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

SAFETY EVALUATION REPORT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

NORTHEAST NUCLEAR ENERGY COMPANY

MILLSTONE NUCLEAR POWER STATION UNIT NO. 2

DOCKET NO. 50-336

CONFORMANCE TO REGULATORY GUIDE 1.97

1.0 INTRODUCTION

Northeast Nuclear Energy Company was requested by Generic Letter 82-33 to provide a report to NRC describing how the post-accident monitoring instrumentation meets the guidelines of Regulatory Guide (R.G.) 1.97 as applied to emergency response facilities. The licensee responded to Item 6.2 of the generic letter on April 15, 1983. Additional information was provided by letters dated February 29, 1984, April 9, 1984, August 7, 1986, June 15, 1987, June 20, 1988, and January 11, 1990.

A detailed review and technical evaluation of the licensee's submittals was performed by EG&G Idaho, Inc., under a contract to the NRC, with general supervision by the NRC staff. This work was reported by EG&G in Technical Evaluation Report (TER), "Conformance to Regulatory Guide 1.97: Millstone-2," dated August 1990 (attached). We have reviewed this report and concur with the conclusions, except for the conclusion concerning wide range steam generator level. For the remaining items we agree with EG&G's conclusion that the licensee either conforms to, or has adequately justified deviations from, the guidance of R.G. 1.97 for each post-accident monitoring variable except for the variables accumulator tank level and pressure, containment sump water temperature, and component cooling water (CCW) temperature to engineered safety features (ESF) system.

2.0 EVALUATION CRITERIA

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 the NRC policy on R.G. 1.97. At these meetings, it was established that the NRC review would only address exceptions taken to the guidance of R.G. 1.97. Further, where licensees or applicants explicitly state that instrument systems conform to provisions of the regulatory guide, no further staff review would be necessary for those items. Therefore, the review performed and reported by EG&G only addresses exceptions to the guidance of R.G. 1.97. This Safety Evaluation addresses the licensee's submittals based on the review policy described in the NRC regional meetings and the conclusions of the review as reported by EG&G.

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3.0 EVALUATION

We have reviewed the evaluation performed by EG&G contained in the attached TER and concur with its bases and findings, except for the findings contained in TER Sections 3.3.1d and 3.3.16 concerning (a) accumulator tank level and pressure, and (d) wide range steam generator level, respectively. For the remaining items, we agree with EG&G's findings that the licensee conforms to, or has provided an acceptable justification for deviations from the guidance of R.G. 1.97 for each post-accident monitoring variable, except for the variables (b) containment sump water temperature and (c) CCW temperature to ESF system.

a) In TER Section 3.3.1d, EG&G concluded that for the variable accumulator tank level and pressure, the licensee should designate either level or pressure as the key variable to indicate accumulator discharge and provide instrumentation for that variable that meets the requirements of 10 CFR 50.49. The staff, however, is currently generically reviewing the need for environmentally qualified Category 2 instrumentation to monitor accumulator tank level and pressure. We will therefore report on the acceptability of this item when the generic review is complete.

b) R.G. 1.97 recommends Category 2 containment sump water temperature instrumentation to monitor the operation of the containment cooling system. The licensee has not provided any instrumentation to monitor the containment sump water temperature. The licensee's justification for not providing this instrumentation is that containment sump water temperature instrumentation serves no safety function and an adequate net positive suction head exists for the high pressure safety injection pumps in the recirculation mode.

   The licensee's justification did not address the need to monitor the containment cooling system operation. The staff finds this justification inadequate. Therefore, the licensee should provide containment sump water temperature instrumentation that meets the Category 2 criteria of R.G. 1.97.

c) R.G. 1.97 recommends Category 2 CCW temperature to ESF system instrumentation to monitor the operation of the cooling water system. The licensee has provided instrumentation which conforms to the Category 2 recommendations of R.G. 1.97 except for environmental qualification. The justification provided by the licensee is that instrument failure does not affect system operation and that emergency operating procedures do not specify any actions based on these signals.

   The licensee's justification did not address the maximum CCW temperature during events described in the justification and whether these temperatures might exceed the design limits of the ESF system components. The staff finds this justification inadequate. Therefore, the licensee should provide CCW temperature to ESF system instrumentation that is environmentally qualified in accordance with the provisions of 10 CFR 50.49 and R.G. 1.97.

d) R.G. 1.97 recommends Category 1 wide range steam generator level instrumentation, with a range from the tube sheet to the separators, to monitor the operation of the steam generators. The instrumentation provided by the licensee has a range from the top of the tube bundles to the separators. Thus, the length of the tube bundles is not measured.

The licensee has committed to install Category 1 wide range steam generator level instrumentation if the steam generators are replaced. On May 11, 1990, at a meeting with the staff, the licensee committed to replacing the steam generators in 1992. Therefore, since the licensee has committed to replace the steam generators, the licensee's commitment to install wide range steam generator level instrumentation that meets the Category 1 criteria of R.G. 1.97 is acceptable.

4.0 CONCLUSION

Based on the staff's review of the enclosed TER and the licensee's submittals, we find that the Millstone Nuclear Power Station Unit No. 2 design is acceptable with respect to conformance to R.G. 1.97, Revision 2, except for the instrumentation associated with the variables (a) accumulator tank level and pressure, (b) containment sump water temperature, and (c) CCW temperature to ESF system.

a) The acceptability of instrumentation for accumulator tank level and pressure will remain open pending the outcome of the staff's review of the need for environmentally qualified instrumentation to monitor this variable. The staff's conclusion will be reported when the generic review is complete.

b) It is the staff's position that information on the containment sump water temperature is valuable to the operator in the evaluation of proper containment cooling system operation. It is also the staff's position that the licensee shall provide containment sump water temperature instrumentation that meets the Category 2 criteria of R.G. 1.97.

c) It is the staff's position that information on the CCW temperature to ESF system is valuable to the operator in the evaluation of proper cooling water system operation. It is also the staff's position that the licensee shall provide CCW temperature to ESF system instrumentation that is environmentally qualified in accordance with the provisions of 10 CFR 50.49 and R.G. 1.97.

