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TECHNICAL EVALUATION REPORT

CONFORMANCE TO REGULATORY GUIDE 1.97: THREE MILE ISLAND-1

Docket No. 50-289

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ABSTRACT

This EG&G Idaho, Inc., report documents the review of the licensee's submittals for Regulatory Guide 1.97, Revision 3, for Unit No. 1 of the Three Mile Island Nuclear Station and identifies areas of nonconformance to the regulatory guide. Exceptions to Regulatory Guide 1.97 are evaluated, and those areas where sufficient basis for acceptability is not provided are identified.

Docket No. 50-289
TAC No. 51361

FOREWORD

This report is supplied as part of the "Program for Evaluating Licensee/Applicant Conformance to RG 1.97," being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Engineering and System Technology, by EG&G Idaho, Inc., Electrical, Instrumentation, and Control Systems Evaluation Unit.

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1. INTRODUCTION

On December 17, 1982, Generic Letter No. 82-33 (Reference 1) was issued by D. G. Eisenhut, Director of the Division of Licensing, Nuclear Reactor Regulation, to all licensees of operating reactors, applicants for operating licenses, and holders of construction permits. This letter included additional clarification regarding Regulatory Guide 1.97, Revision 2 (Reference 2), relating to the requirements for emergency response capability. These requirements have been published as Supplement No. 1 to NUREG-0737, "TMI Action Plan Requirements" (Reference 3).

GPU Nuclear Corporation, the licensee for the Three Mile Island Nuclear Station, provided a response to Section 6.2 of the generic letter on October 1, 1984 (Reference 4). Additional information was submitted on June 5, 1986 (Reference 5), and additional updated information was submitted on May 7, 1987 (Reference 6). On December 10, 1987, a response to the identified open items was submitted (Reference 7). These responses provide a comparison of the licensee's instrumentation to the recommendations of Revision 3 of Regulatory Guide 1.97 (Reference 8).

This report provides an evaluation of the submitted material.

2. REVIEW REQUIREMENTS

Section 6.2 of NUREG-0737, Supplement No. 1, sets forth the documentation to be submitted in a report to the NRC describing how the licensee complies with Regulatory Guide 1.97 as applied to emergency response facilities. The submittal should include documentation that provides the following information for each variable shown in the applicable table of Regulatory Guide 1.97.

1. Instrument range

2. Environmental qualification

3. Seismic qualification

4. Quality assurance

5. Redundance and sensor location

6. Power supply

7. Location of display

8. Schedule of installation or upgrade

The submittal should identify any deviations from the recommendations of Regulatory Guide 1.97 and should provide supporting justification or alternatives for the deviations identified.

Subsequent to the issuance of the generic letter, the NRC held regional meetings in February and March 1983 to answer licensee and applicant questions and concerns regarding NRC policy on this subject. At these meetings, it was noted that the NRC review would address only exceptions taken to Regulatory Guide 1.97. Where licensees or applicants explicitly state that instrument systems conform to the regulatory guide,

it was noted that no further staff review would be necessary. Therefore, this report addresses only exceptions to Regulatory Guide 1.97. The following evaluation is an audit of the licensee's submittals based on the review policy described in the NRC regional meetings.

3. EVALUATION

The licensee provided a response to Item 6.2 of NRC Generic Letter 82-33 on October 1, 1984. Additional information was submitted on June 5, 1986 and May 7, 1987. On December 10, 1987, a response to the identified open items was submitted. These responses described the licensee's position on post-accident monitoring instrumentation. This evaluation is based on the submitted material.

3.1 Adherence to Regulatory Guide 1.97

The licensee has provided a review of their post-accident monitoring instrumentation that compares the instrumentation characteristics against the recommendations of Regulatory Guide 1.97, Revision 3. The review lists the regulatory guide variables, showing either full compliance, noncompliance with justification, or noncompliance with a commitment and schedule to upgrade. The licensee states that all upgrade modifications are scheduled for completion by the second refueling outage after restart (designated refueling outage 7R). We conclude that the licensee has provided an explicit commitment on conformance to Regulatory Guide 1.97. Exceptions to and deviations from the regulatory guide are noted in Section 3.3.

