

VERMONT YANKEE NUCLEAR POWER STATION

**OPERATING PROCEDURE**

**OP 0631**

**REVISION 19**

**RADIOCHEMISTRY**

USE CLASSIFICATION: **INFORMATION**

RESPONSIBLE PROCEDURE OWNER: **Superintendent, Chemistry**

REQUIRED REVIEWS		Yes/No
E-Plan	10CFR50.54(q)	No
Security	10CFR50.54(p)	No
Probable Risk Analysis (PRA)		No
Reactivity Management		No

LPC No.	Effective Date	Affected Pages
1	05/02/06	Appendix D pg 1 & 6 of 6; Appendix E pg 1 of 3; Appendix F pgs 1, 2, 3, & 5 of 5; VYOPF 0631.02 pg 1 of 1

**Implementation Statement: N/A**

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DO NOT REPLY TO THIS DATE  
 USNRC

August 12, 2008 (11:00am)

OFFICE OF SECRETARY  
 RULEMAKINGS AND  
 ADJUDICATIONS STAFF

*Template Secy-028*

U.S. NUCLEAR REGULATORY COMMISSION  
 In the Matter of Energy Nuclear Vermont Yankee LLC  
 Docket No. 50-271 Official Exhibit No. E3-10-VY  
 OFFERED by Applicant/Licensee Intervenor \_\_\_\_\_  
                   NRC Staff                   Other \_\_\_\_\_  
 IDENTIFIED on 7/23/08 Witness/Panel NEC 3  
 Action Taken: ADMITTED REJECTED WITHDRAWN  
 Reporter/Clerk MAC

OP 0631 Rev. 19  
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*DS-03*

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## PURPOSE

To enable Chemistry personnel to properly perform necessary Radiochemical Analyses.

The following sections include methodologies used to perform Technical Specification (TS) or Off-Site Dose Calculation Manual (ODCM) required surveillances:

1. Fission Product Analysis for Noble Gases and Iodines

### SURVEILLANCE

Reactor Coolant	Iodine: <u>TS 3.6.B.1, 4.6.B.1</u>
Noble Gases (SJAЕ):	<u>TS 3.8.K.1 to 3, 4.8.K.1 to 2 and ODCM Table 4.3.1</u>

2. Alpha and Gamma Determinations

### SURVEILLANCE

Reactor Coolant Isotopic	<u>TS 4.6.B.1.b</u>
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3. Tritium Measurement

### SURVEILLANCE

Stack Tritium	<u>ODCM Table 4.3.1</u>
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4. Calculation of Sample Activity and MDA

### SURVEILLANCE

Waste Samples As Needed	<u>ODCM Table 4.2.1</u>
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## DISCUSSION

For additional Discussion, see the individual appendices.

## ATTACHMENTS

- |    |               |   |
|----|---------------|---|
| 1. | Appendix A    | Fission Product Analysis for Noble Gases and Iodines    |
| 2. | Appendix B    | Alpha and Gamma Determinations                          |
| 3. | Appendix C    | Tritium Measurement                                     |
| 4. | Appendix D    | Preparation and Accountability of Radioactive Standards |
| 5. | Appendix E    | Calculation of Sample Activity and MDA                  |
| 6. | Appendix F    | Moisture Carryover/Iodine Transport Determinations      |
| 7. | VYOPF 0631.01 | Radioactive Standard Accountability                     |
| 8. | VYOPF 0631.02 | Moisture Carryover/Iodine Transport Calculations        |

## QA REQUIREMENTS CROSS REFERENCE

1. None

## REFERENCES AND COMMITMENTS

1. See individual appendices.

## PRECAUTIONS/LIMITATIONS

1. See individual appendices.

## PREREQUISITES

1. See individual appendices.

## PROCEDURE

1. See individual appendices.

## FINAL CONDITIONS

1. See individual appendices.

## APPENDIX A

### FISSION PRODUCT ANALYSIS FOR NOBLE GASES AND IODINES

#### DISCUSSION

Fission product analysis will be done to detect the effect of tramp  $U^{235}$  and  $U^{238}$  in the reactor or any defects that may occur in the fuel thereby releasing fission products into the reactor coolant.

