Omaha Public Power District

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December 3, 1982
LIC-82-389

Mr. Robert A. Clark, Chief
U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Licensing
Operating Reactors Branch No. 3
Washington, D. C. 20555

Reference: Docket No. 50-285

Dear Mr. Clark:

NUREG-0737, Item II.B.3
Post Accident Sampling System

The Commission's letter to Omaha Public Power District dated July 14, 1982 provided clarification of criteria for the post accident sampling system required by NUREG-0737, Item II.B.3. This letter also requested the District to document how each of the criterion of NUREG-0737, Item II.B.3, were satisfied for the Fort Calhoun Station. Accordingly, please find attached the District's response to each of the specific criterion enclosed with the July 14, 1982 letter.

Sincerely,

W. C. Jones
Division Manager
Production Operations

WCJ/TLP:jmm

Attachment

cc: LeBoeuf, Lamb, Leiby & MacRae
1333 New Hampshire Avenue, N.W.
Washington, D.C. 20036

A046

POST ACCIDENT SAMPLING SYSTEM
NUREG-0737 ITEM II.B.3.
RESPONSE TO NRC LETTER DATED JULY 14, 1982

Criterion(1): The licensee shall have the capability to promptly obtain reactor coolant samples and containment atmosphere samples. The combined time allotted for sampling and analysis should be 3 hours or less from the time a decision is made to take a sample.

Clarification(1): Provide information on sampling(s) and analytical laboratories locations including a discussion of relative elevations, distances and methods for sample transport. Responses to this item should also include a discussion of sample recirculation, sample handling and analytical times to demonstrate that the three-hour time limit will be met (see (6) below relative to radiation exposure). Also describe provisions for sampling during loss of off-site power (i.e. designate an alternative backup power source, not necessarily the vital (Class IE) bus, that can be energized in sufficient time to meet the three-hour sampling and analysis time limit).

Response(1): General - The post accident sampling system, as depicted in the attached drawing No. 13007.54-EM-1A, is a remotely operated semi-automatic system designed with on-line analysis capabilities for obtaining data on a real time basis without the need to obtain grab samples for subsequent off-line analysis. In addition, sample flasks are provided as backup to the on-line equipment. The system was also designed for on-line Boron and Chloride analysis however, due to problems with the Ion Chromatograph, Boron and Chloride analysis will be done by taking a diluted sample and analyzing it in the chemistry lab. It should be noted that Boron and Chloride analysis can presently only be done on low activity, undiluted or slightly diluted samples to achieve required analysis accuracies. As discussed in our response to item 10, the District will have the complete sample and analysis capability once the Ion chromatograph is operational or other equipment will be procurred.

The system components which are used for the total dissolved gas, boron and chloride analysis of liquid samples are located in the existing sample room at El. 1007'. The system components which are used for diluting liquid, gas and pH samples are located in the gas compressor room at El. 989'. The Intrinsic Germanium Detectors and dilution loop Gross Gamma Detectors for liquid and gas isotopic analysis are located in the radwaste panel area adjacent to the gas compressor room. Control of the system is from the hot lab. Readout from the Gross Gamma Detector, Intrinsic Germanium Detectors, Ion chromatograph, pH cell, and the various pressure and temperature transmitters is provided in the hot lab. Both the hot lab and the rad waste panel areas are accessible in a post accident situation.

Liquid Samples - Liquid samples are introduced into the system from the Reactor Coolant System (RCS) or containment sump. The RCS pressure is used as the driving head to overcome sample system pressure drop for the RCS sample. The containment sump sample driving head is provided by the containment sump pumps up to the Post Accident Sample System. In the unlikely event this path should become plugged an alternate path is provided from the recirculation line of the HPSI pumps

through valve SL-159. The handle of this valve is extended into corridor, RM 4, from the sample room. (Corridor, RM 4, is accessible during accident conditions).

Samples are introduced into a dilution loop where any dissolved gases are removed and stored for subsequent analysis. The degassed liquid is diluted with demineralized water when necessary to reduce isotopic concentrations to levels suitable for analysis with an on-line Gamma Spectroscope. This is done by purging a sample through the loop and back to the reactor coolant drain tank within the containment until a representative sample is available for analysis. The sample, which is cooled by the sample coolers as it is introduced into the system, is reduced to 65 psig pressure as it enters the dilution loop.

