U.S. NUCLEAR REGULATORY COMMISSION
REGION I

Report No. 50-289/84-03

Docket No. 50-289

License No. DPR-50 Priority -- Category C

Licensee: GPU Nuclear Corporation
P. O. Box 480
Middletown, Pennsylvania 17057

Facility Name: Three Mile Island Nuclear Station, Unit 1

Inspection At: Middletown, Pennsylvania

Inspection Conducted: January 16-20, 1984

Inspectors: Marie T. Miller — 2/9/84 date
Marie T. Miller
Radiation Specialist

for — 2/9/84 date
Andrew P. Hull, Health Physicist
Brookhaven National Laboratory

for — 2/9/84 date
Wayne H. Knox, Health Physicist
Brookhaven National Laboratory

Approved by: M. Shanbaky — 2/9/84 date
Dr. M. M. Shanbaky, Chief
Facilities Radiation Protection Section

Inspection Summary:
Inspection conducted on January 16-20, 1984 (Report No. 50-298/84-03)
Areas Inspected: Special, announced safety inspection of the licensee's implementation and status of the following task actions identified in NUREG-0737: Post-accident sampling of reactor coolant and containment atmosphere; increased range of radiation monitors; post-accident effluent monitoring; containment radiation monitoring; and in-plant radioiodine measurements. The inspection involved 132 hours on site by one region-based inspector and two contractors from Brookhaven National Laboratory.

Results: Several deficiencies were identified relative to the licensee's provision for post-accident sampling and analyses. Items pertaining to sample acquisition for all accident situations, analytical capability; and shielding and exposure evaluations appear less than adequate.

DETAILS

1.0 Persons Contacted

1.1 Licensee Personnel

During the course of the inspection, the following personnel were contacted or interviewed:

*H. Hukill, Director, Three Mile Island (TMI) Unit 1
*R. Toole, O&M Director, TMI Unit 1
G. Davis, Operations Shift Foreman
*G. Derk, Modification/Operations QA Supervisor
*E. Fuhrer, Plant Chemistry Manager
*G. Giangi, Emergency Preparedness Manager
L. Harding, Licensing Engineer
*T. Hawkins, Startup and Test Manager
E. Houser, Chemistry Foreman
*R. Knight, Senior Licensing Engineer
P. Mergen, Senior Chemist
*V. Orlandi, Lead I&C Engineer
*I. Porter, Startup & Test Manager
R. Rolph, Group Rad Con Supervisor
*R. Shaw, Radiological Engineering Manager
*L. Shorts, Technical Functions Manager - TMI Site
*J. Whitehead, Emergency Planner

*denotes those personnel present at the exit interview.

The exit interview was also attended by M. Shanbaky, Chief, Facilities Radiation Protection Section, NRC Region I.

Other members of the licensee's staff and GPU Nuclear Corporation were also contacted during this inspection.

2.0 Purpose

The purpose of this inspection was to verify and validate the adequacy of the licensee's implementation of the following task actions identified in NUREG-0737, Clarification of TMI Action Plan Requirements:

Task No.	Title
II.B.3	Post Accident Sampling Capability
II.F.1-1	Noble Gas Effluent Monitor
II.F.1-2	Sampling and Analysis of Plant Effluents
II.F.1-3	Containment High-Range Radiation Monitor

Item III.D.3.3, Improved In-plant Iodine Instrumentation Under Accident Conditions, had been documented as adequate in NUREG-0680, Supp. No. 3, TMI-1 Restart, and Inspection Report 50-289/83-04.

Licensee action on previous inspection findings for these task actions were also reviewed.

3.0 Status of Previously Identified Items

(Closed) Inspector Followup Item (50-289/82-BC-42): LM-24A, Improve post accident sampling - reactor coolant system sampling. Details are in paragraph 5.2.2.1.

(Closed) Inspector Followup Item (50-298/82-BC-43): LM-24B, Improve post accident sampling - containment atmosphere. Details are in paragraph 5.2.2.2.

