T avg	Note (2) (327ft³/10346ft³) (2.21 gpm/°F) 10346 ft³	0.07
Incorrect make up tank mass change rate	5 inches in MVT level	Note (4) 5(257-255#/in) (.1612gal/#) ~~/60 min~~ 60 min	0.03

move right 3 places

Table 2

Expected Variation leak rate calculation due to normal variation in measurements.

Parameter	Basis for Estimate of Variation	Var. in Meas.	No. times Value used	Calculation of Variation for one hour test	Var. in leak rate (gpm)
RCS avg. Temperature	Repeatability = .2% of range range = 520°F to 620°F Variation = .2% X 100/$\sqrt{3}$ note (5)	.115°F	note(6) 8	note (6) note(4) $\frac{\sqrt{8}(.115°F)^2 (2587 ft^3)(.0776 \#/°F ft^3)(.1612 gal/\#)}{60 min}$	.18
Pressurizer Level	Oscillation of 2.5" during measurement Variation = 2.5"/$\sqrt{3}$	1.44"	2	$\frac{\sqrt{2}(1.44 in)^2 (102 \#/in)(.1612 gal/\#)}{60 min}$	.56
Make Up Tank Level	Oscillation of 1.5" during measurement Variation = 1.5"/$\sqrt{3}$	.87"	2	$\frac{\sqrt{2}(.87 in)^2 (257 \#/in)(.1612 gal/\#)}{60 min}$	.73
RC Drain Tank Level	Repeatability = .2% of range range = 0 to 92" Variation = .2% X 92/$\sqrt{3}$	.11"	2	note (1) $\frac{\sqrt{2}(.11 in)^2 (1.343)(73.33 gal/in)}{60 min}$	.26
Combined Variation	Square root of sum of squares of individual Variations	—	—	$\sqrt{(.18)^2+(.56)^2+(.73)^2+(.26)^2}$	.97

TURN SIDEWAYS

Notes on Tables 1 and 2

(1) The ratio of the ambient water density to the RCS water density
$= (62.31\#/ft^3)/(46.4\#/ft^3) = \underline{1.343}$.

(2) Effect of temperature change in RCS

$$= \frac{\text{Volume of RCS} \times \Delta P/P \times (\text{Gal per ft}^3)/\text{time}}{}$$

$$= \frac{(1034\ ft^3)(.776\#/°F\ ft^3)(7.4805\ gal/ft^3)}{(46.4\#/ft^3)(60\ min)} = \underline{2.2\ gpm/°F}$$

(3) RCDT error = level change by correct table less level change by computer table
= (6558 gal - 6256 gal) - (6755 gal - 6465 gal)
(for 78") (for 74") (for 78") (for 74")
= *12 gal*

(4) ← Conversion from lbs to gallons $= (7.4805\ gal/ft^3)/(46.4\#/ft^3)$
$= \underline{.1612\ gal/\#}$

(5) Each measurement is taken 3 times at one minute intervals

(6) The RCS average temperature is derived from the hot leg and cold leg temperatures in each of the two loops. Each temperature measurement represents one fourth of the RCS volume of 10346 cu ft, or 2587 ft^3. This results in a total of eight temperature values that are used in the leak rate calculation, four for the beginning data set and four for the end data set.

Table 3

Leak Rate Tests during which water was added to the RCS without correct entry into the computer and the effect of the descrepency on the unidentified leak rate.

DATE	TIME	WATER ADD(Gal)	COMPUTER ENTRY (gal)	*EFFECT ON LEAK RATE (GPM)	ORGINAL LEAK RATE (GPM)	*CORRECTED LEAK RATE (GPM)
12/~~23~~ 29/78	~~20:48~~ 17:32	200	0	3.33	.0451	3.38
1/13/79	9:37	117	0	1.95	.2639	2.21
2/2/79	0.55	300	0	5.0	.7513	5.75
2/11/79	18:08	300	0	5.0	-.0603	4.94
2/23/79	11:07	150	0	2.5	.3217	2.82
3/19/79	0:58	400	200	3.33	.1851	3.52

* As it would have been calculated by the computer, without accounting for expansion in the RCS.

Table 4

TMI LEAK RATE CALCULATIONS

Date	By Investigators 24 HR PERIOD Gross	Un-I.D.	Time	By Investigators Based on 1 HR Gross	I.D.	Un-I.D.	By TMI Computer Based on 1 HR Gross	I.D.	Un-I.D.
1978:									
12/24	2.52	0.32	17:36	4.69*	0.27	4.41*	0.39	0.21	0.18
"			17:36	(0.20)	(0.27)	(-0.07)			
12/25		0.25	1:20	1.25	0.24	1.01	0.50	0.18	0.31
"			7:52	-0.45	0.25	-0.70	-0.43	0.17	0.61
26	1.96	0.34	2:48	0.69	0.36	0.33	0.65	0.25	0.40
"			9:16	0.37	0.57	0.07	0.35	0.41	-0.06
27	1.55	0.68	8:10	1.74	0.27	1.47	1.15	0.20	0.95
28		0.66							
29		0.27							
30		0.57	6:15	-3.38	1.29	-4.40	-3.23	0.57	-3.80
31	3.77	0.48	5:17	0.99	0.48	0.50	1.05	0.17	0.89
"			12:25	-2.02	0.46	-2.48	-2.08	0.35	-2.43
1979:									
1/1	2.28	0.89							
2	4.41	0.61							
3	1.49	0.45							
4	2.78	1.00	3:02	0.39	0.47	-0.09	0.56	0.35	0.21
5	0.50	1.14	2:54	1.18	0.84	0.33	1.22	0.63	0.59
"			17:23	0.76	0.61	0.15	1.13	0.47	0.66
6	0.19	1.28	10:29	1.41	0.61	0.80	0.11	0.61	-0.50
"			19:20	1.18	0.61	0.57	1.34	0.46	0.87
7	1.97	1.37	3:41	0.10	0.56	-0.46	0.20	0.42	-0.22
8	2.21	1.48	3:21	-0.28	0.47	-0.75	-0.19	0.34	-0.53
9		1.66							
10	1.02	2.09	1:48	1.12	0.36	0.76	1.37	0.53	0.83
11	4.38	2.16	21:53	1.65	1.01	0.64	0.58	0.75	-0.19
12	3.10	1.32							
13	3.06	1.57	9:37	3.11*	0.75	2.36*	0.84	0.58	0.26
"			"	(0.78)		(0.03)			
14		1.20							
15			0:24	1.65	0.93	0.71	1.70	0.71	0.99
			Shut down until 1/30/79						
30			22:06	1.64	1.21	0.43	1.51	0.81	0.70
31		0.41							

