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BECo 84-122

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Operating Reactors Branch #2
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

License No. DPR-35
Docket No. 50-293

NUREG-0737, Item II.B.3: Additional
Information on the Post Accident Sampling System (PASS)

References: (A) NRC letter of August 9, 1982

(B) Telephone Conversation of February 2, 1984

Dear Sir:

In Reference (A) Boston Edison Company (BECo) was requested to provide a schedule for documenting how it satisfied the criteria of Item II.B.3. Enclosed with the letter were guidelines developed by NRC staff to facilitate the post implementation review by the Commission.

Because this request dealt with a post implementation review of a rather sophisticated modification, BECo responded that it would address this shortly after the modifications were emplaced and operational, which was expected by June 1, 1984.

In Reference (B) Mr. Leech of NRR requested that BECo address the attachment to the August 9, 1982 letter because it would aid in the NRC's preparation of a Safety Evaluation Report (SER) on Pilgrim's proposed PASS.

The following is submitted to satisfy that request.

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.

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Response

The three hour time constraint for the collection, transport and analysis of post LOCA samples is based on the collection, transport and analysis of a single sample which has been determined to be most representative of core conditions at the time of the sample. While actual durations for the analysis of a single sample are site specific, data submitted to the NRC by stations with BWROG PASS similar to that being installed at PNPS indicate that approximately one hour and fifty minutes are required to complete a single sampling evolution, which is well within the three hour time limit.

The actual plant-specific time for Pilgrim will be determined after the modifications are complete.

Criterion #2

The licensee shall establish an onsite radiological and chemical analysis capability to provide, within the 3-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, and boron concentration of liquids.

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

Response

The PNPS PASS design is based on a sample collection station and ancillary components provided for the BWROG by General Electric. The system provides samples from the reactor coolant, RHR, torus, and containment atmosphere systems as recommended by G.E.

Radiological and chemical analysis of the above samples are provided as follows:

(a) Liquid samples can be collected from any of three locations.

1. "hot, pressurized" reactor coolant via redundant jet pump flow sensing line sample points

2. "cold, de-pressurized" reactor coolant via redundant RHR (in shutdown cooling mode) sample points

3. torus water via redundant RHR (in torus cooling mode) sample points

Containment atmosphere samples can be collected from any of four sample points: two located in the drywell and two located in the torus.

Radiological analysis is provided using existing gamma spectral equipment to quantify the radionuclides present in the above liquid or gas samples. Additional shielding will be provided around the existing detector cave to minimize the effects of post LOCA background radiation.

(b) Containment atmosphere hydrogen levels will be provided on a continuous basis during normal and post LOCA conditions via the Comsip $H_2/O_2$ analyzers.

(c) Dissolved hydrogen concentration will be provided by a gas volume calculation in the sample chamber. Boron, if required, and chloride concentrations will be provided via routine chemical analysis.

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.

Response

The operation of isolated auxiliary systems is not required to facilitate post LOCA sampling. Reactor coolant samples are provided upstream of the excess flow check valves in the jet pump flow sensing lines through primary containment isolation valves which are operable post LOCA. RHR samples are obtainable during system operation through safety boundary isolation valves which are operable post LOCA. Containment atmosphere samples are obtained from the same sample points as the Comsip $H_2/O_2$ System through primary containment and safety boundary isolation valves which are operable post LOCA.

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.

Response

The sample station can provide pressurized samples of primary coolant. A known volume of coolant sample is injected into the holdup cylinder, which is under vacuum, and the resulting pressure rise in the gas collection region will determine the dissolved gas concentration.

Criterion #5

The time for a chloride analysis to be performed is dependent upon two factors: (1) 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.

Response

PNPS is designed such that cooling of essential heat exchangers provide a double barrier between sea water and reactor coolant. Therefore PNPS falls under the 4 day criteria.

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 of Appendix A, 10 CFR Part 50.

(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 1 uCi/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 ventilation system design which will control the presence of airborne radioactivity.

Response

(a) The CINDER code was used to calculate the core inventory of fission products assuming a three year irradiation, 100% availability, and reactor operation at 102% of rated power. Fractional releases of fission products from the fuel to the reactor water, suppression pool and, and containment atmosphere were based on Regulatory Guide 1.3 and 1.7 assumptions.

Primary coolant samples obtained from the sampling station are diluted by a factor of 100 (0.1 ml coolant diluted to 10 ml). Under severe accident conditions a calibrated syringe would be utilized to obtain an aliquot of this sample for further dilutions. At the maximum expected primary coolant activity level (3 Ci/cc), an additional dilution factor of $1 \times 10^5$ would be required for gamma spectroscopy.