(Closed) Inspector Followup Item (50-289/82-BC-44): LM-23, Install two safety grade in-containment radiation monitors. Details are in paragraph 8.2.

(Closed) Inspector Followup Item (50-289/82-BC-45): LM-25A, High range noble gas effluent monitor. Details are in paragraph 6.2.

(Closed) Inspector Followup Item (50-289/82-BC-46); LM-25B, Expand range of iodine/particulate effluent monitor. Details are in paragraph 7.2.

(Closed) Unresolved Item (50-289/83-16-02): Verification of a qualified cable assembly for the required In-Containment Radiation Monitors. Review of the licensee's equipment qualification test reports indicated that the coaxial cables were environmentally qualified for post-accident radiation levels.

4.0 TMI Action Plan Generic Criterion and Commitments

The licensee's implementation of the task actions specified in Section 2.0 were reviewed against criteria and commitments contained in the following documents:

- NUREG-0737, Clarification of TMI Action Plan Requirements

- Generic Letter 82-05, Letter from Darrell G. Eisenhut, Director, Division of Licensing (DOL), NRC, to All Licensees of Operating Power Reactors, dated March 17, 1982

- NUREG-0578, TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations, dated July 1979

- Letter from Darrell G. Eisenhut, Acting Director, Division of Operating Reactors, NRC, to All Operating Power Plants, dated October 30, 1979

- Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors"

- NUREG-0680, TMI-1 Restart, dated June 1980.

- NUREG-0680, Supp. No. 3, TMI-1 Restart, dated April 1981.

- Regulatory Guide 1.97 Rev. 2, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident".

- Regulatory Guide 8.8, Rev. 3, "Information Relevant to Ensuring that Occupational Radiation Exposure at Nuclear Power Station will be As Low As Is Reasonably Achievable".

4.1 Documents Reviewed

The implementation, adequacy, and status of the licensee's post-accident sampling and monitoring systems were reviewed against the criteria identified in Section 4.0, and in regard to numerous licensee letters, memoranda,drawings and station procedures (see Attachment 1).

5.0 Post Accident Sampling Capability Item II.B.3

5.1 Position

NUREG-0737, Item II.B.3, specifies that licensees shall have the capability to promptly collect, handle, and analyze post accident samples which are representative of conditions existing in the reactor coolant and containment atmosphere. Specific criteria are denoted in commitments to the NRC relative to the specifications contained in NUREG-0737.

The licensee's performance relative to these criteria was determined by interviewing principal personnel associated with post-accident sampling, reviewing associated procedures and documentation, and conducting a performance test to verify hardware, procedures and personnel capabilities.

5.2 Findings

Within the scope of this review, the following items were identified:

5.2.1 PASS Performance Testing

Reactor coolant and containment samples were collected during an operational test of the PASS witnessed by the NRC Inspection Team on January 18, 1984. The test was designed to verify the licensee's integrated capability to collect and analyze a sample within the constraints of NUREG-0737.

During the performance of this test, the following was identified:

5.2.2 Sampling

5.2.2.1 Reactor Coolant Sampling

Although a sample was obtained, there were questions concerning the ability to collect a representative sample under all accident conditions and modes of operation. Additionally, it appeared that the dose associated with the collection of a sample may exceed GDC 19. (See Section 5.2.3 of this report for further discussion of dose and shielding concerns).

The system relies entirely on RCS pressure to drive the liquid through the post accident sampling system (PASS). There are no pumps to assist in generating flow at low pressures. The licensee submitted an analysis which was based on a maximum system pressure of 2105 psig and a minimum pressure of 320 psig. From review of this analysis and discussions with the associated technical personnel it was apparent that there were no provisions to acquire an RCS sample in a depressurized condition.