Date	By Investigators 24 HR PERIOD Gross	Un-I.D.	Time	By Investigators Based on 1 HR Gross	I.D.	Un-I.D.	By TMI Computer Based on 1 HR Gross	I.D.	Un-I.D.
2/1		1.39							
2		0.22	0:55	8.51 *	1.42	7.08*	1.83	1.08	0.75
"			"	(1.78)		(0.35)			
"			14:31	-0.03	1.43	-1.46	0.12	1.08	-0.95
3	1.45	0.39	5:17	1.34	1.41	-0.38	0.75	1.05	-0.29
"			10:32	1.11	1.43	-0.33	0.07	1.07	-0.99
"			23:49	1.15	1.82	-0.66	1.50	1.33	0.18
4	2.04	0.28	14:45	1.73	1.37	0.37	0.97	1.03	-0.06
5	1.89	0.62	3:12	1.27	1.47	-0.20	0.55	1.13	-0.58
"			8:35	2.03	1.48	0.55	1.62	1.13	0.48
"			18:37	1.40	1.54	-0.14	1.32	1.16	0.16
6		0.23	0:25	2.10	1.59	0.51	1.84	1.18	0.66
7		0.17	13:52	1.65	1.74	-0.08	2.10	1.26	0.84
8	1.70	0.24	1:00	2.32	1.66	0.66	2.20	1.27	0.92
"			20:50	1.82	1.64	0.18	1.79	1.21	0.59
9		0.62	2:20	2.41	1.65	0.77	2.03	1.26	0.76
10		0.56	8:41	2.26	1.82	0.44	2.17	1.40	0.76
11		1.04	2:42	1.78	1.41	0.37	1.82	1.06	0.76
"			18:08	6.59*	-0.18	6.78*	-0.19	-0.13	-0.06
"			"	(-0.13)	-0.18	(-0.05)			
12	2.16	2.05	21:20	0.37	-0.57	0.95	0.48	-0.41	0.90
13	1.66	1.07	12:36	2.18	1.92	0.26	2.19	1.38	0.81
"			18:42	2.00	1.88	0.12	2.04	1.35	0.68
14	1.29	0.48	5:30	2.45	1.95	0.50	1.24	1.48	-0.24
15	2.95	0.77	20:26	5.10*	2.04*	3.06*	2.46	1.53	0.93
"			"	(2.33)	(2.04)	(0.34)			
16	1.89	0.77	2:53	2.03	2.07	-0.03	2.40	1.54	0.86
"			12:03	2.69	2.26	0.42	1.77	1.73	0.05
17	2.37	1.80	4:11	2.82	2.69	0.13	2.88	2.08	0.84
18	2.35	0.68							
19	2.48	0.77	0.01	2.41	2.67	-0.26	2.54	1.99	0.56
"			1:36	2.67	2.54	0.13	2.89	1.90	0.99
"			21:28	2.82	2.69	0.13	2.93	2.02	0.91
20	3.89	0.46							
21	3.20	0.41	8:36	2.31	2.69	-0.37	2.38	2.03	0.34
22	3.70	0.76							

Date	By Investigators 24 HR PERIOD Gross	Un-I.D.	Time	By Investigators Based on 1 HR Gross	I.D.	Un-I.D.	By TMI Computer Based on 1 HR Gross	I.D.	Un-I.D.
2/23	3.39	0.37	11:07	3.75*	0.42	3.71*	0.35	0.29	0.32
"			"	(0.39)		(0.35)			
24	3.35	0.41							
25	4.18	0.28	20:02	3.91	3.17	0.74	3.00	2.41	0.59
26		0.42	18:39	3.93	3.30	0.63	3.26	2.50	0.76
27		0.27	21:50	4.23	3.14	1.09	3.34	2.39	0.96
28	4.13	0.27	19:09	3.81	3.42	0.39	3.25	2.59	0.66
3/1	3.31	0.41	0:41	5.28*	3.41	1.87*	2.98	2.58	0.41
"			"	(2.69)	3.41	(-0.71)			
2	4.29	0.15	1:46	3.58	3.63	-0.51	3.70	2.75	0.95
"			19:35				3.27	2.66	0.61
3	3.79	0.29	2:38	3.95	3.23	0.72	2.77	2.46	0.32
4	4.70	0.62	1:42	4.34	3.79	0.56	2.84	2.87	-0.03
5		0.32	3:20	4.29	3.65	0.63	3.64	2.77	0.87
6			3:21	4.02	3.58	0.44	3.48	2.71	0.77
7									
8	5.50	0.61	3:50	4.83	4.11	0.72	3.58	3.11	0.47
9	5.41	0.64	3:23	5.24	4.63	0.60	4.34	3.49	0.85
10	5.42	0.78							
11	5.13	0.59							
12	4.71	0.60							
13	5.46	0.55	2:00	3.87	4.81	-0.94	3.63	3.64	-0.02
"			11:05	5.88	5.01	0.87	4.32	3.80	0.52
14	5.93	0.41	12:05	4.76*	2.40	2.36*	-6.75	-6.50	-0.25
15	5.29	0.51	4:50	3.64	5.03	-1.39	3.81	3.75	0.06
16	5.55	0.87	20:09	6.05	5.30	0.74	4.86	5.61**	-0.75**
17	7.14	0.99	2:48	5.77	5.13	0.63	4.43	5.43**	-0.99**
18	6.67	0.75							
19	5.45	0.96	0:58	11.04*	5.30*	5.74*	5.35	5.53**	-0.17*
"				(6.59)	(5.30)	(1.26)			
20	7.02	0.96							
21	7.47	0.84	1:14	8.59*	5.54*	3.05*	6.05	5.83**	0.22**
"				(7.08)	(5.54)	(1.54)			
22	6.88	0.98	3:00	7.76	5.81	1.95	6.73	6.15**	0.58**
23	7.65	0.39							

Date	By Investigators 24 HR PERIOD Gross	Un-I.D.	Time	By Investigators Based on 1 HR Gross	I.D.	Un-I.D.	By TMI Computer Based on 1 HR Gross	I.D.	Un-I.D.
3/24	8.48	1.11	5:40	7.61	6.06	1.55	6.55	6.39**	0.16**
25	6.01	0.92	5:25	8.02	6.07	1.95	6.60	6.16**	0.43**
26	7.70	1.42							
27	7.26	1.56							
28			1:34	8.66	6.87	1.79	6.94	6.93**	0.01**

TABLE 5

Unidentified Leakage at TMI - 2

Based on differences between running three day averages of water added to the RCS, and Reactor Coolant Drain Tank levels from computer input data.

