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RELATED CORRESPONDENCE

GOVERNMENT ACCOUNTABILITY PROJECT
1555 Connecticut Avenue, N.W., Suite 202
Washington, D.C. 20036

DOCKETED
USNRC

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November 19, 1984 ^{*84 NOV 27} AIO:15

OFFICE OF SECRETARY
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BRANCH

Administrative Judges
Ivan W. Smith, Chairman
Sheldon J. Wolfe
Gustave A. Linenberger, Jr.
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

In the Matter of
Metropolitan Edison Company
(Three Mile Island Nuclear Station, Unit 1)
Docket No. 50-289 *sp*

Dear Sirs:

Attached are five additional exhibits which should be appended to the pre-filed written testimony of TMIA witness David H. Gamble. These exhibits were only recently received by TMIA after the Staff and OIA conducted a requested search of their files for these documents.

The exhibits are referred to in the following part of Mr. Gamble's testimony:

- Exhibit 4: April 1, 1980 Memorandum for Norman C. Mosely from Victor Stello, Jr. --
Testimony at pp. 1-2.
- Exhibit 5: April 18, 1980 Memorandum for IE TMI Task Group from Norman C. Mosely --
Testimony at p. 3, first full paragraph.
- Exhibit 6
and 7: Draft Report on "Reportability of a Predicted Offsite Exposure Rate" --
Testimony at p. 3, first full paragraph.
- Exhibit 8: Draft Report, with notation "Haynes Draft" --
Testimony at p. 3, second full paragraph.

Sincerely,

Lynne Bernabei
per Lynne Bernabei
Attorney for Three Mile Island Alert

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

SSINS 3800

APR 1 1980

MEMORANDUM FOR: Norman C. Moseley, Director
Division of Reactor Operations Inspection
Office of Inspection and Enforcement

FROM: Victor Stello, Jr., Director
Office of Inspection and Enforcement

SUBJECT: COMPLETION OF IE INVESTIGATION OF INFORMATION FLOW
AT TMI DURING MARCH 1979 ACCIDENT

The Commission has directed IE to complete its investigation of the information flow from the licensee to NRC during the accident at Three Mile Island in March 1979. You are assigned the lead responsibility for the task. The following guidelines are provided for direction:

- (1) The prompt completion of this task is to be considered your top priority assignment. If you believe it to be necessary, you should assign someone to act in your stead as Division Director until this task is completed.
- (2) The background of this task is as follows:
 - (a) At the time enforcement action was taken on the IE investigation results, it was concluded that until completion of other on-going investigations, final conclusions should be held in abeyance on the following three matters:
 - Reporting of a calculated exposure rate of 40 rem/hr at Goldsboro.
 - Reporting of the high core exit temperatures.
 - Reporting of the containment pressure spike.
 - (b) The Kemeny Commission and the NRC Special Inquiry investigations have been completed.
 - (c) In view of all the information now available, we must reach final conclusions on the matters left open, and make a recommendation on actions to be taken.

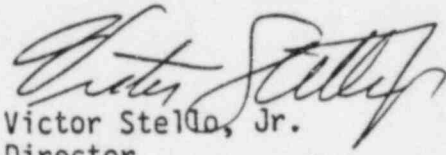
(3) As a minimum, the task should include:

- (a) Review of the prior IE investigation into this particular matter.
- (b) Review of the NRC/TMI Special Inquiry Group investigation into this particular matter.
- (c) Review of the material available from the House Subcommittee on Energy and the Environment, Committee on Interior and Insular Affairs.
- (d) To the maximum extent practical, reliance should be placed on available interview transcripts and testimony. However, as necessary, you should conduct interviews of individuals whose testimony is needed to determine the proper extent or meaning of written material or past testimony, or to complete the available evidence in matters not previously pursued or inadequately pursued on the basis of new considerations. If there is a need for deposing individuals under oath, the proper request for the power to do so should be made promptly.
- (e) Other evidence, information or allegations that has come to light since the completion of the prior IE investigation, and that relate to the determinations that are to be made should be considered in your assignment. This includes any material from other investigations that may reflect in a significant way on the tendencies of the principal participants to initiate or accede to practices intended to alter information or to restrict the required flow of information for any reason.
- (f) Three IE personnel should be selected to assist you in this task on essentially a full-time basis. If additional resources are needed during the course of the task please inform me promptly. The task should be completed as soon as practicable, but in no event should the date of the final report be later than June 6, 1980.
- (g) David Gamble, a representative from OIA, will actively participate as a working member of this task group. Marian Moe of OGC will be kept informed of the ongoing activities of the group.

It is essential that we initiate this task with an open mind. The conclusions reached in the prior IE investigation are to be set aside and every effort should be made to impress upon everyone contributing to this assignment that they should not be influenced in this task by the previously stated IE conclusions.

The report of your task should briefly summarize the background that led to your task; should clearly specify the purpose and scope of your efforts; should describe how you conducted the task including the personnel involved in the task, the information reviewed, new information obtained, and how it was obtained; should describe the evaluations made in sufficient detail to clearly define the bases for the conclusions reached; should list the conclusions reached, and finally, the actions recommended on the bases of those conclusions.

Please initiate work on this assignment immediately. I want to be informed of progress periodically (at least twice weekly). Inform me immediately of any matters that arise that may interfere with the prompt execution of this task.



Victor Stello, Jr.
Director
Office of Inspection
and Enforcement

cc: Chairman Ahearne
Commissioner Kennedy
Commissioner Gilinsky
Commissioner Hendrie
Commissioner Bradford
W. J. Dircks
R. DeYoung
L. Bickwit
H. Shapar
J. Murray
J. Cummings
D. Thompson
M. Moe
R. Fortuna
D. Gamble



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

APR 18 1980

MEMORANDUM FOR: IE TMI TASK GROUP
FROM: Norman C. Moseley, Dir., ROI, IE
SUBJECT: DRAFT REPORTS, TASK GROUP MEETING

The initial draft reports for the three areas (40 R/hr calculated dose rate, high core exit temperatures and containment pressure spike) are due by April 25, 1980. These drafts should be available for HQ distribution to all Task Group participants on April 25, 1980. This will allow all members to review the draft reports prior to the meeting on April 28, 1980. This meeting is expected to last for two days (4/28-29/80).

The meeting will be held at 8:30 a.m. on April 28, 1980 in room 550 of East West Towers (Hearing Room) and in the morning of April 29, 1980. The afternoon session of April 29 will be held in room 332A of East West Towers.

If you have any questions about the draft reports or the meeting please call John Craig on 49-28019.

Norman C. Moseley
Norman C. Moseley
Director
Division of Reactor
Operations Inspection, IE

cc: V. Stello, IE
R. Haynes, RV
W. Fisher, RIII
T. Harpster, IE
J. Craig, IE ✓
D. Gamble, OIA
M. Moe, OGC
R. Bachmann, ELD

REPORTABILITY OF A PREDICTED
OFFSITE EXPOSURE RATE

At about 0740 on March 28, 1979, the licensee attempted to report to NRC Region I the General Emergency involving known major fuel damage. ^{1/} During telephone contacts with Region I personnel, which began at about 0750, the licensee did not notify Region I of an offsite release calculation which predicted significant exposure rates downwind toward Goldsboro. ^{2/} The reportability of that prediction is the object of this investigation.

Except for minor time variances, matters bearing on the reportability of the offsite exposure rate prediction have been described rather consistently by TMI-2 accident participants and investigators.

Prediction -10(40?) R/hr in Goldsboro

Upon arriving at the plant in time to hear a Site Emergency announced at 0655, Howard Crawford, a nuclear engineer, proceeded to the Unit 2 control room. Upon arrival, he gathered materials to be used in predicting release rates, a task he had performed during drills for two years. ^{3/} Crawford recalls that his first calculation, completed soon after 0700, showed an exposure rate of 40 R/hr in Goldsboro. Neither the time nor the result of this calculation has been substantiated by records or the recollection of others. ^{4/} However, that early prediction, if it occurred, is not pertinent to this investigation, since a similar, documented

prediction (10 R/hr at the Low Population Zone boundary) was performed before the licensee reached NRC Region I by telephone at about 0750.

This prediction (10R/hr at the LPZ) appears to have been performed by Crawford during or after the massive release of radioactivity to the reactor building atmosphere, which began at 0713.^{5/} Both the time and magnitude of Crawford's dome monitor (HP-R-214) reading (300 R/hr) are uncertain. Accurate or not, the 300 R/hr reading formed the basis for the LPZ calculation. The time shown on the calculation sheet, 0744, could indicate when HP-R-214 was read or when the calculation was performed. Therefore, Mr. Crawford's prediction of 10 R/hr at the LPZ seems to have occurred between 0713 and 0744.

Crawford recalls discussing a 40 R/hr prediction with Richard Dubiel, Supervisor of Radiation Protection and Chemistry, and with James Seelinger, Unit 1 Superintendent.^{6/7/} Dubiel and Seelinger recall such discussions, only concerning the 10R/hr prediction.^{8/9/10/11/} Again, this distinction is unimportant.

During the 6/6/79 interview,^{7/} Crawford stated:

They both thought it appeared too high and they immediately talked, you know, possible steam damage to the dome monitor...they wanted to get a very good feel to see if they wanted to believe that number....

On 5/22/79, Dubiel stated:^{9/}

...I don't think we ever had projections that were meaningful and I don't believe at that time we had any projections that indicated anything of a serious nature, even based on the procedures.

This statement appears to have been based on two factors - disbelief of the dome monitor reading and knowledge of low pressure in the reactor building - as indicated in the following exchange.^{10/}

Q Do you recall doing an off-site dose calculation at approximately 7:10 on the morning of March 28th?

Dubiel I did not do any off-site dose calculations.

Q Do you recall verifying one?

Dubiel I recall verifying one. I recall looking at several during the morning.

Q An specifically, do you recall one that was made by Mr. Crawford based on a reading of the dome monitor?

Dubiel Yes, sir, I do.

Q Do you remember verifying that one?

Dubiel Yes, I do.

Q Am I correct that Mr. Crawford's calculation was incorrect?

Dubiel No, I think Mr. Crawford's calculation was correct.

Q Was it based on an incorrect reading of the monitor?

Dubiel No, I don't believe so.

Q What was the calculation of the off-site dose he came up with?

Dubiel Approximately 10 R per hour gamma at a location which was the center of the town of Goldsboro, which is on the west shore of the Susquehanna.

Q And your understanding is that, based upon the information that he had, he correctly calculated a projected dose of 10 R per hour?

Dubiel Yes.

Q Can you explain how Mr. Crawford could have made an accurate calculation of 10 R per hour as the expected level in Goldsboro when in fact there were no detectable levels?

Dubiel I think that the single biggest factor in that particular

item is that the dome monitor did not respond accurately. The projected levels are based on the dome monitor readings, plus some very conservative assumptions. Since we are trying to do, in defining the procedure for dose projections, there are a lot of parameters which cannot be determined, so that conservative assumptions are made. And, I feel, first of all, that the dome monitor over-responded significantly.