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Idaho
National
Engineering
Laboratory

Managed
by the U.S.
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TECHNICAL EVALUATION REPORT

CONFORMANCE TO REGULATORY GUIDE 1.97: MILLSTONE-2

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EG&G Idaho

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TECHNICAL EVALUATION REPORT

CONFORMANCE TO REGULATORY GUIDE 1.97: MILLSTONE-2

Docket No. 50-336

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SUMMARY

This EG&G Idaho, Inc., report documents the review of the Regulatory Guide 1.97, Revision 2, submittals for Unit No. 2 of the Millstone Nuclear Power Station. This report, as part of this review, 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.

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PREFACE

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 Systems Technology, by EG&G Idaho, Inc., Regulatory and Technical Assistance Unit.

CONTENTS

CONFORMANCE TO REGULATORY GUIDE 1.97: MILLSTONE-2

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).

Northeast Nuclear Energy Company, the licensee for Unit 2 of the Millstone Nuclear Power Station, provided a response to the generic letter on April 15, 1983 (Reference 4). The response to Section 6.2 of the generic letter was submitted on February 29, 1984 (Reference 5), and revised on April 9, 1984 (Reference 6). Additional information was provided on August 7, 1986 (Reference 7), June 15, 1987 (Reference 8), June 20, 1988 (Reference 9), and January 11, 1990 (Reference 10).

This report compares the instrumentation proposed by the licensee's submittals with the recommendations of Regulatory Guide 1.97, Revision 2.

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 documentation should provide 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 submittals should identify any deviations taken from the regulatory guide recommendations and provide supporting justification or alternatives for the deviations identified.

Subsequent to issuing the generic letter, the NRC held regional meetings, in February and March 1983, to answer licensee and applicant questions and concerns regarding the 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. It was also noted that when licensees or applicants explicitly state that instrument systems conform to the regulatory guide, no further staff review would be necessary. Therefore, this report addresses only those exceptions to Regulatory Guide 1.97 that have been identified by the licensee. 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 responded to Item 6.2 of NRC Generic Letter 82-33 on February 29, 1984. The licensee revised the response on April 9, 1984. The response describes the licensee's position on post-accident monitoring instrumentation. This evaluation is based on the April 9, 1984 submittal, on Revision 2 of Regulatory Guide 1.97, and on the additional information provided on August 7, 1986, June 15, 1987, June 20, 1988, and January 11, 1990.

3.1 Adherence to Regulatory Guide 1.97

The licensee reviewed their post-accident monitoring instrumentation, comparing the instrumentation characteristics against the recommendations of Regulatory Guide 1.97, Revision 2. The licensee states that in several instances, satisfactory instrumentation exists. The licensee also committed to install additional instrumentation to comply with provisions of Regulatory Guide 1.97, except those instances where deviations are justified. In Reference 7, the licensee states that all identified modifications were complete by December 31, 1985. Therefore, 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. pressurizer level

2. pressurizer pressure

3. reactor coolant system (RCS) hot leg water temperature

4. RCS cold leg water temperature

5. steam generator pressure

6. steam generator level -- narrow-range

7. auxiliary feedwater flow

8. containment pressure

9. degrees of subcooling

10. containment hydrogen concentration

11. containment radiation

These variables, with exceptions as noted in Section 3.3, either meet or were upgraded to meet the Category 1 recommendations consistent with the requirements for Type A variables.

3.3 Exceptions to Regulatory Guide 1.97

The licensee identified deviations and exceptions to Regulatory Guide 1.97. The following paragraphs discuss these deviations and exceptions.

3.3.1 Environmental Qualification

In the licensee's submittals, the following Category 2 variables did not identify environmentally qualified instrumentation. The justifications listed below are from References 7, 8, 9, and 10.

a. Containment sump water level -- Narrow-range -- The licensee uses this instrumentation for normal operation. The sump is small (approximately 1000 gallons), and would fill quickly following an accident. The sump contents are not transferred outside containment following an accident. This is to prevent the transferring of contaminated water outside of the containment. The environmentally qualified wide-range instrumentation records the sump level. The operators use the wide-range instruments in post-accident situations. Based on this, we find the provided instrumentation acceptable.

b. Residual heat removal (RHR) system flow -- The licensee states that the failure of this instrumentation does not cause non-operability of the RHR system. The RHR system valves are prepositioned. The operator has pump motor current indication (located in a mild environment) available to show system operation. Normal RHR system operation indicates 20 amperes on a 100 ampere scale.

The shutdown cooling mode of RHR operation does not involve a harsh environment. The reactor coolant system is below 300 psia and less than 300°F when entering this mode of operation. No radiation field is present.

More than 40 minutes after the accident occurs, RHR recirculation starts. The RHR flow instrumentation is in a mild environment except for a potentially harsh radiation field. Radiation induced thermal fluence caused by x-rays can damage unprotected semiconductors. Gamma rays cause transient ionizing radiation which affects the p-n junction in semiconductors. The total ionizing dose creates excess charge carriers, which change semiconductor characteristics. Thus, a harsh radiation field will cause deterioration or failure of the exposed instrumentation. We are unable to predict whether the licensee's instrumentation is subject to sudden failure or a gradual change in operating characteristics due to the radiation environment.

The licensee states that this instrumentation is not a direct measure of heat removal nor is it used to meet a critical safety function. Incore thermocouples and RCS loop temperature instrumentation determine these functions.