With regard to the representativeness of the sample under different accident conditions, the licensee's June 15, 1982 Inter-Office Memorandum from J. D. Abramovici to C. W. Smyth, Subject: TMI-1 Use of Loop B Cold Leg for Post Accident Sampling, stated that the B cold leg sample is representative of all accident conditions except three (large break LOCA, small break LOCA with loss of natural circulation and HPI cooling). The memorandum further stated:

a. "For a large break LOCA the reactor building sump is somewhat representative of core status if frequent sampling is conducted".

b. "For a small break LOCA with loss of natural circulation with a hot leg bubble, samples of the pressurizer combined with B loop cold leg sample will provide adequate core status."

c. "Under the HPI cooling mode with no steam generators available, flow through the pressurizer is considered representative and therefore, a pressurizer sample is considered adequate".

Based on our review, there appear to be no provisions for obtaining a representative sample under these conditions.

Based on the above findings, the following item should be resolved:

- Provide the capability to obtain reactor coolant samples under all accident conditions and modes of operation, including radiation exposure considerations (50-289/84-03-01).

5.2.2.2 Containment Air Sampling (CAS)

The ability to obtain a representative sample of containment air for analysis was questionable. With regard to the operation and design characteristics of the system, the following concerns were identified.

The heat traced portion of the CAS system piping had reached a temperature of 175°F rather than the design temperature of 250°F. Piping following the system pressure regulator appeared to be at room temperature which could possibly cause significant condensation in the gas sample bomb. The licensee's review of the adequacy of the heat trace indicated that the instrument air mixes with the reactor building sample air at the eductor causing a decrease in the return air temperature during sampling conditions. The licensee also stated that condensation formation is not expected unless the temperature drops below 100°F. However, the bases for not expecting condensation and possible loss of sample representativeness was not provided.

The system and associated procedures did not provide a capability to sample when accident conditions cause containment system isolation. In addition, the system and associated procedures had no provisions for estimating sample losses attributed to sample transfers and made no temperature and pressure corrections.

Based on the above findings, the following items need to be resolved to assure adequate provisions for containment air sampling(50-289/84-03-02):

- Evaluate whether containment samples are representative because of possible sample condensation and because of iodine plate-out in the gas sample bomb.

- Modify the containment sampling system to permit sampling after containment isolation and provide temperature and pressure indications for the gas in the sample bomb. Sample quantification procedures including temperature and pressure normalization should be developed.

- Perform an error analysis to estimate sample losses attributed to sample transfers called for in analytical procedures.

5.2.2.3 Other Considerations

In addition to the above findings, the following items should be considered for improvement:

- A pressure of 125 psig on reactor coolant system relief valve CA-RV5, located downstream of CA-110, will cause it to lift and vent coolant to the Auxiliary Building sump. The possibilities of this situation occurring during the flushing and purging of the lines or valve failure was not analyzed.

- Given the total amount of dissolved gases in reactor coolant (H_2, N_2, O_2, and fission product), in the 40 ml sample bomb (plus line) under 2000 psig, the licensee was unable to determine the resultant pressure in the expansion cylinder once the gases are stripped from the solution. (Note: The pressure relief valve (CA-V328) for the expansion cylinder is set at 25 psig. The procedure instructs the operator to bubble Argon at 6 psig through the sample until the pressure in the expansion cylinder reaches 2 psig). Such determination is necessary to accurately determine activity concentration.

- There has been no formally established preventive maintenance and surveillance program for the containment sampling system. Licensee personnel indicated that the program was being developed. SDD-555-B page II-19 recommended leak testing and operationally checking the system quarterly.

- There was no cask or shielded container available to transport the gas samples to the counting room for analysis. The two syringes containing a total of 7 cc of gas were carried to the counting room in a plastic bag. The dose received by personnel in transporting the sample was not addressed in the shielding study.

- The licensee did not consider it necessary to wear a respirator and protective clothing during the collection of the containment air sample. It should be noted that the system may become pressurized and there may be leaks in the rubber septum, syringe and lines. There is no continuous air monitor in the area to alert personnel of high airborne radioactivity.

