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

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MEMORANDUM FOR: Bernard J. Snyder, Program Director
TMI Program Office
Office of Nuclear Reactor Regulation

THROUGH: Rick Weller, Section Leader
Safety Review Section
TMI Program Office, NRR

FROM: T. C. Poindexter
Scott Newberry
Safety Review Section
TMI Program Office, NRR

SUBJECT: BORON DILUTION & RE-CRITICALITY MEETING MINUTES

Meeting Date: January 8, 1981; 10:00 a.m.; NRC Trailers, TMI Site

ATTENDEES

Bud Beebe	- GPU	G. K. Hovey	- GPU
Ron Bellamy	- NRC	Falk Kantor	- NRC
Mike Benson	- Met-Ed	Brian Kelly	- GPU
Gordon Bond	- GPU	Rick Kiernan	- GPU
John Brummer	- Met-Ed	L. J. Lehman, Jr.	- GPU
Jim Byrne	- GPU	John Luoma	- GPU
J. J. Chwastyk	- Met-Ed	Scott Newberry	- NRC
Rick Conte	- NRC	T. C. Poindexter	- NRC
Branch Elam	- GPU	G. R. Skillman	- GPU
Les Gage	- NRC		

This meeting was held with the licensee to discuss the potential for a boron dilution event and the detection measures available should one occur so that all concerns on this subject could be resolved. The attached agenda was used as a guide for the discussion. Scott Newberry (NRC) stated that the need for these discussions resulted from preliminary work done in preparation of the Final PEIS and that, while the likelihood of a boron dilution event in the current system configuration was low, additional information was necessary to confirm this in present and future operations. Additional information was also necessary to define in detail the procedural and design controls, as well as the instrumentation and sampling detection methods. The following paragraphs provide a summary of the information exchanged verbally and briefly describe the calculations performed by the licensee to support their positions.

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A. Boron Dilution Analyses & Studies for TMI-2 to Date

1. B&W Studies

While studies have been done to determine a reactor coolant system boron concentration necessary for ensuring sufficient core subcriticality, no specific studies have been done by B&W on dilution/recriticality.

2. Met-Ed/GPU

a. Met-Ed/GPU has done work in this area and it was discussed by Dick Skillman and his staff at the meeting. TDR-155, Analysis of MDHR System Startup and Operational Effects on RCS Boron Concentrations was forwarded to the NRC on June 4, 1980. The TMIPO site and headquarters staff generally concurred with the conclusion of the report which states that the RCS boron concentration will not drop below 3000 ppm even if the MDHR system volume is injected into the RCS completely unborated at system startup.

b. The staff was also informed of a technical review completed by GPU August 5, 1980 on Differential Concentration of Boron in the Reactor Coolant System. These calculations were done to determine the effects of a postulated secondary to primary leak for the Long Term Cooling - B. This is a system designed, constructed and tested since the accident which consists of a pump and heat exchanger loop utilizing the "B" OTSG. It has been determined by Met-Ed/GPU that, at the present RCS pressure of ~100 psi, the only operational system that could inject demineralized water into the RCS is Long Term - B. The pumps associated with LT-B "dead head" at approximately 300 psig. From past operating experience at 300 psig, the RCS leak rate averaged 0.22 gpm. It was the licensee's opinion that, based on the above data and normally ongoing surveillance data, an injection of this type would be readily observable in the control room (RCS pressure and LTB surge tank level) and, if allowed to continue, would take around 35 days to dilute the reactor coolant system to 3000 ppm boron. After the meeting, the staff received this calculation for review. Met-Ed/GPU believes that this is the "worst case" dilution event.

3. NRC Studies

In conjunction with the TMIPO review of the PEIS, the NRC is also reviewing a report from the Argonne National Laboratory on boron dilution scenarios and consequences. Some work has also been done by NRC Research. These studies were not discussed in detail. Scott Newberry (NRC) stated that the Argonne work was preliminary, but concluded that a recriticality could have significant consequences if conservative assumptions were made. The licensee stated that the conclusions would obviously be dependent on many

assumptions. While they had not reviewed the Argonne work and were not familiar with the assumptions, they thought that assuming no control rod poison in the core was too conservative.

