REVIEW OF THE POST-ACCIDENT SAMPLING FACILITY

COMPLIANCE WITH NUREG 0737, ITEM II.B.3

FOR THE

DUANE ARNOLD ENERGY CENTER

IOWA ELECTRIC LIGHT AND POWER COMPANY

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EXECUTIVE SUMMARY

A design and operational review of the post-accident sampling (PAS) facilities at the Duane Arnold Energy Center (DAEC) was performed in accordance with the requirements of NUREG 0737, Item II.B.3, Post-Accident Sampling Capability. This report documents that review.

For this report, the DAEC PAS facilities (PAS Sample Station and PAS Chemical and Radiological Analysis Laboratories) were evaluated against the design and/or operational criteria detailed in Item II.B.3. Based on this review, the report concludes that with the completion of the PAS modifications, the DAEC is in compliance with the requirements of NUREG 0737, Item II.B.3.

1.0 INTRODUCTION

This report documents a design and operational review of the Post-Accident Sampling (PAS) facilities at the Duane Arnold Energy Center (DAEC). For the DAEC, this report demonstrates compliance with the requirements of NUREG 0737, Item II.B.3, Post-Accident Sampling Capability.

The PAS facilities are based on a design developed by General Electric (Reference 1) and consist of a sample station, a chemical analysis laboratory, and a radiological analysis laboratory. The PAS facilities are located in the DAEC administration building. The location of the PAS sample station was selected as a result of the review of plant shielding required by NUREG 0737, Item II.B.2. For the DAEC it was concluded that, with the worst-case fission product release assumptions required by Item II.B.2, the reactor building (location of the existing reactor liquid sample station) must be considered inaccessible after a postulated loss of coolant accident (LOCA).

This report considers each of the three PAS facilities individually. Specific design and/or operational criteria, detailed in the clarification to Item II.B.3 and applicable to the DAEC, are addressed in the appropriate sections of this report.

2.0 POST-ACCIDENT SAMPLING FACILITIES

As required by NUREG 0737, Item II.B.3, the PAS facilities are designed to enable personnel to obtain and analyze, under post-accident conditions, representative grab samples of reactor coolant and containment atmosphere gas without radiation exposure to any individual exceeding the guidelines of General Design Criterion 19 (i.e., 5 rem whole-body, 75 rem extremities).

In accordance with the requirements of Item II.B.3, the PAS facilities are designed to enable personnel to obtain samples and perform the required chemical and radiological analyses within 3 hours from the time a decision is made to sample.

The PAS facilities are powered from reliable ac power supplies which can be tied to the diesel generators in the event that offsite power is lost.

2.1 PAS SAMPLE STATION

2.1.1 Operational and Design Criteria Review

The PAS sample station was designed and supplied by General Electric (Reference 1) and is located in the administration building at elevation 757'-6", adjacent to personnel access control. The sample station includes a sample panel (with liquid and gas sampling units) and a remote sample control panel.

NUREG 0737 Requirement

The post-accident reactor coolant and containment atmosphere samples should be representative of reactor coolant in the core area and gases in the containment atmosphere. Furthermore, reactor coolant and containment atmosphere sampling, under post-accident conditions, shall not require an isolated auxiliary system (e.g., the letdown system, reactor water cleanup system [RWCS]) to be placed in operation in order to obtain samples.

Compliance

The PAS sample station is designed to provide representative grab samples of reactor coolant (representative of coolant in the core area), suppression pool liquid, and containment atmosphere under normal and accident conditions. Samples can be taken without requiring an isolated auxiliary system to be placed in operation.

Sample taps into the jet pump flow-sensing instrument lines provide reactor coolant samples with the reactor vessel pressurized. Reactor coolant pressure provides the motive force for liquid sample flow to the sample station. During preoperational testing of the PAS system, difficulties were experienced in obtaining samples from the jet pump sample taps. Modifications have been developed to resolve these difficulties. However, due to procurement of long lead time components required for this modification, only one jet pump sample tap will be available when the system is declared operational. As soon as practical after receipt of the long lead time components, a second jet pump sample tap will be placed into operation.

Sample taps into the residual heat removal (RHR) system heat exchanger discharge piping provides reactor coolant samples when the vessel is depressurized and the RHR system is in the shutdown cooling mode of operation. The RHR sample taps also provide suppression pool liquid samples when the RHR system is in the low-pressure coolant injection, suppression pool cooling, or test mode of operation.

Containment (drywell and torus) atmosphere samples are provided via the containment atmosphere monitoring (CAM) system analyzer samples lines.

NUREG 0737 Requirement

Design consideration should be given to preventing blockage of sample lines by loose material in the RCS or containment.

