EVALUATION OF THE

POST ACCIDENT SAMPLING SYSTEM

FOR THE

PERRY NUCLEAR POWER PLANT

Prepared by

The Cleveland Electric Illuminating Company

July 1983

ATTACHMENT NO. 1 TO
POST ACCIDENT SAMPLING SYSTEM
NUREG-0737, II.B.3 EVALUATION
CRITERIA GUIDELINES

In July 1982 the U.S. Nuclear Regulatory commission (NRC) issued Attachment No. 1 to the Post Accident Sampling System (NUREG-0737, Item II.B.3). Attachment No. 1 presented guidelines that the NRC staff will use in reviewing the design of a Post Accident Sampling System (PASS).

This report addresses The Cleveland Electric Illuminating Company's (CEI) conformance to the criteria guidelines presented in Attachment No. 1 to NUREG-0737. The enclosed Sentry Equipment Corp. (SEC) topical report is to supplement this report.

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: Provide information on sampling(s) and analytical laboratories locations including a discussion of relative elevations, distances and methods for sample transport. Response 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 Criterion (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

The Post Accident Sampling System provides remote monitoring capability in the event of a loss-of-coolant accident. The system is manually controlled by an operator from the Process Control/Monitor Panel located adjacent to the Grab Sample Panels (GSP) and the Chemical Analysis Panel (CAP). There are two GSPs, one for each Unit. These are located in the Intermediate Building at Elevation 574'-10" next to the Control Complex. Refer to System Diagrams D-302-431 and D-352-431 (attached).

A liquid sample stream drawn from a selected sample location is passed through a cooler rack to the Grab Sample Panel. Five different sample streams can be collected for analysis. Dissolved gases are extracted and analyzed locally by the in-line dissolved hydrogen and total dissolved gas analyzer module. The extracted gases are also collected in a sample bottle for laboratory analysis. A depressurized, degassed liquid stream is directed to the Chemical Analysis Panel (CAP) for pH, specific conductivity, and dissolved oxygen analysis. A

1000:1 diluted liquid sample is collected for on-site gamma spectrum analysis in the station laboratory and an undiluted liquid sample is collected for off-site boron analysis. See SEC's Report, Section 3.1, for liquid and off-gas sampling times.

An atmospheric sample from any one of the four selected sample locations is drawn to the Grab Sample Panel. It is collected inside a sample bottle inside a tong for on-site analysis in the station laboratory for oxygen, gamma spectrum and backup hydrogen analysis.

The elapsed time to capture an atmospheric sample is 4.5 minutes from start. This includes all necessary valve line-ups and purging. Continued purging to complete the cycle takes a total elapsed time of 15 minutes.

Demineralized water is supplied to the GSP and CAP for decontamination of the GSP and CAP plenums, flushing of liquid sample lines, and dilution of liquid samples. Nitrogen is supplied to the GSP's and CAP for drying of the sample lines and various components, and purging of gas sample lines. The GSP and CAP panels and tubing are essentially decontaminated after each sample.

The sample bottles for laboratory analysis are transported in metal tongs form the Grab Sample Panel in the Intermediate Building to the laboratory in the Control Complex. The total distance traversed is 300 feet which includes going from Elevation 574'-10" where the GSP panels are located to the laboratory in the Control Complex at Elevation 599'-0". Access to the upper elevation is either by stairs or the Control Complex elevator which is powered

from diesel backed motor control centers. The panel has battery inverters that supply 120V backup power when needed (during loss of off-site power).

The undiluted sample (in a 500 lb. mobile shielded cask) for off-site analysis would follow the same route up the elevator but to grade Elevation 620'-6". At this elevation, the sample would be moved either to the truck bay in the Radwaste Building or the machine shop truck doors in the Service Building. Total traversed distance including elevation is a maximum of 425 feet. (See Attachment No. 1.)

