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October 2, 1985
IPN-85-51

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing

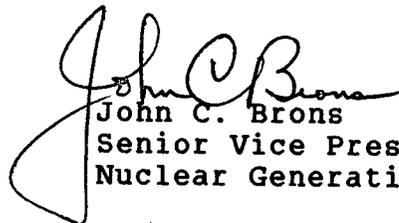
Subject: Indian Point 3 Nuclear Power Plant
Docket No. 50-286
NUREG-0737 Item II.B.3 - Post Accident Sampling System

Dear Sir:

Your July 1, 1985 letter served to transmit a supplemental safety evaluation of the post accident sampling system (PASS). As noted therein, the Authority had committed to address the standard test matrix requirements of criterion/clarification (10) of the subject NUREG-0737 item, by September 30, 1985. The Attachment to this letter provides a discussion of the PASS capability in the post accident water chemistry and radiation environment.

Should you or your staff have any questions please contact Mr. P. Kokolakis of my staff.

Very truly yours,


John C. Brons
Senior Vice President
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cc: Resident Inspector's Office
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Attachment to IPN-85-
Post Accident Sampling System
Standard Test Matrix

New York Power Authority
Indian Point 3 Nuclear Power Plant
Docket No. 50-286

The post accident sampling system consists of four main components: 1) sampling system isolation valves, 2) sampling room, 3) sample cask station, and 4) the analysis station. The isolation valves are Class I and environmentally qualified. Following an accident, the valves located in the sampling room will be aligned as shown in Figure 1. Subsequent to this valve alignment, the sampling room will be locked, thereby precluding further access and valve re-alignment. Flow to the sample cask is now controlled by valve V-CS1, which is operated by a through-wall reach rod. The sample cask holds 62 ml of reactor coolant sample.

The filled sample cask is transported to the analysis station for analysis. This system is composed of a glass bulb and cylinder, and solenoid valves connected by Tygon (polyvinyl chloride) tubing. This system is flushed with demineralized water following each usage, thereby, limiting the integrated dose to well below the measurable damage effects threshold dose of 10^5 rads.

The radiation effects on organic materials are documented in EPRI NP-2129, "Radiation Effect on Organic Materials in Nuclear Plants" dated November 1981. One of the major conclusions is that, with the exception of Teflon, there is no significant degradation of mechanical or permanent electrical properties of plastics at exposures less than 10^5 rads. Table 1 provides a summary of the testing results.

Measurable damage to Teflon occurs at 10^4 rads. Valves V-CS3 and V-CS4 have Teflon seats. However, as these valves are flushed with demineralized water after use, the Teflon seats should not be adversely affected. The fragility of glasses and ceramics increases at exposures greater than 10^6 rads, although changes in optical properties (darkening) of some glasses can occur at as low as 10^4 rads.

A description of the effects of the post accident water chemistry and radiation environment on the PASS components follows:

Gross Activity, Gamma Spectrum

The radiochemical measurements required to determine the extent of core damage involve only gamma spectroscopy. The Nuclear Data 6600 gamma spectroscopy system measurements are independent of the chemical species in solution and are not affected by the standard test matrix. Design basis accident samples will be diluted by a factor of 10^5 to 10^6 to reduce the activity to levels acceptable from an ALARA standpoint. This dilution will reduce the dose to the gamma spectrometer to a negligible level.

Boron

Boron concentration analysis will be performed on a 1600:1 diluted sample of reactor coolant utilizing a Spectrometric Model 3B plasma emission spectrometer. The minimum analysis sensitivity for this spectrometer is 80 ppb. Therefore, based upon an analysis of a 1600:1 diluted sample, the minimum measurable concentration of the equivalent undiluted reactor coolant would be 130 ppm. A greater sensitivity on the concentration of the equivalent undiluted reactor coolant can be achieved by employing a sample of less dilution. The chemical constituents of the standard test matrix do not pose any interferences for this method of analysis.

The maximum dose rate from an unshielded 10 milliliter aliquot of the 1600:1 sample would be 680 mR/h at 10 cm. This will be further reduced by placing the 10 ml sample in a small lead carrier. Instrument radiation levels will not be a problem as the rate of aspiration of the sample into the plasma is very small. Contamination will be limited to the plasma exhaust which is ducted to a monitored exhaust.