3.2 Type A Variables

Regulatory Guide 1.97 does not specifically identify Type A variables, i.e., those variables that provide the information required to permit the control room operator to take specific, manually controlled safety actions. The licensee classifies the following instrumentation as Type A.

1. Reactor coolant system (RCS) cold leg water temperature

2. RCS pressure

3. Core exit temperature

4. Degrees of subcooling

5. Containment hydrogen concentration

6. Low pressure injection/decay heat removal system flow

7. Flow in high pressure injection system

8. Refueling water storage tank level

9. Steam generator level

10. Steam generator pressure

11. Auxiliary or emergency feedwater flow

12. Condensate storage tank water level

This instrumentation meets the Category 1 recommendations consistent with the requirements for Type A variables, except as noted in Section 3.3.

3.3 Exceptions to Regulatory Guide 1.97

The licensee identified deviations and exceptions from Regulatory Guide 1.97. These are discussed in the following paragraphs.

3.3.1 Reactor Coolant System (RCS) Soluble Boron Concentration

Regulatory Guide 1.97 recommends on-line instrumentation with a range of zero to 6000 ppm. The licensee has not provided this on-line instrumentation, but can obtain the information by utilizing the post-accident sampling system and on-site laboratory analysis.

The licensee deviates from Regulatory Guide 1.97 with respect to post-accident sampling capability. This deviation goes beyond the scope of this review and is being addressed by the NRC as part of their review of NUREG-0737, Item II.B.3.

3.3.2 RCS Cold Leg Water Temperature

Regulatory Guide 1.97 recommends instrumentation with a range of 50°F to 700°F for this variable. The licensee has supplied instrumentation with a range of 50°F to 650°F. The licensee considers the existing range adequate based on the maximum steam generator pressure of 1200 psig and a corresponding saturation temperature of 600°F. Therefore, the cold leg temperature would always be at or below this value.

Based on the licensee's statement that the instrumentation will remain on scale for any anticipated event, we find the range of this instrumentation acceptable.

3.3.3 RCS Hot Leg Water Temperature

Regulatory Guide 1.97 recommends instrumentation with a range of zero to 700°F for this variable. The licensee has supplied instrumentation with a range of 120°F to 920°F. The licensee states that at temperatures less than 300°F, the plant will be in the decay heat removal mode (i.e., in cold shutdown), and that this temperature is not then required. The decay heat removal system has additional temperature instrumentation to monitor the RCS in this temperature range. Category 1 core exit thermocouples also provide information below 120°F.

Based on the alternate instrumentation and on the justification provided by the licensee, we conclude that the instrumentation supplied for this variable is adequate and, therefore, acceptable.

3.3.4 RCS Pressure

Regulatory Guide 1.97 recommends instrumentation for this variable with a range from zero to 3000 psig. In Reference 4, the licensee states that instrumentation with a range from zero to 2500 psig is provided for this variable. The licensee states that no additional operator action would be taken or performed with an extended range of from 2500 psig to 3000 psig and that the code safety valves on the pressurizer are set to relieve pressure at 2500 psig.

In Reference 5, the licensee states that they will be in compliance with the regulatory guide requirement by refueling outage 7R. We find this commitment acceptable.

3.3.5 Radiation Level in Circulating Primary Coolant

The licensee states that radiation level measurements that indicate fuel cladding failure are provided by the following instruments:

1. Letdown line radiation monitors (during normal operation)

2. Post-accident sampling system

This post-accident sampling system is available with the reactor isolated. This system has been reviewed by the NRC as part of their review of NUREG-0737, Item II.B.3.

Based on the alternate instrumentation provided by the licensee, we conclude that the instrumentation supplied for this variable is adequate and, therefore, acceptable.