B. Boron Dilution Prevention

1. Procedural Controls

a. The licensee stated that there has been a concerted effort to incorporate boron dilution preventative measures into all applicable operating and emergency procedures. Leak rate calculations are done once every four hours, boron concentration confirmation calculations once per shift, RCS pressure readings hourly, thermocouple readings hourly, hot and cold leg temperature readings hourly and system lineup checks taken each shift to immediately detect any changes in the core and the RCS. EP-16 (2202-EP16) "Loss of Source Range Instrumentation", is currently in place in the control room. This emergency procedure provides guidance for actions to be taken to prevent re-criticality and actions to be taken should an increased count rate be detected. Also, 2102-3.4, "RCS Operation with Core Cooling Via Natural Losses", incorporates directives on actions to be taken to terminate an increasing count rate. This procedure has been reviewed and approved by the NRC.

b. Gale Hovey, Vice President and Director of TMI-2, stated that Met-Ed was committed to address how each equipment design change or operating mode would effect the control of boron in the reactor coolant system in future reports. Emergency procedures applicable to these different modes would be rewritten as well. For example, Hovey stated that the proposed use of EPICOR/SDS to clean up the reactor coolant system would include an evaluation of boron dilution controls and mitigation.

2. Design Controls

a. The licensee believes that systems that have dilution potential presently have preventative steps incorporated into their operational procedures. Administrative control, tagging, and valve isolation are applicable for all these systems.

b. All sources for demineralized water injection are checked via system lineup verifications performed each shift.

c. Future systems will also have appropriate operational, design and administrative controls incorporated into their associated procedures. These procedures are reviewed by the NRC TMIPO staff.

C. Boron Dilution Detection

1. Nuclear Instrumentation

a. Any increase in count rate is taken as an approach to critical and is addressed this way in EP16 and the RCS Operation With Core Cooling via Natural Losses procedures, 2102-3.4. The required operator actions have been reviewed and approved by the NRC.

b. The following is the current status of existing and future nuclear instrumentation:

--NI-1: (Source Range) This instrument appears to be operating correctly. It has not shown any symptoms of failure similar to what was seen when NI-2 failed after the accident. Currently the meter indicates 1.2-1.5 cps.

--NI-2: (Source Range) Currently inoperable. A spare pre-amp was obtained from Duke Power, and during pre-installation tests it appears that the replacement may be defective. Information on the "detector system" was requested and obtained from B&W. Also on December 22, 1980, Westinghouse checked out the NI-2 string. Results were that the pulse shapes seen were distorted with incorrect amplitudes. The signal cable is believed defective. It is also possible that the inner shield for the cable just inside of the reactor building penetration (located at approximately 342 ft elevation) is disconnected. Other cables that go through the penetration have also indicated that there may be inner shield problems. During the next entry, instrumentation will be taken into the RB that will "look" towards the detector and towards the control room within the cable in an attempt to re-confirm the location of the defect and assess whether the detector itself is operable. If the detector is inoperable it could be replaced but it would be a large expenditure of time, manpower, and exposure. L. J. Lehman (GPU) stated that a copy of Met-Ed/GPU letter TLL-449 dated September 12, 1980 which described the steps for removal of a detector, and one or two neutron shield tanks, was forwarded to the NRC.

The installation of an operable NI-2 would add to the re-criticality detection methods and assist in verifying NI-1's operability.

--NI-3/4: These intermediate range detectors are considered operational.

--3 Power Range Detectors: These detectors are considered operable.

--A pico ammeter is scheduled for installation on one of the power range monitors. This instrument will potentially provide another detector down to the intermediate range which will be near another portion of the core.

When asked to provide a predicted source range instrument reading at criticality, resulting from different reactivity insertion rates, the licensee stated that this would be extremely difficult unless the scenario were better defined. Local criticalities may or may not be indicated on the operable source range instrument and, if indicated, could be anywhere in the source range. They stressed that the nuclear instrumentation was only one of many ways to detect dilution and an approach to criticality.