Sample transport time from the GSP to the in-plant laboratory is a maximum of 10 minutes. Transport time to the machine shop truck doors or Radwaste Building truck bay is 8 minutes.

The following are estimated times required to perform onsite laboratory analyses:

- Boron content of reactor water: Approximately 1 hour is required to perform this analysis.

- Gamma spectrum and gross activity of containment air. Twenty minutes is required to perform each of these analyses.

- Oxygen content of containment air: Approximately 1 hour is required to perform this analysis.

- Hydrogen content of containment air: The analysis of hydrogen should take about 10 minutes.

The route used to transport the chloride detector from the analytical lab to the sample room is the same route used in transporting samples (see Attachment No. 1). The time required to transport and prepare the detector for analysis is approximately 20 minutes.

The maximum amount of time required to perform all of the above analyses, including the transportation and preparation of the chloride detector, is 1 hour and 15 minutes. This time of 1 hour and 15 minutes in combination with the sample transport time of 10 minutes and the sampling duration time of approximately 1-1/2 hours (from SEC's Report, Section 3.1) gives a total of 2 hours and 55 minutes. This total time of 2 hours and 55 minutes, allotted for sampling and analysis, is within the 3 hour time limit.

Criterion: (2) The licensee shall establish an on-site radiological and chemical analysis capability to provide, within three-hour time frame established in Criterion (1), 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 in-line 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 nonvolatile 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.

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

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

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 Criterions (8) and (10) relative to back-up grab sample capability and instrument range and accuracy].

Response

(a) The radiological analysis of liquid and containment air samples will be performed using twin DEC PDP/1144 computers in conjunction with two Canberra Series 85 multi-channel analyzers. The time required to perform each of these analyses is approximately twenty minutes. (See Attachments 2 and 3.)

A procedure for relating radionuclide concentrations to core damage will be written in accordance with the generic General Electric Procedures for the Determination of the Extent of Core Damage Under Accident Conditions (NEDO-22215, see Attachment 4).

(b) The analysis of hydrogen in the containment air is accomplished with in-line instrumentation. There are two Comsip hydrogen analyzers that give readings within ten minutes after receiving the gas.

See SEC's Report, Section 3.2.(b) and CEI's Response to Criterion (1) for additional information in meeting this criterion.

(c) The following discussion involves the capability to sample and analyze the following sample species:

Primary Coolant

- Gross Activity

  A 1000:1 diluted sample will be counted for gamma activity on a single channel anaylzer.

- Gamma Spectrum

  A 1000:1 diluted sample will be counted on Canberra gamma spectrum equipment.

- Boron Content

  A diluted boron sample will be analyzed on an ion chromatograph.

Containment Air

- Oxygen Content

  A grab sample from the Sentry panel will be analyzed with a gas chromatograph.

- Gamma Spectrum

  A grab sample from the Sentry panel will be analyzed on Canberra gamma spectrum equipment.

See SEC's Report, Section 3.2(c), for additional information in meeting this criterion.

(d) See SEC's Report, Section 3.2(d), for information in meeting this criterion.

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

Clarification: System schematics and discussions 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

All atmospheric samples withdrawn from containment or the annulus are removed by a nitrogen gas powered vacuum eductor which will draw the samples from containment and return the sample to containment, regardless of containment atmosphere pressure. The nitrogen gas is supplied by storage bottles which are a dedicated part of and adjacent to the Post Accident Sampling System panels.

The reactor coolant samples are taken from the jet pump calibration lines which are under reactor pressure. The reactor pressure drives the sample to the sampling station and discharges it to the suppression pool. When the reactor pressure decays to insufficient pressure, the RHR system will be operational and provide the reactor coolant samples.

The drywell sump and suppression pool post accident sample pumps are part of the post accident sampling system and are independent of any other systems.

All remotely actuated valves in the post accident sampling system are safety-related class electric solenoid valves and have been environmentally qualified. The post accident sampling pumps are constructed in accordance with N-Stamping requirements and are seismically qualified.