I feel, secondly, that the building pressure of one or two pounds versus the conservative assumption of 55 pounds would add to it.

On 5/11/79, Gary Miller, TMI Station Manager, testified before the U. S. House of Representatives, Committee on Interior and Insular Affairs:^{12/}

Weaver: What did you think of that? The high reading on that dome monitor?

Miller: I just did not think about it in terms of fuel damage. I knew that it meant there was a potential to release things offsite. My only concern was to get readings.

Cheney: Did you have any question about the values of those readings?

Miller: I thought it was too high, but I did not need to be convinced that it was high enough to be concerned. It was reading 40,000 or 50,000. I mean that was beyond what I had ever envisioned ever seeing on the dome monitor, so you can discuss whether there was shielding and moisture and whether it was beta radiation, and all that sort of thing.

But I did not need to be convinced. What I really wanted was somebody out there with a meter and an iodine kit sampling, and the wind direction. That is real numbers. That is really what someone is going to get out there. So that was our concern.

Onsite and Offsite Monitoring

Mr. Miller's statement reflects a common concern for getting radiation measurements onsite and offsite to supplement the Crawford prediction. Upon declaration of a Site Emergency at 0655, efforts to organize and dispatch onsite and offsite monitoring teams began. 8/13/ This seems to have occurred rather clumsily; nevertheless, an onsite team (Alpha) was instructed at about 0730 to measure the radiation level west of the Unit 2 reactor building. 14/15/ During that survey, the wind was westward and very light with minute-to-minute variations of about 10 to 30 degrees. This survey was appropriate, but tardy. At 0746, Alpha Team reported less than 1 mR/hr at Station GE-8 west of the Unit 2 reactor building. As discussed later, this measurement became the basis for discounting Crawford's prediction(s) of high exposure rates offsite.

At about 0800 and 0830, respectively, Charlie and Bravo Teams were dispatched by vehicle to Goldsboro. At about 0830, Charlie Team reported less than 1 mR/hr in Goldsboro. Bravo Team reported similarly at about 0940. Given that there had been no significant release from the reactor building, these surveys seem adequate from the exposure rate measurement standpoint. However, had a major release occurred, these surveys would have been too little, too late.

TMI management appears to have realized the need for a quick measurement in Goldsboro to confirm or deny Crawford's predictions(s). In statements following the accident, Miller and Dubiel maintained that a State Police helicopter had flown a survey team to Goldsboro soon after the General Emergency was declared.

To the U. S. House of Representatives, Committee on Interior and Insular Affairs, Miller stated:^{17/}

At approximately 0730 or a little before, I had received predictions of an offsite dose of 10 R at Goldsboro. This was based on the Reactor Building dome monitor, which was still increasing and from our past experience with this source calculation, we did feel these were really this high, but as a precaution, I dispatched a State Police helicopter with an offsite team along with an offsite team in a car and separately, to the West Shore (Goldsboro).

0740 - York Haven radiation monitor reading (0) - helicopter
(approx.) at TMI - dispatched offsite teams in helicopter and one

separately in car to West Shore (from G. P. Miller and R. W. Dubiel recall of the incident).

0800 - Offsite team in Helicopter at West Shore (Goldsboro)
(approx.) '0' reading - we actually were ahead of the plume -
plus onsite team at our West site boundary-'0' reading.

To the NRC Special Inquiry Group, Miller stated:^{18/}

Q In fact, you or someone called the State Police that morning for a helicopter and you got one very fast, didn't you?

Miller There may be---subsequently I know there's some disparities in my time versus the time the thing landed here or the time it's documented. I remember as soon as I had the projection, which was high, for Goldsboro and knowing the west---knowing the wind was blowing to the west and knowing that it was seven or eight in the morning, that I know that I asked for a helicopter before seven thirty.

I knew that that was in my mind and knew that I had the York Haven monitor out over there and I knew I had a guy on the West Shore. That's something that I had practiced and thought about it. Even in the Unit 2 hearings when we discussed the wind blowing west, slow as it was.

Q Do you know whether the helicopter actually came on the site and picked up somebody to go over the river?

Miller To my knowledge it was verified to me that they picked up one or two of our people and they were flown over there. And readings were back, and as I remember the readings were back before Dubiel had thought the plume had gotten there. In other words, we had gotten over there faster than the radiation would have at the wind speed, which was very slow.

On 4/24/79, Dubiel stated:^{8/}

At some point around 7:30, Gary Miller asked me for the status of the offsite teams, and I gave him the information that we had two teams ready to go offsite both available for transportation over to the West Shore. Gary directed me to make contact with the State Police and get a State Police helicopter to get one crew over there in a more timely fashion. He was concerned about the traffic--the early morning rush hour traffic trying to go up over the bridge in Harrisburg and then back down and that it might take an hour or more to get over there. He requested that we send one team in a helicopter and a second team in a car of driving over at a normal pace to back them up. I do not recall exactly who told me that they would get the State Police helicopter. I believe it was George Kunder, I do not remember exactly, but within minutes I had it confirmed to

me that the State Police had been notified, and a helicopter would be on its way since they are stationed up at Harrisburg, Harrisburg International Airport. It would be here in a matter of minutes, and that security was notified that this helicopter was coming and would be landing somewhere in the vicinity of the north parking lot, and that they were to allow it to land and make preparations to support its landing in getting our technician on board.

...the timing may be poor but I am estimating 7:40 we had a man in the helicopter and sometime by two to three maybe five minutes later the man was in Goldsboro.

By 9/21/79, Dubiel's position regarding the helicopter survey had changed.^{10/}

Q Did you have any role in ordering a Pennsylvania State -- or requesting a Pennsylvania State Police helicopter to come to TMI and take a team to Goldsboro to verify what you thought and hoped was the fact, which is that it did not have a 10 R per hour reading there?

Dubiel Yes, I was involved in the determination for the need of a helicopter. I did not make the specific request.

Q Do you know who did?

Dubiel George Kunder made the request via the site protection officer. It might have been a sergeant, someone in the security force.

Q Did the helicopter arrive?

Dubiel The helicopter came in. I don't recall a time. I believe it was an hour later.

Q To your knowledge, did a team go in the helicopter to Goldsboro and take a measurement?

Dubiel I thought one did. I have been led to believe -- when we determined the need for the helicopter, we simultaneously sent a team in a car to drive around. But recognizing the time it takes to get there, we requested a helicopter. Which team got there first I don't know. I know the helicopter was available, because I subsequently used it for other things.

The fact seems to be that TMI management, being concerned about potential exposure rates in Goldsboro, did order a helicopter after declaring a General Emergency at 0724.^{19/} However, the helicopter did not arrive until 0835, by which time Charlie Team had reported in from Goldsboro and Bravo Team had left by truck for Goldsboro. The helicopter was not used to transport a survey team to Goldsboro.

By 0830, when Charlie Team reported less than 1 mR/hr from Goldsboro, it was clear that a major offsite release from the reactor building had not occurred. But little comfort should have been derived from that knowledge while the reactor building contained an inventory of perhaps 300 million curies of noble gases and other radionuclides.^{20/}

Reportability and Reporting

The situation was intuitively reportable to NRC under 10 CFR 20.403, which requires immediate notification "...of any incident involving byproduct... material...which may have caused or threatens to cause... release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 5,000 times the limits specified for such materials in Appendix B, Table II...."

Since there was no reason to believe that the dome monitor (HP-R-214) increase was transient, the "immediately reportable" concentration of Xe-133 would have been $1.5E-3 \mu\text{Ci/ml}$ (i.e., $5000 \times 3E-7 \mu\text{Ci/ml}$). Using a source term of 1325 Ci/sec and a X/Q of $2.5E-4$ seconds per cubic meter, at about 0744 Crawford used Radiation Emergency Procedure 1670.4, Rev. 3, dated 2/15/78 to calculate a concentration of $0.33 \mu\text{Ci/ml}$ at the LPZ, 220 times this "immediately reportable" concentration. Using the same procedure, the minimum concentration immediately reportable under 10 CFR 20.403 ($1.5E-3 \mu\text{Ci/ml}$) can be found to correspond to an HP-R-214 reading of only 1.4 R/hr.

Early in the accident, the licensee logically could have challenged the Procedure 1670.4 calculation on the basis of low reactor building pressure. But as the reactor building radioactivity inventory increased, as measured by HP-R-214, the licensee should have become progressively less concerned about the conservatism of the calculation and more concerned about the magnitude of the potential hazard.

Telephone contact between the Unit 2 control room and NRC Region I was established, after appropriate efforts by the licensee, at about 0750.^{4/} Although earlier contacts had been made with the Region I answering service, this was the licensee's first good opportunity to report the accident in accordance with 10 CFR 20.403.

However, the 0744 prediction of 10 R/hr was not reported, apparently because the first onsite measurement at point GE-8 west of Unit 2 (1 mR/hr at 0746) had been used to calculate a new source term at 0750. Although this one onsite measurement did not prove that the release was insignificant, the licensee could have concluded justifiably that the release was not as bad as calculated. The reportability of the situation remained, however, in that: (1) the incident still threatened to cause a major release and (2) offsite field measurements had not been completed.

The licensee reported Crawford's 10 R/hr prediction to the Bureau of Radiation Protection but not to NRC. The only identified NRC reference to a high radiation level outside the plant was the following telephone conversation recorded after 10:00 a.m. on 3/28/79, in the NRC Operations Center.

VOICE: The indications are that low levels are being released, we will find out.

VOICE: What is your MDC?

VOICE: There is no question that there was -

VOICE: There was?

VOICE: --released when the incident first occurred.

VOICE: Yeah, I heard somebody, I guess on the radio, I think it was from the Bureau, saying that there were 10 R per hour out the cooling tower.

VOICE: No.

VOICE: Was that emergency services?

VOICE: I don't know who said that.

VOICE: It was somebody from the State of Pennsylvania being interviewed, that's what.

It is unlikely that the licensee inadvertently omitted the 10 R/hr prediction when describing the accident to Region I after 0750. Clearly, from the Crawford and Dubiel statements, the licensee wanted not to believe the dome monitor and Crawford's calculation.

The licensee not only failed to report the 10 R/hr prediction to Region I, but also, according to the following statement of Thomas Gerusky, Director of the Bureau of Radiation Protection, countered the report to BRP with nonexistent Goldsboro survey results.^{21/}

In the meantime, I requested them to try to get their teams somehow to Goldsboro, and they said that the State Police helicopter was there and that they would get one of their teams up in the air and over Goldsboro. We stayed on the phone with them. They found no radiation levels onsite or in Goldsboro that would indicate any kind of a leak. So therefore, we then notified the Civil Defense to hold tight. This was all before 8:00.

The desire to disprove the 10 R/hr prediction, which could have triggered massive evacuations, is understood. Use of the first onsite, downwind measurement to partially achieve such disproof also is understood. The use of nonexistent offsite survey results to further disprove the prediction is not understood.