Closure of the valve in the incoming line stops all flow and traps a sample of liquid in the dilution loop. Gas is released as the sample is depressurized if any dissolved gas is present. The recirculation pump is started and liquid samples are recirculated past the Gross Gamma Detector and through the gas separator tank allowing the gas to collect in the top of the tank. The difference in Gross Gamma measurement between the detector in the incoming line, downstream of the coolers and the detector in the recirculation pump discharge is the activity in the gas collected in the separator tank. Demineralized water is now introduced into the recirculation pump suction line and the isolation valve between the gas separator tank and vent trap is opened allowing the separated gas to vent to the gas collection tank. The recirculation pump is operated diluting the sample with demineralized water with the excess relieved to the containment by the back pressure regulator valve. When sample activity reaches a level suitable for performing spectroscopy, demineralized water flow is stopped and the sample recirculated through the part of the dilution loop containing the Intrinsic Germanium Detector. Gamma spectroscopy is then performed with the Intrinsic Germanium Detector. The results of this analysis are adjusted back to undiluted sample conditions by multiplying by the ratio of the undiluted degassed sample Gross Gamma reading to the diluted sample reading. The dilution loop and sample is then flushed back to the containment with demineralized water.

If a diluted grab sample is desired, a sample is obtained, degassed, and diluted as described above but collected in the sample collection flask, SL-18. Closing the flask isolation 3-way valves leaves the flask bypass open allowing the quick disconnects to be flushed. Uncontaminated demineralized water will then be released by the disconnects upon removal of the sample flask.

If a high pressure undiluted grab sample is desired, the sample is purged through the sample collection flask, SL-19, and flask bypass back to the containment until a representative sample is obtained. The isolation valve in the discharge line is closed and the sample pressurized to source pressure. The flask's 3-way isolation valves are then closed and the system flushed to the containment with demineralized water. The quick disconnects can then be released without a release of contaminated liquid. The sample flask is mounted inside a two (2) ton cast iron shield to protect the operator during the disconnect operation and sample transport.

Gas Samples - A containment atmosphere sample is withrawn by operating the gas pump in the flow stream passing the sample in front of the Gross Gamma Detector. When the detector reading stabilizes, a representative sample is available for analysis. The gas pump, a positive displacement pump, has a liquid separator and drain trap on the suction side to protect the pump from slugs of liquid. The sample lines are also heat traced to prevent volatiles from condensing on the lines causing inaccurate analysis. The sample is recirculated and diluted with Nitrogen until the gas activity has been reduced to a level appropriate for isotopic analysis. The dilution factor to be used in relating the analysis back to undiluted sample conditions is the ratio of original and final Gross Gamma readings including a gas density correction based on sample and containment temperatures and pressure.

In a fashion similar to the containment atmosphere sample, the gas stripped from the reactor coolant sample is introduced into the dilution loop from the gas collection tank by the gas pump. If the activity of the stripped gas is very high, an initial volumetric dilution can be made by expanding the gas in the gas collection tank to the dilution tank and then purging the dilution tank to the gas space of the drain collector tank. This step can be repeated as many times as desired before the gas is introduced into the dilution loop. This initial dilution factor is calculated based on collection and dilution tank volumes and number of cycles. This initial dilution will reduce the possibility of contaminating the sample tube being reviewed by the Gross Gamma Detector.

Final dilution of the sample and isotopic analysis is performed in the same manner as the containment atmosphere sample. After completion of analysis the loop is flushed with nitrogen back to the containment.

If either an undiluted or diluted grab sample of the containment atmosphere or stripped gas is desired, it is collected in the gas sample collection flask, SL-34. Closing the 3-way valves isolates the sample but allows flushing of the system and the quick disconnect fittings eliminating any activity release upon removal of the sample flask. A small dilution will unavoidably take place in collecting the sample. The density correction will have to be determined based upon temperature and pressure changes and applied to the analysis performed on the sample.

Sampling Time: Because of the availability of on line instrumentation and dilution capability, samples can be taken and analyzed in less than three (3) hours.

Loss of Offsite Power: Power for the PASS is provided by the vital motor control center 4C2 which is not load shed upon loss of offsite power. Remote operation of the sampling system also requires availability of the instrument air system. The compressors are connected to Class 1E Buses, but are load shed upon loss of offsite power. However, they can be restarted subject to availability of the diesel generators; thus, they can be energized to meet the three hour sample and analysis criteria.