The licensee's instrumentation is acceptable in the initial phases of an accident. The licensee considers the RHR flow instrumentation as a backup to the Category 2 RHR pump motor current instrumentation for system operation, and to the Category 1 incore thermocouples and loop coolant (hot leg and cold leg) water temperature.

Because of this diversity, alternate instrumentation, and a mild environment that extends into the accident timeframe, we find the provided instrumentation acceptable for this variable.

c. RHR heat exchanger outlet temperature -- The licensee states that environmental qualification for this instrumentation is not necessary. The licensee states that the Category 1 incore thermocouples monitor the core heat removal.

The licensee states that the resistance temperature detector (RTD) in question monitors the water temperature of the common line on the outlet side of the RHR heat exchangers during the shutdown cooling mode of RHR operation. This requires the manual alignment of the RHR system. In this mode of operation, the instrumentation is in a mild environment. The licensee also states that, following an accident, there is no safety injection flow directed past the RTD for this variable. Thus, the indication has no meaning under these condition.

Based on the described design and operation, we find the provided instrumentation acceptable for this variable.

d. Accumulator tank level and pressure -- The licensee states that this instrumentation is less important after an accident than during normal operation. The licensee states that 20 seconds after a large break accident, the accumulators would be empty. The licensee states that this instrumentation is for readout only, because the system is passive and functions automatically early in the accident sequence. The licensee states that no automatic functions or operator actions are based on this instrumentation. We find this justification unacceptable. An environmentally qualified instrument is necessary to monitor the status of these tanks, to determine whether discharge has occurred, and to help evaluate the extent of the accident. The licensee should designate either level or pressure as the key variable to indicate accumulator discharge and provide instrumentation for that variable that meets the requirements of 10 CFR 50.49.

e. High pressure injection system flow -- The licensee states that the failure of this instrumentation does not cause non-operability of the system. The operator has the Category 2 pump motor current indication (located in a mild environment) available to show system operation. Normal system operation indicates 20 amperes on a 100 ampere scale.

The licensee states that a transmitter is located on each of four injection lines. The instrumentation is all outside of containment. Only the transmitters are in a potentially harsh environment. A harsh environment results from 1) a steamline break outside of containment, or 2) the recirculation phase following a loss of coolant accident. In the first instance, temperature and pressure effects occur. In the second instance, a potentially harsh radiation field occurs.

The licensee verifies the adequacy of core cooling with the core exit thermocouples, RCS subcooling monitor, reactor vessel water level, and steam generator parameters. These are all Category 1 instruments. Thus, this flow instrumentation is backup instrumentation to verify core cooling.

The licensee states that because a steamline break will not result in uncovering the core, recovery from this event does not require this instrumentation.

In the accident recovery, the licensee enters the recirculation phase of injection more than forty minutes after the accident. This results in a potential radiation field for the transmitters.

Radiation induced thermal fluence caused by x-rays can damage unprotected semiconductors. Gamma rays cause transient ionizing radiation which affects the p-n junction in semiconductors. The total ionizing dose creates excess charge carriers, which change semiconductor characteristics. Thus, a harsh radiation field will cause deterioration or failure of the exposed instrumentation. We are unable to predict whether the licensee's instrumentation is subject to sudden failure or a gradual change in operating characteristics due to the radiation environment.

The licensee states that failure of the transmitters has no direct effect on the mitigation of an accident. If the indicated rate is less than required for mitigation, the operators check pumps, valves, and electric power for proper lineup and power availability. This situation will not aggravate the accident mitigation. If the indicated rate is higher then required for mitigation, yet the actual flow is less than required, the licensee states that no adverse consequences result. This is because the Category 1 instrumentation used to verify the adequacy of core cooling have a higher priority in implementing additional functional recovery actions.

We note the following.

1. The licensee has alternate instrumentation to verify system operation.

2. The licensee has alternate instrumentation to verify the continued adequacy of core cooling.

3. A steamline break, while causing a harsh environment, does not require the use of this instrumentation in recovery from the event.

4. Initial safety injection does not create a harsh environment for this instrumentation.

5. When a harsh radiation environment occurs during the recirculation phase of injection, the licensee can continue observing the adequacy of core cooling by the use of additional instrumentation.

Thus, we find the provided instrumentation acceptable.

f. Low pressure injection system flow -- The licensee states that the failure of this instrumentation does not cause non-operability of the system. The operator has the Category 2 pump motor current indication (located in a mild environment) available to show system operation. Normal system operation indicates 20 amperes on a 100 ampere scale.

The licensee states that a transmitter is located on each of four injection lines. The instrument is all outside of containment. Only the transmitters are in a potentially harsh environment. A harsh environment results from 1) a steamline break outside of containment, or 2) the recirculation phase following a loss of coolant accident. In the first instance, temperature and pressure effects occur. In the second instance, a potentially harsh radiation field occurs.

The licensee verifies the adequacy of core cooling with the core exit thermocouples, RCS subcooling monitor, reactor vessel water level, and steam generator parameters. These are all Category 1 instruments. Thus, this flow instrumentation is backup instrumentation to verify core cooling.

The licensee states that because a steamline break will not result in uncovering the core, recovery from this event does not require this instrumentation.

In the accident recovery, the licensee enters the recirculation phase of injection more than forty minutes after the accident This results in a potential radiation field for the transmitters.

Radiation induced thermal fluence caused by x-rays can damage unprotected semiconductors. Gamma rays cause transient ionizing radiation which affects the p-n junction in semiconductors. The total ionizing dose creates excess charge carriers, which change semiconductor characteristics. Thus, a harsh radiation field will cause deterioration or failure of the exposed instrumentation. We are unable to predict whether the licensee's instrumentation is subject to sudden failure or a gradual change in operating characteristics due to the radiation environment.