Conclusion

Nothing discovered in this investigation relieved the licensee of the requirement to report to NRC all pertinent facts concerning the accident. The 10 R/hr prediction seems not to have been adequately disproved by 0750, when telephone contact was established with Region I. The decision not to report the 10 R/hr prediction was improper. By not reporting to Region I at about 0750 on 3/28/79 that the calculational method described in Radiation Emergency Procedure 1670.4 had predicted a reportable release of radioactive material, the licensee violated the reporting requirement of 10 CFR 20.403(a)(2).

References

1. NUREG 0600
2. Ibid.
3. Crawford Interview IE 48, 5/3/79
4. NRC Special Inquiry Group, Volume II, Part 3
5. Ibid.
6. Crawford Interview IE 48, 5/3/79
7. Crawford Interview IE 174, 6/6/79
8. Dubiel Interview IE 20, 4/24/79
9. Dubiel Interview IE 133, 5/22/79
10. Dubiel Deposition (SIG), 9/21/79
11. Seelinger Interview IE 77, 5/8/79
12. Oversight Hearings, Subcommittee on Energy and the Environment,
May 9, 10, 11, and 15, 1979, Serial No. 96-8, Part I
13. Egenrieder Interview IE 82, 5/8/79
14. Ethridge Interview IE 89, 5/9/79
15. Burkholder Interview IE 99, 5/17/79
16. Leach Interview IE 47, 5/3/79
17. Oversight Hearings, Subcommittee on Energy and the Environment,
May 21 and 24, 1979, Serial No. 96-8, Part II
18. Miller Deposition (SIG), 9/20/79
19. Warren Interview IE 70, 5/7/79
20. Report of the President's Commission on the Accident at Three Mile
Island, Technical Staff Analysis Report on Alternative Event Sequences,
Appendix E, Fission Product Inventory Within the Containment.
21. Gerusky Interview IE 46, 5/3/79

REPORTABILITY OF A PREDICTED
OFFSITE EXPOSURE RATE

At about 0740 on March 28, 1979, the licensee attempted to report to NRC Region I the General Emergency involving known major fuel damage. ^{1/} During telephone contacts with Region I personnel, which began at about 0750, the licensee did not notify Region I of an offsite release calculation which predicted significant exposure rates downwind toward Goldsboro. ^{2/} The reportability of that prediction is the object of this investigation.

Except for minor time variances, matters bearing on the reportability of the offsite exposure rate prediction have been described rather consistently by TMI-2 accident participants and investigators.

Prediction -10(40R) R/hr in Goldsboro

Upon arriving at the plant in time to hear a Site Emergency announced at 0655, Howard Crawford, a nuclear engineer, proceeded to the Unit 2 control room, ^{where} ~~Upon arrival~~ he gathered materials ^{for} ~~to be used in~~ predicting ^{offsite exposure} rates, ^{on the basis of the reactor building dome monitor reading,} ^{3/} a task he had performed during drills for two years.

Crawford recalls that his first calculation, completed soon after 0700, ^{predicted} ~~showed~~ an exposure rate of 40 R/hr in Goldsboro. Neither the time ^{of day} nor the result of this calculation has been substantiated by records or ^{by} the recollection of others. ^{4/} ~~However, that early prediction, if it occurred, is not pertinent to this investigation,~~ since a similar, documented

^{note} However, it is not essential to this investigation to know whether the 40 R/hr prediction occurred,

*note where LPZ is
in respect to its distance*

prediction (10 R/hr at the Low Population Zone boundary) was performed

before the licensee reached NRC Region I by telephone at about 0750. *The question then, is whether this 10R/hr prediction was properly reported*

documented
¶ This prediction (10R/hr at the LPZ) appears to have been performed by Crawford ^{after 0713, the beginning of} ~~during or after~~ the massive release of radioactivity ^{a material} to the reactor building atmosphere, ^{5/} which began at ~~0713~~ ^{5/}. Both the time and magnitude of Crawford's dome monitor (HP-R-214) reading (300 R/hr) are uncertain. ~~Accurate or not, the 300 R/hr reading formed the basis for the LPZ calculation.~~ The time shown on the calculation sheet, 0744, *probably indicates either* ~~could indicate~~ when HP-R-214 was read or when the calculation was performed. ^{thus,} ~~Therefore,~~ Mr. Crawford's prediction of 10 R/hr at the LPZ seems to have occurred between 0713 and 0744.

Crawford recalls discussing a 40 R/hr prediction with Richard Dubiel, Supervisor of Radiation Protection and Chemistry, and with James Seelinger, Unit 1 Superintendent. ^{6/7/} Dubiel and Seelinger recall ~~such~~ discussions

only concerning the 10R/hr prediction. ^{8/9/10/11/} *As stated previously,* ~~Again,~~ this distinction *between 40R/hr and 10R/hr* is unimportant *to this safety investigation.*

^a During ~~the~~ 6/6/79 interview, ^{7/} Crawford stated:

They both thought it appeared too high and they immediately talked, you know, possible steam damage to the dome monitor...they wanted to get a very good feel to see if they wanted to believe that number....

On 5/22/79, ^{had} Dubiel ^{9/} stated:

...I don't think we ever had projections that were meaningful and I don't believe at that time we had any projections that indicated anything of a serious nature, even based on the procedures.

This statement appears to have been based on two factors - disbelief of the dome monitor reading and knowledge of low pressure in the reactor building - as indicated in the following exchange ^{on 9/21/79. ~ 10/}

Q Do you recall doing an off-site dose calculation at approximately 7:10 on the morning of March 28th?

Dubiel I did not do any off-site dose calculations.

Q Do you recall verifying one?

Dubiel I recall verifying one. I recall looking at several during the morning.

Q ^d_A Specifically, do you recall one that was made by Mr. Crawford based on a reading of the dome monitor?

Dubiel Yes, sir, I do.

Q Do you remember verifying that one?

Dubiel Yes, I do.

item is that the dome monitor did not respond accurately. The projected levels are based on the dome monitor readings, plus some very conservative assumptions. Since we are trying to do, in defining the procedure for dose projections, there are a lot of parameters which cannot be determined, so that conservative assumptions are made. And, I feel, first of all, that the dome monitor over-responded significantly.

I feel, secondly, that the building pressure of one or two pounds versus the conservative assumption of 55 pounds would add to it.

Earlier, on

On ^{5/11/79}, Gary Miller, TMI Station Manager, ^{had} testified before the U. S. House of Representatives, Committee on Interior and Insular Affairs: 12/

Weaver: What did you think of that? The high reading on that dome monitor?

Miller: I just did not think about it in terms of fuel damage. I knew that it meant there was a potential to release things offsite. My only concern was to get readings.

Cheney: Did you have any question about the values of those readings?

Miller: I thought it was too high, but I did not need to be convinced that it was high enough to be concerned. It was ~~reading~~ ^{reading} 40,000 or 50,000. I mean that was beyond what I had ever envisioned ever seeing on the dome monitor, so you can discuss whether there was shielding and moisture and whether it was beta radiation, and all that sort of thing.

But I did not need to be convinced. What I really wanted was somebody out there with a meter and an iodine kit sampling, and the wind direction. That is real numbers. That is really what someone is going to get out there. So that was our concern.

Onsite and Offsite Monitoring

Mr. Miller's statement reflects a common concern for getting radiation measurements onsite and offsite to supplement the Crawford prediction⁽⁴⁾. Upon declaration of a Site Emergency at 0655, efforts to organize and dispatch onsite and offsite monitoring teams began. 8/13/ This seems to have occurred rather clumsily; nevertheless, an onsite team (Alpha) was instructed at about 0730 to measure the radiation level west of the Unit 2 reactor building. 14/15/ During that survey, the wind was westward and very light with minute-to-minute variations of about 10 to 30 degrees. This survey was appropriate, but tardy. At 0746, Alpha Team reported less than 1 mR/hr at Station GE-8 west of the Unit 2 reactor building. As discussed later, this measurement became the basis for discounting ^a Crawford's prediction(s) of high exposure rates offsite.

At about 0800 and 0830, respectively, Charlie and Bravo Teams were dispatched by vehicle to Goldsboro. At about 0830, Charlie Team reported less than 1 mR/hr in Goldsboro. Bravo Team reported similarly at about 0940. Given that there had been no significant release from the reactor building, these surveys seem adequate from the exposure rate measurement standpoint. However, had a major release occurred, these surveys would have been too little, too late.

TMI management appears to have realized the need for a quick measurement in Goldsboro to confirm or deny Crawford's predictions(s). In statements following the accident, Miller and Dubiel maintained that a State Police helicopter had flown a survey team to Goldsboro soon after the General Emergency was declared.

To the U. S. House of Representatives, Committee on Interior and Insular Affairs, ^{on May 24, 1979,} Miller stated: 17/

At approximately 0730 or a little before, I had received predictions of an offsite dose of 10 R at Goldsboro. This was based on the Reactor Building dome monitor, which was still increasing and from our past experience with this source calculation, we did feel these were really this high, but as a precaution, I dispatched a State Police helicopter with an offsite team along with an offsite team in a car and separately, to the West Shore (Goldsboro).

0740 - York Haven radiation monitor reading (0) - helicopter (approx.) at TMI - dispatched offsite teams in helicopter and one

separately in car to West Shore (from G. P. Miller and R. W. Dubiel recall of the incident).

0800 - Offsite team in Helicopter at West Shore (Goldsboro)
(approx.) '0' reading - we actually were ahead of the plume -
plus onsite team at our West site boundary-'0' reading.

Later, to
to the NRC Special Inquiry Group *on 9/20/79,* Miller stated: 18/

Q In fact, you or someone called the State Police that morning for a helicopter and you got one very fast, didn't you?

Miller There may be---subsequently I know there's some disparities in my time versus the time the thing landed here or the time it's documented. I remember as soon as I had the projection, which was high, for Goldsboro and knowing the west---knowing the wind was blowing to the west and knowing that it was seven or eight in the morning, that I know that I asked for a helicopter before seven thirty.

~~I knew that that was in my mind and knew that I had the York Haven monitor out over there and I knew I had a guy on the West Shore. That's something that I had practiced and thought about it. Even in the Unit 2 hearings when we discussed the wind blowing west, slow as it was.~~

Q Do you know whether the helicopter actually came on the site and picked up somebody to go over the river?

Miller To my knowledge it was verified to me that they picked up one or two of our people and they were flown over there. And readings were back, and as I remember the readings were back before Dubiel had thought the plume had gotten there. In other words, we had gotten over there faster than the radiation would have at the wind speed, which was very slow.

On 4/24/79, Dubiel^{had} stated: 8/

At some point around 7:30, Gary Miller asked me for the status of the offsite teams, and I gave him the information that we had two teams ready to go offsite both available for transportation over to the West Shore. Gary directed me to make contact with the State Police and get a State Police helicopter to get one crew over there in a more timely fashion. He was concerned about the traffic--the early morning rush hour traffic trying to go up over the bridge in Harrisburg and then back down and that it might take an hour or more to get over there. He requested that we send one team in a helicopter and a second team in a car of driving over at a normal pace to back them up. I do not recall exactly who told me that they would get the State Police helicopter. I believe it was George Kunder, I do not remember exactly, but within minutes I had it confirmed to

Reportability and Reporting

The situation was intuitively reportable to NRC under 10 CFR 20.403, which requires immediate notification "...of any incident involving byproduct... material... which may have caused or threatens to cause... release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 5,000 times the limits specified for such materials in Appendix B, Table II...." For Xe-133 the Appendix B Table II limit is $3 \times 10^{-7} \mu\text{Ci/ml}$.