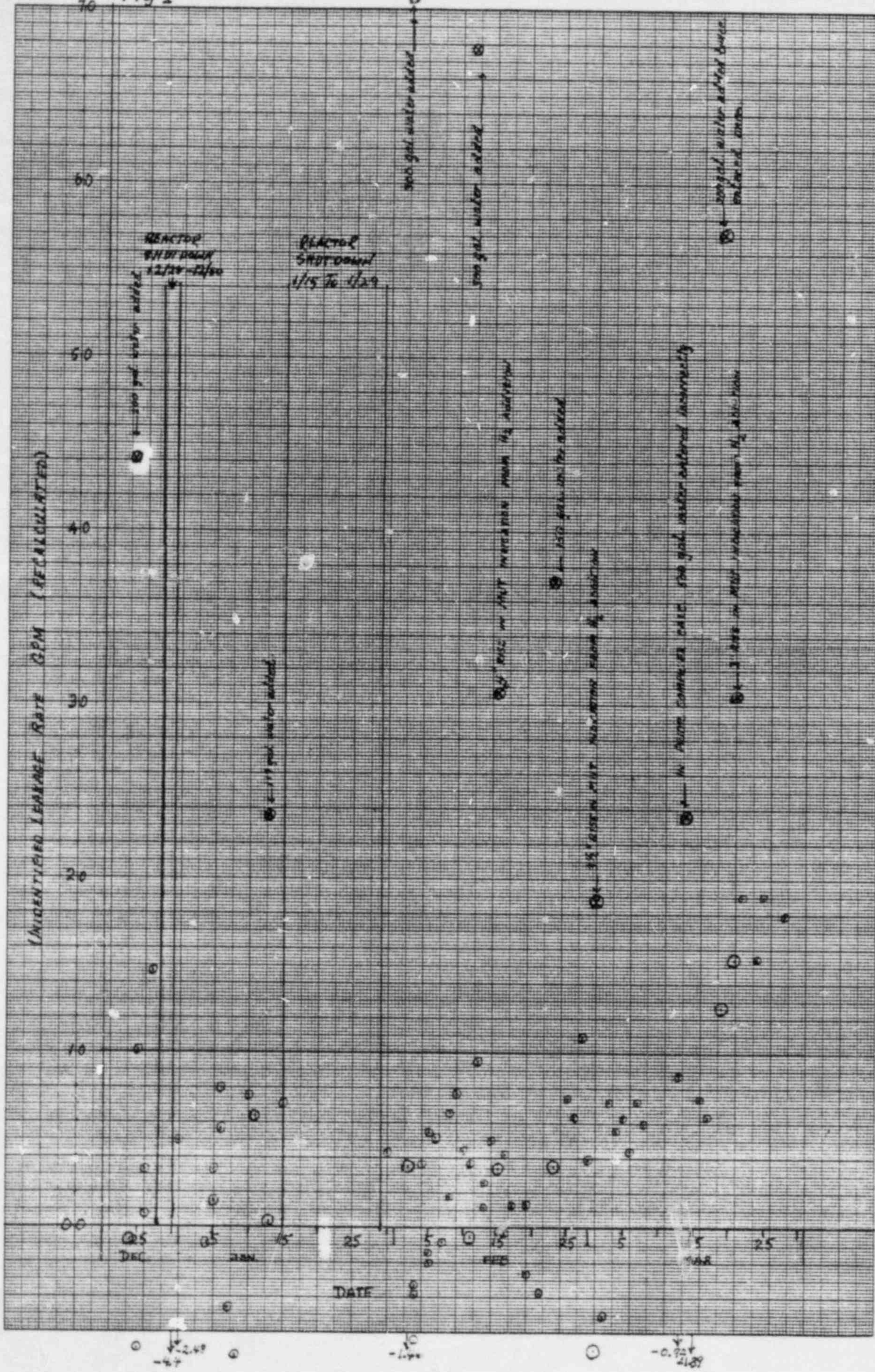
Date	Un I.D. Leakage (GPH)	Date	Un I.D. Leakage GPH	Date	Un ID Leakage GPH
1/5/80	0.43	2/16/79	0.05	3/8/79	1.10
6	0.48	17	0.08	9	0.99
7	0.74	18	0.12	10	0.78
8	1.12	19	0.25	11	0.55
9	1.40	20	0.36	12	0.43
10	1.72	21	0.50	13	0.43
11	2.07	22	0.57	14	0.48
12	2.27	23	0.62	15	0.67
13		24	0.70	16	0.85
14		25	0.70	17	0.91
		26	0.75	18	1.11
REACTOR		27	0.75	19	1.20
SHUTDOWN		28	0.75	20	1.33
1/15/79		3/1/79	0.77	21	1.45
to 1/29/79		2	0.77	22	1.53
		3	0.78	23	1.56
Leakage		4	0.79	24	1.56
near 0		5	0.85	25	1.55
from 1/30		6	0.95	26	1.54
to 1/15		7	1.04	27	

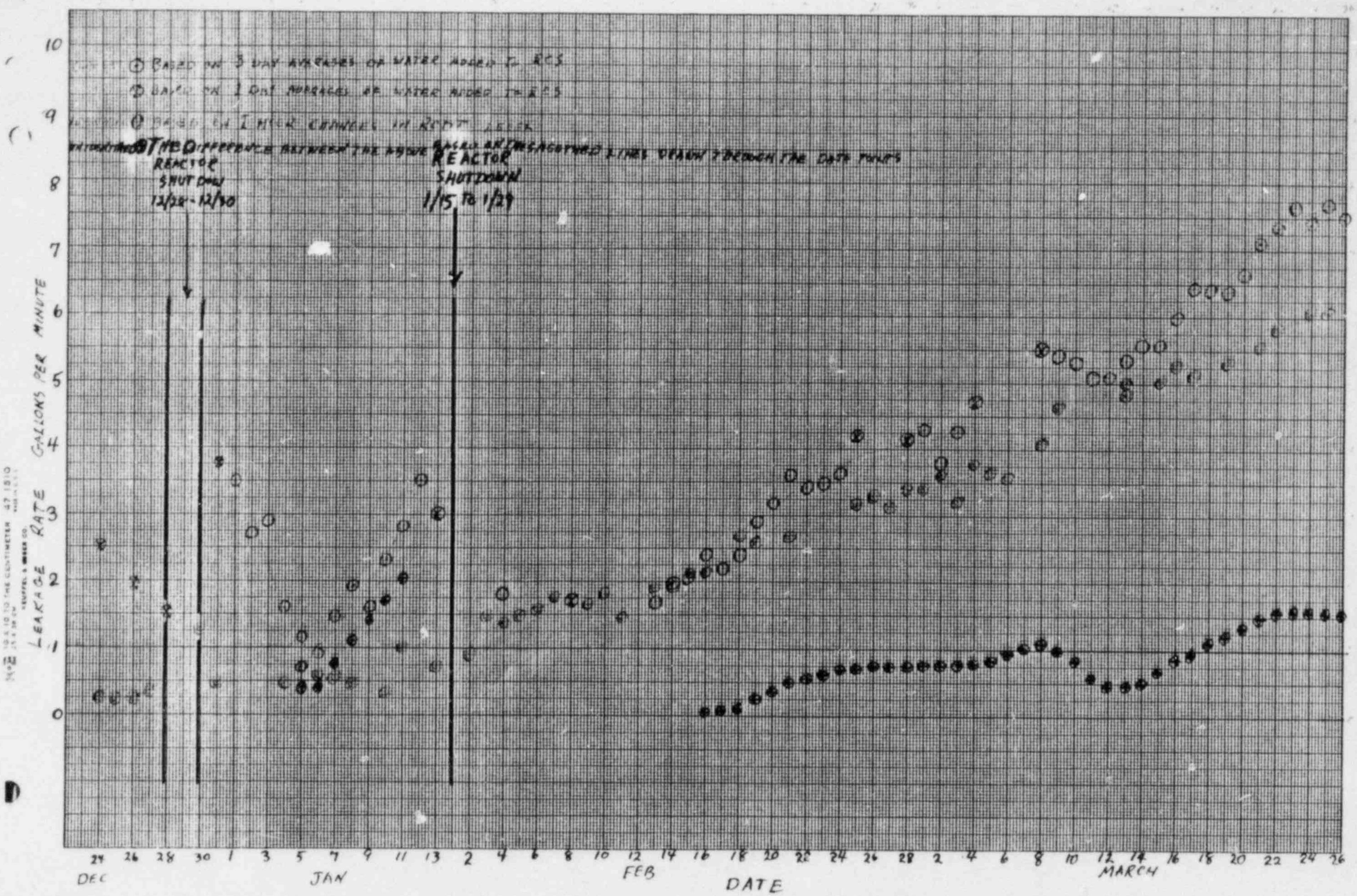
NOTES FOR FIGURE 1

Figure 1 is a plot of the licensees leak rate test results corrected for the known ~~computer~~ errors. The blue points are corrected for computer errors only. The red points include the correction for known leak rate falsifications. Each red point has the same point plotted (in green), which represents the leak rate test result corrected for the computer errors, but not the falsification

K+E 10 X 10 TO THE CENTIMETER 47 1510
KEUFFEL & ESSER CO.