#### REFERENCES AND COMMITMENTS

1. Technical Specifications and Site Documents
  - a. TS Sections 3.6.B.1, 4.6.B.1.a,c,d and e
  - b. TS Sections 3.8.K.1 to 3 and 4.8.K.1 to 2
  - c. ODCM Section 3/4
2. Codes, Standards, and Regulations
  - a. None
3. Commitments
  - a. None
4. Supplemental References
  - a. "Radiolytic Gases" by General Electric
  - b. General Electric SIL No. 524, "Analysis for Radioisotopes in GE BWR Reactor Water"
  - c. OP 0630, Water Chemistry
  - d. OP 2611, Stack Effluent Sampling and Analysis
  - e. OP 2613, Sampling and Analysis of the Off Gas System
  - f. RP 2614, Sampling and Analysis of the AOG System
  - g. OP 2615, Sampling and Analysis of the CST for Iodine
  - h. DP 2631, Radiochemical Instrumentation
  - i. OP 4612, Sampling and Treatment of the Reactor Water System

## APPENDIX A (Continued)

### PRECAUTIONS/LIMITATIONS

1. Do not exceed 10% dead time when using the MCA.
2. Wear lab coat, protective glasses, and proper gloves when handling hazardous material.
3. Do not put hot (thermal) samples on germanium or sodium iodide detectors.
4. Notify Chemistry supervision when:
  - a. Reactor coolant reaches 0.011 microcuries of I-131 dose equivalent per gram of water
  - b. There is a 25% increase or 5,000  $\mu\text{Ci}/\text{sec}$  in SJAE activity during steady state operation

### PREREQUISITES

1. Apparatus as required:
  - a. Noble Gases
    - 14 ml sample vials
    - Multi-channel analyzer with a Germanium crystal
  - b. Iodines
    - 23 ml scintillation vial
    - Graduated cylinder or pipette
    - Vacuum flask and filter apparatus
    - Multi-channel analyzer with Germanium crystal
    - Millipore and cation filter papers
    - Other approved geometry containers as needed

### PROCEDURE

- A. Noble Gases
  1. Collect an appropriate volume of sample for analysis.
  2. Count the sample as soon as possible on the multi-channel analyzer.
  3. Calculate the activity of each noble gas isotope manually or using the computer program.

## APPENDIX A (Continued)

### B. Iodines

#### **NOTE**

The method outlined below is to be used when counting liquid samples that contain high levels of corrosion and activation products; i.e., reactor coolant. All other samples should be counted without filtering (straight sample). However, DEAD TIME on the MCA should not exceed 10%.

1. Collect an appropriate volume of sample for analysis.
2. Filter a portion of the sample through a 0.45 micron filter and one Toray cation filter paper unless otherwise directed by Supervision.
3. Decant the filtrate into a 23 ml vial or other approved geometry container and dilute as necessary to achieve a MCA dead time of  $\leq 10\%$ .

#### **NOTE**

2-hour decay following collection is only required for reactor coolant samples during power operation.

4. Using the MCA analyzer, count the sample for a minimum of 1000 seconds approximately two (2) hours after collection.
5. If the 2-hour decay count fails to yield I-131, the sample may be saved as directed by supervision and counted approximately 24 hours later. The total Iodine activity and I<sup>131</sup> Dose Equivalent may then be calculated by adding the I<sup>131</sup> to the iodine isotopes from the previous analysis.

### FINAL CONDITIONS

1. Results recorded and forms completed per AP 0658, OP 2611, OP 2613, RP 2614, OP 2615 and OP 4612 as applicable.

## APPENDIX B

### ALPHA AND GAMMA DETERMINATIONS

#### DISCUSSION

An alpha activity measurement is used to indicate the presence of uranium or other alpha emitters. Since the presence of alpha activity may indicate a fuel element defect, contaminated core, or a ruptured source, knowledge of such activity is essential to early implementation of corrective action.

