January 14, 1985

Docket No. 50-271

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Mr. R. W. Capstick
Licensing Engineer
Vermont Yankee Nuclear Power Corporation
1671 Worcester Road
Framingham, Massachusetts 01701

Dear Mr. Capstick:

SUBJECT: NUREG-0737, ITEM II.B.3

Re: Vermont Yankee Nuclear Power Station

We have completed our review of the information you submitted on May 4, August 15, and September 21, 1984, concerning the post accident sampling system (PASS) at the Vermont Yankee Nuclear Power Station. As a result of this review, we find that you meet ten of the eleven criteria in Item II.B.3 of NUREG-0737. The remaining criterion requiring a procedure for estimating the extent of core damage is acceptable on an interim basis. By letter dated August 15, 1983 you agreed to provide by April 1, 1985 a plant specific procedure to permanently satisfy the remaining criterion. Based on our review of the information which you have submitted, and the procedure you have committed to provide, we consider NUREG-0737, Item II.B.3 complete for the Vermont Yankee Nuclear Power Station. Any further action associated with the PASS will be handled on a plant specific basis.

Enclosed is a copy of our Safety Evaluation.

Sincerely,

Original signed by/

Domenic B. Vassallo, Chief
Operating Reactors Branch #2
Division of Licensing

Enclosure:
Safety Evaluation

cc w/enclosure:
See next page

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WASHINGTON, D. C. 20555

# SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

## VERMONT YANKEE NUCLEAR POWER CORPORATION

## VERMONT YANKEE NUCLEAR POWER STATION

## DOCKET NO. 50-271

## TMI ACTION -- NUREG-0737, ITEM II.B.3

## POST ACCIDENT SAMPLING SYSTEM

### Introduction

Subsequent to the TMI-2 incident, the need was recognized for an improved post-accident sampling system (PASS) to determine the extent of core degradation following a severe reactor accident. Criteria for an acceptable sampling and analysis system are specified in NUREG-0737, Item II.B.3. The system should have the capability to obtain and quantitatively analyze reactor coolant and containment atmosphere samples without radiation exposure to any individual exceeding 5 rem to the whole body or 75 rem to the extremities (GDC-19) during and following an accident in which there is core degradation. Materials to be analyzed and quantified include certain radionuclides that are indicators of severity of core damage (e.g. noble gases, isotopes of iodine and cesium, and nonvolatile isotopes), hydrogen in the containment atmosphere and total dissolved gases or hydrogen, boron, and chloride in reactor coolant samples.

To comply with NUREG-0737, Item II.B.3, the licensee should (1) review and modify his sampling, chemical analysis, and radionuclide determination capabilities as necessary and (2) provide the staff with information pertaining to system design, analytical capabilities and procedures in sufficient detail to demonstrate that the criteria are met.

### Evaluation

By letters dated May 4, August 15 and September 21, 1984, the licensee provided information on the PASS.

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 three hours or less from the time a decision is made to take a sample.

The licensee has provided the capability to promptly obtain and analyze reactor coolant samples and containment atmosphere samples within three hours from the time a decision is made to take a sample. The PASS has the capability to obtain samples when the reactor system is depressurized. We find that these provisions meet Criterion (1) and are, therefore, acceptable.

Criterion (2):

The licensee shall establish an onsite radiological and chemical analysis capability to provide, within the 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 non-volatile 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.

The PASS provides the capability to collect liquid and gaseous reactor coolant and containment atmosphere grab samples that can be transported to the onsite radiological and chemical laboratory for hydrogen, oxygen, pH, conductivity, boron, chloride, and radionuclide analyses. The minimum and maximum dilution o reactor coolant samples coming from the PASS is 100:1 and 1800:1 respectively. In the event, the counting room is not habitable, several options exist for sample analysis:

1. The Multi-channel analyzer (MCA) is semi-portable and can be moved to another location that is habitable.

2. The plant has a portable MCA with an intrinsic germanium detector that can be used for PASS sample analysis.

3. Other Yankee Plant facilities are available to the licensee through the Yankee Mutual Assistance Plan.

The core damage estimate procedure based on radionuclide measurements of reactor coolant and containment atmosphere samples is acceptable for the interim. The licensee is preparing a methodology to estimate the extent of core damage which includes other physical parameters such as core temperature data, radiation monitor response, and containment hydrogen concentration. The licensee indicated that this final procedure will be available by April 1, 1985.

At present, we find that the provisions partially meet Criterion (2) by establishing an on-site radiological and chemical analysis capability. The provisions will fully meet Criterion (2) when the licensee provides a [illegible] core damage procedure based on radionuclides concentrations and taking into consideration other physical parameters such as core temperature data, radiation levels and hydrogen concentrations. The licensee has committed to provide such a procedure by April 1, 1985.

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) to be placed in operation in order to use the sampling system.

Reactor coolant and containment atmosphere sampling during post-accident conditions does not require an isolated auxiliary system to be placed in operation in order to perform the sampling function. The PASS valves which are not accessible after an accident have been selected to withstand the specified service environment. These provisions meet Criterion (3),and are, therefore, acceptable.