Compliance

Except as discussed above, redundant taps for the gas and liquid sample lines provide sampling capability in the event that a line becomes blocked by loose material. During preoperational testing of the PAS system, flow blockages developed in certain components when sampling from the RHR system. These flow blockages resulted from an accumulation of crud and particulates which entered the system from the RHR sample points. Based on a recommendation from General Electric (Reference 2), modifications have been developed to minimize the potential for flow blockages to develop. These modifications include installation of hydrocyclone separators to remove excessive insoluble impurities from samples taken from the RHR sample points. The modifications will also include provisions for bypassing of the separators.

NUREG 0737 Requirement

Design consideration should be given to provisions for flow restrictions to limit reactor coolant loss from a rupture of the sample line.

Compliance

The sample taps in the jet pump flow-sensing instrument lines are located downstream from the existing flow limiting orifices. In the event that one of these high-pressure sample lines breaks, the resultant flow is limited by the orifice and will not exceed the flow evaluated for the worst case instrument line break. Coolant loss can be limited in the event a low-pressure RHR sample line ruptures by closing the isolation valves for the damaged line.

NUREG 0737 Requirement

Design consideration should be given to provisions for purging the sample lines and the residues of sample collection should be returned to containment or to a closed system. Furthermore, the sample lines should be as short as possible to minimize the volume of fluid to be taken from containment.

Compliance

The sample system has been designed to allow purging the liquid and gas sample lines in order to obtain representative samples. After obtaining samples, the liquid and gas sample lines can be flushed with demineralized water and nitrogren, respectively. The flow from the purge and flush operations is returned to the suppression pool.

A small-volume liquid sump within the sample panel enclosure collects all leakage from sample station components. The sump can be isolated and pressurized to discharge into the suppression pool.

The sample lines are designed to be as short as possible. This minimizes the volume of fluid removed from containment.

NUREG 0737 Requirement

Design consideration should be given to provisions for reducing plateout in sample lines and for minimizing sample loss or distortion.

Compliance

The containment atmosphere sample lines are provided with electric heat tracing to minimize condensation and subsequent plateout in the sample lines. In addition, ANSI N13.1 was used as a guide in the design of the gas sample lines in order to minimize plateout. Distortion of liquid samples through loss of noncondensible gases is minimized by maintaining the liquid samples under pressure in the sample lines.

NUREG 0737 Requirement

The ventilation exhaust from the sample station should be filtered with charcoal adsorbers and high-efficiency particulate air (HEPA) filters.

Compliance

Ventilation exhaust from the PAS sample station enclosure is directed to the standby gas treatment system (SGTS) via a reactor building exhaust duct inside the reactor building. The SGTS filters the exhaust through charcoal adsorbers and HEPA filters.

2.1.2 Conclusions

With the completion of the PAS sample station modifications, the DAEC is in compliance with the PAS sample station requirements of NUREG 0737, Item II.B.3.

2.2 PAS CHEMICAL ANALYSIS LABORATORY (CHEMICAL LABORATORY)

2.2.1 Operational and Design Criteria

The design of the PAS chemical laboratory is based on the General Electric generic design requirements given in Reference 1. The PAS chemical laboratory is located in the DAEC administration building at elevation 786'-0" in the vicinity of the normal plant hot chemistry laboratory.

NUREG 0737 Requirement

The chemical laboratory shall be provided the capability to quantify the following:

a) Hydrogen levels in containment atmosphere samples

b) Dissolved gases in liquid samples: The measurement of either total dissolved gases or hydrogen gas in reactor coolant samples is considered adequate. Measuring the oxygen concentration is recommended but not mandatory.

c) Chloride concentration in liquid samples: The chloride analysis shall be completed within 24 hours of obtaining the sample when 1) the plant's coolant water is seawater or brackish, and 2) there is only a single barrier between primary containment systems and the cooling water. For all other cases, the chloride analysis shall be completed within 4 days.

d) Boron concentration in liquid samples: The analysis of primary coolant samples for boron is required for PWRs. (Note that Revision 2 of Regulatory Guide 1.97, when issued, will likely specify the need for primary coolant boron analysis capability at BWR plants.)

Compliance

a) The PAS chemical laboratory is equipped with a gas chromatograph capable of quantifying hydrogen, oxygen, and nitrogen levels in containment atmosphere gas samples. In addition, the hydrogen/oxygen analyzer provides inline monitoring of hydrogen and oxygen levels in the containment atmosphere.

b) The [illegible]al dissolved gas concentr[illegible]ion in liquid samples is obtained by sampling the gas phase over a specific liquid volume (provided by the dissolved gas portion of the liquid sample unit) and applying Henry's Law. The capability to measure oxygen concentration in liquid samples is not required, and has not been provided.

c) Reactor coolant chloride analysis capability is provided by a turbidimeter. Since the RHR service water system is neither seawater nor brackish, the chloride analysis will be completed within 4 days of obtaining the sample.

d) Although Item II.B.3 does not require the analysis of primary coolant samples for boron concentrations in BWRs, the DAEC is equipped with a spectrophotometer capable of providing this analysis.