- Two hydrogen analyzers have been installed to provide in-line monitoring of the containment hydrogen concentrations. At the time of the inspection, they had not been tested or calibrated. Also, the operational procedures had not been written.

- No procedural provisions have been made for collecting a grab sample for hydrogen analysis in the event the in-line system is inoperative.

These items will be reviewed in a subsequent inspection.
(50-289/84-03-03)

5.2.3 Item II.B.2 Design Review of Plant Shielding and Environmental Qualification of Equipment for Spaces/Systems which May Be Used in Post-Accident Operations

The results of the shielding study were contained in several documents:

- TMI-1/FSAR Appendix 11A
- TDR No. 121 dated 10/1/80
- TDR No. 183 dated 4.24/81
- Attachment 2 to a November 22, 1983 letter to J. F. Stolz from H. D. Hukill.

In general, the study appeared to be incomplete and did not contain sufficient detail to characterize the expected radiation environment. For example:

1. The study of the Nuclear Sampling Room during the collection of reactor coolant samples did not include all contributors of radiation exposure. Some of the sources not considered were:

   a. the sink drain trap and drain line,

   b. the undiluted coolant in the sink,

   c. scattered radiation,

   d. unshielded auxiliary lines,

   e. residual contamination during subsequent sampling attempts, and

   f. airborne radioactivity originating from the sink.

2. A study of the dose associated with collecting and transporting of containment air samples had not been formally conducted based on the installed system. (Note: A shielding study was based on the normal containment sampling system which the licensee had originally considered using to obtain a containment air sample.)

These items require resolution in order to be determined as acceptable (50-289/84-03-04).

5.2.4 Analysis Capability

The licensee commitments relative to the analysis of the samples are contained in the enclosures and attachments to the November 22, 1983 letter from H. D. Hukill to J. F. Stolz.

5.2.4.1 Chloride

The licensee committed to have the capability of measuring chloride concentrations from 0.1 to 20 ppm using an ion chromatograph. The accuracy of the analysis was stated to be:

+/- 0.05 ppm between 0.1 to 0.5 ppm and
+/- 10% between 0.5 to 20.0 ppm.

The licensee was provided three spiked chloride samples for analysis which covered the range of his stated capability. The ion chromatograph was not functioning properly; therefore, the samples could not be analyzed. Based on CP N1918, "Determination of Boron, Chloride and Sulfate in Water Samples by Ion Chromatography", and discussions with licensee personnel, undiluted samples greater than approximately 0.2 ppm could not be adequately analyzed. CP N1918, Section 1.2, specifies the optimum range of the chromatograph to be 0.005 to 0.2 ppm. The November 22, 1983 letter to J. F. Stolz, Tabel 1, states "The lower limits of detectability for chloride... using the ion chromatograph are known to be 0.1 ppm".

The December 28, 1983 letter from H. D. Hukill to J. F. Stolz indicated that procedures would be developed to require the use of an auto-sampler and controller to minimize personnel exposure. This equipment is to be available by April, 1984. In the event of an accident, this equipment would be transported to the site from the licensee's Reading, Pennsylvania laboratory. Based on discussions with licensee personnel, the auto-sampler and controller had not been brought to the site for compatibiltiy tests. Also, onsite personnel had not been trained in the installation and operation of auto-sampler and controller. Further, Section 3 of the, "Instructor Notes of the Emergency Chemistry Lesson Plan" (dated 1/11/84) states,"Chloride sample preparation is to be omitted at this time as a procedure utilizing the Ion Chromatograph for Post Accident Chloride analysis is currently being developed".

CP N1918, Section 5.5.3 indicates the need to process 100 ml of sample if the pH is greater than 8. This amount was not considered in the assessment of the dose resulting from using the procedure. Additionally, only a 20 to 30 ml sample is collected for analysis. The collection of 100 ml aliquot in a post-accident condition would likely be prohibited due to personnel exposure.

