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TECHNICAL EVALUATION REPORT

CONFORMANCE TO REGULATORY GUIDE 1.97: QUAD CITIES-1 AND -2

Docket Nos 50-254/50-265

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ABSTRACT

This EG&G Idaho, Inc., report reviews the submittals for Regulatory Guide 1.97 for the Quad Cities Station, Unit Nos. 1 and 2 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 Nos. 50-254 and 50-265
TAC Nos. 51124 and 51125

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).

Commonwealth Edison, the licensee for the Quad Cities Station, provided a response to Item 6.2 of the generic letter on August 1, 1985 (Reference 4). Schedular information was provided in letters dated January 31, 1986 (Reference 5), October 6, 1986 (Reference 6), May 28, 1987 (Reference 7) and May 29, 1987 (Reference 8). A letter dated November 4, 1985 (Reference 9) addressed instrumentation readouts for the emergency response facilities.

This report provides an evaluation of that material.

2. REVIEW REQUIREMENTS

Item 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 taken from the regulatory guide recommendations and 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 the NRC policy on this subject. At these meetings, it was noted that the NRC review would only address 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 only addresses 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 August 1, 1985. The response describes the licensee's position on post-accident monitoring instrumentation. This evaluation is based on that material. Other schedular information submitted is listed in the References Section of this report.

3.1 Adherence to Regulatory Guide 1.97

The licensee has provided a review of their post-accident monitoring instrumentation that shows instrumentation that presently complies with the recommendations of Regulatory Guide 1.97, discusses modifications to bring instrumentation into full compliance with the regulatory guide and discusses deviations that the licensee supports as appropriate to the Quad Cities Station design. The licensee has committed to complete all the modifications required to bring the presently identified deviations into compliance with Regulatory Guide 1.97 by the completion of the Unit 2 Spring 1988 outage. One possible exception to this exists, in that rescaling the drywell pressure recorder cannot be completed until the corresponding technical specification change has been approved by the NRC. The change is scheduled for submittal to the NRC in July 1987. 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. Coolant level in reactor

2. Reactor coolant system pressure

3. Drywell pressure

4. Suppression chamber pressure

5. Suppression pool water level

6. Suppression pool water temperature

These variables, with exceptions as noted in Section 3.3, either meet or will 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 from Regulatory Guide 1.97. These are discussed in the following paragraphs.

3.3.1 Neutron Flux

Regulatory Guide 1.97 recommends Category 1 instrumentation for this variable. The licensee's instrumentation is stated to be Category 1 except for environmental and seismic qualification of the cables, detectors and the detector drives that are inside the primary containment. These are not qualified for a loss of coolant accident.

The licensee states that there is a known relation between the source range reading when fully withdrawn and the actual power level. This is based on the attenuation factor of the materials in the vicinity of the detectors and the neutron leakage factor that are known for this design of boiling water reactor. The source range period meter also shows increases or decreases in power level, even with the detectors withdrawn. There are

four source range channels per unit. There are also eight intermediate range monitors that measure down to 5×10^{-4} percent of full power when fully inserted.

Additionally, the licensee states that a scram can be verified by these diverse parameters:

1. Scram relay position indication,

2. Scram valve position indication,

3. Control rod drive scram accumulator low pressure indication,

4. Scram discharge volume high level alarm, and

5. Indication of responses such as makeup flow, pressure decay, and torus pressure increase.

In the process of our review of neutron flux instrumentation for boiling water reactors, we note that the detectors and their cables have not satisfied the environmental qualification requirement of Regulatory Guide 1.97. A Category 1 system that meets all the criteria of Regulatory Guide 1.97 is an industry development item. Based on our review, we conclude that the existing instrumentation is acceptable for interim operation. The licensee should follow industry development of this equipment, evaluate newly developed equipment and install Category 1 instrumentation when it becomes available.

3.3.2 Drywell Pressure

Regulatory Guide 1.97 recommends Category 1 instrumentation for this variable. As such, the information should be continuously recorded. The licensee indicates that this is not recorded, but is available in the control room on an indicator only. No justification was presented for this deviation.

The licensee should provide recording of the drywell pressure as recommended by the regulatory guide.