~~Since~~ ^{It} There was no reason to believe that the dome monitor (HP-R-214) increase was transient. The "immediately reportable" concentration of Xe-133 ^{was therefore} ~~would have been~~ $1.5 \times 10^{-3} \mu\text{Ci/ml}$ (i.e., $5000 \times 3 \times 10^{-7} \mu\text{Ci/ml}$). ~~Using a source term of 1325 Ci/sec and a X/Q of 2.5×10^{-4} seconds per cubic meter,~~ ~~not~~ ^{By} ~~at about~~ ^{had} 0744, Crawford ^{used} ~~used~~ Radiation Emergency Procedure 1670.4, Rev. 3, dated 2/15/78 to calculate ^d a concentration of $0.33 \mu\text{Ci/ml}$ at the LPZ, 220 times ^{the} ~~this~~ "immediately reportable" concentration. ^{(This concentration was determined as an intermediate step in using Radiation Emergency Procedure 1670.4, Rev. 3, dated 2/15/78 to predict the 10 R/hr} ~~Using the same procedure, the minimum concentration immediately reportable under 10 CFR Procedure 1670.4, Rev. 3, dated 2/15/78 to predict the 10 R/hr~~ ~~($1.5 \times 10^{-3} \mu\text{Ci/ml}$) can be found to correspond to an HP-R-214 reading at the LPZ.)~~ ~~of only 1.4 R/hr.~~

Early in the accident, the licensee logically could have challenged the Procedure 1670.4 calculation on the basis of low reactor building pressure. But as the reactor building radioactivity inventory increased, as measured by HP-R-214, the licensee should have become progressively less concerned about the conservatism of the calculation and more concerned about the magnitude of the potential hazard.

Telephone contact between the Unit 2 control room and NRC Region I was established, after appropriate efforts by the licensee, at about 0750.^{4/} Although earlier contacts had been made with the Region I answering service, this was the licensee's first good opportunity to report the accident in accordance with 10 CFR 20.403.

However, the 0744 prediction of 10 R/hr ^{(0.33 μ Ci/ml) at the LPZ} was not reported, apparently because the first onsite measurement at point GE-8 west of Unit 2 (1 mR/hr at 0746) had been used to calculate a new source term at 0750. Although this one onsite measurement did not prove that the release was insignificant, the licensee could have concluded justifiably that the release was not as bad as ~~calculated~~. ^{Crawford ~~initially~~ had ~~initially~~ calculated.} ~~The reportability of the situation~~ ^{reportable,} remained, however, in that: (1) the incident still threatened to cause a major release and (2) offsite field measurements had not been completed.

^{apparently} The licensee reported Crawford's 10 R/hr prediction to the Bureau of Radiation Protection but not to NRC. The only identified NRC reference to a high radiation level outside the plant was the following telephone conversation recorded after 10:00 a.m. on 3/28/79 in the NRC Operations Center.

VOICE: The indications are that low levels are being released, we will find out.

VOICE: What is your MDC?

VOICE: There is no question that there was -

Handwritten notes on the left margin, including "MDC", "6-6", "after", "if they", "RT", "10 R/hr", "prediction", "out", "of", "the", "plant", "and", "the", "area", "of", "release".

In the meantime, I requested them to try to get their teams somehow to Goldsboro, and they said that the State Police helicopter was there and that they would get one of their teams up in the air and over Goldsboro. We stayed on the phone with them. They found no radiation levels onsite or in Goldsboro that would indicate any kind of a leak. So therefore, we then notified the Civil Defense to hold tight. This was all before 8:00.

The desire to disprove the 10 R/hr prediction, which could have triggered massive evacuations, is understood. Use of the first onsite, downwind measurement to partially achieve such disproof also is understood. ^{But} ~~A~~ The use of nonexistent offsite survey results to further disprove the prediction is not understood.

Conclusion

Nothing discovered in this investigation relieved the licensee of the requirement to report to NRC all pertinent facts concerning the accident. The 10 R/hr prediction seems not to have been adequately disproved by 0750, when telephone contact was established with Region I. The decision not to report the 10 R/hr prediction was improper. By not reporting to Region I at about 0750 on 3/28/79 that the calculational method described in Radiation Emergency Procedure 1670.4 had predicted a reportable release of radioactive material, the licensee violated the reporting requirement of 10 CFR 20.403(a)(2).

Hogas
2-21

Investigation of Information Flow
During the Three Mile Island March 1979 Accident

A. High Core Exit Temperatures

1. Introduction

a. Purpose

This investigation of the information flow of core exit temperature data during the course of the accident at TMI-2 on March 28, 1979 was conducted to determine if the licensee willfully withheld information from the NRC about the severity of the accident.

b. Method of Investigation

This investigation was conducted by reviewing and evaluating information contained in the several documents listed in Appendix A. The best evidence available for many of the issues were those contained in the transcripts of recorded telephone conversations on March 28, 1979 and contemporaneous notes, data and logs. Transcripts and records of statements made by key licensee and NRC personnel in various forums and interviews, including both sworn and unsworn testimony, were examined. The credibility and meaning of these statements were evaluated considering: the aforementioned best available evidence, what we now know to have been the plant status, the statements of others, the questions eliciting the statement, and the statements made by the individual at other times.

c. Background

On March 28, 1979 information was available at the Unit 2 control room during the ongoing accident which clearly indicated that fuel rods were severely damaged from overheating. This information included temperatures as high as 2650^oF as measured by the incore thermocouples at the upper end fitting of the fuel assemblies and temperatures of 800^oF in the reactor coolant system hot-leg piping.

Adequate cooling of the fuel elements in the reactor core is assured if the fuel rods are covered by water, i.e., water is maintained in contact with the full length of the fuel rods. Overheating of the fuel rods may occur if the water flashes to steam such that all or part of the length

of the fuel rods is cooled only by steam. Damage from slight overheating may result in perforation of the zircalloy tubes enclosing the fuel pellets. These tubes comprise the pressure boundary of the fuel rods and contain the radioactive gaseous fission products which collect in the free space outside of the fuel pellets. Such gases are often referred to as "gap activity". It should also be noted that sudden depressurization of the reactor coolant system immediately after high power operation can also cause perforations of the fuel rods and release the gap activity. This latter fuel rod failure mechanism is not unexpected by persons within the industry. Greater extents of overheating may result in: an exothermic reaction of the zircalloy tubes with steam resulting in the formation of free hydrogen gas, dissolving of the oxidized zircalloy tube material by formation of an eutectic with uranium oxide fuel pellets or, in worst case, melting of the fuel pellets. Post accident analyses indicate that the overheating during the TMI-2 accident stopped just short of fuel pellet melting.

Measured temperatures in excess of 2000°F at the incore thermocouple location are well within the range of where the exothermic zircalloy-steam reaction occurs. Measured hot leg temperatures of 800°F are significantly above the critical temperatures of steam (705.4°F) and demonstrate steam cooling of the fuel rods regardless of the pressure in the hot legs. (The saturation pressure corresponding to the critical steam temperature is 3206 psia. Steam at temperatures above 705.4°F cannot be liquified no matter how much pressure may be applied.)

As is evident by inspection of the reactor coolant flow paths shown in Figures I and II of Appendix B, circulation of subcooled water through the reactor coolant system, whether by forced or natural circulation, will result in the same temperatures being measured by the incore thermocouples and hot leg temperature detectors. For this reason, many pressurized water reactors, including Three Mile Island Unit 1, do not have the capability to monitor temperatures at the TMI-2 incore thermocouple location. Also included in Appendix B is a brief description of the incore thermocouples which was extracted from Volume II of the NRC's Special Inquiry Group report. Figure III was included in Appendix B to show the location of the thermocouples as described in the extracted write-up. Figures II-28 and II-28 A & B show temperatures measured incore thermocouples during the course of the accident. Figures II-28 A & B are based on thermocouple data called into NRC-Headquarters offices after a reactor coolant pump was restarted at 7:50 p.m. on March 28, 1979.

Finally, during review of transcriptions of the recorded telephone conversations, it was difficult to fix the time precisely and to understand the relevance of certain statements since the statements were often abbreviated and provide only a glimpse of what was or may have been occurring. To assist in developing a fuller understanding of the statements, the plot of system parameters developed by NRC's Special Inquiry Group was used. This plot is also included in Appendix B and shows instrument data and information on critical plant operations which were developed during post accident investigations.

2. Information Reported on March 28, 1979

A Site Emergency was declared by the shift supervisor at TMI-2 at 6:55 a.m. on March 28, 1979 based on several process and area radiation monitor instruments exceeding their high alarm set point. Shortly after this declaration, the Station Manager, Gary Miller, declared a General Emergency based on the greater than 8 R/hr reading on the containment dome monitor. Notification of the NRC Region I office of these emergency declarations was attempted by licensee personnel at 7:04 a.m. and 7:35 a.m. These attempts reached the answering service and the licensee was unable to contact NRC officials until the NRC Region I switchboard opened at 7:45 a.m. Recordings of telephone conversations between the NRC and the licensee did not begin until about 9:15 a.m. However, there are earlier recordings of telephone conversations between the Director of the NRC Region I office and the NRC Headquarters Response Center. Review of transcripts of these conversations show that by about 8:00 a.m. the Region I office had been informed of high radiation levels in the containment, that fuel failures had apparently occurred and that there was a bubble in the reactor vessel. (Transcript 01-01017-CH2/20-FFC at 1-6). Based on this information the Region I office activated its Incident Response Center and designated the accident as a Level I severity incident, the most severe classification of NRC's emergency plan.

NRC Manual Chapter 0502 defines a Level I incident as that where there is an actual or imminent serious threat or hazard presented. This requires activation of the NRC Incident Response Program. Section 20.403 Part 20, Title 10 of the Code of Federal Regulations requires licensees to immediately notify the appropriate NRC Regional Office -- Region I in this case -- of incidents involving licensed material which may have caused or threatens to cause any one of four listed effects. The accident at TMI-2 met all of these effects and warranted classification as a Level I severity incident.