3.3.6 RHR Heat Exchanger Outlet Temperature

Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable with a range of 40°F to 350°F, thus environmentally qualified

instrumentation is required in accordance with 10 CFR 50.49. In Reference 4, the licensee states that the existing range of zero to 300°F is sufficient to cover all post-accident conditions, since operation of the decay heat removal system is initiated when the RCS temperature is below 300°F.

Based on the licensee's justification, we find this range adequate to monitor this variable during all accident and post-accident conditions. However, the licensee did not provide justification for the environmental qualification deviation in Reference 4.

In Reference 5, the licensee states that this instrumentation has been incorporated on the TMI-1 environmental qualification master list. We find this acceptable.

3.3.7 Accumulator Tank Level and Pressure

Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable. The licensee has provided Category 3 instrumentation that, except for environmental qualification, is Category 2. The licensee justifies this deviation in Reference 4 by stating that these instruments provide the operator with information pertaining to tank status during normal operation. Since the core flooding system is totally passive, no monitoring of these parameters is required for any manual actions to mitigate the consequences of an accident. Reference 5 restated the licensee's position that Category 3 instrumentation is adequate to monitor this variable.

We conclude that the existing instrumentation is not acceptable. An environmentally qualified instrument is necessary to monitor the status of these tanks. The licensee should designate either level or pressure as the key variable to determine accumulator discharge and should provide instrumentation for the variable that meets the requirements of Regulatory Guide 1.97 and 10 CFR 50.49.

3.3.8 Accumulator Tank Isolation Valve Position

Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable. The licensee states that these are motor operated valves. They are open for reactor operation. The circuit breakers for these valves are open and de-energized when the reactor is critical. Therefore, the licensee recommends that this variable be reclassified as Category 3.

Based on the licensee's justification and on the fact that these valves are open and do not change position during or following an accident, we consider Category 3 instrumentation adequate for this variable.

3.3.9 Boric Acid Charging Flow

The licensee does not have instrumentation for this variable. The licensee states that the charging system is not part of the emergency core cooling system (ECCS). The flow paths of the ECCS that are monitored are high pressure injection and low pressure injection. Therefore, we find that this variable is not applicable at the Three Mile Island Station.

3.3.10 Pressurizer Level

Regulatory Guide 1.97 recommends Category 1 instrumentation for this variable. In Reference 5, the licensee considers pressurizer level instrumentation to be Category 2. The licensee has not met the environmental qualification requirement for the temperature compensation elements.

The justification provided by the licensee in Reference 5 for the Category 1 deviation was that the pressurizer level is used only to indicate to the operator that throttling of the high pressure injection flow is allowed. Therefore, the licensee's position was that the pressurizer level is an indication of system operating status, not a key variable.

In Reference 7 the licensee no longer identifies pressurizer level instrumentation as Category 2, and states that pressurizer level is no longer utilized for HPI throttling. The licensee further states in Reference 7 that all four pressurizer level transmitters are environmentally qualified and that the RTD elements used for temperature compensation will be environmentally qualified prior to startup following the cycle 7 refueling outage.

Based on the commitment to qualify the temperature compensation elements and on the detailed discription of the pressurizer level monitoring system provided in Reference 7, we conclude that the pressurizer level instrumentation is acceptable.

3.3.11 Pressurizer Heater Status

Regulatory Guide 1.97 recommends instrumentation to monitor the current drawn by the pressurizer heaters. The licensee's instrumentation consists of on/off indication of the pressurizer heaters. In Reference 4, the licensee stated that this was sufficient indication when used in conjunction with RCS pressure.

Section II.E.3.1 of NUREG-0737 requires a number of the pressurizer heaters to have the capability of being powered by the emergency power sources. Instrumentation is to be provided to prevent overloading a diesel generator.