The sampling station is centrally located at a low elevation to utilize available static head to assist sample transmission.

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: 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 less than or equal to 0.1 ppm by measurement of a dissolved hydrogen residual of greater than or equal to 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

See SEC's Report, Section 3.4, for information in meeting this criterion.

Criterion: (5) The time for a chloride analysis to be performed is dependent upon two 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 four days. The chloride analysis does not have to be done onsite.

Clarification: 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 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 less than 0.1 ppm, consistent with the guidelines above in clarification No. 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

See SEC's Report, Section 3.5, for information in meeting this criterion.

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, 10CFR, 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 10CFR, Part 20 (NUREG-0578) to the GDC 19 criterion (October 30, 1979, letter from H. R. Denton to all licensees].

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

Response

The following are estimated dose rates that will be received by the operator during transport and analysis. Estimates are based upon SEC's Report, Appendix III, Section 15.0, Sample Radiochemistry Design Parameters. All estimated times and doses are based on performing sample manipulations with eighteen inch tongs and with worst case sample activities.

Primary Coolant (after one hour)

- Gross Activity and Gamma Spectrum

The whole body dose received in an estimated ten minute period is 0.554 millirems. The extremity dose in this time period is 178.9 millirmes.

- Boron Content

The whole body dose received in an estimated thirty minute period is 0.169 millirems. The extremity dose in this time is 354 millirems.

Sump (after one hour)

- Gross Activity and Gamma Spectrum

The whole body dose received in an estimated ten minute period will be 0.017 millirems. The extremity dose received in this same period of time will be 0.068 millirems.

Containment Air

- Oxygen Content

The whole body dose received in an estimated thirty minute period will be 0.414 millirems. The extremity dose received in this same period of time will be 385.9 millirems.

- Gamma Spectrum

The whole body dosage received in an estimated ten minute period will be 0.046 millirems. The extremity dose received in this same period of time will be 0.184 millirems.

The dosage received from an undiluted sample transported in a pig for a ten minute time period will be 0.0001085 millirems.

See SEC's Report, Section 3.6, for predicted exposures during sampling.

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: 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

A diluted boron sample will be analyzed on a Dionex Model 2010I ion chromatograph. To prepare the sample for analysis on this equipment, it is converted to a common BF_4^- ion with hydrofluoric acid.

Criterion: (8) If in-line 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 off-site facilities is acceptable. Equipment provided for backup sampling shall be capable of providing at least one sample per day for seven days following onset of the accident and at least one sample per week until the accident condition no longer exists.

Clarification: A capability to obtain both diluted and undiluted backup samples is required. Provisions to flush in-line monitors to facilitate access for repair is desirable. If an off-site 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

The following is a discussion of the procedures that will be used as backup to the in-line instrumentation:

Primary Coolant

- Chloride Content

  The analysis method is equivalent tc the primary one. The coolant sample, however, will be manually injected into a set of Dionex 2010I columns.

- Dissolved Oxygen

  The analysis method is equivalent to the primary one. An Orbisphere dissolved oxygen analyzer will be connected to the grab sample spigot of the Sentry panel.

- pH

  An in-line pH analyzer will be connected to the grab sample spigot of the Sentry panel.

Containment Air

- Hydrogen Content

  A grab sample from the Sentry panel will be analyzed with a gas chromatograph.

See SEC's Report, Section 3.8, for additional information in meeting this criterion.

As discussed in Criterion (1), an off-site laboratory is relied on only for boron analysis of an undiluted liquid sample.

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 on-site 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 ventilation 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.

(9) (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

(a) The dilution of samples is performed manually in the Sentry panel by the operator. Dilution factors up to a 1000:1 can be achieved.

The gamma spectrum system can analyze samples up to 1mCi on the detector face with acceptable results. By increasing the distance between the source and the detector readings up to 10Ci can be analyzed with acceptable results.