Chloride

Procedure RE-CS-042 specifies chloride analysis by chloride specific ion electrode or by ion chromatography. The specific ion electrode is a Graphic Controls type PHI 91100 solid state electrode. This electrode has a sensitivity (mg/l) for iodide ions which is equal to that for chloride ions. The standard test matrix requires analysis of 0.5 to 20 ppm chloride in up to 40 ppm iodide, which is outside of the resolution range of the ion electrode. As the specific ion electrode cannot differentiate between chloride ions and iodide ions, this method provides an indication of total halogen concentration. Hence, the specific ion electrode analysis results will be conservative with respect to chloride concentration. Although methods are available to eliminate the iodide interference by volatilization, these methods present a significant radiological hazard and are not suitable for power plant application. For this reason the chloride specific ion electrode fails to satisfy the NUREG-0737 criteria.

Chloride analysis by ion chromatography meets the NUREG - 0737 criteria and has been widely adopted by other utilities. DIONEX models QIC and 2110 analyzer are available for PASS application. Realistically the sample will not be injected into the ion chromatograph until at least an hour after shutdown. At that time the NUREG-0578 source term for a degassed sample would be on the order of 1.5 curies per milliliter. This concentration will be diluted by a factor of 1.6 at the PASS analysis station. The corresponding dose rates at 10 cm (4 inches) and 30.5 cm (12 inches) for the 0.050 standard milliliter sample would be 3.4 R/h and 370 mR/h, respectively. These dose rates are acceptable from a sample injection and ion chromatograph operation standpoint as little time is spent in close proximity to the sample or analyzer. The radioactivity of the sample does not affect the analysis as only inert chloride will be present at the conductivity cell at the time of chloride analysis.

Hydrogen or Total Gas

The stated purpose for measuring dissolved hydrogen in the reactor coolant is to monitor the extent of zircalloy corrosion and to monitor the susceptibility of the reactor coolant system to stress corrosion cracking. The Authority's June 29, 1984 letter, provided a detailed justification for a deviation from the 0-2000 cc/kg dissolved hydrogen accuracy range of Regulatory Guide 1.97. The current system cannot measure dissolved hydrogen at a level greater than 200 cc/kg primarily due to the design of the sample delivery system.

As discussed in the Authority's January 2, 1985 response to I&E Inspection Report No. 50-286/84-10, it was determined that the sample collection system design limited the hydrogen concentration detectability to an upper limit of 167 cc/kg. A sample collection system modification performed during the Cycle 4/5 refueling outage provides the current capability of hydrogen concentration detectability to an upper limit of 200 cc/kg.

Dissolved hydrogen analysis involves separation of a fraction of the gases from the liquid phase and analysis by a Fisher gas chromatograph. The chemical species identified in the test matrix remain in solution and do not affect the gas phase analysis. Furthermore, the specified concentration of these species is sufficiently low that they do not effect the mole fraction, and hence the volatility, of the dissolved gases.

The gas chromatograph is located in the chemistry laboratory and consequently is subject only to the radiation fields of the fractional milliliter samples injected into the gas chromatographic column. This column fractionates the gases into the various gas chemical species which are sequentially eluted past a thermal conductivity detector. The radioactive gases pass the sensor after the hydrogen has already been measured. Although the transient dose rate may be relatively high, it is far less than the amount required to damage the thermal conductivity detectors.

There may also be a localized buildup of activity on the gas chromatographic column due to the presence of iodine or other non-mobile species. This buildup will pose an ALARA concern long before it effects the overall column performance. All parts of the gas chromatograph, including columns and detectors are considered expendable and the column can be readily replaced if the activity builds up over a period of time.

Oxygen

The stated purpose of oxygen analysis is to assess coolant corrosion potential. Criterion/clarification (4) states:

Measuring the O₂ concentration is recommended but is not mandatory. Verification that dissolved oxygen is < 0.1 ppm by measurement of a dissolved hydrogen residual of ≥ 10 cc/kg is acceptable for up to 30 days after the accident. Within 30 days consistent with ALARA, direct monitoring for dissolved oxygen is recommended.

The existing oxygen analyzer is an in-line RexNord oxygen analyzer which is located in the sampling room. Immediately following the postulated design basis accident, the sampling room will be locked to preclude entry into the resulting high radiation area. The postulated design basis accident will produce hydrogen by way of the zircalloy-water reaction and oxygen by way of radiolysis of the reactor coolant. Any dissolved oxygen would react with the excess dissolved hydrogen.