The licensee states that failure of the transmitters has no direct effect on the mitigation of an accident. If the indicated rate is less than required for mitigation, the operators check pumps, valves, and electric power for proper lineup and power availability. This situation will not aggravate the accident mitigation. If the indicated rate is higher then required for mitigation, yet the actual flow is less than required, the licensee states that no adverse consequences result. This is because the Category 1 instrumentation used to verify the adequacy of core cooling have a higher priority in implementing additional functional recovery actions.

We note the following.

1. The licensee has alternate instrumentation to verify system operation.

2. The licensee has alternate instrumentation to verify the continued adequacy of core cooling.

3. A steamline break, while causing a harsh environment, does not require the use of this instrumentation in recovery from the event.

4. Initial safety injection does not create a harsh environment for this instrumentation.

5. When a harsh radiation environment occurs during the recirculation phase of injection, the licensee can continue observing the adequacy of core cooling by the use of additional instrumentation.

Thus, we find the provided instrumentation acceptable.

g. Containment spray flow -- The licensee states that the failure of this instrumentation does not cause non-operability of the system nor will it cause the operator to take an incorrect action. All system valves are prepositioned. The operator has the pump motor current indicator (located in a mild environment) to show system operation. Normal system operation indicates 20 amperes on a 100 ampere scale. There is one transmitter for each containment spray line. The transmitters are outside the containment. The licensee uses the containment spray in response to an event (loss of coolant accident or main steamline break [MSLB]) inside containment. The transmitters are in a harsh environment if a MSLB occurs outside of containment. Therefore, environmental qualification is not necessary if a MSLB occurs outside of containment.

Containment spray starts when the containment pressure reaches 27 psig and terminated when the containment pressure is reduced to less than 10 psig. In the injection phase of operation, which lasts greater than 40 minutes, there is no environmental effect on the containment spray transmitters. When the recirculation phase begins, a potentially harsh radiation field results from the recirculation of sump contents. However, the containment pressure has already peaked (at approximately 4 minutes into the accident).

Radiation induced thermal fluence caused by x-rays can damage unprotected semiconductors. Gamma rays cause transient ionizing radiation which affects the p-n junction in semiconductors. The total ionizing dose creates excess charge carriers, which change semiconductor characteristics. Thus, a harsh radiation field will cause deterioration or failure of the exposed instrumentation. We are unable to predict whether the licensee's instrumentation is subject to sudden failure or a gradual change in operating characteristics due to the radiation environment.

The licensee states that the containment spray flow rate is not critical during recirculation. This is because a significant reduction of heat load has already occurred and the containment air recirculation coolers are also operating to reduce the containment pressure. Category 1 containment pressure instrumentation monitors the effectiveness of the containment spray and the containment air recirculation coolers. The licensee states that the flow rate does not impact any operating criteria.

We note the following.

1. The licensee has alternate instrumentation to verify system operation.

2. During the initial injection phase, this instrumentation is in a mild environment.

3. The heat load that the containment spray must control is much less during recirculation when a harsh environment occurs for this instrumentation, than during the initial injection phase.

4. The licensee uses containment pressure instrumentation to verify continued effectiveness of the containment spray and containment air recirculation coolers.

Thus, we find the provided instrumentation acceptable.

h. Containment atmosphere temperature -- The licensee states that this instrumentation is for diagnostic purposes only. The licensee defines the containment pressure as the key variable for monitoring containment conditions. Containment pressure has Category 1 instrumentation. Containment atmosphere temperature is a backup for containment accident monitoring. Based on the licensee's justification, we find the application of Category 3 backup instrumentation acceptable under the regulatory guide recommendations.

i. Makeup flow-in -- The licensee states that the Category 3 charging system pressure instrumentation can supplement the makeup flow instrumentation. Additionally, the charging pumps are positive displacement. Each pump motor has operation indicated. When operating, each pump pumps 44 gallons per minute. We find this instrumentation with positive displacement pumps acceptable for post-accident monitoring instrumentation.

j. Letdown flow-out -- Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable. Category 2 criteria include environmental qualification. The licensee states that response to accident conditions does not require this instrumentation. The licensee states, in Reference 10, that the letdown line isolates automatically by either a safety injection actuation signal or a containment isolation actuation signal in response to an accident. Thus, there is not letdown flow in post-accident recovery.

As an accident signal isolates letdown, and no letdown flow occurs post-accident, we find the instrumentation provided acceptable.

k. Volume control tank level -- The licensee states that this tank isolates by a safety injection actuation signal. As this tank is not used with a safety-system, we find the instrumentation provided acceptable.

l. Component cooling water temperature to ESF system -- The reactor building component cooling water (RBCCW) system has three temperature sensors. These sensors are downstream of the RBCCW heat exchangers (one sensor per heat exchanger) in the auxiliary building. The instrumentation for this variable is in a mild environment except two instances. First, when the recirculation mode of operation starts, the sensors, while still in a normal pressure and temperature environment, could have exposure to a radiation field. Temperature sensors, either thermocouples or resistance temperature detectors, do not degrade rapidly in a radiation field as do semiconductor devices. The licensee states that instrument failure does not affect system operation and that emergency operating procedures do not specify any actions based on these signals.

Second, a steamline break outside containment could expose these temperature sensors to elevated temperatures. The sensors would observe and respond to the temperature increase. The operator has other indications for steamline breaks and the RBCCW temperature is not one of them. Again, this instrumentation is not the basis for operator action.

Based on the described events, Category 3 instrumentation could be allowed, provided the licensee shows an analysis of the RBCCW temperature. The analysis should show what the maximum RBCCW temperature will be and if it might exceed the design limits of the engineered safety features (ESF) system components. However, without the analysis, we do not know if the ESF components can operate within their design limits for the duration of the accident recovery. Therefore, we conclude that the licensee should environmentally qualify this instrumentation. The licensee should provide instrumentation that is environmentally qualified under the provisions of 10 CFR 50.49 and Regulatory Guide 1.97 for the variable CCW temperature to ESF system.

m. Component cooling water flow to ESF system -- The licensee states that failure of this instrumentation does not cause non-operability of the system. All system valves are prepositioned. The licensee can verify system operation by observing the pump motor current (located in a mild environment). Normal system operation indicates 40 amperes on a 100 ampere scale.