Fig 1





BASED ON 3 DAY AVERAGES OF WATER ADDED TO RCS
REACTOR SHUTDOWN 12/28 - 12/30
REACTOR SHUTDOWN 1/15 TO 1/29
LEAKAGE RATE GALLONS PER MINUTE
10
9
8
7
6
5
4
3
2
1
0
DEC
24
26
28
30
JAN
1
3
5
7
9
11
13
2
4
6
8
10
FEB
14
16
18
20
22
24
26
28
2
4
6
8
10
MARCH
12
14
16
18
20
22
24
26
DATE

Note #1 on Fig 2 Leak rates calculated by investigators based on a 24-hr. period:

Gross - Sum of all water added between midnight and midnight in gallons expanded to reactor temperature volume (570°) and divided by minutes per day (1440)

$$G.L.R. = \sum gal \times (62.27/44.64)/1440$$

Un I.D. Unidentified Leak Rate = Water pumped from containment sump over a three day period divided by minutes in 3 days (4320)

1J-10

To: TIM MARTIN RI FROM DCK. IE HQ.

TMI LEAK RATE CALCULATIONS

Date	By Investigators 24 HR PERIOD		Time	By Investigators Based on 1 HR			By TMI Computer Based on 1 HR		
	Gross	Un-I.D.		Gross	I.D.	Un-I.D.	Gross	I.D.	Un-I.D.
1978:									
12/24	2.52	0.32	17:36	4.69*	0.27	4.41*	0.39	0.21	0.18
"			17:36	(0.20)	(0.27)	(-0.07)			
12/25		0.25	1:20	1.25	0.24	1.01	0.50	0.18	0.31
"			7:52	-0.45	0.25	-0.70	-0.43	0.17	0.61
26	1.96	0.34	2:48	0.69	0.36	0.33	0.65	0.25	0.40
"			9:16	0.37	0.57	0.07	0.35	0.41	-0.06
27	1.55	0.68	8:10	1.74	0.27	1.47	1.15	0.20	0.95
28		0.66							
29		0.27							
30		0.57	6:15	-3.38	1.29	-4.40	-3.23	0.57	-3.80
31	3.77	0.48	5:17	0.99	0.48	0.50	1.05	0.17	0.89
"			12:25	-2.02	0.46	-2.48	-2.08	0.35	-2.43
1979:									
1/1	2.28	0.89							
"	4.41	0.61							
3	1.49	0.45							
4	2.78	1.00	3:02	0.39	0.47	-0.09	0.56	0.35	0.21
5	0.50	1.14	2:54	1.18	0.84	0.33	1.22	0.63	0.59
"			17:23	0.76	0.61	0.15	1.13	0.47	0.66
6	0.19	1.28	10:29	1.41	0.61	0.80	0.11	0.61	-0.50
"			19:20	1.18	0.61	0.57	1.34	0.46	0.87
7	1.97	1.37	3:41	0.10	0.56	-0.46	0.20	0.42	-0.22
8	2.21	1.48	3:21	-0.28	0.47	-0.75	-0.19	0.34	-0.53
9		1.66							
10	1.02	2.09	1:48	1.12	0.36	0.76	1.37	0.53	0.83
11	4.38	2.16	21:53	1.65	1.01	0.64	0.58	0.75	-0.19
12	3.10	1.32							
13	3.06	1.57	9:37	3.11*	0.75	2.36*	0.84	0.58	0.26
"			"	(0.78)		(0.03)			
14		1.20							
15			0:24	1.65	0.93	0.71	1.70	0.71	0.99
				Shut down until 1/30/79					
30			22:06	1.64	1.21	0.43	1.51	0.81	0.70
31		0.41							

Date	By Investigators 24 HR PERIOD		Time	By Investigators Based on 1 HR			By TMI Computer Based on 1 HR		
	Gross	Un-I.D.		Gross	I.D.	Un-I.D.	Gross	I.D.	Un-I.D.
2/1		1.39							
2		0.22	0:55	8.51 *	1.42	7.08 *	1.83	1.08	0.75
"			"	(1.78)		(0.35)			
"			14:31	-0.03	1.43	-1.46	0.12	1.08	-0.95
3	1.45	0.39	5:17	1.34	1.41	-0.38	0.75	1.05	-0.29
"			10:32	1.11	1.43	-0.33	0.07	1.07	-0.99
"			23:49	1.15	1.82	-0.66	1.50	1.33	0.18
4	2.04	0.28	14:45	1.73	1.37	0.37	0.97	1.03	-0.06
5	1.89	0.62	3:12	1.27	1.47	-0.20	0.55	1.13	-0.58
"			8:35	2.03	1.48	0.55	1.62	1.13	0.48
"			18:37	1.40	1.54	-0.14	1.32	1.16	0.16
6		0.23	0:25	2.10	1.59	0.51	1.84	1.18	0.66
7		0.17	13:52	1.65	1.74	-0.08	2.10	1.26	0.84
8	1.70	0.24	1:00	2.32	1.66	0.66	2.20	1.27	0.92
"			20:50	1.82	1.64	0.18	1.79	1.21	0.59
9		0.62	2:20	2.41	1.65	0.77	2.03	1.26	0.76
10		0.56	8:41	2.26	1.82	0.44	2.17	1.40	0.76
11		1.04	2:42	1.78	1.41	0.37	1.82	1.06	0.76
"			18:08	6.59 *	-0.18	6.78 *	-0.19	-0.13	-0.06
"			"	(-0.13)	-0.18	(-0.05)			
12	2.16	2.05	21:20	0.37	-0.57	0.95	0.48	-0.41	0.90
13	1.66	1.07	12:36	2.18	1.92	0.26	2.19	1.38	0.81
"			18:42	2.00	1.88	0.12	2.04	1.35	0.68
14	1.29	0.48	5:30	2.45	1.95	0.50	1.24	1.48	-0.24
15	2.95	0.77	20:26	5.10 *	2.04 *	3.06 *	2.46	1.53	0.93
"			"	(2.33)	(2.04)	(0.34)			
16	1.89	0.77	2:53	2.03	2.07	-0.03	2.40	1.54	0.86
"			12:03	2.69	2.26	0.42	1.77	1.73	0.05
17	2.37	1.80	4:11	2.82	2.69	0.13	2.88	2.08	0.84
18	2.35	0.68							
19	2.48	0.77	0.01	2.41	2.67	-0.26	2.54	1.99	0.56
"			1:36	2.67	2.54	0.13	2.89	1.90	0.97
"			21:28	2.82	2.69	0.13	2.93	2.02	0.91
20	3.89	0.46							
21	3.20	0.41	8:36	2.31	2.69	-0.37	2.38	2.03	0.34
22	3.70	0.76							