Criterion(2): The licensee shall establish an onsite radiological and chemical analysis capability to provide, within three-hour time frame established above, quantification of the following:

(a) certain radionuclides in the reactor coolant and containment atmosphere that may be indicators of the degree of core damage (e.g., noble gases; iodines and cesiums, and nonvolatile isotopes);

(b) hydrogen levels in the containment atmosphere;

(c) dissolved gases (e.g., H_2), chloride (time allotted for analysis subject to discussion below), and boron concentration of liquids.

(d) Alternatively, have inline monitoring capabilities to perform all or part of the above analyses.

Clarification(2): (a) A discussion of the counting equipment capabilities is needed, including provisions to handle samples and reduce background radiation to minimize personnel radiation exposures (ALARA). Also, a procedure is required for relating radionuclide concentrations to core damage. The procedure should include:

1. Monitoring for short and long lived volatile and non-volatile radionuclides such as ^{133}Xe, ^{131}I, ^{137}Cs, ^{134}Cs, ^{85}Kr, ^{140}Ba, and ^{88}Kr.

   (See Vol. II, Part 2, pp. 524-527 of Rogovin Report for further information.)

2. Provisions to estimate the extent of core damage based on radionuclide concentrations and taking into consideration other physical parameters such as core temperature data and sample location.

(b) Show a capability to obtain a grab sample, transport and analyze for hydrogen.

(c) Discuss the capabilities to sample and analyze for the accident sample species listed here and in Regulatory Guide 1.97 Rev. 2.

(d) Provide a discussion of the reliability and maintenance information to demonstrate that the selected on-line instrument is appropriate for this application. (See (8) and (10) below relative to back-up grab sample capability and instrument range and accuracy).

Response(2): (a) For a discussion of sample handling and dilution provisions refer to Response 1. For information on background radiation refer to Response (9b)

As discussed in Response (1), on line instrumentation has been provided for performing isotopic analysis. The instrumentation used for this analysis consists of two (2) CANBERRA Pure Germanium Coaxial Detectors. The Gamma Spectroscopy equipment is capable of monitoring

for short and long lived volatile and nonvolatile radionuclides such as ^{133}Xe, ^{131}I, ^{137}Cs, ^{134}Cs, ^{85}Kr, ^{140}Ba, and ^{88}Kr.

A procedure for relating radionuclides concentrations to core damage is being written and will be provided to the commission by January 1, 1983.

(b) The containment Hydrogen monitoring requirements of NUREG-0737, Section II, F.1-3 are more stringent than the requirements of NUREG-0737, Item II.B.3. Therefore, this capability is provided for by redundant H_2 analyzers which remotely monitor the containment atmosphere from various sample extraction points located at various elevations throughout the containment.

(c) For Chloride analysis see Response (5).
For Boron analysis see Response (5).
For total dissolved gas analysis see Response (4).

Criterion(3): Reactor coolant and containment atmosphere sampling during post-accident conditions shall not require an isolated auxiliary system [e.g., the let down system, reactor water cleanup system (RWCUS)] to be placed in operation in order to use the sampling system.

Clarification(3): System schematics and discussion should clearly demonstrate that post accident sampling, including recirculation, from each sample source is possible without use of an isolated auxiliary system. It should be verified that valves which are not accessible after an accident are environmentally qualified for the conditions in which they must operate.

Response(3): As shown in Stone and Webster drawing No. 13007.54-EM-1A the Post Accident Sampling System is not tied into any auxiliary system and as such does not require operation of any other system except as noted in response to item 1.

Since NUREGS 0578 and 0737 do not require a safety grade system the Post Accident Sampling System was designed and constructed as a non-qualified, nonsafety-related system. With the exception of the containment isolation valves and valves which are directly tied into the safety related systems, none of the other valves were required to be qualified. No environmental test reports are, therefore, available. However, proper operation in the intended service condition was considered in the selection of various valves and good quality commercial grade valves were selected for this system.

Criterion(4): Pressurized reactor coolant samples are not required if the licensee can quantify the amount of dissolved gases with unpressurized reactor coolant samples. The measurement of either total dissolved gases or H_2 gas in reactor coolant samples is considered adequate. Measuring the O_2 concentration is recommended, but is not mandatory.

Clarification(4): Discuss the method whereby total dissolved gas or hydrogen and oxygen can be measured and related to reactor coolant system concentrations. Additionally, if chlorides exceed 0.15 ppm, verification that dissolved oxygen is less than 0.1 ppm is necessary. Verification that dissolved oxygen is <0.1 ppm by measurement of a dissolved hydrogen residual of $\geq$ 10 cc/kg is acceptable for up to 30 days after the accident. Within 30 days, consistent with minimizing personnel radiation exposures (ALARA), direct monitoring for dissolved oxygen is recommended.