Two flow sensors monitor the RBCCW flow. These transmitters are downstream of the RBCCW heat exchangers (one transmitter per RBCCW header) in the auxiliary building. The instrumentation for this variable is in a mild environment except two instances. First, when the recirculation mode of operations starts, the transmitters, while still in a normal pressure and temperature environment, could experience a radiation field. Radiation induced thermal fluence caused by x-rays can damage unprotected semiconductors. Gamma rays cause transient ionizing radiation which affects the p-n junction in semiconductors. The total ionizing dose creates excess charge carriers, which change semiconductor characteristics. Thus, a harsh radiation field will cause deterioration or failure of the exposed instrumentation. We are unable to predict whether the licensee's instrumentation is subject to sudden failure or a gradual change in operating characteristics due to the radiation environment. The licensee states that instrument failure does not affect system operation and that emergency operating procedures do not specify any action based on these signals.

Second, a steamline break outside containment could expose these flow transmitters to elevated temperatures. The licensee has not described the effect of the elevated temperature. Again, the instrumentation is not the basis for operator action. The licensee states that a steamline break accident does not have extreme containment heat loads to remove, therefore, the licensee considers this instrumentation less important to recovery from this event.

We note the following.

1. The instrumentation is normally in a mild environment. Only the transmitters will experience a radiation field or elevated temperature.

2. The instrumentation is available in the initial recovery during the injection phase of accident (LOCA) recovery. This phase lasts more than 40 minutes.

3. Instrument failure does not change the system operating characteristics, either automatically or by operator action.

4. The licensee can verify continued system operation, should the flow instrumentation fail, by observing pump motor current.

Based on the above, we find this deviation acceptable.

n. Status of standby power -- The licensee states the location of this instrumentation is in a mild environment. We find this instrumentation acceptable.

o. Containment isolation valve position -- The licensee states, in Reference 8, that seven containment isolation valves (each located outside containment) will be qualified to a more severe environment than originally required. These valves, 2CH-198, 2AC-47, 12 and 15, 2EB-92 and 99 and 2SSP-16.2, were upgraded during the January-March 1988 refueling outage. This change brings full compliance for this variable.

3.3.2 Reactor Coolant System (RCS) Soluble Boron Concentration

The range of the instrumentation for this variable is zero to 2050 parts per million. The range recommended in the regulatory guide is zero to 6000 parts per million. The licensee's justification for this deviation from the recommended range is that the boron concentration will not exceed the technical specification limit of 1720 parts per million. Should a higher range be needed, the post-accident sampling system provides the needed information.

The licensee takes exception to Regulatory Guide 1.97 with respect to post-accident sampling capability. This exception goes beyond the scope of this review. The NRC has addressed this as part of their review of NUREG-0737, Item II.B.3.

3.3.3 RCS Cold Leg Water Temperature

Regulatory Guide 1.97 recommends redundant instrumentation for this variable with a range from 50°F to 750°F. The licensee has supplied one wide-range channel for each cold leg, with a range from zero to 600°F.

The licensee identifies one wide-range temperature instrument in each of the hot legs and cold legs. Millstone Unit 2 is a two loop unit. Thus, there is redundancy because the licensee monitors the coolant temperature delivered to the core by independent instruments. The licensee verified (Reference 7) that each channel of instrumentation, including power supplies, is independent and redundant.

The licensee states that for all design basis accident scenarios, the range of zero to 600°F is adequate to monitor the cold leg fluid temperature. Based on this statement, we find the existing range acceptable.

3.3.4 RCS Hot Leg Water Temperature

Regulatory Guide 1.97 recommends redundant instrumentation for this variable with a range from 50°F to 750°F. The licensee has supplied one wide-range channel for each hot leg, with a range from 150°F to 750°F.

The licensee identifies one wide-range temperature instrument in each of the hot legs and cold legs. Millstone Unit 2 is a two loop unit. Thus there is redundancy because the licensee monitors the coolant temperature as it leaves the reactor with independent instruments. The licensee verified (Reference 7) that each channel of instrumentation, including power supplies, is independent and redundant.

The licensee states that 212°F is the saturation temperature at atmospheric pressure. Therefore, the licensee states the 150°F lower range provides sufficient margin to monitor the approach to saturation in a cold shutdown situation if a loss of shutdown cooling occurs. In addition, the RCS cold leg water temperature and the residual heat removal (RHR) heat exchanger outlet temperature have spans down to zero. Therefore, this deviation in the lower limit of the range for this variable is acceptable.

3.3.5 RCS Pressure

Regulatory Guide 1.97 recommends Category 1 instrumentation with a range from zero to 4000 psig for this Combustion Engineering unit. The licensee has supplied instrumentation for this unit as follows:

- Redundant, Category 1, zero to 1600 psig channels
- Redundant, Category 1, 1500 to 2500 psig channels
- One zero to 3000 psig channel that is not Category 1

The redundant ranges overlap to provide redundancy from zero to 2500 psig. The licensee states that the upper range of 3000 psig is adequate for all design basis events. The primary safety relief valves limit the RCS pressure to 2500 psig following the initial pressure increase. The licensee states that any pressure excursions above 2500 psig would be short.

The pressure range of zero to 3000 psig is adequate to monitor all expected pressures based on the licensee's design basis event analysis. The licensee commits (Reference 7) to upgrade these instrument channels under the resolution of the anticipated transient without scram (ATWS) issue. We find this commitment acceptable.