Date	By Investigators 24 HR PERIOD		Time	By Investigators Based on 1 HR			By TMI Computer Based on 1 HR		
	Gross	Un-I.D.		Gross	I.D.	Un-I.D.	Gross	I.D.	Un-I.D.
2/23	3.39	0.37	11:07	3.75*	0.42	3.71*	0.35	0.29	0.32
"			"	(0.39)		(0.35)			
24	3.35	0.41							
25	4.18	0.28	20:02	3.91	3.17	0.74	3.00	2.41	0.59
26		0.42	18:39	3.93	3.30	0.63	3.26	2.50	0.76
27		0.27	21:50	4.23	3.14	1.09	3.34	2.39	0.96
28	4.13	0.27	19:09	3.81	3.42	0.39	3.25	2.59	0.66
3/1	3.31	0.41	0:41	5.28*	3.41	1.87*	2.98	2.58	0.41
"			"	(2.69)	3.41	(-0.71)			
2	4.29	0.15	1:46	3.58	3.63	-0.51	3.70	2.75	0.95
"			19:35				3.27	2.66	0.61
3	3.79	0.29	2:38	3.95	3.23	0.72	2.77	2.46	0.32
4	4.70	0.62	1:42	4.34	3.79	0.56	2.84	2.87	-0.03
5		0.32	3:20	4.29	3.65	0.63	3.64	2.77	0.87
6			3:21	4.02	3.58	0.44	3.48	2.71	0.77
7									
8	5.50	0.61	3:50	4.83	4.11	0.72	3.58	3.11	0.47
9	5.41	0.64	3:23	5.24	4.63	0.60	4.34	3.49	0.85
10	5.42	0.78							
11	5.13	0.59							
12	4.71	0.60							
13	5.46	0.55	2:00	3.87	4.81	-0.94	3.63	3.64	-0.02
"			11:05	5.88	5.01	0.87	4.32	3.80	0.52
14	5.93	0.41	12:05	4.76*	2.40	2.36*	-6.75	-6.50	-0.25
15	5.29	0.51	4:50	3.64	5.03	-1.39	3.81	3.75	0.06
16	5.55	0.87	20:09	6.05	5.30	0.74	4.86	5.61**	-0.75**
17	7.14	0.99	2:48	5.77	5.13	0.63	4.43	5.43**	-0.99**
18	6.67	0.75							
19	5.45	0.96	0:58	11.04*	5.30*	5.74*	5.35	5.53**	-0.19**
"				(6.59)	(5.30)	(1.26)			
20	7.02	0.96							
21	7.47	0.84	1:14	8.59*	5.54*	3.05*	6.05	5.83**	0.22**
"				(7.08)	(5.54)	(1.54)			
22	6.88	0.98	3:00	7.76	5.81	1.95	6.73	6.15**	0.58**
23	7.65	0.39							

Date	By Investigators 24 HR PERIOD		Time	By Investigators Based on 1 HR			By TMI Computer Based on 1 HR		
	Gross	Un-I.D.		Gross	I.D.	Un-I.D.	Gross	I.D.	Un-I.D.
3/24	8.48	1.11	5:40	7.61	6.06	1.55	6.55	6.39**	0.16**
25	6.01	0.92	5:25	8.02	6.07	1.95	6.60	6.16**	0.43**
26	7.70	1.42							
27	7.26	1.56							
28			1:34	8.66	6.87	1.79	6.94	6.93**	0.01**

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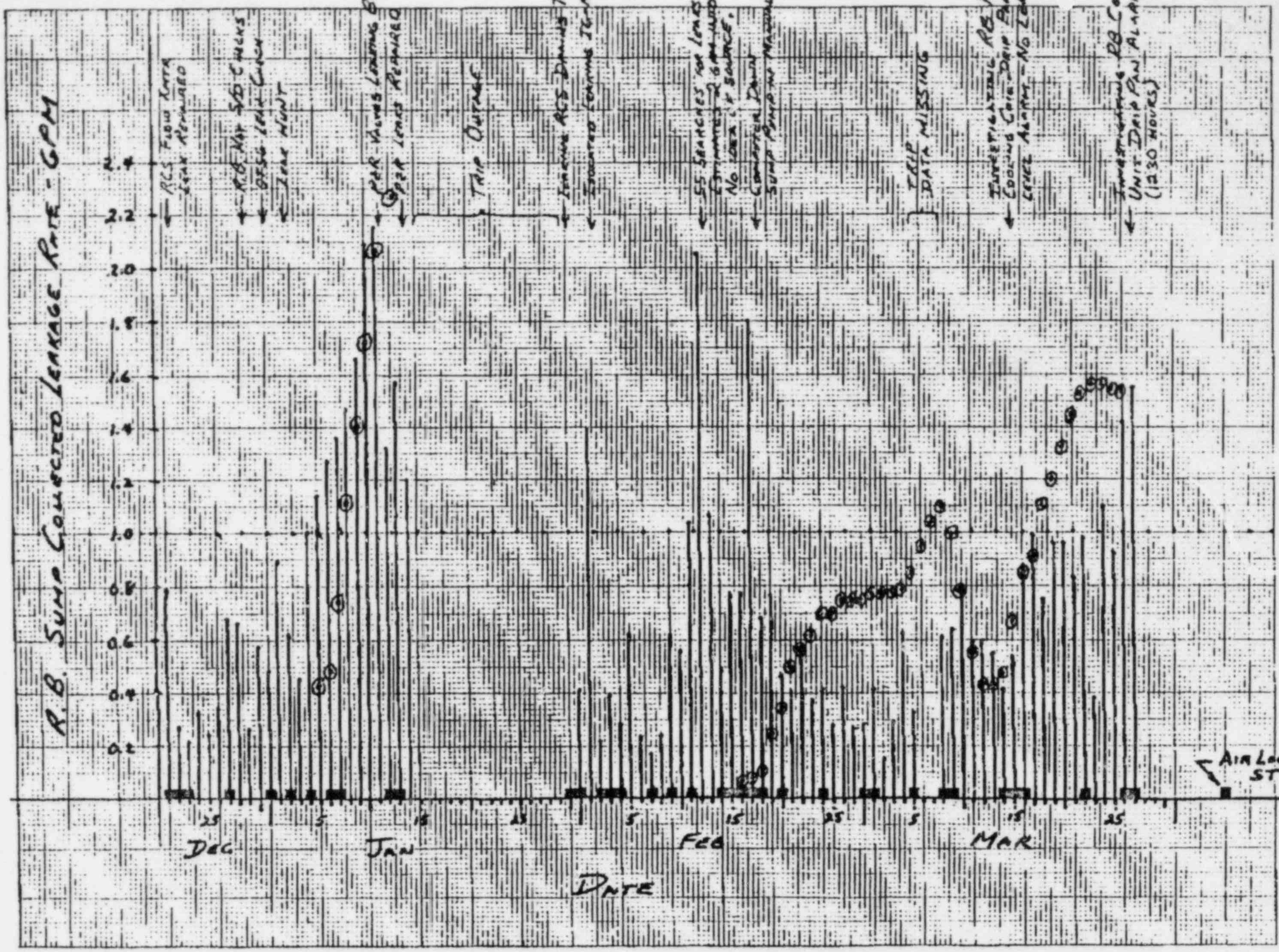

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INDEPENDENT EVALUATION OF HARTMAN'S ALLEGATION
CONCERNING ESTIMATED CRITICAL POSITION DURING A
REACTOR STARTUP AT TMI UNIT 2 ON APRIL 23, 1978

J. W. CHUNG

1.0 ALLEGATION

Document, transcriptions and statements were reviewed independently to evaluate the allegation made by former TMI Unit 2 Control Room Operator, Harold W. Hartman, Jr. The essence of the allegation seems to be that during a reactor startup on April 23, 1978, the actual critical positions of the reactor control rods were outside of the tolerance band (± 0.5 percentΔ K/K) of the Estimated Critical Position (ECP), and that after the critical position was established, a new ECP was calculated by "fudging the numbers" to conform the measured ECP under the direction of alleger's supervisor, Brian Mehler, in violation of the startup procedural steps.