After approximately 24 hours the dose within the sampling room will have decayed to a rate, which would allow re-entry. Direct monitoring of oxygen could then be performed utilizing the in-line system.

pH

Primary coolant pH is determined at the Analysis Station using a conventional pH glass electrode and reference cell. The chemical species listed in the test matrix do not interfere with measurement of pH. The General Electric Company report NEDC-30088, "Response to NRC Post-Implementation Review Criteria for Post-Accident Sampling System", demonstrated that a standard combination pH electrode would perform within the required accuracy of 0.3 pH units at Co-60 radiation levels as high as 1.3×10^6 R/h in buffered solutions and at radiation levels as high as 10^5 R/h in unbuffered solutions (10^6 R/h of Co-60 radiation corresponds to approximately 9.8×10^5 rads/h in water). There was no permanent effect after an integrated exposure of 10^6 rads. Similar testing was also performed on the pH electrode and reference cell used in the Digchem Analyzer. The results are given in Tables 2 and 3 and are similar to the General Electric findings.

Consequently, conventional pH electrodes meet the criteria of adequately functioning in solutions of 10^5 rads/hour.

TABLE 01
RADIATION TESTING OF VARIOUS ELASTOMERS

<u>Item</u>	<u>Exposure in Rads</u>	<u>Material</u>	<u>Results</u>
O-Ring	10 ⁶	Buna	Control, 75 Durometer (1); Irradiated, 70-75 Durometer
O-Ring	10 ⁷	Buna	Irradiated, 75-80 Durometer
O-Ring	10 ⁶	Kalrez	Control, 84-85 Durometer (1); Irradiated, 80-85 Durometer
O-Ring	10 ⁷	Kalrez	Irradiated, 83-89 Durometer
O-Ring	10 ⁶	Viton	Control, 78-80 Durometer (1); Irradiated, 75-80 Durometer
O-Ring	10 ⁷	Viton	Irradiated, 75-80 Durometer
Delivery Tips	10 ⁶	Kel-F	No visible effect; material would still serve its intended purpose
Delivery Tips	10 ⁷	Kel-F	Slight darkening noted; material would still serve its intended purpose
Tubing (Lot 1)(3)	10 ⁵	Teflon	No irradiation effect
Tubing Lot 1	10 ⁶	Teflon	Rupture pressure - 1600 psi(2) for three specimens
Tubing (Lot 1)	10 ⁷	Teflon	Severly embrittled; tubing would break when bent
Tubing (Lot 2)(3)	10 ⁵	Teflon	No irradiation effect
Tubing (Lot 2)	10 ⁶	Teflon	Rupture pressure - 1600 psi(2)
Tubing (Lot 2)	10 ⁷	Teflon	Longitudinal cracking occurred when the tubing was bent
Tubing	10 ⁷	Tygon	Rupture pressure - 300 psi (4) for three specimens

- (1) Evaluation of results was based on change in hardness. There was no visual indication of damage.
- (2) Control samples from both lots ruptured at 1600 psi. The failure mode differed in that a bubble developed on the control sample prior to rupture. Pressure failure of the irradiated samples resulted from development of pin-hole cracks.
- (3) Two lots of tubing from separate sources were tested.
- (4) One control specimen ruptured at 270 psi and the other at 290 psi.

Table 2
 AFFECT OF RADIATION (3) ON An
 INTERNAL REFERENCE pH PROBE
 (L & N CAT #117495)

<u>Type Buffer Solution</u>	<u>Initial pH No Radiation</u>	<u>pH at 3×10^5 R/Hr</u>	<u>pH at 9.77×10 R/Hr</u>
KH ₂ PO ₄	4.60	4.60(1)	4.50(2)
KH ₂ PO ₄ + NaOH	7.05	7.06(91)	6.93
K ₂ CO ₃ , K ₃ BO ₃	10.10	10.13(1)	10.12

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- (1) No change in pH from the instantaneous reading was noted over a 5-10 minutes exposure period.
 - (2) After taking the initial readings, the probe was left immersed in this solution. Readout of the pH meter varied between 4.48 and 4.51 during a 90 minute exposure period. The probe was broken at this time when it was moved.
 - (3) Total exposure = 2×10^6 rads.

Table 3

AFFECT OF RADIATION ON EXTERNAL REFERENCE PROBES
(FISHER CAT # 13-639-8 and 13-639-63)

Types Buffer Solution	Initial pH No Radiation	pH At 3×10^5 R/Hr	Rads Cum. Ex	pH At 9.77×10^5 R/Hr	Rads Cum. Ex	pH At 3×10^5 R/Hr	Rads Cum. Ex	pH At 3×10^5 R/Hr	Rads Cum. Ex.	Final pH ⁽¹⁾ No Radiation
KH_2PO_4	4.39	4.53	1.5×10^5	Spilled buffer solution	-	-	-	-	-	-
KH_2PO_4 + NaOH	7.06	7.20	1.5×10^5	7.28	5×10^5	7.19	10^6	7.19	5×10^6	7.10
K_2CO_3 , K_3BO_3 + KOH	10.06	10.19	1.5×10^5	10.27	5×10^5	Not (3) determined	10^6	Not (3) determined	5×10^6	9.60 ⁽²⁾

- (1) A pH determination was made after all sources were removed from the hot cell.
(2) A control sample that was exposed to the same environmental conditions without radiation exposure had a pH of 10.05.
(3) Readings were not taken because of the extreme difficulty in moving the pH probe with the manipulations.