3.3.3 Suppression Pool Pressure

The licensee classifies this as a Type A variable, even though it is not a variable defined in the regulatory guide. The licensee states that the instrumentation for the variable drywell pressure will be used for this variable as well, because there are twelve vacuum breakers that keep the suppression pool (or torus) pressure within ±0.5 psi of the drywell. This is within one-half percent of the instrument range, and within the accuracy of the instruments. We find this acceptable, contingent on the recorder as concluded in Section 3.3.2.

3.3.4 Drywell Sump Level
Drywell Drain Sumps Level

Regulatory Guide 1.97 recommends Category 1 instrumentation for these variables. The licensee indicates that leakage rate, not sump level, is the parameter of concern. This is monitored by Category 3 flow rate recorders. The leakage rate is determined every four hours when the sumps are required to be pumped out. A high sump level alarm is caused if the sumps fill in less than four hours. Large leaks isolate the sumps.

We conclude that appropriate monitoring of the parameters of concern is provided. This is based on (a) for small leaks, the instrumentation is not expected to experience harsh environments during operation, (b) for larger leaks, the sumps fill promptly and the sump drain lines isolate due to the increase in drywell pressure, thus negating the drywell sump level and drywell drain sumps level instrumentation, and (c) this instrumentation neither automatically initiates nor alerts the operator to initiate operation of a safety-related system in a post-accident situation. Therefore, we find the Category 3 instrumentation provided acceptable.

3.3.5 Primary Containment Pressure

Regulatory Guide 1.97 recommends instrumentation for this variable with a range of -5 psig to 4 times the design containment pressure of 63 psig (252 psig). The licensee's instrumentation has a range of -5 psig to 250 psig. The licensee has chosen this range because the scale is less awkward than the recommended range and because it meets the intent of the regulatory guide.

We find this deviation of 2 psig out of 250 psig to be minor (less than 0.8 percent of the recommended range). Therefore, the range is acceptable.

3.3.6 Primary Containment Isolation Valve Position

From the information provided, we find that the licensee deviates from a strict interpretation of the Category 1 redundancy recommendation. Only the active valves have position indication (i.e., check valves have no position indication). Since redundant isolation valves are provided, we find that redundant indication per valve is not intended by the regulatory guide. Position indication of check valves is specifically excluded by Table 1 of Regulatory Guide 1.97. Therefore, we find that the instrumentation for this variable is acceptable.

3.3.7 Radiation Level in Circulating Primary Coolant

The licensee states that their instrumentation is justified based on the critical actions to be taken to prevent and to mitigate a gross breach of fuel cladding being (a) shut down the reactor, and (b) maintain the water level. The licensee states that the post-accident sampling system provides a means of obtaining samples of reactor coolant and determining the status of fuel cladding and that the primary containment radiation monitors and the containment hydrogen monitors also provide information on the status of fuel cladding.

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

3.3.8 Primary Containment Area Radiation

Regulatory Guide 1.97 recommends Category 1 instrumentation for this variable with a range of 1 to 10^7 R/hr. The licensee's instrumentation is Category 1, except for seismic qualification, and has a range of 10 to 10^8 R/hr in the drywell and Category 3 instrumentation with a range of 1 to 10^6 R/hr in the torus. The licensee's identification of the instrumentation says that seismic qualification is not required for this Category 1 instrumentation; no basis for this statement was given. The licensee should show that the installed instrumentation complies with the original station seismic criteria.

The licensee states that the detectors will be recalibrated and rescaled to meet the range of 1 to 10^7 R/hr.

3.3.9 Containment and Drywell Hydrogen Concentration

Regulatory Guide 1.97 recommends instrumentation for this variable with a range of 0 to 30 percent. The range of the licensee's instrumentation is 0 to 10 percent. A remote display that is accessible has a range of 0 to 20 percent, however, this remote display is not Category 1 as recommended by the regulatory guide. The licensee states that the 0 to 10 percent range monitors the hydrogen concentration well into the explosive range and that there are no additional required operator actions for concentrations greater than 10 percent.

The NRC has reviewed the acceptability of this variable as part of their review of NUREG-0737, Item II.F.1.6.

3.3.10 Radiation Exposure Rate

Revision 2 of Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable with a range of 10^{-1} to 10^{4} R/hr. The licensee's instrumentation is Category 3. As Revision 3 of the regulatory guide (Reference 10) changes the recommendation to Category 3 instrumentation, we find the category of instrumentation acceptable.