2.0 INVESTIGATION

Based on the transcripts of interviews and statements made by alleger, Hartman, and others, and available plant records and data files, three separate sequences of the event were constructed; one from the allegation, second from the plant records, and third, an expected sequence from independent calculations and procedural requirements under the given plant conditions during the startup in question.

Each line item was compared with the documented records and files to establish the credibility of the allegation, in that consistency and discrepancy were identified. This investigative report thus includes following:

a. Identification of the reactor startup in question.

b. Sequence of Events.

c. Independent Evaluation.

2.1 IDENTIFICATION OF THE REACTOR STARTUP IN QUESTION

2.1.1 HARTMAN STATEMENTS

a. In two separate interviews (references 1 and 2), Hartman stated that the alleged startup took place at midshift (page 47 of reference 1; page 3 of reference 2).

b. However, Hartman made conflicting statements on the startup date: April or May of 1978 (page 48, reference 1); between October and November of 1978 (page 2 of reference 2).

c. Hartman stated that the shift supervisor during the alleged startup was Brian Mehler (page 44 and 46 of reference 1; page 4 of reference 2). Even though Mehler was not his normal shift supervisor (page 48 of reference 1). He also identified one of the other control room operators as Ray Booher (page 4 of reference 2) and the shift foreman was Dick Hoyt (page 5 of reference 2).

d. Hartman testified that the original ECP was 52% withdrawn position on group 6-7 with lower and upper limits of 32% and 52% withdrawn positions respectively for ± 0.5% delta K band from ECP (page 3, reference 2). He also stated that he continued pulling group 5 rods to 100% withdrawn position with group 6-7 at 25% (page 4, reference 2), and that the reactor went critical with group 6 and 7, at 28% withdrawn positions which was below the ECP lower limit of 32% withdrawn position on group 6/7 (reference 3).

2.1.2 BOOHER STATEMENT (REFERENCE 5)

Booher acknowledged that he worked some shifts with Harold Hartman, and on several occasions on the same shifts with Brian Mehler. However, he did neither recall being asked to recalculate an ECP after a startup nor the incident in question.

2.1.3 HOYT STATEMENT (REFERENCE 6)

He did not recall the incident in question but acknowledged that he worked with Brian Mehler.

2.1.4 MEHLER STATEMENT (REFERENCE 7)

He did not know the specific incident in question.

2.1.5 DOCUMENT REVIEW

a. Reactivity calculation sheet (reference 10) was signed by Hoyt (0045 hour, April 23, 1978) and Mehler (0100 hour, April 23, 1978), and the ECP in the work sheet was 25% withdrawn on group 6/7. The reactivity calculation was performed by Hoyt.

b. Shift turnover sheet was signed by Hoyt at 2300 hour on April 22, 1978, and the reactor went critical at 0158 hour, April 23, 1978, at which intermediate range detector reading was 10^{-8} Amps., with RCS boron concentration of 1262 ppm, T average of 533°F, and group 6/7 at 26% withdrawn position (reference 12).

2.1.6 SUMMARY

Even though there was discrepancy in Hartman's recollections of the date at which the alleged startup took place, the findings and observations indicated that the startup date in question appeared to be April 23, 1978 during mid-shift. The reactor went critical on group 6/7 with 26% withdrawn and the ECP was calculated by Hoyt with group 6/7 at 25% withdrawn position. The measured critical position, 26% withdrawn on group 6/7, was below 32% of the original ECP lower limit, as alleged by Hartman. He also claimed that actual criticality occurred at approximately 28% withdrawn position on group 6/7. In general, Hartman's statements were consistent with the documented findings, except the approximately date in one of his two statements (page 2 of reference 2).

2.2 SEQUENCE OF EVENT

2.2.1 BACKGROUND

The reactor contains a total of 69 control rods to regulate the neutron population in the core and consequently to control the reactor power output. These control rods are divided into 8 groups, and each group consists of 4 to 12 symmetrical control rods. The groups 1-4 are safety groups to provide the reactor shutdown margin and therefore are in fullout position during normal operation and startup periods. Groups 5, 6 and 7 are regulating groups to control the reactor power. However, it is required to withdraw the regulating group in sequence, starting from group 5 with a minimum of 25% overlap. Group 8 rods are axial power shaping rods (APSRs) to control the axial neutron flux distribution, and contain neutron absorbers in the bottom 36" of the rods. Therefore, the APSR group 8 are normally positioned in the core at its most reactive position, normally at 32% withdrawn or to a position determined by the nuclear engineer (paragraph 4.6, page 6.0 of reference 13).

Technical Specification 4.1.1.1.2 requires that the ECP must be within ± 1 percent ΔK/K of a measured reactivity balance. However, the TMI Unit 2 procedure (reference 8) imposed more conservative limits on the ECP, in that a measured control rod position in percent of the control rod group withdrawn were required to be within ± 0.5 percent delta K of ECP. Therefore, it was required to determine the ECP prior to criticality. Also, plant operating procedure (CAUTION, pages 6.0-7.0, reference 13) specified that when criticality was achieved outside the ECP window (±0.5 percent ΔK/K) rod insertion was required to achieve a 1 percent ΔK/K shutdown position.

During a startup operation, approach-to-criticality procedure (reference 13) required to limit a reactivity addition rate (by control rod withdrawal) to equal or less than 1 decade per minute (DPM) startup rate (SUR), and to employ "1/M' plot (paragraph 4.13, page 6.0 of reference 13).

SUR of 1 DPM and 3 DPM implied the rates of reactivity addition into a core, such that the neutron populations in the core would be increased by 10 and 1000 times in every 60 seconds, respectively, or "e" times (approximately 2.7) in every 26 and 8.67 (26/3) seconds respectively. In other words, a high SUR was an indicative of high probability of achieving or exceeding a criticality. However, it is also possible that a high SUR could be caused by a rapid addition of reactivity even at a subcritical state. Thus, 1DPM SUR limit was imposed to monitor the reactivity addition rate into a core, and, consequently, to prevent excessive and rapid addition of the reactivity during a startup.

As an additional precautionary step, "1/M" plot was employed to monitor the reactor core state during a reactor startup. The objective of using "1/M" plot was to estimate a criticality during an approach to criticality. However, "1/M" plot would be precisely valid only if the reactor is critical in a steady state and if the contribution of delayed neutrons is neglected.

When the control rods were withdrawn continuously in a subcritical reactor, "1/M" plot would not be valid, until the reactor was in its critical state and steady state.