2. Boron Sampling

a. The TMIPO staff was presented with a calculation dated Jan. 7, 1981 titled Sodium Concentration in RCS. Generally, the paper looks at data taken on RCS sodium concentration from the time that NaOH addition to the system was terminated after the startup of the SPC in early April 1980 until November 17, 1980 (approximately two weeks after the reactor coolant system was declared stagnant - no burps). The Na sample concentrations were compared to theoretical concentrations of a homogeneously mixed system. Met-Ed feels that the results of the study show that sample results are consistent with homogeneous results and therefore indicated that the RCS is thoroughly mixed.

b. B. Beebe (GPU) had previously discussed the "mini-burp" phenomenon with the NRC staff and stated that he could not show that there was communication between the core area coolant and the rest of the RCS. However, Beebe stated that he recently found indications that the steam generator shell temperatures increased 8-12 hours after a "mini-burp". This rise is minor in magnitude, but Met-Ed believes that it shows clear evidence that core water is reaching other areas of the RCS loop. The TMIPO received copies of this document. Beebe also believes that there are continuous thermal convective currents which induce continuous localized flow and mixing which promotes complete RCS mixing.

c. D. Skillman (GPU) stated that until the stoppage of pressurizer sampling, the pressurizer results and other sample results tracked each other very well. Rick Conte (NRC) asked whether a current pressurizer sample would be useful to see if this tracking is still

taking place. The licensee will respond to the TMIPO by January 23, 1981 on their opinion on whether a pressurizer sample is technically helpful. (This sample was taken on 2/2/81).

d. Current boron samples are accurate ±80 ppm and results track very well with boron additions. Currently, the sampling point and the SPC injection point is in the same cold leg. Procedures are currently being modified to change the injection point to the other leg.

3. Other Ways to Detect Dilution

The licensee stressed in discussions on instrumentation and the discussion on chemistry that there are a number of parameters that are watched for re-criticality indication:

1. NI-1
2. Pressure Gauge at the sample sink
3. Pressure Gauge at DH-V3
4. Incore T/C's
5. Hot & Cold Leg RTD's
6. Leak Rate
7. RCS Samples

With the reactor coolant system "solid", the pressure indications should provide early warning of a high pressure water source. Temperature indications would provide indication of any core heat up.

4. Commitments

a. Met-Ed to NRC

(1) Na Concentration in RCS Calculations (received)

(2) Differential Concentration of Boron in Reactor Coolant System (received)

(3) Summary of B. Beebe evaluation of S. G. Shell Temperatures (received)

(4) Analysis of Pressurizer Sample Technical Necessity (received)

(5) In the future, the licensee will address the potential and preventive measures for boron dilution with each significant change in system operation.

2. NRC to Met-Ed

None.

*NOTE: These minutes were also reviewed by Met-Ed Licensing for accuracy and completeness.

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Enclosure:
Meeting Agenda

BORON DILUTION/RE-CRITICALITY

MEETING AGENDA

January 8, 1981

BORON DILUTION ANALYSES & STUDIES FOR TMI-2 TO DATE

- -B&W
- -MET-ED/GPU
- -NRC

BORON DILUTION PREVENTION

- -PROCEDURAL CONTROLS
  - -EXISTING OPERATING, EMERGENCY AND ADMINISTRATIVE PROCEDURES
  - -PLANS FOR REVISING PROCEDURES
  - -PROCEDURES PLANNED FOR FUTURE/SCHEDULE
- -DESIGN CONTROLS
  - -SYSTEM OPERATIONAL STATUS, I.E., SPC, MAKEUP AND PURIFICATION, OTHERS
  - -DEMINERALIZED WATER SOURCES
  - -PLANS FOR FUTURE SYSTEM DESIGN CONTROLS

BORON DILUTION DETECTION

- -NUCLEAR INSTRUMENTATION
  - -PREDICTED INSTRUMENT RESPONSE FOR APPROACH TO CRITICALITY (DIFFERENT DILUTION RATES) AND RELATIONSHIP TO PROCEDURES
  - -ALARMS & INDICATIONS CURRENTLY AVAILABLE
  - -PLANS & SCHEDULE FOR MAINTENANCE, TESTING & UPGRADING OTHER SOURCE RANGE CHANNEL AND/OR INTERMEDIATE OR POWER RANGE CHANNELS
- -BORON SAMPLING
  - -FREQUENCY SUFFICIENCY
  - -ADEQUACY CONSIDERING THE RELATIVELY STAGNANT RCS - CAN IT BE EXPECTED TO PREDICT A DILUTION EVENT?
  - -FUTURE SAMPLING PLANS/ALTERNATIVES TO PRESENT PLAN
- -OTHER WAYS TO DETECT DILUTION

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