In Reference 5, the licensee maintained the position that an on-off indication is adequate to monitor this variable. The licensee stated that the most direct and effective measure of heater performance is the response of reactor coolant pressure. The licensee further stated that diesel generator current can be monitored with the diesel generator ammeters. This enables the operator to determine (based on the known power consumption of the heaters) whether the heaters can be energized without overloading the diesel generators.

In Reference 7, the licensee has committed to the addition of qualified pressurizer temperature instrumentation that will be displayed in the control room. Indication of pressurizer temperature provides another indication of heater function in addition to RCS pressure and the on/off indication of breaker status and diesel generator current.

Based on the addition of the pressurizer temperature indication and on the ability to monitor the heater bank current on the diesel generator ammeters in the control room, we find the instrumentation provided for this variable to be acceptable.

3.1.12 Quench Tank Temperature

Regulatory Guide 1.97 recommends instrumentation for this variable with a range from 50°F to 750°F. The installed instrumentation has a range of zero to 275°F. The licensee states that the tank is isolated with a reactor trip and that the existing temperature range is adequate to detect leakage into the tank.

In Reference 5, the licensee states that a relief valve set at 40 psig (saturation temperature 287°F) and a rupture disc set at 55 psig (saturation temperature 308°F) are installed on the tank. This means that for a short period of time the temperature of the tank could be above the existing range. The licensee has committed to providing the capability to monitor the complete range of postulated temperatures by refueling outage 7R. We find this commitment acceptable.

3.3.13 Steam Generator Level

Regulatory Guide 1.97 recommends instrumentation for this variable with a range that monitors the steam generator level from the tube sheet to the separators. In Reference 5, the licensee indicated compliance to the level recommendation, adding additional clarification in Reference 6. The clarification states that the TMI-1 steam generator is a once-through design; thus, the area of heat exchange would be described as tube sheet

to tube sheet. The licensee has redundant, Category 1 full range level indicators on each steam generator with a range of zero to 640 inches. The instrument zero is actually 6 inches above the lower tube sheet. Should the water level reach this level, the steam generator would be essentially dry. Therefore, we find the lower tap location acceptable.

The licensee further states that their analyses shows that the range of interest during design basis accidents is up to the aspirating port (376 inches above the lower tube sheet). Reference 6 identifies the installation of recorder LR1046/LR1054 in the control room for the steam generator level. This recorder records the "start-up" range level of each steam generator (i.e., zero to 388 inches) and is stated to cover the range of interest for design basis accidents. As this range includes the aspirating port, we find the range acceptable.

Based on the justification provided by the licensee that the instrumentation will remain on scale and functional for the analyzed transients and accidents, we find the range provided acceptable.

3.3.14 Safety/Relief Valve Positions or Main Steam Flow

Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable. The licensee has provided Category 3 instrumentation. The licensee states that Category 3 instrumentation is acceptable for this variable, because they consider steam generator (SG) level and pressure to be the key variables used in determining the SG safety/relief valve position or main steam flow. Valve position indication is provided as backup instrumentation.

The licensee considers the valve position indication to be a backup for the Category 1 steam generator level and pressure instrumentation. As the regulatory guide allows backup instrumentation to be Category 3, we find this deviation acceptable.

3.3.15 Containment Spray Flow

Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable. The licensee has provided instrumentation that, except for environmental qualification, is Category 2. The licensee did not submit justification for the environmental qualification deviation in Reference 4.

In Reference 5, the licensee states that this instrumentation has been incorporated in the TMI-1 environmental qualification master list. We find this acceptable.

3.3.16 Heat Removal by the Containment Fan Heat Removal System

Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable to provide indication that the reactor building cooling system is performing its design objective. In Reference 5, the licensee committed to installing Category 2 instrumentation for this variable. In Reference 6, the licensee re-evaluated the instrumentation provided for this variable and determined that containment pressure is the key variable for this function, with other indications for this variable used for backup instrumentation. The Category 3 instrumentation used for backup at TMI-1 includes indication of river water pump motor breaker status and reactor building fan motor contractor status, indication of each reactor building emergency cooling coil outlet pressure, and annunciation of leak detection for each reactor building emergency cooling coil.