The licensee has purchased a standard post-accident matrix solution, however, chloride analyses have not been conducted using the solution. Results are expected to be available and sent to NRC Region I by February 28, 1984.

The additional shielding for the ion chromatograph resin column was planned but not yet installed.

5.2.4.2 Boron

The licensee committed to have the capability of determining boron concentrations over the range of 25 ppm to 6000 ppm by using the mannitol titration method. The accuracy of the analysis was stated to:

+/- 50 ppm between 25 to 1000 ppm and
+/- 5% between 1000 to 6000 ppm.

Procedure CP N1904, "Boron By Titration", is used for the analysis of boron. Section 1.2 states the analysis range of the procedures is approximately 5 to 25,000 ppm. Section 1.2 also indicates the need for 5 ml sample in order to determine boron in the 100 to 5000 ppm range; and 100 ml for the 25 to 100 ppm range. A 1 ml of sample was considered in the dose analysis. Processing a 100 ml undiluted sample would undoubtedly produce personnel exposures in excess of GDC 19 specifications. Also diluting the sample in order to reduce exposures may compromise the detection capability.

The licensee has purchased a fluoroborate probe for determining the concentration of boron. Once the probe has been tested and calibrated and procedures developed, it is expected to be the primary method used for boron analyses.

The licensee has purchased a solution which contains the standard post-accident solution Matrix. Presently, the solution has not been used in conjunction with any analyses of boron samples.

5.2.4.3 Gross Activity and Isotopic Analyses

In view of the shutdown status of the plant and the use of the normal sink for post-accident sampling, it was difficult to test the adequacy of the gross activity and isotopic analyses.

The licensee, however, had not planned to determine the gross activity of the sample. Note 2, Table 1 of the November 22, 1983 letter indicated that GPUN did not intend to measure the gross activity of the post-accident sample due to personnel exposure considerations.

5.2.4.5 Hydrogen

The licensee committed to determining dissolved Hydrogen in the range of 4 to 2000 cc (STP)/Kg. The accuracy of the measurement was stated to be:

+/-20% between 50 to 2000 cc/Kg
+/-5 cc/Kg below 50 cc/Kg

The ability to analyze gases for the hydrogen content was satisfactorily demonstrated using a gas chromatograph.

5.2.4.6 Fission Gas Activity From Reactor Coolant

There was no procedure which required the analysis of the fission gases stripped from the reactor coolant. Based on discussions with licensee representatives, this did not appear to be a specific requirement in NUREG-0737. Therefore, this measurement was not planned.

The concentration and type of gases in the coolant is used to determine the degree of core damage and is required by NUREG-0737, Clarification 2(a)

5.2.4.7 pH

The licensee committed to measuring pH in range of 1 to 13. The accuracy of the measurement was stated to be:

within +/- 0.3 pH units in the range of 5 to 9 pH units and

within +/-0.5 pH units for all other ranges.

Note 6 in table 1 of the November 22, 1983 letter stated that the equipment for measuring pH of the undiluted post-accident sample would be available in December 1983. During the week of the inspection, the miniprobes were received. The licensee did not have an opportunity to test and calibrate the new probes, and to write an operating procedure.

5.2.4.8 Resolution

Based on the above findings, resolution is required in the following areas to achieve acceptable analytical capability:

- Perform demonstrations of chemical analysis capability for chloride, boron, and pH using intended post-accident instrumentation and procedures on a standardized sample and provide results of these demonstrations.

- Develop procedures for use of fluoroborate probe for boron analysis; and mini-probes for pH determination.

- Revise procedures to address the analysis of fission gases stripped from reactor coolant sample and for determining gross activity of reactor coolant sample.

- Provide shielding for ion chromatograph resin column.

These items will be reviewed in a subsequent inspection (50-289/84-03-05).