There is some overlap between post accident and normal sampling capabilities in that the Canberra gamma spectrum system will also be used for routine analysis.

(b) The predicted background radiation levels in the counting room are predicted to be a maximum of fifteen millirems/hour. Samples will be located outside of the counting room behind a two-foot thick wall. Therefore, virtually no increase in background radiation will be contributed by the sample. Additionally, all samples will be counted within a lead counting pig.

The background radiation should have no effect on the counting accuracy. The normal practice is to count for a 95% confidence level (i.e., 2 sigma).

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: 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 will be accurate within a factor of two 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 pH 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	Potassium 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/gm of Reactor Coolant	Adsorbed 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

The following is a discussion of the accuracy of the instruments used to perform the required analyses:

- Gross Activity and Gamma Spectrum

  The gamma spectrum system has been tested using nontraceable sources and has performed well within the required range. The normal practice for this system is to count for a 95% confidence level (i.e., 2 sigma).

  This piece of equipment is in a counting room exposed only to the radiation of the source. Therefore, there are no added effects on the instrument in the post accident condition.

- Boron

Although the procedure to measure boron has not been tested, ion chromatograph generally gives high accuracy results. Obtaining of accuracy within ±5% of the measured value is expected. This instrumentation also sees no special effects during post accident conditions.

Since the above instruments will be used to do routine analysis, calibration frequency should be more than adequate.

Chemistry technician training will be conducted at a frequency to ensure safe and efficient operation. This will follow the program provided by Sentry for the operation of the PASS panel.

See SEC's Report, Section 3.10, for further discussion in meeting this criterion.

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 closed 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 11.a 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 an demonstrate how they are representative of core conditions.

Passive flow restrictions 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.

(11) (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

Each liquid sample line has a mixed-bed demineralizer water purge connection located as close as practicable to the sample point. Purging and flushing of the sample line is initiated before and after each sampling. At the start of sampling the sample line is purged at seven times the normal sampling rate with the sample itself before a sample is taken for analysis. After sampling, the sample line is flushed with demineralized water at seven times the normal sampling rate for an appropriate period of time.

Flushing and purging is done at a fully turbulent flow rate which prevents particulate settling and plateout. The two reactor water samples are taken from the jet pump calibration lines downstream of the flow restricting orifices which control discharge in the event of a break. Each sample is approximately 180° apart from the other and good representation of the sample is assured by the fact that the reactor water is taken from inside the reactor.

All sampling tubing is Type 304L stainless steel with long radius bends and welded connections.

Each containment atmosphere sample line is heat traced and insulated from the containment to the sample panel. Temperature of the sample line is thermostatically controlled above the highest dew point temperature of containment atmosphere. At the start of sampling, the sample line is purged by inducing a sample flow in the sampling panel by means of a nitrogen gas powered eductor. The educted sample is returned to containment. After a

sample is obtained, the sample line is backpurged to the sample point with nitrogen. The purge and backpurge velocity of the sample lines exceeds 10 feet/second. Since the sample line is maintained above the highest possible dew point of the containment atmosphere, no condensation is possible in the line. The sample line is then backpurged with dry nitrogen gas to clear it of any particulate settlement.

The containment atmosphere samples are taken from existing sample points in the hydrogen analysis system. Namely, one point from the top of containment, one point from just above the top of the reactor, one point from above the suppression pool and one point from the annulus atmosphere near the top of the annulus.

Both grab sample panels and the chemical analysis panel are connected to and ventilated by the station ventilation system which contains charcoal absorbers and HEPA filters.

Blockage of sample lines by loose material is minimized by the fact that all liquid samples are drawn from lines that have in-line upstream strainers. The exception is the suppression pool sample which is taken at the side and near the top of the pool such that particulates, if any, will settle past and below the sample point. The reactor water samples from the jet pump nozzles are not strained. The sample taps are from the sides of the nozzle. The jet pump or reactor water sample line is purged and flushed with demineralized water from a point inside containment as close as practicable to each sample tap. All liquid sample lines are purged and flushed with demineralized water as close as practicable to the sample tap.