Response(4): As described below, on line capability has been provided for measurement of total dissolved gases.

To sample for total dissolved gas in the reactor coolant system, the sample cooler is bypassed and the sample collected at a temperature as close to source temperature as possible. A measurement of total dissolved gas in reactor coolant is made by collecting a representative sample in the high pressure sample flask SL-20 of the dissolved gas analyzer apparatus SL-24. After the sample is collected, it is released to the first and second expanded sample flask depending upon the resulting pressure. The waterbath is then filled and the sample allowed to reach a uniform temperature. The amount of gas originally dissolved in the sample is then calculated using the PV=NRT ideal gas law (assuming that the gas is Hydrogen). The degassed liquid in the apparatus is then drained to the collection vessel for further chemical analysis or to the drain collector tank for disposal back to the containment. The apparatus is then flushed and drained in preparation for the next analysis. A high pressure undiluted sample can be taken in sample flask SL-19 as a backup to the automatic gross dissolved gas analyzer.

No on line provisions were made to determine O_2, as this is an optional requirement.

Criterion(5): The time for a chloride analysis to be performed is dependent upon two (2)factors: (a) if the plant's coolant water is seawater or brackish water and (b) if there is only a single barrier between primary containment systems and the cooling water. Under both of the above conditions the licensee shall provide for a chloride analysis within 24 hours of the sample being taken. For all other cases, the licensee shall provide for the analysis to be completed within 4 days. The chloride analysis does not have to be done onsite.

Clarification(5): BWR's on sea or brackish water sites, and plants which use sea or brackish water in essential heat exchangers (e.g. shutdown cooling) that have only single barrier protection between the reactor coolant are required to analyze chloride within 24 hours. All other plants have 96 hours to perform a Chloride analysis. Samples diluted by up to a factor of one thousand (1000) are acceptable as initial scoping analysis for chloride, provided (1) the results are reported as _____ ppm Cl (the licensee should establish this value; the number in the blank should be no greater than 10.0 ppm Cl) in the reactor

coolant system and (2) that dissolved oxygen can be verified at <0.1 ppm, consistent with the guidelines above in clarification (4). Additionally, if chloride analysis is performed on a diluted sample, an undiluted sample need also be taken and retained for analysis within 30 days, consistent with ALARA.

Response(5): With the new Post Accident Sampling System the Boron and Chloride analysis was to be performed on line using an Ion Chromatograph. However, due to design and operational problems with the Ion Chromatograph it is currently not available for use. For that reason Boron and Chloride samples will be taken and analyzed manually. The sample is obtained, degassed, and diluted as described in Response (1) and then collected in sample flask SL-18 in Room 4a. The sample is then taken to the hot lab and analyzed using titration. Once the problems encountered with the Ion Chromatograph are resolved, the following method of analysis for Boron and Chloride will be used. As shown on Stone and Webster Drawing No. 13007.54-EM-1A, a high pressure undiluted sample is flushed through the gross dissolved gas analyzer (SL-24) until a representative sample is in SL-20. The flask is then isolated and expanded into SL-21 and if necessary SL-22. The sample is cooled using the water bath in SL-24 and then sent to the Ion Chromatograph (SL-25) where the Chloride and Boron levels are measured. Then the system is flushed to the Containment Reactor Coolant Drain Tank with demineralized water.

Criterion(6): The design basis for plant equipment for reactor coolant and containment atmosphere sampling and analysis must assume that it is possible to obtain and analyze a sample without radiation exposures to any individual exceeding the criteria of GDC 19 (Appendix A, 10 CFR Part 50) (i.e., 5 rem whole body, 75 rem extremities). (Note that the design and operational review criterion was changed from the operational limits of 10 CFR Part 20 (NUREG-0578) to the GDC 19 criterion (October 20, 1979 letter from H. R. Denton to all licensees.)

Clarification(6): Consistent with Regulatory Guide 1.3 or 1.4 source terms, provide information on the predicted personnel exposures based on personmotion for sampling, transport and analysis of all required parameters.

Response(6): The Post Accident Sampling System, as depicted in Drawing No. 13007.54-EM-1A, is a remote operated semi-automatic system designed with on-line analysis capabilities for obtaining data on a real time basis without the necessity of obtaining grab samples for subsequent off-line analysis. However, sample flasks are provided as backup to the on-line equipment. As it is a remote operated system, the exposure, when all the on-line equipment is working, is negligible. If a grab sample is needed it can be diluted to any fraction of the original concentration to reduce exposure to an acceptable level.