6.0 Noble Gas Effluent Monitor, Item II.F.1-1

6.1 Position

NUREG-0737, Item II.F.1-1 requires the installation of noble gas monitors with an extended range designed to function during normal operating and accident conditions. The criteria, including the design basis range of monitors for individual release pathways, power supply, calibration and other design considerations are set forth in Table II.F.1-1 of NUREG-0737.

6.2 Findings

The licensee was able to demonstrate the pertinent specifications for this item were acceptably performed. While no major discrepancies were noted, the following item is recommended for improvement:

- The licensee is taking action to eliminate a source of confusion in the interpretation of monitor readouts (currently in terms of "counts per minute"), by providing conversion factors directed to "$\mu Ci/cm^3$". Such conversion factors are expected to be more relevant to the changing distribution of noble gases expected in the post-accident condition (50-289/84-03-06).

7.0 Sampling and Analysis of Plant Effluents, Item II.F.1-2

7.1 Position

NUREG-0737, Item II.F.1-2, requires the provision of a capability for the collection, transport and measurements of representation samples of radioactive iodines and particulates that may accompany gaseous effluents following an accident. It must be performable without exceeding specified dose limits to the individuals involved. The criteria including the design basis shielding envelope, sampling media, sampling considerations, and analysis considerations are set forth in Table II.F.1-2.

7.2 Findings

MAP-5 systems, fabricated by Nuclear Research Corporation have been installed as supplements to existing low-range radioiodine and particulate samplers, for the sampling of high-level radioiodine and particulates which may be contained during post-accident conditions in the condensor gas exhaust, the auxiliary and fuel handling exhaust and the containment purge duct.

The MAP sampling station is provided with three sampling positions in parallel, one of which collects a continuous sample, one of which collects a sample for 4 seconds in 40 and one of which collects a sample for 4 seconds in 400. The continuous sample position for each station is provided with a lead shield . Only one such shield was in evidence at the time of this inspection, but others are being fabricated.

The licensee indicated that its present analytic capability for its Ge-Li system was limited to samples not exceeding 1 mR/hr and that during accident conditions, they would limit the sampling time so as not to exceed this level. For the established flow rate of 0.1 cfm and at the design basis concentration of 100 uCi/cm^3, even a sample collected in 10 seconds would exceed 1 mR/hr at 3 feet. The representativeness of such a brief sample is questionable.

The applicability of IE Information Notice 82-49, "Correction for Sample Conditions for Air and Gas Monitoring" to gas monitor flow indications at TMI, particularly for the condensor off gas channel, was considered. However, there was no indication that it was followed up, particularly for the MAP-5 rotameter for the condensor off-gas line.

Based on the above findings, the following item should be resolved:

- Develop procedures which address the collection of representative plant effluent samples, and the provisions for handling and analyzing high dose rate samples (50-289/84-03-07).

7.3 Other Considerations

In addition to the above findings, the following items should be considered for improvement (50-289/84-03-08):

- Install shields around all MAP-5 continuous sampling position cartridges.

- Document followup action taken related to IE Information Notice 82-49.

8.0 Containment High Range Radiation Monitor, Item II.F.1-3

8.1 Position

NUREG-0737, item II.F.1-3, specifies that high range containment radiation monitors be installed. The specific requirements are set forth in Table II.F.1-3.

Findings

Within the scope of this review, the following was identified:

Two Victoreen Model-877 ion-chamber detectors with extended ranges of 10^1 - 10^7 R/hr have been installed with appropriate separation in the containment. Functional tests have been performed, calibration procedures established and an on-site calibration has been performed by the vendor. The monitors provide the capability to detect and measure the radiation level within the reactor containment during and following an accident.

9.0 Exit Interview

The inspection team met with the licensee's repres[illegible] (denoted in Section 1.1) at the conclusion of the inspection on [illegible], 1984. The inspection team leader summarized the purpose and scope of the inspection and identified the findings as described in this report.

At no time during this inspection effort was written material provided the licensee by the NRC inspection team.