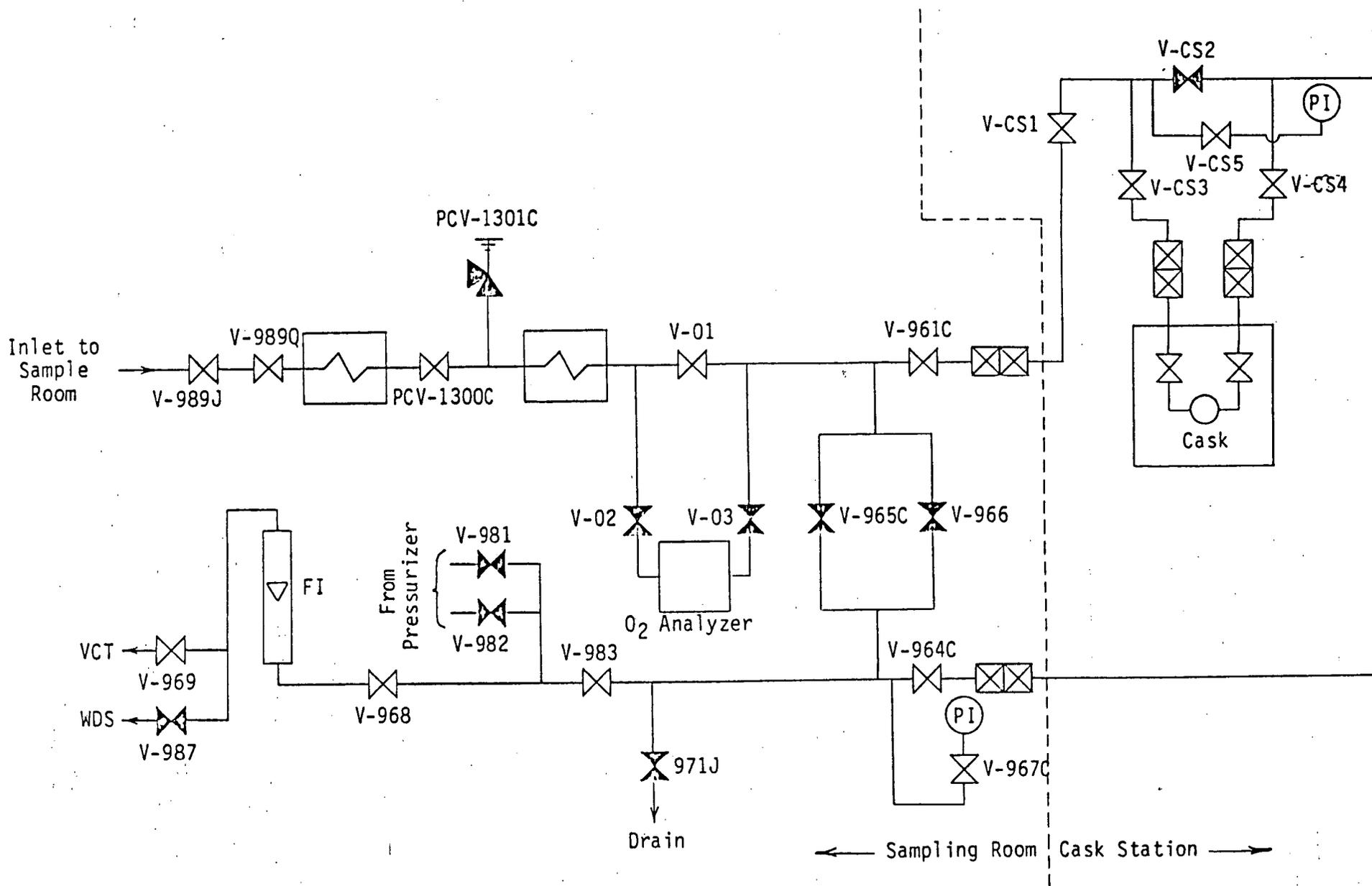


Figure 1 Sampling Room and Cask Station Valve Lineup During Sampling
 (Post Accident Valve Lineup in Sampling Room Will Remain Fixed as Shown)

note: valves in cask station have been arbitrarily numbered for convenience