Exposure to individuals requiring access to vital areas for the purpose of obtaining grab samples will not exceed the limits of GDC 19. Radiation level calculations have been done using the source terms of Regulatory Guide 1.4; the following table provides information regarding the predicted personnel exposure.

ACTIVITY	LOCATION	BACKGROUND RADIATION LEVEL (POST-LOCA)	ESTIMATED EXPOSURE TIME	EXPOSURE
On Line Sampling	Radiochemistry Lab	28 mR/Hr	180 Min	84 mR
Diluted Liquid Grab Sample	Rad. Waste Control PNL Area (El. 989')	57 mR/Hr	10 Min	10 mR
Diluted Gas Grab Sample	Rad. Waste Control PNL Area (El. 989')	57 mR/Hr	10 Min	10 mR
Pressurized Undiluted Grab Sample	Corridor 26 @ Col. Lines T & 6e (El.1007')	500 mR/Hr	30 Min	250 mR

Criterion(7): The analysis of primary coolant samples for boron is required for PWRs. (Note that Rev. 2 of Regulatory Guide 1.97 specifies the need for primary coolant Boron analysis capability at BWR plants).

Clarification(7): PWR's need to perform boron analysis. The guidelines for BWR's are to have the capability to perform boron analysis but they do not have to do so unless boron was injected.

Response(7): The Boron sample is analyzed the same way as the Chloride sample. See the response (5).

Criterion(8): If inline monitoring is used for any sampling and analytical capability specified herein, the licensee shall provide backup sampling through grab samples, and shall demonstrate the capability of analyzing the samples. Established planning for analysis at offsite facilities is acceptable. Equipment provided for backup sampling shall be capable of providing at least one sample per day for 7 days following onset of the accident, and at least one sample per week until the accident condition no longer exists.

Clarification(8): A capability to obtain both diluted and undiluted backup samples is required. Provisions to flush inline monitors to facilitate access for repair is desirable. If an offsite laboratory is to be relied on for the backup analysis, an explanation of the capability to ship and obtain analysis for one sample per week thereafter until accident condition no longer exists should be provided.

Response(8): Both diluted and undiluted backup samples of liquid and gas samples can be obtained. By using a diluted sample any analysis that needs to be done can be done using the normal inplant equipment without excessive exposure to the personnel doing the analysis. In addition, the District has an agreement with Nebraska Public Power District (NPPD) for use of analytical equipment available at the Cooper Nuclear Station (CNS) in case of an emergency.

All instruments in the PASS can be remotely flushed to reduce exposure during any repair work.

No arrangements have been made for offsite analysis of high pressure, undiluted samples. However, backup sampling equipment has been provided for obtaining diluted grab samples. This equipment can be used for providing at least one sample per day for seven (7) days following onset of the accident, and at least one sample per week until the accident condition no longer exists.

Criterion(9): The licensee's radiological and chemical sample analysis capability shall include provisions to:

(a) Identify and quantify the isotopes of the nuclide categories discussed above to levels corresponding to the source terms given in Regulatory Guide 1.3 or 1.4 and 1.7. Where necessary and practicable, the ability to dilute samples to provide capability for measurement and reduction of personnel exposure should be provided. Sensitivity of onsite liquid sample analysis capability should be such as to permit measurement of nuclide concentration in the range from approximately 1μ Ci/g to 10 Ci/g.

(b) Restrict background levels of radiation in the radiological and chemical analysis facility from sources such that the sample analysis will provide results with an acceptably small error (approximately a factor of 2). This can be accomplished through the use of sufficient shielding around samples and outside sources, and by the use of a ventiltion system design which will control the presence of airborne radioactivity.

Clarification(9)(a): Provide a discussion of the predicted activity in the samples to be taken and the methods of handling/dilution that will be employed to reduce the activity sufficiently to perform the required analysis. Discuss the range of radionuclide concentration which can be analyzed for, including an assessment of the amount of overlap between post accident and normal-sampling capabilities.

(b) State the predicted background radiation levels in the counting room, including the contribution from samples which are present. Also, provide data demonstrating what the background radiation levels and radiation effect will be on a sample being counted to assure an accuracy within a factor of 2.