Direct counting of the initial 100:1 dilution sample would allow analysis at coolant activity levels down to 1 uCi/cc.

The above was prepared for Philadelphia Electric Peach Bottom 2/3 stations. It is considered conservative for PNPS.

(b) The use of additional shielding on the counting cave, and a dedicated fume hood in the PNPS chemistry/counting laboratory assures that background radiation levels will have no significant effect on the accuracy of the analysis.

Confirmation of the above will be provided by the completion of the PASS implementation plan.

Response

Calculations predict radiation exposures of <5 rem whole body and <75 rem extremities to any individual for the collection, transport, and analysis of a PASS sample. (It is anticipated that the exposure incurred for the collection and analyses of any one sample will be distributed among two or more individuals.)

Criterion #7

The analysis of primary coolant samples for boron is required for PWR's (Note that Rev. 2 of Regulatory Guide 1.97 specifies the need for primary coolant boron analysis capability at BWR plants).

Response

The system design as discussed per criterion #2 has the capability to sample primary coolant samples for boron. Analysis will be conducted as required.

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.

Response

Conformance to the above requirements is not applicable because in-line monitoring of the specified chemical analysis/species is not employed in the PNPS PASS.

Criterion #9

The licensee's radiological and chemical sample analysis capability shall include provisions to:

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.

Response

The post accident sampling and analysis provisions at PNPS will be of adequate accuracy, range, and sensitivity to provide pertinent information regarding the reactor coolant system and primary containment systems. The following provides a description of the post accident analytical capability of the proposed PNPS PASS.

(a) Gross Activity, Gamma Spectra

These analyses will be accurate within at least a factor of two over a coolant activity range of 10 uCi/cc to 3 Ci/cc. Please refer to the Response #9.

(b) Boron

Boron concentrations can be measured within the range of 35 to 2000 ppm.

(c) Chlorides

Chloride concentrations can be measured within the range of 0.05 to 100 ppm.

(d) Dissolved Hydrogen

The accuracy for this measurement has been determined by GE to be at least $\pm$ 50% for dissolved gas concentrations between 25 cc/kg to 50 cc/kg, and at least $\pm$ 30% for dissolved gas concentrations greater than 50 cc/kg.

Criterion #11

In the design of the postaccident sampling an 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 postaccident 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 adsorbers and high-efficiency particulate air (HEPA) filters.

Response

(a) All gas and liquid samples are circulated through their sample lines in the reactor building to the torus or drywell to assure that samples taken are representative of actual conditions. All gas sample lines are heat traced at 300°F to preclude condensation and minimize plateout.

Sample line routings are as direct and short as practical. Recirculation flow rates in the liquid sample lines are maintained in the turbulent flow regime.

Sample taps are located in areas protected from RCS or containment debris. Each sample line is equipped with flow restrictions and/or isolation valves to limit the loss of fluid in the event of a sample line failure.

Samples taken from the jet pump sample lines will be most directly indicative of coolant conditions in the core. If a small break or no break has occurred, reactor water level will be maintained at or near normal levels. As long as water is maintained in the upper plenum, natural circulation will occur from the downcomer to the shroud region via the jet pumps. Another recirculation path may exist within the shroud depending upon primary recirculation flow rate. With thermal conditions circulating water up through the core and back down past the tap from which the sample is taken, a representative relationship will exist. If normal water level cannot be maintained, as in the case of a large break like the DBA LOCA recirculation line break, the jet pump sample point will still provide a representative sample. In this case, the Core Spray System will supply water to flood the core. This flow will be down through the core, then up through the jet pumps to exit the break. Again, flow past the sample point directly from the core will assure a representative sample as one of the two core spray loops is capable of supplying ten times as much water as is required for replacement of core boil-off after only ten minutes.

Samples taken from the RHR system will be representative of conditions in the suppression pool if RHR is in the suppression pool cooling mode. They will be representative of the RCS if RHR is in the shutdown cooling mode, or representative of the RCS/suppression pool mixture if a LOCA has occurred or the alternate shutdown cooling mode of RHR (through SRV's) is being used.

Please note that all samples are provided with redundant sample points, and all sample lines are capable of being purged with either demineralized water or nitrogen, as appropriate.

(b) The post accident sample stations are ventilated by the standby gas treatment system which contains both HEPA filters and charcoal adsorbers.

BECo believes this submittal satisfies your request. Should you require any further information on this or any other aspect of BECo's effort to address Item II.B.3, please contact us.

Very truly yours,

W D Harrington

PMK/kmc