The transcript of a recorded telephone conversation starting at 9:26 a.m. between George Kunder, TMI-2 Superintendent of Technical Support, and the NRC Region I Response Center includes a discussion wherein Kunder responded to a request for the "scenario" and information on the status of the plant. (Kunder had been at the plant since 4:50 a.m. and of the six senior people on Miller's emergency command team - Kunder, Rogers, Ross, Dubiel, Seelinger and Logan - he was in the best position to answer questions). Kunder reported that the condensate polisher system valves closed due to water in the air lines causing the feedwater pumps to trip on low pressure. This, in turn, caused a turbine trip and a reactor trip. He also reported that the pressurizer level (water level) went up and the pressurizer went solid. He noted that the reactor pressure had decreased and caused an activation of the high pressure injection system. The bubble in the pressurizer was "lost" by supposedly "pushing through the relief valves into the reactor coolant drain tank" and the rupture disc on the drain tank had ruptured. He further reported that the pressure dropped to 1000 psi and that the temperature had stayed around 545°F which baffled the people (apparently these were the reactor coolant pressure and temperature conditions which existed up to 5:45 a.m. when the reactor coolant pumps were shut down). It was also reported that they were experiencing steam bubbles vapor locking the coolant system such that they don't have good flow and that apparently the vapor blocking effect was being fed by heat in the core. Kunder went on to say that high pressure injection had been re-initiated to get coolant flow in but that they didn't get the desired effect. (This high pressure injection was initiated at about 8:00 a.m.) Further, it was reported that they tried to start another (reactor) coolant pump but it didn't give any flow and was still apparently vapor locked (this pump operation attempt occurred at about 8:15 a.m.). Kunder went on to say "The problem is trying to get the pressure down low enough so we are sure the flow is going into the -- is going down -- in the reactor vessel annulus and up into the core. The vapor lock apparently is preventing that from occurring -- and that is apparently what led to failed fuel". Continuing the conversation, Donald Haverkamp, NRC Region I Principal Reactor Inspector for TMI-2, confirmed that the licensee had said that high pressure injection had been secured and was informed that this occurred about five minutes after its initiation because pressurizer level went up. Kunder replied that this was a normal operator response. Further on, a discussion of outside radiation readings takes place where the licensee reports that the State is involved and small amounts of iodine were detected downwind. At about 9:55 a.m., Kunder reports the primary system pressure and temperature as follows:

"The pressure -- it is cycling around 2000 lbs., the T_{av} is still up around 571 - indicated -- I don't think that our indicators

are really giving us representative of indication of T_{av} , however, I am sure you will take that with a grain of salt, because we - you know - I am sure - we don't have an equilibrium temperature throughout the loops." (NRC Region I Tape 1) Subsequent investigation has shown that under conditions where the cold leg temperature (T_c) is pegged at the bottom of the narrow range scale (520°F) and the hot leg temperature (T_h) is pegged at the top of the scale 620°F , the "T average" indicator will indicate 570°F .

At 10:00 a.m. Kunder updated the Region I Incident Response Center and reported that inside the containment the radiation levels were 10 R/hr at the operating floor by the incore area, 100 mr/hr at the access hatch, the dome monitor was 6000 R/hr and Kunder questioned its accuracy, and that they had 140 microcuries/cc beta-gamma primary coolant activity but that this sample was obtained before the (radiation) levels had gone so high (this primary sample had been taken at about 6:40 a.m. and the level of 140 microcuries/cc is about 350 times normal levels). By 10:15 a.m. Kunder updated the reactor status as follows:

KUNDER: Talking to Mike Ross - he's looking at the indications, his assessment is that he's surely certain got the core covered and we are getting water - you know - water into the core. The only thing the is that the T_h are still high and that's what bothers us -- the pressure - and getting control of it - and...

HAVERKAMP: What is your pressure and temperature now?

KUNDER: The pressure is still up around what I told you -- it's holding there -- okay? We got a bubble in the pressurizer -- the only thing now -- he thinks -- it looks to him like we are getting some natural circulation cooling...okay? But he is still baffled by the "T" hot - we are really trying to access that -- "T" hot (?) right now are reading 571°F but, again, I am not sure how real a number that is.

HAVERKAMP: 571°F .

KUNDER: Yeah.

Shortly after this interchange Kunder says "I am going to have to talk through a mask here." (NRC Region I, Tape 2).

Post accident investigations have shown that the hot leg temperatures at that time were about 780°F and 730°F for the "B" and "A" hot legs; therefore, the report of 571°F is erroneous. The reason for the (?) in the transcript was checked and listening

to the tape we found that the words are slightly garbled. The last sentence should read "But he is still baffled by the T hot - we are really trying to assess that -- T hot is like -- right now the T hot is reading 571⁰F but, again, I am not sure how real a number that is." Kunder had previously reported the "T" average as 571⁰F and it is evident that the temperature reported here was "T" average.

Review of transcripts of the NRC Headquarters Incident Response Center tapes show that the plant status information was discussed in many telephone conversations and that the people in this center were busy notifying others. The NRC Operations Center Log shows heavy telephone usage beginning at 8:20 a.m. For example, Morris Howard, OIE Director of Safeguards and Security and former Director of Region IV, was given the task to update the regional directors. Robert Engelken, Director of Region V was the last of the regional directors to be contacted by Howard. At 10:15 a.m. Howard informed Engelken that TMI-2 cannot get the reactor coolant pumps operating because they appear to be vapor locked, there was high radiation readings in the containment, there was some activity in the reactor coolant and an offsite iodine reading. Engelken comments that these are indicative of defective (sic, damaged) fuel. (Transcript OI-118-CH4/22-EG-2)

There is no indication that Gary Miller personally communicated by telephone that day with the NRC. Miller did communicate with NRC personnel in the Unit 2 Control room after they entered the control room at about 11:00 a.m. Miller was functioning as the Emergency Director and primarily involved in executing the station radiological emergency plan and trying to assure the plant was in a stable condition. Miller was often on the telephone with Jack Herbine, Met Ed Vice President of Generation. Miller also updated the Lt. Governor's office at about 9:00 - 9:30 a.m. at the state's request. Evidently the request was prompted by the Governor's news conference which was scheduled for 10:00 a.m. Miller then called the Met Ed corporate office in Reading, Pennsylvania to relay what he had told the Lt. Governor. The Reading call was recorded and Miller spoke with George Troffer, Met Ed Manager of Generation Quality Assurance and Richard Klingaman, Met Ed Manager of Generation Engineering (Miller knew that Herbine was in Philadelphia for naval reserve training since he had spoken with Herbine earlier). This transcript begins with Miller saying

"Lt. Governor -- I had no choice but to talk to him." Miller tells Troffer he told the Lt. Governor's office that Unit-2 experienced a turbine trip and reactor trip from very high power but that wasn't a problem, reactor coolant had been released to the reactor building floor when a relief valve lifted due to high pressure and that this gave an indication of radioactivity in the

reactor building, that the coolant release to the reactor building floor "was not a break or a leak or anything that was designed to release at a high pressure". Further, Miller goes on to say,

"In addition to this the plant obviously experienced a pressure and temperature change fairly fast. I didn't say this to them -- I'm just saying it to the group. I was on the phone with a nuclear engineer (Dornsife) over there so he knows about fuel pins. I said yes we may have had some fuel pin leakage. I don't know that right now. That's part of small term assessment on this thing and that's economic. He asked if I had any melting on fuel. I said I don't have any indication of melted fuel, but I may have had some fuel pin leakage which is not abnormal in the industry. I didn't say any at the present but I did say that we had reactor coolant released in the building which was giving radioactivity on the monitor.

When we get that, I said our emergency plan mandates that when I see it in the reactor building I assume it's getting out. Therefore, I go into the general emergency. I fully gear-up like I already got an emergency in the public. That means that I put people on stations, I closed the gates, I get the State Police, I make all the phone calls and I say subsequent to doing everything in the plant we have had confirmation very rapidly the number 1. (?) From the time the incident started we have had no release to the environment especially above background. We have had no indication of a millirem an hour that I know of. We know where the wind is moving -- it is moving slowly to the west. We have people at the west site boundary. We had a helicopter fly over to Goldsboro. We had the meters taken out at York Haven -- if I have to go back I will. Never had any indication. We have been in communications with Molloy in the State for most of the day. We had no action level by the plan for the public.

We do not expect any additional or any release. We are in the process of taking the plant to a cold shutdown to evaluate the situation and that evaluation is probably more economically damaging than anything else -- from the public standpoint."

Appendix A

List of Documents Reviewed During Investigation

Appendix B

Technical Data Concerning Core Outlet Temperatures

Incore Thermocouples

A type K (Chromel-Alumel) sheathed thermocouple with a grounded bead was located in the top of each of the 52 instrumentation tubes positioned in a specific spiral pattern in the core. Each instrumentation tube was located in the center of a fuel bundle and was permanently fastened into the bottom support plate for the core. Each also contained seven self-powered neutron detectors (SPND) spaced at about 1 3/4-foot intervals vertically and located between neighboring grid spacers. The instrumentation was being used in an experimental study of power tilt and power shaping in the core and is not normally present. The incore thermocouples measured water temperatures exiting the bundles, and the SPNDs measured the neutron flux and flux profile in the bundles. The physical elevation of the incore thermocouples was in a flow mixing cup contained in the lower part of the upper end fitting of the bundles and was 12 inches above the top of the fuel in the fuel rods of the bundles. The data from both the thermocouples and the SPNDs could be requested from the plant computer via either the alarm printer or the utility typer at operator option. Both were connected to print out on the alarm printer when the set reading range limits, 700°F and 2×10^{-6} amps, had been exceeded. Data from selected SPNDs were also available on two multiple-point recorders located in the control room.

The incore thermocouples began going off scale (indicating temperatures above 700°F) during the later part of the time the alarm printer was unavailable between 5:15:16 and 6:48:08 a.m. At the time of the earliest record of alarming of the incore thermocouples, between 6:55 and 7:13 a.m. (2 hours 55 minutes and 3 hours 13 minutes accident time), 39 of the 52 incore thermocouples were recorded off scale, i.e., above 700°F. The records thereafter are incomplete because either some thermocouples were missed in an ordered sequence of recording, or only a partial listing was requested, or they simply were not requested by the operators from either the alarm printer or the utility typer for a considerable period of time. The data that are available have been reported elsewhere. A set of measurements of temperature was made at the computer terminals in the cable spreading room by using a calibrated thermocouple reader instrument and manually recorded. Temperatures as high as 2650°F were measured, as shown in Figure II-28. The trend of the data on incore thermocouples indicating temperatures greater than 700°F either at the time of recording or both before and after the period show that 49 of the 52 thermocouples read above 700°F in the period between 3 hours 13 minutes and 3 hours 21 minutes, 33 between 3 hours 21 minutes and 3 hours 36 minutes, 44 between 3 hours 44 minutes and 3 hours 47 minutes, and 26 between 4 hours 34 minutes and 4 hours 47 minutes. The number above 700°F decreased thereafter in reasonable order, but 11 were still up scale at 00:43 a.m. the next day (March 29, 1979), 3 were still up scale at noon on March 29, 1979, and 1 was still up scale (greater than 700°F); 20 were above 300°F at 10:22 a.m. on April 1, 1979, more than 4 days after the start of the accident. No evidence available at this time can determine whether the temperatures indicated were measured at the thermocouple bead in the

mixing cup of the upper end fitting or were those at newly formed junctions located in the "liquefied fuel" region of the core. Attempts to measure the resistances of the legs of the thermocouples could not resolve the question, nor could other types of measurement made to determine the continuity of the thermocouple wires.