In Reference 7, the licensee indicates that the above mentioned backup instrumentation is Category 2, not Category 3 as previously stated. In addition, Reference 7 states that fan cooler flow, fan cooler outlet temperature, and river water temperature are available to the operators in an accessible area outside of the control room. If the control room indications suggest that the fan coolers are not operating, a more detailed evaluation of the system could be performed using the information provided by these accessible instruments.

Based on the additional information provided in Reference 7, we conclude that the means of monitoring heat removal by the containment fan heat removal system is acceptable.

3.3.17 Containment Atmosphere Temperature

Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable with a range from 40°F to 400°F. The licensee has supplied Category 3 instrumentation with a range of zero to 300°F. Their justification for this deviation is that the primary variable required to show accident mitigation and containment integrity is reactor building pressure, a Category 1 variable. The licensee considers the containment atmosphere temperature to be a Category 3 variable.

The key variable used by the licensee for reactor building monitoring is reactor building pressure, which is monitored by Category 1 instrumentation. The reactor building atmosphere temperature is a backup variable for reactor building accident monitoring, and is measured by Category 3 instrumentation.

We find that the licensee's application of Category 3 backup instrumentation is in accordance with the regulatory guide.

The licensee states that the zero to 300°F containment temperature indicators monitor the entire spectrum of containment temperature transients as analyzed in the Final Safety Analysis Report (FSAR).

Based on this justification, we find that the existing range is adequate to monitor this variable during all accident and post-accident conditions.

3.3.18 Containment Sump Water Temperature

Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable. The licensee has supplied instrumentation that, except for

environmental qualification, is Category 2. In Reference 4, the licensee states that the minimum available net positive suction head for the decay heat removal pump is independent of sump temperature, and no automatic or manual actions are initiated based on this temperature. No additional justification was provided by Reference 5.

The temperature of the sump water is useful to the operator in determining the amount of containment heat removed during recirculation. Therefore, an environmentally qualified means of determining the containment sump water temperature should be provided by the licensee.

3.3.19 Letdown Flow-Out

Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable. The licensee does not consider this variable to be a post-accident Category 2 instrument, and has supplied Category 3 instrumentation. The licensee states that this variable is not required in the mitigation of an accident and that the letdown system is isolated by any accident requiring containment isolation.

As this variable is not utilized in conjunction with a safety system, we find that the instrumentation provided for this variable is acceptable.

3.3.20 Component Cooling Water Temperature to Engineered Safety Feature (ESF) System

Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable. The licensee is supplying instrumentation that, except for environmental qualification, is Category 2. The licensee states that the decay heat removal heat exchanger outlet temperature provides an adequate measure of the decay heat removal closed cooling water system heat removal capability.

In Reference 5, the licensee states that this instrumentation is not located in a harsh environment; therefore, qualification to the requirements of 10 CFR 50.49 is not required. We find this instrumentation acceptable.

3.3.21 Component Cooling Water Flow to ESF System

Regulatory Guide 1.97 recommends Category 2 flow instrumentation for this variable. The licensee does not have instrumentation for this variable. The licensee justified this exception in Reference 4 by stating that, since all component cooling water valves for the decay heat removal and nuclear services closed-cycle cooling water systems are manually operated, and are normally open, pump status and system temperature is sufficient indication of system operation.

In Reference 5, the licensee provided information on the availability of pump discharge pressure indication and low flow alarms in the control room, in addition to pump status and temperature indication. We conclude that the intent of Regulatory Guide 1.97 is met with the instrumentation provided. Therefore, we find this deviation acceptable.

3.3.22 Radioactive Gas Holdup Tank Pressure

Regulatory Guide 1.97 recommends control room instrumentation for this variable with a range of zero to 150 percent of design pressure. The licensee has local indication only. The licensee states that the design pressure for these tanks is 150 psig. When the pressure reaches 82 psig, it initiates a local high pressure alarm. Also, the pressure can be indicated on a local indicator on demand. At 85 psig, the relief valve opens and discharges to the auxiliary building, where it will be detected and indicated by the auxiliary building radiation monitor. In addition, when the relief valve opens, it will annunciate in the common problem panel in the control room.