3.3.6 Coolant Level in Reactor

Revision 2 of Regulatory Guide 1.97 recommends instrumentation for this variable with a range from the bottom of the core to the top of the vessel. The licensee is supplying instrumentation with a range from the top of the core to the top of the vessel and notes that it deviates from the recommendation of Revision 2 of the regulatory guide. This is acceptable, as it exceeds the range recommended by Revision 3 (Reference 11) of the regulatory guide (bottom of the hot leg to the top of the vessel).

3.3.7 Containment Sump Water Level

Regulatory Guide 1.97 recommends measuring the sump level with wide range instruments up to the height equivalent to 600,000 gallons. The licensee has instrumentation for this variable that measures from -22 feet 6 inches to -15 feet 5 inches. This is equivalent to 565,000 gallons.

The licensee ref to a previous letter (Reference 12) that shows the maximum post-accide containment water volume will not exceed 563,800 gallons. As the range exceeds the maximum expected water volume, we find this deviation acceptable.

3.3.8 Radiation Level in Circulating Primary Coolant

The licensee states that the post-accident sampling system, which the NRC reviewed as part of their review of NUREG-0737, Item II.B.3, can provide this information with an isolated nuclear steam supply system.

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

3.3.9 Containment Hydrogen Concentration

Regulatory Guide 1.97 recommends that this instrumentation remain functional for containment pressures from -5 psig to the maximum design pressure. The licensee states that the hydrogen analyzers can operate with a positive containment pressure up to 10 psig. Furthermore, they state that the containment not see a negative pressure under any Final Safety Analysis Report (FSAR) analyzed accident condition.

Reference 13 provides additional information. The containment structure is not of subatmospheric design. Therefore, the atmospheric pressure will be positive when using the hydrogen monitoring instrumentation in a post-accident situation. The limit of 10 psig is because of the particulate radiation monitors that share the same sample lines. The licensee shows the acceptability of this operational limit because the hydrogen concentration instrumentation is not necessary until after the containment pressure has decayed to less than 10 psig.

We find this justification sound. Therefore, we find the provided instrumentation acceptable.

3.3.10 Radiation Exposure Rate

The licensee takes exception to the instrument range recommended by Regulatory Guide 1.97 (10^{-1} R/hour to 10^{4} R/hour). The licensee's instrumentation has either one of two location specific ranges. The installed area radiation monitors have a span up to either 10 R/hour or 10^{3} R/hour. The licensee's justification for this deviation is that the existing area radiation monitors provide adequate employee protection, portable monitors augment these monitors, and these monitors warn of changing or unusually high radiological conditions.

From a radiological standpoint, if the radiation levels reach or exceed the upper limit of the range, personnel would not be permitted to the areas except of life saving. We therefore find the proposed ranges for the radiation exposure rate monitors acceptable.

3.3.11 Accumulator Tank Pressure

Regulatory Guide 1.97 recommends instrumentation with a range of zero to 750 psig for this variable. The range provided is zero to 250 psig. On the basis that the design pressure of the accumulators is 250 psig, we find this deviation acceptable.

3.3.12 Refueling Water Storage Tank Level

Regulatory Guide 1.97 recommends instrumentation with a range from the top to the bottom of the tank for this variable. The range of the instrumentation supplied by the licensee is from 4.3 percent to 100 percent. At 4.3 percent, the tank is essentially empty. Therefore, this is an acceptable deviation from Regulatory Guide 1.97.

3.3.13 Pressurizer Heater Status

Regulatory Guide 1.97 recommends Category 2 electric current instrumentation for this variable. The licensee has identified circuit breaker position indication for this variable. The licensee states, in Reference 7, that the human engineering discrepancy program will address the lack of this instrumentation. The licensee states, in Reference 8, the intent to install current meters for the proportionally controlled heaters. The licensee states, in Reference 9, that this modification is scheduled and part of the control room design review corrections. We find the added instrumentation acceptable for this variable.

3.3.14 Quench Tank Level

Regulatory Guide 1.97 recommends instrumentation for this variable with a range from the top to the bottom of the tank. The tank is a horizontal cylindrical tank with an outside diameter of 60 inches. The licensee's instrumentation measures the level for 20 inches on each side of the centerline of the tank. We calculate that this range covers approximately 74 percent of the tank volume.

The licensee states that the existing range will adequately cover any anticipated event except an uncontrolled or continuous safety/relief valve discharge. Such a discharge will cause the tank rupture disk to rupture, venting the tank contents to containment. Based on this, we find this instrumentation adequate. Therefore, this deviation is acceptable.

3.3.15 Quench Tank Temperature

Regulatory Guide 1.97 recommends instrumentation for this variable with a range from 50°F to 750°F. The licensee has instrumentation for this variable that has a range of zero to 300°F.

The licensee states that the range of zero to 300°F is sufficient to monitor normal and design basis accident scenarios. Based on this justification, we find this deviation acceptable.

3.3.16 Steam Generator Level

Regulatory Guide 1.97 describes a minimum set of variables to be monitored by control room personnel during and following an accident. Regulatory Guide 1.97 recommends wide-range Category 1 steam generator level instrumentation with a range from the tube sheet to the separators for this variable. The licensee has provided instrumentation with a range from the top of the tube bundles to the separators. Thus, the length of the tube bundles is not measured. The licensee, in Reference 7 indicates that this deviation will be addressed as part of the human engineering discrepancy (HED) program. In Reference 8, the licensee defers resolution of this variable to the end of the 1991 refueling outage. The licensee repeats this stand in References 9 and 10. The licensee is anticipating making a decision on replacing the steam generators. Should the licensee replace the steam generators, the licensee will include wide-range level indication. Should the licensee decide not to replace the steam generators, there is no commitment to provide the wide-range level indication in this two loop plant.