Miller continues on to inform the Reading personnel that no one has had an overdose or an overexposure, that plant radiation surveys had been performed and the appropriate areas roped off, that they may have used up some operator's quarterly doses taking coolant samples and that they had maintained a general emergency because they had been testing the plant. The transcript closes with Miller saying,

"The reason we have not, and you're right George, is because to be honest with you we've been testing the plant. We don't know where the hell the plant was going. See the situation we're in is a delicate one because we actually have plant integrity. If we had a leak we'd be all right -- as far as we'd have a lot more economic consequences. We've been trying to figure out how to cool down in the most expeditious fashion without releasing and without damaging too much. That's taking a pretty hard assessment. I'll work on getting out of the emergency right now."

The foregoing colloquy shows that Miller tried to put the best face on the situation when talking to the Lt. Governor's office and that Miller did not understand the true plant status during the discussion. Although Miller was somewhat more candid with the Med Ed people in Reading, no mention was made of the high core exit temperature readings, notably the hot leg temperatures which were then of concern in the control room. His statements about having plant integrity and if we had a leak we'd be all right appears to be alluding to the idea that a steam bubble was trapped in the system and inhibiting the cooldown. As noted previously, this was the message Kunder was simultaneously giving the NRC Region I Incident Response Center but Kunder was providing more details. When asked about the information provided Met Ed Reading office personnel, Miller replied:

"I talked to Reading I think early in the morning. At least the engineering manager, and I don't believe that there was any more they could advise me on what to do. I was aware Jack (Herbein) was coming to the site, or at least to the observation center...I didn't believe there was anyone in the Reading office in the early morning that could have understood the plant conditions and specified action better than the five senior people I had with me..."
(Miller, SIG Deposition, 10/29/79 at 41)

The Lt. Governor's office was not solely dependent on the information provided by Miller for the Governor's 10:00 a.m. news conference. They had access to Thomas Gerusky, Director of the Pennsylvania Bureau of Radiation Protection and his associate Margaret Reilly. Both Gerusky and Reilly had been in contact with the plant nearly continuously since about 7:30 a.m. Their contacts were mostly with Richard Dubiel, TMI-2 Supervisor of Radiation Protection and Chemistry, and the Met Ed person in charge of controlling the onsite and offsite radiological surveys. Gerusky telephoned Bernard Weiss at the NRC Headquarters Incident Response Center at about 10:00 a.m. and informed Weiss that: (1) there was radioactive material in the air of the Unit 2 control room and that personnel were moving to Unit 1, (2) it appeared that the problem was created by gap activity rather than melted fuel, (3) it appeared there may be fuel cladding problems based on the iodine activity in the coolant, (4) no off-site radiation levels had been detected using portable equipment, (5) it seemed they had detected onsite readings with a SAM-2 (radiation detection instrument), (6) the Governor would have a press conference at 10:00 a.m. and he (Gerusky) called the Lt. Governor's office to inform them that "we" were detecting radioactivity, and (7) they (the State) were going to say that very low levels of radioactive materials were being released to the environment. Weiss challenged the release statement asking how they could be so definitive but Gerusky maintained his position. The transcript of this discussion also includes the following comment by someone at the NRC Incident Response Center - "yeah, I heard somebody, I guess on the radio, I think it was from the Bureau, saying that there were 10R per hour out the cooling tower". The response to this, apparently from Gerusky, began "Unfortunately, the estimates were that if..." and then background noise from radio report drowned out the comment (Transcript 01-838-CH19/203D-SW at 8-12). This latter exchange is noteworthy in that Gerusky and his people were notified by Met Ed personnel at 7:35 a.m. of a 10 R/hr projected dose rate at Goldsboro. This was based on calculations using the indicated radiation levels in the containment as the source term. Margaret Reilly had told the State Civil Defense to prepare for evacuation of Goldsboro upon learning of the projection; this alert was rescinded when onsite radiation surveys showed that 10 R/hr at Goldsboro could not exist. (Draft, SIG Report to the Commissioners, Volume II, Part 3, at 128-130).

Apparently John Davis, Acting Director of the Office of Inspection and Enforcement was aware of most of the information that Weiss received from Gerusky. At about 10:30 a.m., Davis, Lee Gossick, NRC's Executive Director of Operations, and Edson Case, Deputy Director of Nuclear Reactor Regulation, placed a conference call to NRC Commissioners Bradford, Gilinsky and Kennedy to update them on the accident. Davis reported that there was

no measurable radiation offsite as of 9:50 a.m., that the dome reading was very high at 3-4,000 Rem/hr, that the containment pressure was low but if it went up there could be some offsite releases, and that there was an indication of some airborne radioactivity in the control room. Under questioning by a Commissioner about the source of the radiation, Davis said that probably the activity was coming from gaps in the fuel and that some of the fuel pins popped because of the pressure transient or low level. (Transcript 02-213-CH 6/24-LFR at 4-5) Shortly before 11:30 a.m., Grier informed Davis that they had an indication of iodine offsite and that the sample was being flown to a hospital for analysis. Grier said the sample was taken downwind at a point one mile west, southwest of the site and that he (Grier) had "no reason not to believe it". (Transcript 01-214-CH 6/24-LF at 7) Davis then updated Commissioners Bradford, Gilinsky and Kennedy at about 11:30 a.m. of the iodine reading and said that it could be coming from the containment. (Transcript 01-215-CH 6/24-LFR at 5-6) At about 2:00 p.m. Commissioner Gilinsky and representatives of the other Commissioners talked to Case and Davis and were informed that the reactor pressure was reduced from 2000 psi to 500 psi, that the radiation levels in the containment were 6000 R/hr at the top and 10 R/hr at the deck level, that there was a radiation level of 500 mr/hr outside the containment at the base of the containment and that this was "shine" (direct radiation reading), that they were seeing particulate readings outside, and that material sample taken on the north side of the island read 3×10^7 microcuries/cc, the sample was being flown to a hospital for analysis, and that if the reading were confirmed as iodine 131 then some protective measures would be required such as protection of food-stuffs but it was not an evacuation level. Additionally they reported that part of Route 441 was closed one-third of a mile from the plant because of a 7 mr/hr shine reading. Under questioning by Commissioner Gilinsky, the shine readings were said to be consistent with the 10 R/hr radiation level measured inside the containment. Additionally, it was pointed out that there has been venting of the secondary system (steam) to the atmosphere but that was now stopped but there may have been some radioactive material released that way. During the conversation the results of the iodine sample check were received and showed a level of 1×10^{-10} microcuries/cc. This was said to indicate that there was not an iodine release. (Transcript 01-220-CH 6/24-LFR at 4-10)

When the information was developing about apparent releases of radioactive material, attention was also placed at the NRC Incident Response Centers about the core exit temperatures. A follow-up discussion took place between Richard "Rick" Keimig, Region I Reactor Operations Section Chief, and Mike Wilber, NRC Headquarters, after the Kunder-Haverkamp exchange about hot leg temperatures. (The transcript does not identify the speakers other than a statement "Yeah Rick, this is Mike".) During this discussion Wilber

questioned Keimig about how the core was being cooled and Keimig noted that the reactor coolant pumps were not operating and that "they're having trouble cooling the core because there might be a vapor bound. (sic) They have no indication of primary system temperature". When asked why, Keimig responded - "no flow". (Transcript 01-01019-CH 2/20-GFC at 5-6) Subsequent follow-up conversations a few minutes later indicate their belief that the plant had natural circulation flow. (Transcript 01-01019-CH 2/20-GFC at 21) Region I dispatched a team of NRC inspectors at 8:40 a.m. to TMI-2. They arrived at the Unit 1 control room and established their communications with the Region I office shortly after 10:00 a.m. James Higgins, a Region I Reactor Inspector, and another inspector were sent to the Unit 2 control room. However they had to first obtain and don respiratory protection masks before entering the control room. This delayed their entry during a period when people at the Headquarters Incident Response Center were eager for plant operations information. At about 10:55 a.m. Higgins reported to the Region I Incident Response Center that there were probably bubbles in both hot legs and the only circulation they had on the primary side was due to natural circulation and even that "wasn't too great". (Region I, Tape 2) At about 11:30 a.m., Region I updated the plant operations information to the Headquarters Incident Response Center as follows:

VOICE: Okay, are you ready for some information?

VOICE: Yes.

VOICE: Yea-a-a

VOICE: The core pressure is approximately 2,000 psi.

VOICE: What? Two thousand. It was 19 something before. Okay.

VOICE: Temperature is 350 degrees.

VOICE: 350, it was 200 before.

VOICE: They are maintaining at 2,000 psi by cycling the electromagnetic relief valve.

VOICE: Okay.

VOICE: They note that the hot leg temperature is around 620 degrees.

VOICE: Then they saturate it.

VOICE: That figure I gave you, 350 degrees F --

VOICE: Yes.

VOICE: is the pressurizer temperature. The cold leg temperature is something around 220 degrees.

(Transcript 01-024-CH 2/20-SW at 9)

(We now know that the hot leg temperatures were then in excess of 700°F and it appears that the reported hot leg temperature was read from the narrow range temperature indicator. This indicator was pegged high at 620°F. Hindsight also shows that natural circulation flow was not taking place). Upon hearing the 620°F hot leg temperatures, background discussions took place at the Headquarters Incident Response Center about in which loop (A or B loop) was the hot leg temperature measured and the desire to find out the core element temperature (incore thermocouple readings). A discussion then took place between Harry Kister, Region I Radiation Protection Section Chief, at the Region I Incident Response Center and Wilber at the Headquarters Incident Response Center. This concerned whether the licensee had looked at the thermocouples at the fuel assembly outlet and whether or not the plant had such thermocouples. Although it is implied that Headquarters wants this information, it doesn't appear that this was understood or communicated at that time to the site. (Transcript 01-025-CH 2/20-SW at 13-14) At about 2:45 p.m., Donald Caphton, Region I Reactor Operations Section Chief, informed Gerald Klingler, Headquarters Senior Operations Specialist, of the reactor parameters as of 2:15 p.m. These were: reactor coolant pressure at approximately 500 psi, temperature near saturation, cold leg temperature of 230°F and hot leg at 600°F. Caphton noted that they still suspected bubbles in the loops which would affect the temperature readings. (Transcript Region 1, Tape 7) Simultaneously Wilber obtained Unit 2 reactor parameters from Gregory Hitz, TMI Shift Supervisor, who was in the Unit 1 Control Room.

HITZ: Unit 2 has a 550T hot; 200 T_c, 450 pounds pressure and are going to go on decay heat removal - via the BWST - that's the game plan.

WILBER: Going on the decay heat removal via the BWST.

At about 3:30 p.m. Wilber asked Hitz "We got a question - you got 450 pounds primary pressure and a 550 degree temperature there, and that would be superheat?" (Transcript Region I, Tape 9) The transcript then has health physics data and contact was lost with Hitz. Wilber then contacted Caphton at Region I and Charles Gallina, Region I Investigation Specialist, who was at the Unit 1 control room and said that before lunch "we" asked about the incore thermocouples and he didn't know if they ever got an answer back.