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.

Pressurized reactor coolant samples are cooled and degassed to obtain representative dissolved hydrogen concentrations at the PASS sampling station. The hydrogen concentration is measured by gas chromatography. The dissolved oxygen content in the coolant is indicated indirectly by verifying that dissolved oxygen is less than 0.1 ppm by measurement of a dissolved hydrogen residual is greater than 10 cc/kg. We have determined that these provisions meet Criterion (4) of Item II.B.3 in NUREG-0737 and are, therefore, acceptable.

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 4 days. The chloride analysis does not have to be done onsite.

Chloride analysis of the the reactor coolant is performed within 96 hours using ion chromatography. The method is capable of detecting chloride concentrations down to 150 ppb on a diluted sample within 96 hours. This provision meets Criterion (5), and is, therefore, acceptable.

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 30, 1979 letter from H. R. Denton to all licensees.)

The licensee has performed a time-person-motion study to ensure that operator exposure while obtaining, transporting, and analyzing a PASS sample is within the acceptable limits. This operator exposure includes entering and exiting the sample panel area, operating sample panel manual valves, positioning the grab sample into the shielded transfer casks, transporting casks and performing sample analyses. PASS personnel radiation exposures from reactor coolant and containment atmosphere sampling and analysis are within 5 rem whole body and 75 rem extremities, which meet the requirements of GDC-19 and Criterion (6) and are, therefore, acceptable.

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.)

Reactor coolant boron analysis is performed by use of plasma emission spectrometry which has a capability of measuring boron concentrations from 50 to 1000 ppm with an accuracy of ±20 ppm. This provision meets the recommendations of Regulatory Guide 1.97, Rev. 2 and Criterion (7) and is, therefore, acceptable.

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 offsite facilities is acceptable. Equipment provided for backup sampling shall be capable of providing at least one sample per week until the accident condition no longer exists.

A diluted reactor coolant grab sample and undiluted containment atmosphere grab sample will be obtained for analyses of boron, dissolved hydrogen, pH, chloride and radioisotopes in the reactor coolant and hydrogen, oxygen and radioisotopes in the containment atmosphere. Containment atmosphere hydrogen concentrations are also monitored by in-line instruments. We find that these provisions meet Criterion (8) and are, therefore, acceptable.

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 term given in Regulatory Guides 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 ventilation system design which will control the presence of airborne radioactivity.

The radionuclides in both the primary coolant and the containment atmosphere will be identified and quantified. Reactor coolant samples are diluted to minimize personnel exposure. Also, shielded transport casks are used for the same purpose. The PASS can perform radioisotope analyses at the levels corresponding to the source term given in Regulatory Guides 1.3, Rev. 2 and 1.7. Radiation background levels will be restricted by shielding. Radiological and chemical analysis facilities are provided to obtain results within an acceptably small error (approximately a factor of 2). We find these provisions meet Criterion (9) and are, therefore, acceptable.

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.

The accuracy, range, and sensitivity of the PASS instruments and analytical procedures are consistent with the recommendations of Regulatory Guide 1.97, Rev. 2, and the clarifications of NUREG-0737, Item II.B.3, Post-Accident Sampling Capability, transmitted to the licensee on September 30, 1982. Therefore, they are adequate for describing the radiological and chemical status of the reactor coolant. The analytical methods and instrumentation were selected for their ability to operate in the post-accident sampling environment. The standard test matrix and radiation effect evaluation indicated no interference in the PASS analyses. PASS operators will be retrained every six months by a combination of the annual retraining session and participation in the required semi-annual emergency drills. We determined that these provisions meet Criterion (10) of Item II.B.3 in NUREG-0737, and are, therefore, acceptable.

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 line, 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 adsorbers and high-efficiency particulate air (HEPA) filters.

The licensee has addressed provisions for purging to ensure samples are representative, size of sample line, and isolation valves to limit reactor coolant loss from a failure of the sample line. Our intent for Criterion 11(b) is to reduce discharges of radioactivity during the sample flushing procedures, when the purge water is drained to an open sink. By purging to containment, the licensee is minimizing discharges of radioactivity during sampling. The licensee has not provided heat tracing on the containment atmosphere sample lines since this sample will be analyzed for noble gases. These results are used for an estimate of core damage from the release of fission products into the containment. Noble gases do not plateout on containment atmosphere sample lines surfaces, therefore, heat tracing, which is used to limit plateout of ionic species, is not needed. We determined that these provisions meet Criterion (11) of Item II.B.3 of NUREG-0737, and are, therefore, acceptable.

Conclusion

On the basis of our evaluation, we conclude that the Post-Accident Sampling System meets ten of the eleven criteria of Item II.B.3 in NUREG-0737. The procedure for estimation of reactor core damage is acceptable on an interim basis. By April 1, 1985, the licensee has committed to provide a plant specific procedure which includes other physical parameters in addition to fission product activities to provide a realistic estimate of core damage.

Principal Contributor; F. Witt

Dated: January 14, 1985