The licensee states there are no instrument taps to allow a direct wide-range steam generator level measurement. The auxiliary feedwater system starts automatically on a low level signal on the narrow-range level channels (12 percent). The auxiliary feedwater system has the capacity and capability to restore the level to normal conditions even with a single failure. The licensee states that the auxiliary feedwater system assures effective heat removal for all design basis accidents. The auxiliary feedwater flow control valves open fully automatically. The licensee can manually ramp the main feedwater pumps to 5 percent flow as another means of restoring steam generator level. Primary side temperatures and pressure and main and auxiliary feedwater flow verify the secondary side availability as a heat sink. While a transient will result in the narrow-range channels losing indication, the licensee states that sufficient steam generator inventory remains to maintain an adequate heat sink with no feedwater flow for 22 minutes. Based on this alternate instrumentation and the low probability of an accident at Millstone-2, we find that short-term continued operation, until wide-range channels are installed, is acceptable.

The licensee states that wide-range channels would be beneficial for loss-of-feedwater events. The licensee states a total loss-of-feedwater event goes beyond any Millstone-2 design basis accidents. Wide-range channels would also be beneficial in determining when to start (primary) feed and bleed operation (once though cooling).

The loss of normal feedwater or total loss-of-feedwater can be the result of a pipe break, a pump failure, valve failure, or the loss of offsite power. The narrow-range level channels automatically start the auxillary feedwater pumps. A reactor trip occurs by more than one initiator. The event will result in the water level being lower than the span of the narrow-range instruments. The licensee did not indicate procedural requirements for auxiliary or main feedwater flow for this event. The licensee indicates the narrow-range instrumentation would be unavailable for 22 minutes in this situation. The licensee did not address whether the operator could take inappropriate actions (based on the unavailability of steam generator level instrumentation) in this scenario. This is particularly critical in two loop plants, where a single failure could cause the loss of the second steam generator. The licensee did not indicate if the primary system relief and safety valves would operate during this event.

The loss of AC power to plant auxiliaries results in a situation similar to the loss of normal feedwater. In fact, the loss of normal feedwater can be the result of loss of AC power. In the loss of AC power, however, natural circulation maintains the capability of the steam generator, as the reactor coolant pumps will not have power. The licensee has not addressed the further consequences involved in this event. A station blackout is inclusive of loss of AC power. The NRC is reviewing this as a separate generic issue. We conclude that a station blackout is an additional reason to have wide-range steam generator level instrumentation.

The licensee has not addressed the potential for steam generator dryout. The licensee states that if the level decreases below the lower limit of the narrow-range span, the operator takes no action until high (75 percent) level is restored. RCS parameters lag a direct measure of steam generator wide-range level. The licensee does not address the results of this event on the primary system safety and relief valves.

Regulatory Guide 1.97 recommends the selection of instrument ranges to assure the instrumentation will always be on scale. The narrow-range instruments will not accomplish this. The regulatory guide mentions this a second time: - "it is essential that the range selections be sufficiently great to keep instruments on scale, or that one of a set of overlapping instruments will be on scale at all times." The regulatory guide designates the wide-range channels as the key variable for monitoring the operation of the steam generators. The regulatory guide states "it is essential that key variables be qualified to the more stringent design and qualification criteria." The regulatory guide emphasizes the identification of degraded conditions and their magnitude. The regulatory guide also stresses that the operators have adequate information by as direct a measurement as possible, so unplanned actions can be taken when necessary. The licensee's evaluation does not address these portions of the regulatory guide.

Therefore, we conclude that the licensee should provide Category 1 wide-range steam generator level channels as recommended by Regulatory Guide 1.97. This conclusion is based on the regulatory guide recommendation that instrumentation should directly indicate the safety function, with readouts that will always be on scale. It is also based on the qualification requirements of 10 CFR 50.49, Regulatory Guide 1.97, and Regulatory Guide 1.100. This conclusion also considers the narrow-range instruments can be off-scale for extended periods. This could lead an operator to take inappropriate actions. The licensee has not addressed this instrumentation for a station blackout event. The licensee has not addressed potential improvements in operator response and training possible by using the direct indication of Category 1 wide-range steam generator level instrumentation.

We conclude that the licensee should provide wide-range steam generator level instrumentation that meets the requirements and recommendations of 10 CFR 50.49, Regulatory Guide 1.97, and Regulatory Guide 1.100.

Deferring a decision that commits to install this instrumentation is unacceptable. The licensee should commit to install the recommended instrumentation should they not replace the steam generators in the near term.

3.3.17 Heat Removal by the Containment Fan Heat Removal System

Regulatory Guide 1.97 recommends plant specific Category 2 instrumentation for this variable. The licensee, in Reference 9, describes the instrumentation available to monitor the containment air recirculation and cooling system (CARCS). The licensee monitors the temperature (zero to 200°F) at the inlet and the outlet of the cooling water (reactor buildup closed cooling water system) heat exchangers (part of the CARCS). The licensee also monitors the flow from the fan blowers. We find that the instrumentation provided would provide satisfactory indication for this variable if environmentally qualified. Environmental qualification is the only Category 2 recommendation not met by this instrumentation.

The licensee states that redundancy in design (only 3 out of 4 units are needed following a LOCA), surveillance testing, valve position verification, and the Category 1 containment pressure instrumentation are adequate to assure system operation. The containment pressure instrumentation cannot distinguish between the containment spray system operation and CARCS operation. System testing and valve position verification will assure a state of system readiness, leading the operator to conclude the system is operable.

The instrumentation, as noted in Reference 10, is in a mild environment, except the sensors. The sensors are outside of containment. Thus, the sensors are in a mild environment during the injection phase of accident recovery. Only after establishing recirculation, more than

40 minutes into the accident recovery, are the sensors exposed to a potential radiation field. As a steamline break does not use the CARCS in response to that event, qualification to elevated temperatures is not necessary.