Caphton then asked Gallina to get Hitz back on the phone. (Transcript Region I, Tape 10) Hitz then told Wilber that at one time "T" hot was pegged high at 620°F and "T" cold at 220°F, and that he (Hitz) questions the accuracy of the "T" hot instruments. Wilber then asked for the incore temperatures and Hitz said "...That would be a better understanding of what you have in the core..." (Transcript Region I, Tape 11) Victor Stello, NRC Director of the Nuclear Reactor Regulation Division of Operating Reactors, took the telephone from Wilber shortly after 4:00 p.m. and explained to Hitz:

STELLO: Let me ask a question of you. If you really have 550 degrees in that hot leg, it's true you are getting super-heat. If you're getting super-heat there's a chance the core could be uncovered. The only way you are going to get rid of that problem is to find a way to get more water into that vessel and get that core level back up. If you thought about what problem you've got, if indeed you've got 550 degrees in that hot leg at 450 pounds.

HITZ: I see what you're saying, okay? They do have the BWST lined up and 175 inches indicated in the pressurizer would mean that the core would be covered. They also got the core flood tanks floating on that.

STELLO: But that doesn't necessarily mean that you don't have a steam bubble in there?

HITZ: Okay, you're talking about a steam bubble in the core?

STELLO: Yeah - if you have a steam bubble in the core you go the top part of the core which could be uncovered super-heating the stuff coming out of there and that's what's giving you the reading. Have any of your people out there talked to B&W about what kind of a problem that could look like?

HITZ: I don't know if they have talked to them over in Unit 2 or not - I'll find out.

STELLO: We have been trying to get in touch with you, as best we can understand it, as we talked to them we see the same concern in the same problem. If that thermocouple reading is correct, and you do have super-heat coming through that core...

HITZ: Let me talk to the guys in Unit 2 and see what...

STELLO: We would appreciate that very much.

HITZ: All right.

(Transcript Region I, Tape 11)

Shortly thereafter, Hitz responded:

HITZ: First of all, I can't get the incore temperature, okay?

WILBER: You cannot get them?

HITZ: They print out question marks.

WILBER: They print out question marks? Okay, what's that mean?

HITZ: That means that either the computer point is messed up. Okay, or the line - you know - where you sense it - that line is broken - something is messed up with that line. They were printing earlier. You know, the computer just won't put out a good number for them. They are trying all of them to see if we can get any of them to print. Okay. That's going to take some time, okay? Because you have to printout each one individually. The core flood tanks are floating on the core like I told you, okay? And the core flood tanks just slide into the vessel a little bit. Now that ties in directly into the core - right on top of the core, okay?

WILBER: Yes.

HITZ: One T hot is 590; the other T hot is still pegged high. All right? We feel that we got boiling in both the T hot legs. The pressurizer is 175 inches and they're trying to increase the pressure to push the pressurizer back up into the loops, okay? To cut the bubble off.

WILBER: What was that again with the bubble?

HITZ: Well, they're talking - yeah, they're trying to force water out of the pressurizer back up into the hot legs, but you know the temperature indication we got in the hot legs - we feel - they tell me they think that they are boiling up there.

WILBER: Yes.

HITZ: There's boiling in the hot legs.

WILBER: Yes.

HITZ: They've got - you know - they've talked about boiling in the core themselves over there, and they tell me they feel - they are not boiling in the core from what they've seen with the core flood tanks and what they - you know - the way they got the makeup system lined up - we lost some pressurizer heaters too.

WILBER: I understood that happened quite a bit earlier.

HITZ: I'm going back and see if they got any of the incores to printout.

WILBER: Hello.

HITZ: Yes.

WILBER: What is the basis that you feel that it is not boiling in the core?

HITZ: What's the basis for what?

WILBER: You feel it is not boiling in the core?

HITZ: Because the core flood tanks are sitting right on top of the core - they feel that the pressure they are seeing is correct. The core flood tanks did slide in at 600 pounds - they've seen a decrease in the core flood tank pressure -- levels, okay?

WILBER: All right.

HITZ: They slid into the pot, and the core flood tanks are now sitting there floating on top of the core. When the pressure - indicated pressure go to 600 pounds we seen a slight decrease in core flood tank level, which means that the core flood tanks - you know - the core flood tanks are pressurized at 600 pounds, so when the pressure in the system gets lower than 600 pounds, they just slide in, and they actually seen the level decrease in the core flood tanks. Can you excuse me a minute?

WILBUR: Yeah.

(Transcript Region I, Tape 11)

The concern at NRC Headquarters Incident Response Center was whether the core was covered since superheated steam conditions existed in parts of the reactor coolant system. Miller, on the other hand, said in a post-accident interview that during the morning he was not totally convinced that the core was covered. After the core flood tank maneuver however, he was convinced the core was covered and that they were getting some heat removal. (Miller, IE 158 at 22-23 on 5/7/79) Norman Moseley, NRC Director of the Office of Inspection and Enforcement Division of Reactor Operations Inspection, at the NRC Headquarters Incident Response Center was not convinced as evidenced by the following colloquy with Higgins who was in the Unit 2 control room. Higgins had agreed that there probably was superheat in the hot leg:

HIGGINS: They're not positively certain that there is not a bubble there; however, they feel confident that there isn't because the flood core tanks are floating essentially on the vessel, and that any water when they first did the blowdown with the electromatic relief valve, they were at 1000 pounds and they came down, they got, when they came below 600 pounds or so, where the core flood tank valves would open and let water into the upper level of the core, the core flood tanks went down a very small amount and they thought essentially the reactor vessel was already full and the core flood tanks are floating on it and maintaining it full.

MOSELEY: I think it's a function of pressure rather than that they necessarily have shown there is not a steam bubble.

HIGGINS: That's true. They're not 100% certain.

Moseley continues a few minutes later,

MOSELEY: Well...have you pursued with them, the question you and I talked about little earlier and that is how do we know that the core is not uncovered partially.

HIGGINS: We have talked that over, actually mostly the discussion on that was, between the people on site here, the Unit Superintendent and with Bob Arnold who was the, I'm not sure of the exact title, with Met-Ed, I think he's the Vice President of Med-Ed, and they talked about it for 20 minutes over the phone and I listened to the whole discussion the final results of it was they felt fairly confident that the core was covered they saw indications when they were blowing down and the flood core tanks and the interactions there, although they could not really give assurance of 100% that the core was covered.

MOSELEY: That flood tank story is not convincing to me.

(Transcript, Region I Tape 12)

The transcript of the Headquarters end of the above Moseley-Higgins discussion picked up background conversation about what the NRC Headquarters personnel were thinking:

BACKGROUND VOICE: Does the licensee understand 580 degree from the hot -- inaudible.

BACKGROUND VOICE: It means that is super heat, they concede that.

BACKGROUND VOICE: They agree to that?

BACKGROUND VOICE: Yeah.

BACKGROUND VOICE: Do they have any way to explain super heat without the core being uncovered?

BACKGROUND VOICE: Not to my satisfaction, no.

BACKGROUND VOICE: Did you ask?

VOICE: (MOSELEY) Have you pursued with them this question...

(Transcript 01-082-CH 3/21-PD at 16)

Stello testified during a post-accident hearing:

"throughout the day, the clear impression was created that there was significant damage being caused to the core. The principal reason - I am giving you a personal feeling - I cannot remember whether the group truly felt this way or not". Stello continued, "The reason for believing you had significant damage was the fact that we had a clear indication that there was superheated steam coming out of the reactor vessel. The only way you can, in fact, get superheated steam out of the vessel is to have the core uncovered. And the core, just from recollection, was uncovered for substantial periods of time throughout the day, which left me with the clear impression that significant damage had occurred in the core". (Oversight Hearings, Udall Committee on May 9, 1979, Serial No. 96-8, Part I at 4) Immediately after expressing his concern to the licensee (Hitz), Stello informed his Deputy Director, Darrell Eisenhut, who later relieved him at the Headquarters Incident Response Center and who was then in contact with Donald Roy, Babcock & Wilcox's Manager of Engineering at Lynchburg, Virginia.

EISENHUT: The guy we're talking to is Don Roy.

STELLO: Don Roy. That's him.

EISENHUT: That's who we're talking to in Denton's office.

STELLO: Yeah.

EISENHUT: They don't see any super heat on it, but we're following up with a couple of more questions. This question mark thing -- we're asking them right now.

The other thing we're doing is Case called over --

STELLO: What do you mean he doesn't see any super heat?

EISENHUT: He says he's got a little bit different numbers. The numbers they've been getting from their man are a little bit different than ours, and they don't run into the same problems. They've gotten the pressure and everything out of the pressurizer, where the temperature is just a little bit different.

STELLO: Darrell, let me give you the correct numbers.

EISENHUT: Okay.

STELLO: The pressurizer is at saturation. That's a true statement. It's about 457 degrees Fahrenheit.

EISENHUT: 457 degrees Fahrenheit.

STELLO: The pressure in the primary system is 450 pounds. The hot leg temperature is 550 degrees Fahrenheit. At one prior time it was pegged all the way up to 620 Fahrenheit. There ain't no way you can get those conditions without super heat.

EISENHUT: Wait a minute now. The pressurizer was at saturation, 457 degrees Fahrenheit?

STELLO: Right.

EISENHUT: Primary system pressure 450 pounds?

STELLO: Yes.

EISENHUT: Hot leg temperature 550 F?

STELLO: Yes.

EISENHUT: Do you know what the cold leg is?

STELLO: 200, 220.

EISENHUT: You got it man. That's it. They've got a problem.

STELLO: Well the cold leg temperature is nonsense because that's where all the water is coming in.

EISENHUT: I know.

STELLO: You're above saturation, and the only way that's possible is with super heat.

EISENHUT: Okay.

STELLO: That's just a fact.

EISENHUT: Okay.

STELLO: Now you go up and give them the right numbers.

EISENHUT: I certainly will.

(Transcript 01-226-CH 6/24-LFR at 2-4)

After talking with Eisenhut, Stello informed Commissioner Gilinsky of his concern about the superheated steam conditions and the need for the licensee to get more water into the core to cover the fuel. (Transcript 01-226-CH 6/24-LFR at 6-10)

When Samuel Bryan of the Headquarters Office of Inspection and Enforcement followed up on Wilber's request to Hitz for incore data, Hitz said he had not yet checked. A decision ensued with Brian asking Hitz if they can inject water into the hot legs and Hitz described the piping arrangement which did not provide for injection into the hot legs. Brian explained "But were concerned that the core is protected" (transcribed RI Tape 11). Walter Baunack, RI Reactor Operations Inspector, came to the unit to control room to assist Higgins and told Kermig at RI that they still had a bubble in the primary loop, that the hot legs temperatures were almost meaningless and you can't have any faith in them. (Transcript Region I, T 4:45 p.m. Higgins reported on the progress in stabilizing the reactor coolant system,

HIGGINS: They do have a few pressurizer heaters now which they didn't have earlier, they still are very limited, they don't have all the pressurizer heaters, by any means, they have some small amount and a while ago while I was in the control room they did get the level back in the pressurizer they said they had it for about 1/2 hour or an hour, they were feeding makeup water in and lost it again, and by this time, they may have it back for now but they are working with the heaters that they had and with the electromatic to re-establish the level in the pressurizer, like they had done initially.