Response(9)(a): The expected specific activity in the sample is in the range of 1.9 μCi/g (Normal Operating) to 3.8 Ci/g (Post-LOCA). The Post LOCA reactor coolant specific activity is based on a postulated LOCA in which the primary system remains pressurized and 100% of core noble gases, 50% of core halogens, and 1% of core solids are released into the primary system. (Reg. Guide 1.4 source terms)

For the methods of handling and diluting the samples, refer to response 1.

The range of radionuclide concentrations which can be measured by the Gross Gamma Detectors is from 0.37 μCi/g (0.1 mR/HR detector reading, based on normal operating radionuclide spectrum) to 53 Ci/g (10,000 R/HR detector reading, based on post-accident radionuclide spectrum). The Intrinsic Germanium detector can analyze radionuclide concentrations at approximately 1μCi/g.

The amount of overlap between post-accident and normal-sampling capability for the Gross Gamma Detectors is discussed below:

The Gross Gamma Detectors are designed to operate from 0.1 mR/HR to 10,000 R/HR. Each Gross Gamma Detector utilizes two (2) GM tubes to cover the required range. The low range tube is used from 0.1 mR/HR to 250 mR/HR and the high range tubes is used from 250 mR/HR to 10,000 R/HR. The actual range for the low range tube is from 0.1 mR/HR to 1 R/HR and the actual range for the high range tube is from 0.1 R/HR to 10,000 R/HR, therefore there is one decade of overlap between the two tubes.

Response(9)(b): The background radiation level in the counting room will not exceed 28 mR/HR (contribution from outside sources at zero (0) hour after LOCA). The background contribution from samples which are present in the counting room will be minimal since the samples are diluted and shielded. The accuracy within a factor of two (2) is assured since the background radiation level in the counting room is low.

The background radiation level in the radwaste control area, where the Gross Gamma and the Intrinsic Germanium detectors are located, will not exceed 57 mR/HR (contribution from outside sources at zero (0) hour after LOCA). The background radiation within the Gross Gamma and the Intrinsic Germanium detectors will not exceed 2.0 mR/HR and 0.1 mR/HR respectively. Since the background radiation within the detectors is low, specifically the intrinsic germanium detectors, the accuracy within a factor of two (2) is assured.

Criterion(10): Accuracy, range, and sensitivity shall be adequate to provide pertinent data to the operator in order to describe radiological and chemical status of the reactor coolant systems.

Clarification(10): The recommended ranges for the required accident sample analyses are given in Regulatory Guide 1.97, Rev. 2. The necessary accuracy within the recommended ranges are as follows:

- Gross activity, gamma spectrum: measured to estimate core damage, these analyses should be accurate within a factor of two (2) across the entire range.

- Boron: measure to verify shutdown margin.

In general this analysis should be accurate within ±5% of the measured value (i.e., at 6,000 ppm B the tolerance is ±300 ppm while at 1,000 ppm B the tolerance is ±50 ppm). For concentrations below 1,000 ppm the tolerance band should remain at ±50 ppm.

- Chloride: measured to determine coolant corrosion potential.

For concentrations between 0.5 and 20.0 ppm Chloride the analysis should be accurate within ±10% of the measured value. At concentrations below 0.5 ppm the tolerance band remains at ±0.05 ppm.

- Hydrogen or Total Gas: monitored to estimate core degradation and corrosion potential of the coolant.

An accuracy of ±10% is desirable between 50 and 2000 cc/kg but ±20% can be acceptable. For concentration below 50 cc/kg the tolerance remains at ±5.0 cc/kg.

- Oxygen: monitored to assess coolant corrosion potential.

For concentrations between 0.5 and 20.0 ppm oxygen the analysis should be accurate within ±10% of the measured value. At concentrations below 0.5 ppm the tolerance band remains at ±0.05 ppm.

- pH: measured to assess coolant corrosion potential.

Between a pH of 5 to 9, the reading should be accurate within ±0.3 pH units. For all other ranges ±0.5 units is acceptable.

To demonstrate that the selected procedures and instrumentation will achieve the above listed accuracies, it is necessary to provide information demonstrating their applicability in the post accident water chemistry and radiation environment. This can be accomplished by performing tests utilizing the standard test matrix provided below or by providing evidence that the selected procedure or instrument has been used successfully in a similar environment.