The licensee states that the range is 10^{-1} to 10^{3} mR/hr (10^{-4} to 1 R/hr) and that this is adequate for normal operation and for use in determining local accessibility. Entry into an area is controlled by portable meters and by emergency plant procedures. The licensee states that this variable is a function of primary containment and emergency core cooling system fluid radioactivity, and that the use of effluent radioactivity monitors provides a positive indication of a break or of leakage.

The licensee has not shown any analysis of post-accident radiation levels expected for the monitor locations. The licensee should show that the existing radiation exposure rate monitors have ranges that encompass the expected post-accident radiation levels in their locations.

3.3.11 Suppression Chamber Spray Flow

The suppression chamber spray is derived from the residual heat removal (RHR) system, and as such uses the same flow detector that the variable low pressure coolant injection flow uses. The range of this instrumentation is 0 to 20,000 gpm, while the recommended range for the variable suppression chamber spray flow is 0 to 110 percent of design flow (this is identified by the licensee as 275 gpm). The licensee acknowledges that the instrumentation accuracy is not adequate for measuring 275 gpm.

The licensee states that the piping is sized to limit the rate of the suppression chamber spray flow. The licensee also indicates that other instrumentation is available including system valve position indication,

The licensee does not provide instrumentation that is a direct indication for this variable for the diesel generator cooling water system, relying instead on component temperature and an accessible readout of the pump discharge pressure.

We find the basis for this deviation unacceptable. The pump output pressure is an early indication of loss of flow, but it is not sufficient to replace flow. Flow blockage cannot be detected by pressure alone. The pressure indication is not in the control room. The component temperature is a lagging indication of loss of flow and thus is not acceptable to replace flow. The licensee should provide Category 2 instrumentation for the diesel generator cooling water system flow and provide the information required by Section 6.2 of NUREG-0737, Supplement No. 1.

3.3.14 Emergency Ventilation Damper Position

Regulatory Guide 1.97 recommends Category 2 indication in the control room for this variable. The licensee identifies the following deviations:

- The diesel generator room ventilation dampers do not have position indication. Room high temperature alarms are used instead.

- The main control room damper position indicators are located just outside the main control room in an accessible area. The main control room fan indication is in the control room and, being interlocked with the dampers, provide information on the damper status.

We find the alternate indications acceptable for this variable, however, the licensee should verify that the indication is Category 2.

3.3.15 Secondary Containment Area Radiation

Regulatory Guide 1.97 recommends Category 2 instrumentation for this variable with a range of 0.1 to 10^4 R/hr for the Mark I containment. The licensee's Category 3 instrumentation has a range of 0.1 to 10^3 mR/hr. The instrumentation deviates in both category and in the upper four decades of the recommended range.

The licensee states that the range is adequate for normal operation and for use in determining local accessibility. Entry into an area is controlled by portable meters and by emergency plant procedures. The licensee states that this variable is a function of primary containment and emergency core cooling system fluid radioactivity, and that the use of effluent radioactivity monitors provides a positive indication of a break or of leakage.

The licensee has not shown any analysis of post-accident radiation levels expected for the monitor locations. The licensee should show that the existing instrumentation for the variable secondary containment area radiation have ranges that encompass the expected post-accident radiation levels in their locations.

The licensee concludes that Category 3 instrumentation is acceptable for this variable because the use of these monitors to detect breach or leakage through primary containment penetration results in ambiguous indications.

We find that Category 3 instrumentation in concert with the noble gas effluent monitors is acceptable for this variable; however, the licensee should verify the adequacy of the range of this instrumentation.

3.3.16 Particulates and Halogens

Regulatory Guide 1.97 recommends instrumentation for this variable with a range of 10^{-3} to 10^{2} µCi/cc. The range of the licensee's instrumentation is stated to be 1 µCi/gm to 10 Ci/gm.

The licensee has stated that this instrumentation complies with the regulatory guide, yet has not shown correlation between the recommended and the provided ranges. The licensee should demonstrate that the provided range encompasses the recommended range.

3.3.17 Plant and Environs Radiation

Regulatory Guide 1.97 recommends instrumentation for this variable with ranges of 10^{-3} to 10^{4} R/hr, photons, and 10^{-3} to 10^{4} rads/hr, beta and low energy photons. The licensee's survey meter for this variable has a range of 0 to 10^{3} R/hr, and is stated to comply with the regulatory guide.