(Transcript Region I Tape 12) (Post-accident review of instrument charts show that this pressurizer level response occurred around 3:30 p.m.)

At about 6:00 p.m., Higgins notified Region I of the licensee's decision to repressurize the plant; a change in coolant strategy.

HIGGINS: Don Haverkamp - okay - change of strategy here - apparently Med-Ed and GPU or somebody on site is talking with the people here - I'm not sure - I think it was Jack Herbein - I told you before that they had concerns about whether or not the core was covered - right?

HVERKAMP: Right.

HIGGINS: Okay, apparently - I'm not sure what the scenario was for making making that decision for change - but whatever that is - they are changing now - and they are continuing the cooldown, with the "A" steam generator - they feel that they are getting some cooldown - they have T₁ on the "A" loop of 548; T₂ of 446; and they feel that they're seeing a definite cooldown on that loop that are steaming the "A" steam generator. What they're doing now is that have increased their make-up to about 480 gpm - they're only letting down about 40 - so they are filling the pressurizer back up - they are letting pressure increase - they might take pressure up to about 2000 pounds - but the pressurizer goes solid and they want to try and make sure by doing that that they have all bubbles collapsed in the vessel, the loops, whatever - and they are continuing in the meanwhile doing the steaming on the "A" steam generator. The thing here is to collapse all the bubbles - to make sure the core is covered - to make sure they don't have any air bubbles or vapor pockets in there.

HAVERKAMP: Okay.

HIGGINS: And they're filling up right now - they're up to about 900 pounds right now - heading for about 2000 the level of the pressurizer is up to about 340 and it's going up also. (Transcript Region I, Tape 14)

Higgins kept the Incident Response Centers informed of the progress on the repressurization strategy in a three way conversation with Haverkamp at Region I and Kermit Whitt, Supervisor of NRC's Performance Appraisal Team, at Headquarters. Higgins responded at about 6:30 p.m. to Haverkamp's question about the incore thermocouple temperatures,

HIGGINS: Is this still Don Haverkamp, they are still proceeding along the same lines, the primary pressure is up to about 800 - 1800 psi, okay? This is an indication that they may not be getting too much natural circulation on the "A" loop - Th hot is 570, they were able to get a reading off one of the incore thermocouples, a lot of them failed and they can't get readings on them but they did get one which also read 570, which leads us to believe that that T hot varies and the loop is accurate, the primary-the reason we do not think they're getting too much natural circulation because the Delta T has the Tc is all the way down to 220 again, and we can't feasibly be losing that much in the steam generator. (Transcript Region I, Tape 15, Side 1)

Higgins also noted that B&W employees in the control room were monitoring hot leg temperatures in the control room by observing extended range temperature instruments on the back panel in the control room.

HIGGINS: Right. In the --(inaudible)-- loop, they still have a bubble on the B loop hot leg and they are still up in the range of 650 to 700. Okay? --(inaudible)-- On the control panel it only goes as high as 620. That is pegged high it has been pegged high. Periodically they go back and take thermocouple readings on the back panel. The B and W people are doing that and they have got around 700 to 750 from the thermocouple readings. (Transcript 01-085-CH 3/21-DLE at 7)

Around 7:00 p.m. Higgins engaged in the following dialog with Whitt,

HIGGINS: They're getting an indication of the vaporlock in the "B" loop but it appears the "A" loop has been cleared of its vaporlock except that they are not getting a tremendous amount of natural circulation by looking at the temperature difference.

WHITT: Yeah, if it was solid, you should be getting that, shouldn't you?

HIGGINS: I would think so, yes.

WHITT: From experience with other plants indicates that they should.

HIGGINS: They should, yes.

WHITT: Okay, so that indicates that maybe they still have some sort of blockage.

HIGGINS: Maybe so, this is a little bit of a unique arrangement here with a once through steam generator, so there's not a lot of this B&W design a lot of other plant experience like we have on Westinghouse.

WHITT: We got experience with B&W just for your information, they did go on natural circulation and cooldown and exceed the cooldown rate.

HIGGINS: Okay.

WHITT: But it cooled down very fast.

HIGGINS: Where do you hypothesizing that the gases are coming from in the other loop.

WHITT: The hypothesis is that maybe it's non-condensable gases.

HIGGINS: Xenon or Krypton or that type of nitrogen or whatever, I guess.

WHITT: Right.

WHITT: It could be oxygen, xenon, hydrogen...

WHITT: Oh, I guess what we're concerned about is are they looking into actually what they can do.

HIGGINS: Okay, let me get to them with that and I'm going to have somebody else get the phone. There's nobody here right now, I'll sent somebody in.

WHITT: Okay. (Transcript Region I, Tape 15, Side 2)

To initiate an adequate amount of coolant flow through the core, the licensee decided to run a reactor coolant pump. At 7:50 p.m. the 1A reactor coolant pump was placed into continuous

operation. James Gagliardo, a Performance Appraisal Team Reactor Inspector, contacted Baunack from the NRC Headquarters Incident Response Center to obtain the incore temperatures. At about 8:00 p.m. Baunack responded from the Unit 2 control room; "...611(^oF) is the highest one I know, 254 (^oF) is the lowest one, so they're just reading at random, I don't think they're of any value at all..." (Transcript Region I, Tape 17, Side 1)

William Raymond, Region I Reactor Inspector and former B&W start-up engineer, took over NRC communications at the Unit 2 control room for the night shift. At about 1:00 - 3:00 a.m. on March 29, Raymond reported the plant status to Wilber at the Headquarter Incident Response Center as: reactor pressure 1036 psi, "A" T inlet 287.4^oF (T Hot A), "B" T inlet 287.6^oF (T Hot B), pressurizer temperature 549^oF, incore thermocouple 569.2^oF. Headquarters questioned this incore temperature and Wilber requested that Raymond make a map of the incore temperatures; which he did and the reported temperatures are shown in Figure II-27A of Appendix B. Raymond noted that the temperatures varied from 207^oF to 617^oF and that "Just off-hand, I don't seem to believe those high numbers..." He later said, "I'd say - okay, with one coolant pump running, they should have a fairly equal flow distribution through there. I don't know of any reason we have these hot spots..." (Transcript, Region I Tape 21, Side 1) The next morning Raymond informed Headquarters that fourteen thermocouples were inoperable. Further,

RAYMOND: I just wanted to pass on to you that Med-Ed has been apprised of our observations on the incore trend - what they are doing is starting to trend selected high ones versus pressure - so they can correlate any sensible trend out of it - in addition to that, they may select some of the higher ones and try to get some readings out of it - the point of all that will be either discredit or qualify the indications that we are getting from them. Okay.

HQ: All right + great. (Transcript, Region I, Tape 26.)

3. What was not Reported on March 28, 1979

a. Background

During the several post accident investigations it was learned that several licensee personnel knew of incore temperature readings which exceeded 2000^oF. The evidence is that this specific information was not reported to the NRC on March 28. Therefore, a question was raised on whether the information was willfully withheld from the NRC in an attempt by licensee personnel to cover up the seriousness of the accident.

Several relevant interviews and testimony were examined to obtain an understanding of why the readings were taken, who knew of the readings, who and what were people told about the readings, and what did people believe the readings to mean at the time. These interviews were conducted by the several TMI-2 accident investigation groups and they are listed in Appendix A. Several persons were interviewed on this subject and some were reinterviewed several times. Interviews were conducted at various times beginning two weeks after the accident and continuing over the next seven months. The peak interview period was in May.

When examining these interviews it is soon apparent that there are problems such as: conflicts in statements between individuals, inconsistencies with what we now know, inconsistencies within a given interview, and inconsistent statements by an individual during different interviews. This was not unexpected considering: the nature of some interviews, i.e., the taking of unsworn statements which were requested and given in the context of a technical investigation to determine what happened during the accident; the complexity and length of the accident and its effects on the people responding to bring the situation under control; and the statements were taken at a relatively long time after the accident. To obtain a reasonable resolution of substantive conflicts and inconsistencies as to what was known, said and understood, these matters were evaluated in the light of what we now know and the weight of the evidence.

b. Incore Thermocouple Readings

Shortly after Station Manager Gary Miller arrived in the Unit 2 control room at 7:05 a.m., he was informed of the reactor coolant system hot leg temperature indications which were then exceeding 700°F. Probably around 7:15 a.m. Miller requested Ivan Porter, Unit 2 Instrument Control Engineer, to obtain incore thermocouple readings from the plant computer read-outs located in the control room. (This time estimate is reasonable because the rapidly rising radiation levels in the containment caused Miller to declare a general emergency at 7:24 a.m. His attention for the next several minutes were devoted to his duties as the Emergency Director. Also, the persons later taking additional thermocouple readings as a result of the computer data obtained, recall being told to obtain the necessary instruments around 7:45 a.m. - therefore, it is believed that Miller probably requested the data before declaring the general emergency). The apparent basis for Miller's request was to assist in evaluating the meaning of the hot leg temperatures. Porter's first attempt

to obtain quantitative incore temperature data was unsuccessful. The computer printed out "question marks" indicating that the valves were out of the range of the computer program. When informed of the question mark outputs, Miller asked Porter if there was any other way to obtain the readings. Porter acknowledged that he could take the readings at the computer input terminals located in a cabinet in a room directly below the control room. Porter then proceeded to get assistance. Douglas Weaver, Unit 2 Instrument Foreman; Nelson Bennett, Nuclear Maintenance Foreman; Robert Gilbert, Foreman, Thomas Wright, Unit 2 Nuclear Instrument Man, and Roy Yeager obtained the necessary equipment and took the readings. Two sets of readings were taken. The first set of 4 or 5 readings were taken with a instrument called a Fluke digital thermocouple meter. This instrument measures millivolts and converts the value to temperature equivalents and displays the temperature. In using this instrument the people disconnected the lead wires from the terminal blocks, connected the wires to the instrument and after the reading was obtained, the lead wires were then removed and reconnected to the terminal blocks. Some 4 to 5 incore thermocouple readings were taken in this manner and although the recollections of the people involved varied, there was basic agreement that some temperatures were low and at least one thermocouple indicated in excess of 2000°F (the testimony ranges from 2000 to 2600°F for the high reading and 0 to 700°F for the lowest readings). According to Porter, he left when the instrument was being set up and upon his return he was informed of the temperatures. Porter then proceeded to the control room to inform Miller of the results. Miller recalls that he and Porter discussed the readings briefly and Porter did not believe the readings were reliable. Miller accepted Porters evaluation and Miller and Porter say they devoted little or no further attention to the temperatures.