Because of its mathematical limitation, "1/M" plot would not give a straight line correlation but would result in a concaved curve, which would approach a critical point asymptotically. Thus, "1/M' plot during a startup operation always tends to under-predict its critical point.

2.2.2 SUMMARY OF HARTMAN'S ALLEGATION

Summarizing the sequence of event as stated by Hartman:

1. On the mid-shift from 2300 hours, April 22, 1978 to 0700 hours, April 23, 1978, the shift crew members were: control room operators - Hartman, Booher and other (unknown)

   Shift Supervisor: Mehler

   Foreman: Hoyt

2. When he took ever the mid-shift as a control room operator, the group 5-7 were full-in position. Hartman commenced the startup by pulling out group 5 rods. The group 5 rods were at 100% withdrawn position when group 6 and 7 were at 25% (pages 3-4 of reference 2).

3. The original ECP was calculated by Booher (page 172 of reference 11) which might or might not be approved. During the approach-to-criticality, Hartman used the Booher's ECP, which projected that:

   ECP: Group 1-5 - 100% withdrawn

   Group 6-8 - 52% withdrawn

   Intermediate Range Detector Reading: 10^{-8} amp.

   ECP Window: Lower limit of group 6/7-32% withdrawn (-0.5 percent ΔK/K); Upper limit of group 6/7-100% withdrawn (0.35 percent ΔK/K).

4. While withdrawing group 5 rods, Hartman saw the "1/M" being plotted.

5. Hartman observed a control rod (withdrawal) inhibit alarm when group 6/7 was withdrawn to approximately 28% position, with group 5 fully (100%) withdrawn. He also observed that source range detector reading (SUR) was 3-3.5 DPM and constant, and intermediate range detector reading was 6×10^{-11} amps. At this point Hartman thought that the reactor was at least critical.

6. Since 28% withdrawn position of group 6/7 was below the lower limit of the Booher's ECP window (32% withdrawn, group 6/7), Hartman felt that all rod groups had to be inserted all the way except the safety group 1-4, in accordance with the station procedure (Reference 13), and thus to achieve 1 percent ΔK/K shutdown position.

   Consequently, he proceeded to insert the rods until shift supervisor, Mehler, stopped him from inserting the rod. At this point, the group 6/7 rods were at 15-18 percent withdrawn position.

7. Mehler instructed him to proceed startup, and Hartman started rod withdrawal again, establishing criticality and 1 DPM SUR with the intermediate range detector reading of 10^{-8} amp.

8. Even though Hartman did not witnessed the actual recalculation, Hoyt calculated a new ECP after the criticality, in order that the actual critical position was within the ECP window. He also alleged that the old Booher ECP was discarded into a waste basket.

2.2.3 ECP Event Documentation

From the available TMI unit 2 records and data files, the following sequence of event could be established.

Date	Time	Reference	Event
4/22/78	2300	10, 11, 12, 14	Mid-shift was assumed by;
			shift supervisor: Mehler
			Foreman: Hoyt
			Control Room Operators: Hartman, Booher, Kidwell
		12	Plant status;
			Reactor Mode: 3
	2315	10, 12	Core: 0.6 EFPD
			Boron: 1262 ppm
			Tave: 532
4/23/78	0045	10	ECP calculation (enclosure 1),
			procedure 2103-1.9) by Hoyt
	0100	10	ECP calculation approved by Mehler
			ECP: group 6/7, 25% withdrawn (WD)
			ECP window: group 6/7
			17% - 38% WD
4/23/78	0100	15	Group 1-4: 95% WD
			Group 5: 1% WD

			Group 6: 1% WD
			Group 7: 0% WD
			Group 8: 29% WD
4/23/78	0135	12, 14, 15	Reactor mode: 2
			Group 6/7: 18% WD
			Tave: 532°F
4/23/78	0158	11, 12, 14, 15	Reactor: Critical
			Intermediate Range Detector: 10^{-8} amp
			Boron: 1262 ppm
			Tone: 533°F
			Group 1-5: 95% WD
			Group 6/7: 26% WD
			Group 8: 29% WD

2.2.4 EVALUATION

1. The plant records and data files indicated that when Hartman assumed the mid-shift on April 22, 1978, the shift personnel on the shift was consistent with the statements made by Hartman. In fact, Booher's statement (Reference 5) conformed the above.

2. Plant Computer printouts (Reference 5) at 0100 hour on April 23, 1978, supported the plant status described by Hartman. Even though the computer inputs for the control rod positions were from the pulse counting "relative position indication", there were no objective evidence that the absolute position indications were different than these of the pulse counter.

3. The essence of Hartman's allegation was existence of another ECP, originally calculated by Booher during the startup. Hartman stated that the official ECP calculated by Hoyt was second one, recalculated after the criticality. The records clearly indicated that the ECP was obtained prior to the criticality. Comparing those two separate ECPs:

Time	Alleged Booher's ECP	Hoyt's ECP
Hartman's Allegation	before criticality	after criticality
Plant record	none existence	before criticality
ECP	group 6/7, 52% WD	Group 6/7, 25% WD
ECP Window Upper limit	group 6/7, 100% WD (0.35% ΔK/K)	Group 6/7, 38% WD (0.5 % ΔK/K)
Lower Limit	group 6/7, 32% WD (- 0.5% ΔK/K)	Group 6/7, 17% WD (- 0.5% ΔK/K)

It was quite interesting to note that plant startup procedure 2103-1.9 (Reference 8), second "NOTE" in paragraph 4.3.11 of page 14.0, provided a guideline for ECP calculation. In that, for a Xenon free core the desired critical position would be between 30% and 40% withdrawn on group 6/7. Therefore, both Booher's and Hoyt's ECPs were all outside of the recommended range. However, let us recontruct the process of calculating the ECP as given in the following sequence:

a. Procedure 2103-1.9, page 14.0

Paragraph 4.3.11, for Xenon free core (Reference 8) — 30% WD - 40% WD Group 6/7

b. Logical selection would be a midpoint of the range in item (a) — $\frac{30 + 40}{2}$ = 35% WD Group 6/7

c. Xenon Reactivity — -0.46% ΔK/K

(item 6, page 23.0 of of reference 10)

(Independent calculation conformed this number: -0.508% ΔK/K)

d. Item (b) in reactivity % ΔK/K for 35% W/D, group 6/7 (from figure 2B, procedure 2103-1.9; reference 8) — -0.7 % ΔK/K

e. Core with Xenon = (Xenon free core) + (Xenon) = item (c) + Item (d) — -0.46 + (-0.70) = -1.16% ΔK/K

f. Item (e), -1.16% ΔK/K, in % W/D for group 6/7 (figure 2B, 2103-1.9) — 26% WD group 6/7

The above 26% withdrawn on group 6/7 would be a logical choice value for the ECP, and was very close to 25% WD - group 6/7, the value choosen by Hoyt. Otherhand, the alleged Booher's ECP, 52% WD - group 6/7, was not only 12% above the upper bound of the procedural recommendation (30 - 40% WD group 6/7), but also beyond the normal comprehension.