The PAS chemical laboratory is also equipped with a pH meter.

NUREG 0737 Requirement

Accuracy, range, and sensitivity shall be adequate to provide pertinent data to the operator to describe the chemical status of the reactor coolant systems.

Compliance

Equipment for the PAS chemical laboratory was selected based on the recommendations contained in Reference 1, and has accuracy, range, and sensitivity adequate to provide pertinent data to the operator to describe the chemical status of the reactor coolant systems.

NUREG 0737 Requirement

Where necessary and practicable, the ability to dilute samples to provide capability for measurement and reduction of personnel exposure should be provided. Furthermore, design consideration should be given to provisions for appropriate disposal of the samples.

Compliance

Sample dilution capability is provided in the PAS chemical laboratory. Partial dilution capability (for small-volume liquid samples only) is provided in the sample panel. However, additional dilution in the PAS chemical laboratory is required prior to analysis.

After analysis, samples will be stored in a locked, shielded vault until they can be properly disposed of.

2.2.2 Conclusions

With the completion of the PAS chemical analysis laboratory modifications, the DAEC is in compliance with the PAS chemical analysis laboratory requirements of NUREG 0737, Item II.B.3.

2.3 PAS RADIOLOGICAL ANALYSIS LABORATORY (COUNTING ROOM)

2.3.1 Operational and Design Criteria

The PAS counting room is based on the General Electric generic PAS facilities design requirements given in Reference 1. The PAS counting room is located in the DAEC administration building at elevation 757'-6", adjacent to the PAS sample station.

NUREG 0737 Requirement

The PAS radiological analysis laboratory (counting room) shall be provided the capability to identify and quantify radionuclides in the reactor coolant and containment atmosphere samples that may be indicators of the degree of core damage (e.g., noble gases, iodines and cesiums,and nonvolatile isotopes). This capability shall be provided to levels corresponding to the source terms given in Regulatory Guides 1.3 and 1.7. Sensitivity for liquid sample analysis should permit measurement of nuclide concentration in the range from approximately 1 uCi/g to 10 Ci/g.

Compliance

Based on the above criteria, the PAS counting room is equipped with a hyperpure germanium detector and computerized multichannel analyzer. This equipment provides the capability to identify and quantify the isotopes of nuclides in reactor coolant and containment atmosphere samples as described in the requirements above.

NUREG 0737 Requirement

Accuracy, range, and sensitivity shall be adequate to provide pertinent data to the operator to describe the radiological status of the reactor coolant systems.

Compliance

The PAS counting room equipment is based on the recommendations contained in Reference 1 and has accuracy, range, and sensitivity adequate to provide pertinent data to the operator to describe the radiological status of the reactor coolant systems.

NUREG 0737 Requirement

The design of the counting room should include provisions to restrict the background radiation levels from sources such that the sample analysis will provide results with an acceptably small error (approximately a factor of 2). This can be accomplished by the use of sufficient shielding around samples and outside sources, and by the use of a ventilation system design which will control the presence of radioactivity.

Compliance

The PAS counting room is provided with shielding designed to comply with the DAEC criterion that the background radiation levels due to contained and external airborne sources will, at all times, be less than 2 mrem/hr following a postulated release of fission products equivalent to that described in Item II.B.2 of NUREG 0737. Special ventilation systems for control of the potential internal airborne, noble gas cloud have not been provided. In the event that background radiation due to the internal airborne source approaches a level which could significantly affect the accuracy of the sample count (by approximately a factor of 2), additional local shielding (e.g., lead bricks) of the counting equipment will be provided. The DAEC low background radiation level criterion is intended to reduce personnel exposure and facilitate accurate sample counts.

2.3.2 Conclusion

With the completion of the PAS radiological analysis laboratory modifications, the DAEC is in compliance with the PAS radiological analysis laboratory requirements of NUREG 0737, Item II.B.3.

3.0 SUMMARY AND CONCLUSIONS

The PAS facilities (sample station and chemical and radiological analysis laboratories) were reviewed against the criteria of NUREG 0737, Item II.B.3. The designs of the PAS facilities were found to include the operational capabilities and design considerations required by this NRC position.

The results of this review demonstrate that, with the completion of the PAS modifications, the DAEC is in compliance with the requirements of NUREG 0737, Item II.B.3.

REFERENCES

1. General Electric Specification NEDC 24889 Sections 1 through 10

2. General Electric Letter, G-KE-2-067 dated May 5, 1982