In Reference 4, the licensee did not state what the range of the local indicator is nor did the licensee state that the instrumentation is accessible post-accident. In Reference 5, the licensee states that the range of the local instrument is zero to 100 psig, which is adequate to monitor the tank pressure. The licensee also stated that local indication is available on the radioactive waste control panel, which is accessible after an accident. We find this acceptable.

3.3.23 Status of Standby Power and Other Energy Sources Important to Safety

Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable. The licensee has provided instrument air instrumentation that, except for environmental qualification, is Category 2.

In Reference 5, the licensee states that this instrumentation is not located in a harsh environment, therefore, qualification to the requirements of 10 CFR 50.49 is not required. We find this acceptable.

3.3.24 Vent from Steam Generator Safety Relief Valves or Atmospheric Dump Valves

The instrumentation provided for this variable has a range of 3.96×10^{-2} µCi/cc to 980 µCi/cc. Regulatory Guide 1.97 recommends 10^{-1} µCi/cc to 10^{3} µCi/cc. The existing range does not envelop the upper end of the recommended range, and deviates from the recommended range by 20 µCi/cc. However, the range suitably provides the necessary accident and post-accident information. Therefore, this is an acceptable deviation from Regulatory Guide 1.97.

4. CONCLUSIONS

Based on our review, we find that the licensee either conforms to or is justified in deviating from Regulatory Guide 1.97, with the following exceptions:

1. Accumulator tank level and pressure--the licensee should provide a level or pressure instrument for this variable that is environmentally qualified and installed in accordance with Regulatory Guide 1.97 and 10 CFR 50.49 (Section 3.3.7).

2. Containment sump water temperature--the licensee should identify an environmentally qualified means of monitoring this variable (Section 3.3.18).

5. REFERENCES

1. NRC letter, D. G. Eisenhut to All Licensees of Operating Reactors, Applicants for Operating Licenses, and Holders of Construction Permits, "Supplement No. 1 to NUREG-0737--Requirements for Emergency Response Capability (Generic Letter No. 82-33)," December 17, 1982.

2. Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident, Regulatory Guide 1.97, Revision 2, NRC, Office of Standards Development, December 1980.

3. Clarification of TMI Action Plan Requirements, Requirements for Emergency Response Capability, NUREG-0737 Supplement No. 1, NRC, Office of Nuclear Reactor Regulation, January 1983.

4. Letter, GPU Nuclear Corporation (H. D. Hukill) to NRC (Office of Nuclear Reactor Regulation), October 1, 1984, Serial No. 5211-84-2252

5. Letter, GPU Nuclear Corporation (H. D. Hukill) to NRC (Office of Nuclear Reactor Regulation), "Emergency Response Capability-Conformance to Regulatory Guide 1.97," June 5, 1986, 5211-86-2097.

6. Letter, GPU Nuclear Corporation (H. D. Hukill) to NRC (Office of Nuclear Reactor Regulation), "Emergency Response Capability-Conformance to Regulatory Guide 1.97," May 7, 1987, 5211-87-2087.

7. Letter, GPU Nuclear Corporation, (H. D. Hukill) to NRC (Office of Nuclear Reactor Regulation), "Regulatory Guide 1.97 Safety Evaluation Report Open Items," December 10, 1987.

8. Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident, Regulatory Guide 1.97, Revision 3, NRC, Office of Nuclear Regulatory Research, May 1983.

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This EG&G Idaho, Inc., report reviews the submittals for Three Mile Island, Unit No. 1, and identifies areas of nonconformance to Regulatory Guide 1.97. Exceptions to these guidelines are evaluated and those areas where sufficient basis for acceptability is not provided are identified.

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