From the information given for this variable, we conclude that a deviation exists; however, no justification was given for the different ranges. The licensee should provide instrumentation that covers the recommended range.

3.3.18 Plant and Environs Radioactivity

Regulatory Guide 1.97 recommends portable instrumentation (i.e., instrumentation that is not in fixed locations) for this variable. The licensee is developing procedures which will utilize an analyzer that is in a fixed location, that uses samples that are taken as required in the plant and from the environs areas. The licensee states that portable equipment should not be used because of the rough handling it would receive in the field.

The laboratory equipment at this station can provide isotopic analysis and a timely assessment of radioactive releases. Therefore, this is an acceptable deviation from Regulatory Guide 1.97.

3.3.19 Estimation of Atmospheric Stability

Regulatory Guide 1.97 recommends instrumentation for this variable with a range of -9 to +18°F or an analogous range for alternate stability analysis. The licensee has supplied instrumentation with a range of -10 to +10°F, based on a elevation differential of either 115 or 265 feet.

Table 1 of Regulatory Guide 1.23 (Reference 11) provides seven atmospheric stability classifications based on the difference in temperature per 100 meters elevation change. These classifications range from extremely unstable to extremely stable. Any temperature difference greater than +4°C or less than -2°C does nothing to the stability classification. The licensee's instrumentation includes this range. Therefore, we find that this instrumentation is acceptable to determine the atmospheric stability.

3.3.20 Accident Sampling (primary coolant, containment air and sump)

The licensee's sample system can obtain samples and provide the analyses within the ranges recommended for this variable with the following exceptions:

Containment air hydrogen content - the range is 0 to 10 percent

Containment air oxygen content - the range is 0 to 10 percent

The licensee considers this adequate since the maximum range covers into the explosive mixture region.

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 has been addressed by the NRC as part of the 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. Neutron flux--the existing instrumentation is acceptable until Category 1 instrumentation is developed and installed (Section 3.3.1).

2. Drywell pressure--the licensee should record this variable (Section 3.3.2).

3. Primary containment area radiation--the licensee should show that this instrumentation meets the original station seismic criteria (Section 3.3.8).

4. Radiation exposure rate--the licensee should show that the ranges supplied for this variable encompass the radiation levels expected at the instrument locations (Section 3.3.10).

5. Diesel generator cooling water system flow--the licensee should provide Category 2 flow instrumentation for this system (Section 3.3.13).

6. Emergency ventilation damper position--the licensee should verify that the alternate instrumentation is Category 2 (Section 3.3.14).

7. Secondary containment area radiation--the licensee should show that the ranges supplied for this variable encompass the radiation levels expected at the instrument locations (Section 3.3.15).

8. Particulates and halogens--the licensee should show that the provided range encompasses the recommended range (Section 3.3.16).

9. Plant and environs radiation--the licensee should provide instrumentation that covers the recommended range (Section 3.3.17).

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, Commonwealth Edison Company (J. R. Wojnarowski) to NRC (D. B. Vassallo), "Compliance with Regulatory Guide 1.97," August 1, 1985.

5. Letter, Commonwealth Edison Company (J. R. Wojnarowski) to NRC (H. R. Denton), "Implementation Schedule for Regulatory Guide 1.97 Modifications," January 31, 1986.

6. Letter, Commonwealth Edison Company (J. R. Wojnarowski) to NRC (H. R. Denton), "Regulatory Guide 1.97 Modification Schedule," October 6, 1986.

7. Letter, Commonwealth Edison Company (I. M. Johnson) to NRC (T. E. Murley), "Drywell Pressure Instrumentation Regulatory Guide 1.97 Commitment," May 28, 1987.

8. Letter, Commonwealth Edison Company (I. M. Johnson) to NRC (T. E. Murley), "Reg. Guide 1.97 Commitments Regarding Acoustic Monitoring and Containment Hydrogen Analyzers," May 29, 1987.

9. Letter, Commonwealth Edison Comapny (J. R. Wojnarowski) to NRC (H. R. Denton), "Emergency Response Facility Regulatory Guide 1.97 Review," November 4, 1985.

10. 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.

11. Onsite Meteorological Programs, Regulatory Guide 1.23, NRC February 17, 1972 or Meteorological Programs in Support of Nuclear Power Plants, Proposed Revision 1 to Regulatory Guide 1.23, NRC, Office of Standards Development, September, 1980.

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