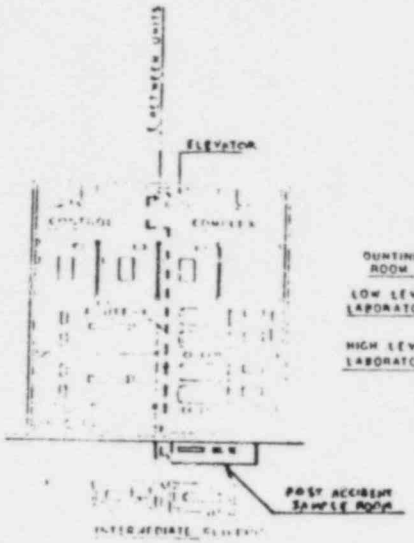
Steam or gas pockets in the lines which are sampled are eliminated by active flow within the lines or by selected location. For example, the reactor water samples are taken from the jet pump calibration lines. These lines are connected to the jet pumps inside the reactor in a location where feedwater and or recirculating water has a cooling effect. The samples from the jet pump calibration lines are representative of core conditions because the reactor water has been recirculated through the core, whether by the jet pumps or by natural recirculation. The reactor water from the RHR system is from an active line.

The RWCU system is not likely to have either gas or steam pockets because the liquid is passed through heat exchangers which cool it prior to sampling.

The backup sampling capability for reactor water consists of two separate jet pump calibration line samples which provide two separate samples. As a further backup, the RHR system is provided with two separate sample points which function in the same way.

See SEC's Report, Section 3.11, for further discussion in meeting this criterion.

DW77/M/29/rd



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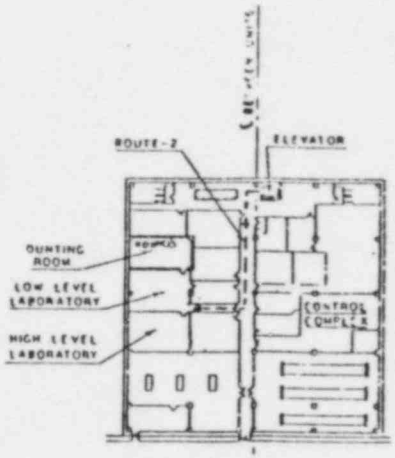

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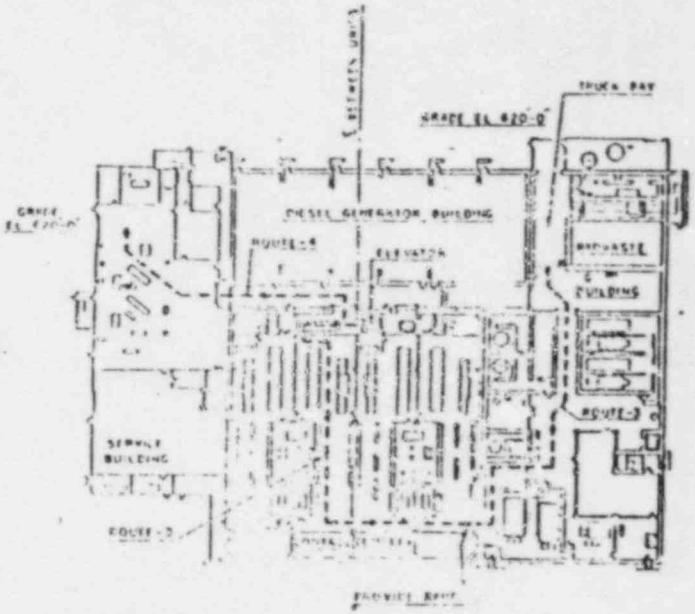

PLAN EL 620'-6" & 623'-6"

POST ACCIDENT SAMPLE ROUTING

FIGURE 1

ATTACHMENT #1