STANDARD TEST MATRIX
FOR UNDILUTED REACTOR COOLANT SAMPLES
IN A POST-ACCIDENT ENVIRONMENT

Constituient	Nominal Concentration (ppm)	Added as (chemical salt)
I^-	40	Posassium Iodide
Cs^+	250	Cesium Nitrate
Ba^{+2}	10	Barium Nitrate
La^{+3}	5	Lanthanum Chloride
Ce^{+4}	5	Ammonium Cerium Nitrate
Cl^-	10	
B	2000	Boric Acid
Li^+	2	Lithium Hydroxide
NO^-_3	150	
NH^+_4	5	
K^+	20	
Gamma Radiation (Induced Field)	10^4 Rad/g of Reactor Coolant	Absorbed Dose

NOTES:

1) Instrumentation and procedures which are applicable to diluted samples only, should be tested with an equally diluted chemical test matrix. The induced radiation environment should be adjusted commensurate with the weight of actual reactor coolant in the sample being tested.

2) For PWRs, procedures which may be affected by spray additive chemicals must be tested in both the standard test matrix plus appropriate spray additives. Both procedures (with and without spray additives) are required to be available.

3) For BWRs, if procedures are verified with boron in the test matrix, they do not have to be tested without boron.

4) In lieu of conducting tests utilizing the standard test matrix for instruments and procedures, provide evidence that the selected instrument or procedure has been used successfully in a similar environment.

All equipment and procedures which are used for post accident sampling and analyses should be calibrated or tested at a frequency which will ensure, to a high degree of reliability, that it will be available if required. Operators should receive initial and refresher training in post accident sampling, analysis and transport. A minimum frequency for the above efforts is considered to be every six months if indicated by testing. These provisions should be submitted in revised Technical Specifications in accordance with Enclosure 1 of NUREG-0737. The staff will provide model Technical Specifications at a later date.

Response(10): Most of the instrumentation for Post Accident Sampling System (PASS) was ordered before Reg. Guide 1.97, Rev. 2 was issued. The instrumentation has been procured per the requirements of NUREG-0578 and NUREG-0737 which allowed use of commercial grade equipment. The following table summarizes the required information for PASS instrumentation.

DESCRIPTION	REQUIREMENTS PER REG. GUIDE 1.97	RANGE/ACCURACY OF THE PROVIDED INSTRUMENTATION
A. Primary Coolant & Sump		
1. Gross Activity		
- Range	*10 μ Ci/cc to 10 Ci/cc	.37 μCi/cc to 53 Ci/cc
- Accuracy	within a factor of two	±20%
2. Gamma Spectrum		
- Range	Isotopic Analysis	CANBERRA Intrinsic Germanium Detectors have been provided to perform isotopic analysis. This equipment has at least 10% relative efficiency, ≤ 1.0 KeV (FWHM) Resolution at 122 KeV, ≤ 2.0 KeV (FWHM) Resolution at 1.33 MeV, and ≥ 38.1 Peak to Compton Ratio at 1.33 MeV. Overall system accuracy data is not available.
- Accuracy	within a factor of two	
3. Boron		
- Range	0 - 6000 ppm	
- Accuracy	± 5% for ≥ 1000 ppm ± 50 ppm for @1000 ppm	See note 1
4. Chloride		
- Range	0 - 20 ppm	
- Accuracy	± 10% for 0.5 to 20 ppm ± 0.05 ppm for < 0.5 ppm	See note 1
5. Total Gas		
- Range	0 to 2000 cc (STP)/Kg	0 to 1350 cc/Kg
- Accuracy	± 10% for 50 to 2000 cc/Kg ± 5 cc/Kg for < 50 cc/Kg	±5%
6. Oxygen	Optional	No provisions have been made for O_2 analysis.
7. pH		
- Range	.1 to 13 pH units	0 to 14 pH units
- Accuracy	± 0.3 in the range of 5 to 9 ± 0.5 in the remaining	0.1 for 5 to 9 0.5 for the remaining

*NUREG-0737 requires a range of 1 μCi/cc to 10 Ci/cc.

B.	Containment Atmosphere		
1.	Hydrogen Content	0 to 10%	0 to 10%
2.	Gamma Spectrum	Isotopic Analysis	CANBERRA Intrinsic Germanium Detectors have been provided to perform isotopic analysis. This equipment has at least 10% relative efficiency, $\leq$ 1.0 KeV (FWHM) Resolution at 122 KeV, $\leq$ 2.0 KeV (FWHM) Resolution at 1.33 MeV, and $\geq$ 38.1 Peak to Compton Ratio at 1.33 MeV. Overall system accuracy data is not available.