Attachment 1

A. NUREG-0737, II.B.3

- Letter from John F. Stolz, Chief Operating Reactors, Br. 4, DOL, to Henry D. Hukill, V.P. GPU Nuclear, dated October 7, 1982.
- Letter from John F. Stolz, Chief, Operating Reactors, Br. 4, DOL, to Henry D. Hukill, V.P. GPU Nuclear, dated July 8, 1982.
- Letter from John F. Stolz, Chief, Operating Reactors, Br. 4, DOL, to Henry D. Hukill, V.P. GPU Nuclear, dated July 18, 1982.
- Letter from H. D. Hukill, Director TMI-1 GPU Nuclear to D. G. Eisenhut Director DOL, dated June 15, 1982.
- Letter from H. D. Hukill, Director TMI-1, GPU Nuclear to John F. Stolz, Chief Operating Reactors 4. DOL, dated September 7, 1982.
- Letter from H. D. Hukill, Director TMI-1 GPU Nuclear to John F. Stolz, Chief Operating Reactors Br. 4, DOL, dated February 9, 1982.
- Letter from H. D. Hukill, Director TMI-1 GPU Nuclear to John F. Stolz, Chief Operating Reactors Br. 4, DOL, dated May 16, 1983.
- Letter from H. D. Hukill, Director TMI-1 GPU Nuclear to John F. Stolz, Chief Operating Reactors Br. 4, DOL, dated November 22, 1983.
- Letter from H. D. Hukill to J. F. Stolz, "Post Accident Sampling System", dated 12/28/83.
- Memos from G. J. Sadavakos to R. Harding, "NRC Inspection TMI-1 Questions Relating to LM-24B CAPASS", dated 1/20/84.
- Design Verification Record, "Calcuation for Pressure Regulator and Safety-Relief Valve", date 5/20/81.
- Operating Procedure 1104-25, Revision 28, "Instrument and Control Air System", 11/10/83.
- Training Content Record, Revision P, "Emergency Chemistry", dated 1/11/84.
- Memo, "Verification of Purge Time for Sampling", undated.
- Memo from J. D. Abramovici to C. W. Smyth, "TMI-1 Use of Loop and Cold Leg for Post Accident Sampling", dated 6/15/82.
- TMI-1/FSAR, Update-1, Section 11.A, "Post Accident Shielding Evaluation", dated 7/82.

- General Public Utility - Three Mile Island I Emergency Plan Implementing Procedures:

  -- EPIP 1004.15 Change 1, "Post Accident In Plant Sampling", dated January 13, 1984.

  -- EPIP 1004.31, Temporary Change, "Airborne Radioactivity Sampling and Analysis", dated January 18, 1984.

  -- EPIP 1004.33, Revision 4, "Handling High Activity Reactor Coolant Samples; Boron, Chloride, Gas and Gamma spectrum Analysis", dated December 29, 1983.

- SDD-555B, Revision 1, "Post-Accident Sampling Containment Atmosphere, TMI-1, Task LM-24B", dated 9/9/81.

- GPU SDD, 552 Rev. 0, "System Design Description for Post-Accident Reactor Coolant Sampling System, TMI-1, Division I", dated August 1, 1980.

- GPU Design Change Notice No. C-007035, Document TI-13-42033-001, "Post Accident Sampling System", dated April 12, 1983.

- GPU SDD 551B, Rev. 0, "System Design Description for TMI-1 Reactor Coolant Post-Accident Sampling Line Reroutes and Shielding", dated August 14, 1981.

- TDR-183, Revision 2, "Shielding and Exposure Study for Post Accident Sampling", dated 4/21/81.

- TDR-121, Revision 1, "Design Review of Plant Shielding and Radiation Qualification for Post Accident Operations Outside Containment", dated 5/21/80 and Revision 2, dated 10/1/80.

- General Public Utility - Three Mile Island I Emergency Plan Implementing Procedures:

  -- EPIP 1004.15 Change 1, "Post Accident In Plant Sampling", dated January 13, 1984.