Hartman claimed that the Hoyt's ECP was calculated after the criticality, which occurred at 0158 hour, April 23, 1978. A record (reference 12) indicated that the reactor entered mode 2 (startup) from mode 3 (Hot standby) at 0135 hours, on April 23, 1978, 23 minutes before the criticality. The fact was that the reactor entered mode 2 with group 6/7 18% withdrawn, at which by definition (reference 9) the multiplication factor (Keff) become equal or greater than 0.99. Now, reconstructing the sequence;

a. At 0135 hour, on April 23, 1978, Reactor was in mode 2 with the rod worth of -1.75% ΔK/K, group 6/7, 18% withdrawn (reference 8, figure 2B). At this point, the reactor reactivity should be at 1.0% ΔK/K (keff $\leq$ 0.99) less than the critical point. This would give the critical point at or less than -0.75 (-1.75 + 1.0) % ΔK/K, **group 6/7 worth, which was equivalent to less than or equal to 34% withdrawn position for group 6/7.**

b. Since alleged Booher's and recorded Hoyt's ECPs were 52% and 25% withdrawn positions on group 6/7 respectively, the decision to enter the mode 2 had to be based on the Hoyt's ECP. Consequently, the Hoyt's ECP existed 23 minutes before the criticality.

c. Let's assume that the alleged Booher's ECP existed when Hartman took the mid-shift at 2300 hour on April 22, 1978. Furthermore, assume that during the approach-to-criticality the Booher's ECP was initially used and "1/M" curve also was plotted. Since "1/M" always gave the critical point before the actual critical point, "1/M" prediction of the criticality could have been less than the actual critical value of 26% withdrawn position of group 6/7.

With this information (ECP of less than 26% withdrawn on group 6/7) from "1/M" plot available and assuming the Booher's ECP (52% WD, group 6/7) was used at that point, Mehler could have realized an error in the Booher's ECP and could have asked recalculation of a new ECP. Now, with the above information and knowing plant status at this point, recalculation of a new ECP could take less than 15 minutes. In fact, a mere correction of the Booher's ECP could have been done within 10 minutes, just in time to enter the reactor mode into 2 at 0135 hour on April 23, 1978.

However, assume that "1/M" plot was used to decide the entry into mode 2 without a new ECP. Mehler should have known already that the Booher's ECP was wrong, and subsequently made a decision to use "1/M' result. At this point he had 23 minutes to recalculate a new ECP, prior to criticality. Even this synopsis indicated that Hoyt's ECP could have existed prior to the criticality.

4. Hartman stated that he observed a control rod inhibit alarm when the group 6/7 was withdrawn to approximately 28% position with a SUR of 3-3.5 DPM. Since plant record (reference 12) indicated that the reactor during the startup in question went critical with 26% withdrawn position of same rod group, the reactor was in super-critical state by an equivalent reactivity of 2% rod worth on group 6/7. From figure 2B, Procedure 2103-1.9 (reference 8);

	Rod Worth % ΔK/K
28% WD, group 6/7	-1.075
26% WD, group 6/7	-1.125
Difference (2%)	0.050

At this point, Hartman obviously added a reactivity, equivalent to 0.05% ΔK/K, into a critical reactor. If 0.05% ΔK/K reactivity was added rapidly by withdrawing group 6/7 rods to 28% position, 2% above the criticality, one would expect to see less than one-tenth of the SUR (greater than 2 DPM) which Hartman observed. To observe such large SUR (over 2 DPM), either he had to pull the rods out to give 0.5% ΔK/K reactivity over the criticality or he was approaching and passing the criticality by pulling out the rods rapidly and continuously.

To give 0.5% ΔK/K excess reactivity (again, using figure 2B, procedure 2103-1.9), he had to withdraw the group 6/7 rods to 32% position, at which the group rod worth was - 0.625% ΔK/K.

Assuming that either he observed high SUR, caused by rapid withdrawal or 32% withdrawal position of group 6/7, or he was alarmed by the inhibit alarm, it was possible for an experienced operator that a natural reflex of his training could have caused the stated (by Hartman) reaction, i.e., insertion of control rods.

5. Hartman testified that shift supervisor, Mehler, interrupted Hartman from inserting the control rods fully at 15-18% withdrawal position of group 6/7, contrary to station procedure 2101-1.2, when the criticality was achieved outside ±0.5% ΔK/K ECP windown. Station procedure 2102-1.2, pages 6.0-7.0, "CAUTION", clearly stated that only one percent ΔK/K worth of the control rod was required to be inserted from the critical point. Since Hoyt's ECP was 25% withdrawal position of group 6/7, 1 percent ΔK/K equivalent rod position would be 18% withdrawal position of group 6/7 or - 1.75 percent ΔK/K rod worth position in figure 2B, procedure 2103 -1.9 (reference 8). Therefore, not only Mehler's instruction (according to Hartman's statements) was correct but also, it clearly indicated that Mehler was using the Hoyt's ECP.

3.0 CONCLUSION

1. Hartman's statements were appeared to be, in general, consistent with the station documented records, except existence of erroneous ECP, which was calculated by Booher, as alleged by Hartman.

2. Evaluation of plant records and data files indicated that Hoyt's ECP appeared to be used prior to criticality.

3. Even though no objective documentation or records were found, the alleged post-critical instruction (preventing to insert the rods fully when the measured critical point was outside the ECP window) by Mehler to Hartman was consistent with the plant procedure. Hartman apparently misunderstood the procedural specifications given in "CAUTION", pages 6.0 - 7.0, procedure 2102-1.2 (reference 13).

4. Hoyt's ECP was consistent with the procedural requirements (references 8 and 13), and no objective evidence or need to "fudge the ECP" was found.

5. Records of "1/M" plot were not available.

4.0 REFERENCES

1. Transcript of NRC Inspection and Enforcement Branch Interview of Harold W. Hartman, Jr., May 22, 1979, pages 43-48.
2. Transcript of NRC Inspection and Enforcement Branch Interview of Harold W. Hartman, Jr., May 26, 1980, pages 1-12.
3. Sworn statement by Harold W. Hartman, Jr., March 26, 1980.
4. Transcript of NRC Inspection and Enforcement Branch Interview of Jim Floyd, March 27, 1980, pages 12-15.
5. Transcript of NRC Inspection and Enforcement Branch Interview of Raymond Booker, March 27, 1980.
6. Transcript of NRC Inspection and Enforcement Branch Interview of Kenneth Hoyt, March 27, 1980, Pages 11-14.
7. Transcript of NRC Inspection and Enforcement Branch Interview of Brian Mehler, March 27, 1980, Pages 3-4.
8. TMI Unit 2 Operating Procedure 2103-1.9, Reactivity Balance; Temporary Change Notice 2-78-410, April 19, 1978.
9. TMI Unit 2 Technical Specifications.
10. Reactivity calculation sheets, performed April 23, 1978 0045 hour, enclosure 1, TMI Unit 2 Operating procedure 2103-1.9.
11. Investigative Report, Chapter IX, Analysis of Hartman's Allegations concerning estimated critical position during a reactor startup at TMI unit 2 on April 23, 1978.
12. Control Room log books, mid-shift, April 22, 1978 (2300 hour April 22, 1978 to 0700 hour, April 23, 1978).
13. TMI Unit 2 Operating procedure 2102-1.2, Approach to criticality.
14. Completed procedure 2102-1.2, performed on April 22, 23, 1978.
15. TMI unit process computer printouts, 0003 hour, 0100 hour, 0200 hour, April 23, 1978.