NOTE 1: As discussed in response (1) Boron and Chloride analysis was originally intended to be done by using Ion Chromatograph. However, this instrument is not operational and Boron and Chloride analysis is now planned to be done manually on a diluted sample using titration equipment available in the chemistry lab. Normally this analysis can be done within an accuracy range of ± 5%. However, if the reactor coolant sample is highly radioactive and requires a dilution by a significant factor, this will reduce Boron or Chloride concentrations by a similar factor also. This dilution will reduce the accuracy of Boron and Chloride analysis. The District is still working on resolving problems associated with the Ion Chromatograph; if this does not work, we will investigate the possibility of installing alternate equipment per the requirements of NUREG-0737.

Testing: Extensive pre-operational testing has been performed to demonstrate proper functioning of the Post Accident Sampling System. The objective of the pre-operational testing was to demonstrate that:

1. The PASS can obtain liquid and gas samples per the requirements of NUREG-0737.

2. The samples can be diluted to required levels, using remote operated equipment.

3. Total Gas Analysis can be performed for post accident conditions per the requirements of NUREG-0737.

4. The pH Cell can function properly within the required range; however, the District is still having problems calibrating this meter but is confident the vendor can resolve this problem.

Boron and Chloride analysis: This will be performed by using the existing lab equipment.

Gross Activity: This will be done using Gross Gamma Detectors supplied by Technology for Energy Corp. (TEC). These monitors have been tested by the vendor at the Georgia Institute of Technology to verify their operation in the required range.

Isotopic Analysis: Similar Ge(Li) detectors have been used at Fort Calhoun Station for performing iotopic analysis for several years. The Ge(Li) detectors for the PASS will be located in a low background area which is accessible during post-accident condition. The sample can be diluted through the dilution loop to an acceptable concentration level. The complete system will be tested using reactor coolant sample before declaring PASS fully operational.

Criterion(11): In the design of the post accident sampling and analysis capability, consideration should be given to the following items:

(a) Provisions for purging sample lines, for reducing plateout in sample lines, for minimizing sample loss or distortion, for preventing blockage of sample lines by loose material in the RCS or containment, for appropriate disposal of the samples, and for flow restrictions to limit reactor coolant loss from

a rupture of the sample line. The post accident reactor coolant and containment atmosphere samples should be representative of the reactor coolant in the core area and the containment atmosphere following a transient or accident. The sample lines should be as short as possible to minimize the volume of fluid to be taken from containment. The residues of sample collection should be returned to containment or to a close system.

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

Clarification(11) (a): A description of the provisions which address each of the items in clarification mo.11a should be provided. Such items, as heat tracing and purge velocities, should be addressed. To demonstrate that samples are representative of core conditions a discussion of mixing, both short and long term, is needed. If a given sample location can be rendered inaccurate due to the accident (i.e. sampling from a hot or cold leg loop which may have a steam or gas pocket) describe the backup sampling capabilities or address the maximum time that this condition can exist.

BWR's should specifically address samples which are taken from the core shroud area and demonstrate how they are representative of core conditions.

Passive flow restrictors in the sample lines may be replaced by redundant, environmentally qualified, remotely operated isolation valves to limit potential leakage from sampling lines. The automatic containment isolation valves should close on containment isolation or safety injection signals.

(b): A dedicated sample station filtration system is not required, provided a positive exhaust exists which is subsequently routed through charcoal absorbers and HEPA filters.

Response(11) (a): Stone and Webster drawing No. 13007.54-EM-1A shows the flushing connections in the PASS. To prevent plateout in the sample lines the following is done. The containment atmosphere sample inlet line and gas dilution loop are heat traced. The gas dilution loop is also flushed with nitrogen after each use.

The use of sample purging ensures that the samples will be undistorted. Timers on the containment isolation override switches limit the amount of sample that could spill if there was a line rupture. Blockage can be prevented by flushing.

If a line does become plugged an alternate sample point can be used. All sample residue is returned to containment.

Samples can be taken from both hot legs, the pressurizer steam space, and pressurizer surge line. Containment sump samples can also be taken from the HPSI pumps recirculation line. This will take care of any sampling problems caused by steam or gas pockets. The isolation valves for the PASS are redundant, environmentally qualified, and remotely operated. They close on CIAS (containment isolation actuation signal).

(b): The ventilation exhaust for the sampling room and the waste gas compresser room (where most of the PASS equipment is located) is part of the auxiliary building ventilation system. This system has HEPA filters but no charcoal adsorbers. However, the inlet and outlet to the above rooms can be isolated remotely from the control room.