Radiation induced thermal fluence caused by x-rays can damage unprotected semiconductors. Gamma rays cause transient ionizing radiation which affects the p-n junction in semiconductors. The total ionizing dose creates excess charge carriers, which change semiconductor characteristics. Thus, a harsh radiation field will cause deterioration or failure of the exposed instrumentation. We are unable to predict whether the licensee's instrumentation is subject to sudden failure or a gradual change in operating characteristics due to the radiation environment. The licensee states that instrument failure does not affect system operation and that emergency operating procedures do not specify any action based on these signals.

The licensee notes that this instrumentation is not part of the emergency operating procedures. Their failure will not degrade system operation. Further, CARCS operation is not changed when the switchover from the injection mode to the recirculation mode occurs. The operator makes no changes to the CARCS at that time. Therefore, it is reasonable to assume the continued availability of the CARCS.

We note the following.

1. During the initial injection phase, the instrumentation is in a mild environment.

2. The heat load that the CARCS must control is much less during recirculation when a harsh environment occurs for this instrumentation, then during the initial injection phase.

3. The licensee uses containment pressure instrumentation to verify the continued effectiveness of the containment spray and the CARCS.

4. The containment spray is not operated below 10 psig in containment. Thus, the containment pressure will be a direct measure of the effectiveness of the CARCS.

Thus, we find the provided instrumentation acceptable.

3.3.18 Containment Atmosphere Temperature

Regulatory Guide 1.97 recommends instrumentation for this variable with a range from 40°F to 400°F. The licensee's instrumentation for this variable has a range of zero to 350°F.

The licensee justifies this deviation, stating that the maximum predicted containment temperature is less than 300°F. Based on this justification, we find the range supplied by the licensee for post-accident monitoring acceptable.

3.3.19 Containment Sump Water Temperature

Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable with a range from 50°F to 250°F. The licensee has no instrumentation for this variable. The licensee does not consider it part of the post-accident monitoring system because it serves no safety function. An adequate net positive suction head exists for the high pressure safety injection pumps in the recirculation mode.

This is insufficient justification for this exception. The licensee should provide the recommended instrumentation for the functions outlined in Regulatory Guide 1.97 or identify other Category 2 instruments (such as the residual heat removal system heat exchanger inlet temperature) that satisfy the regulatory guide.

3.3.20 Radioactive Gas Holdup Tank Pressure

Regulatory Guide 1.97 recommends instrumentation for this variable with a range from zero to 150 percent of design pressure. The licensee has local instrumentation for this variable because system operation is local. There are no controls in the control room, only a common alarm. A surge tank (design pressure of 20 psig) has instrumentation that reads from zero to 25 psig.

A compressor compresses the surge tank contents when the surge tank reaches 3 psig. The compressed gases are stored in one of six waste decay tanks. The waste decay tanks have a design pressure of 165 psig. Zero to 200 psig instrumentation monitors the pressure. The capability of the compressor limits the tank pressure. While the instrumentation range is to only 121 percent of design pressure, we find the overrange sufficient for this application. We find this instrumentation acceptable.

3.3.21 Accident Sampling (Primary Coolant, Containment Air and Sump)

The licensee's post-accident sampling system provides sampling and analysis as recommended by the regulatory guide, except the capability to analyze for dissolved oxygen.

The licensee takes exception to Regulatory Guide 1.97 with respect to post-accident sampling capability. This exception goes beyond the scope of this review. The NRC addressed this exception as part of their review of NUREG-0737, Item II.B.3.

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 environmentally qualified instrumentation for either level or pressure under 10 CFR 50.49 and Regulatory Guide 1.97. (Section 3.3.1d)

2. Component cooling water temperature to ESF system -- The licensee should provide environmentally qualified instrumentation for this variable under 10 CFR 50.49 and Regulatory Guide 1.97. (Section 3.3.11)

3. Steam generator level -- The licensee should commit to provide the recommended instrumentation regardless of steam generator replacement. (Section 3.3.16)

4. Containment sump water temperature -- The licensee should either provide instrumentation for this variable or identify appropriate alternative instrumentation. (Section 3.3.19)

5. REFERENCES

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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, Northeast Utilities (W. G. Counsel) to NRC (D. G. Eisenhut), "Requirements for Emergency Response Capability (Generic Letter No. 82-33)," April 15, 1983, A02959.

5. Letter, Northeast Utilities (W. G. Counsel) to NRC, "Supplement 1 to NUREG-0737, Revision 2 to Regulatory Guide 1.97," February 29, 1984, A02959.

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7. Letter, Northeast Utilities (J. F. Opeka) to NRC, "Supplement 1 to NUREG-0737, Revision 2 to Regulatory Guide 1.97," August 7, 1986, A04770/A02959.

8. Letter, Northeast Utilities (E. J. Mroczka) to NRC, "Supplement 1 to NUREG-0737, Revision 2 to Regulatory Guide 1.97," June 15, 1987, A04770, A02959.

9. Letter, Northeast Utilities (E. J. Mroczka) to NRC, "Supplement 1 to NUREG-0737," June 20, 1988, A04770, A02959.

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12. Letter, Northeast Utilities (W G. Counsel) to NRC (R. A. Clark), "NUREG-0737 Item II.F.1.5, Containment Water Level Monitor," March 8, 1983, B10717.

13. Letter, Northeast Utilities (W. G. Counsel) to NRC, "TMI Action Item II.F.1.6, Containment Hydrogen Monitor," March 27, 1984, B11073.

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This EG&G Idaho, Inc., report documents the review of the Regulatory Guide 1.97, Revision 2, submittals for Unit No. 2 of the Millstone Nuclear Power Station, and identifies areas of noncon[illegible]mance to the regulatory guide. Exceptions to Regulatory Guide 1.97 are evaluated a[illegible] [illegible]hose areas where sufficient basis for acceptability is not provided are identified.

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