  -- EPIP 1004.31, Temporary Change, "Airborne Radioactivity Sampling and Analysis", dated January 18, 1984.

  -- EPIP 1004.33, Revision 4, "Handling High Activity Reactor Coolant Samples; Boron, Chloride, Gas and Gamma spectrum Analysis", dated December 29, 1983.

  -- EPIP 1004.9, Revision 3, "Radiological Controls During Emergencies", dated March 29, 1983.

- General Public Utility - Three Mile Island I Chemistry Procedures:

  -- CP N1990.1, Revision 1, "High Resolution Gamma-Ray Spectroscopy Using Canberra Industries Jupiter System", dated December 22, 1983.

  -- CP N1990, Revision 0, "Electrometric Determination of pH", dated February 22, 1982.

  -- CP N1904, Revision 1, "Boron by Titration", dated March 24, 1983.

  -- CP N1918, Revision 0, "Determination of Boron, Chloride and Sulfate in Water Samples by Ion Chromatography", dated October 17, 1983.

  -- CP N1957, Revision 1, "Determination of Total Gas", December 15, 1983.

- Drawing No. C-302-640, Revision 33, "Decay Heat Removal", dated August 8, 1982.

- Drawing No. C-302-661, Revision 23, "Makeup and Purification", dated March 3, 1983.

- Drawing No. C-302-660, Revision 7, "Makeup and Purifiction", dated August 29, 1978.

- Drawing No. C-302-721, Revision 8, "Hydrogen Purge Discharge and Containment Atmosphere Post Accident Sampling", dated December 6, 1983.

- Drawing No. C-302-671, Revision 25, "Sampling Liquid and Gas", dated May 16, 1983.

- Drawing No. C-302-673, Revision 0, "Post Accident Reactor Coolant Sampling", dated May 16, 1983.

B. NUREG-0737, II.F.1

- Licensee Procedures

  1302-17.1 "TMI Nuclear Power Station Unit No. 1 Surveillance Procedure 1302-17.1 RM-A5, A8 and A9 High Range Calibration", dated August 23, 1983.

  1392-17.2 "TMI Nuclear Power Station Unit No. 1 Surveillance Procedure 1302-17.2 RM-G24 and G25", dated 8/10/83.

1004.7 Three Mile Island Nuclear Station, Unit 1 Emergency Plant Implementing Procedure 1004.7, Off-site/On-site Dose Projections" dated 11/3/83.

1004.31 Three Mile Island Nuclear Station, Unit No. 1 Emergency Plant Implementing Procedure 1004.31 "Airborne Radioactivity Sampling and Analysis", dated September 27, 1983.

"MAP-5 Iodine and Particulate Air Monitors, V-3 and V-4 Models", NRC Industries, no date indicated.

1302-15 "TMI Nuclear Power Station Unit No. 1 Surveillance Procedure 1302-15 High Range RM Containment Monitor Calibration", dated May 12, 1983.

Temporary Change Notice Procedure 1302-14, Rev. 0, "High-range Containment Monitor Calibration", dated July 13, 1983.

- Licensee Design Documents

SDD-661C Rev. 1, "Containment High Range Radiation Monitor TMI-1", January 13, 1984.

GPU SSD 661-C Rev. 0 "System Design Description for High Range Effluent and Iodine Monitor, TMI-1, Division II", dated December 19, 1980.

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- Licensee Correspondence

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- Licensee Memoranda

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From T. M. Hawkins to A. P. Spivak, Tech Functions TWG Representative, "TWG Approval of Test Results" which Enclosure SP 366/4 "Post Accident High Range Containment Purge Monitor (RM-G24) Calibration-Test Results", dated August 16, 1983.

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- NRC Correspondence

  John F. Stolz, Chief Operating Reactors, Br. 4 DOL to Henry D. Hukill, VP GPU Nuclear, dated July 13, 1983.