The purpose of monitoring the gamma emitting nuclides is to determine if a trend exists in the build-up of radioactive materials in the water being surveyed.

The reactor coolant samples during power operation will be counted for isotopic analysis two hours after they are taken. This is a standard time that will allow for the decay of very short-lived isotopes and allows comparison between BWRs. They will then be stored for eight days and counted again to aid in the determination of long-lived isotopes.

#### REFERENCES AND COMMITMENTS

1. Technical Specifications and Site Documents
  - a. TS 4.6.B.1.b
2. Codes, Standards, and Regulations
  - a. None
3. Commitments
  - a. None
4. Supplemental References
  - a. ASTM Standards, Water, Atmospheric Analysis, Part 23, Nov., 1969
  - b. "Radionuclide Analysis by Gamma Spectroscopy", published by Training Branch Division of Radiological Health, H.E.W.
  - c. OP 0630, Water Chemistry
  - d. AP 0658, Chemistry Department Practices
  - e. DP 2631, Radiochemical Instrumentation
  - f. OP 4612, Sampling and Treatment of the Reactor Water System

## APPENDIX B (Continued)

### PRECAUTIONS/LIMITATIONS

1. Notify Chemistry supervision when alpha activity in the vessel reaches  $3 \times 10^{-8}$   $\mu\text{Ci/ml}$ .
2. Be sure the bias setting on the well counter is correct as listed on the detector, the daily calibration check and background have been performed, and the appropriate Control Chart indicates the instrument is functioning properly.
3. When approaching the well counter detector with high activity samples, have the counter counting so that you can tell if the counter is going to saturate. This is noticeable if counter exceeds  $5 \times 10^5$  cpm.
4. Do not exceed 10% dead time when using the MCA.
5. Do not keep excess sources in the Counting Area.
6. Always make sure you record the required data on the count record log sheet.
7. Be sure to label all samples and dispose of them properly after the analysis is completed.
8. Wear lab coat, protective glasses and proper gloves when handling hazardous material.
9. Do not put hot (thermal) samples on germanium or sodium iodide detectors.

### PREREQUISITES

1. Apparatus as required:
  - a. Alpha
    - 2" planchets
    - Alpha counting instrument
    - Hot plate
    - Silicone grease
  - b. Gamma
    - Sodium iodide scintillation detector (NaI(Tl)) and associated electronics
    - Multi-channel analyzer system (MCA)
    - High purity Germanium detector(s) and associated electronics
    - Tape, plastic wrap or parafilm
    - 2-dram vials
    - 1-liter or 0.5 liter Marinelli beakers
    - 23 ml scintillation vial

## APPENDIX B (Continued)

### PROCEDURE

#### A. Alpha

1. Sample preparation for samples with high solids:
  - a. Filter the sample using a 0.45 micron filter.
  - b. If sample is still not clear, notify supervision.
2. Prepare planchets for counting in the following manner:
  - a. Wash planchet with acetone, then
  - b. Grease inside vertical edges of planchet with silicon grease.
  - c. Reduce sample volume as needed by boiling, then
  - d. Pipet approximately 2 ml of sample into the planchet.
3. Slowly dry the 2" planchet using the hot plate in the lab hood. **Avoid rapid boiling. Excessive heat will cause the sample to bubble and affect recovery of radionuclides.**
4. If sample is highly radioactive, as in Reactor Coolant, put the sample into a petri dish, label and store in a desiccator for approximately 30 days prior to counting.
5. After the sample has cooled, count for approximately 30 minutes or 1000 gross counts using the Ludlum 2600 alpha counter.
6. Calculate alpha activity ( $\mu\text{Ci/ml}$ ) according to "Calculation of Sample Activity and MDA" section of this procedure.

#### B. Gamma

1. Specific Activity ( $\mu\text{Ci/ml}$ ).
  - a. Obtain sample.
  - b. Measure an appropriate volume into container.
    - 1) Dilute or filter as required.
  - c. Wrap the container in parafilm (not for beakers).
  - d. Count the sample in the NaI(Tl) well counter.

APPENDIX B (Continued)

- e. Calculate the specific activity ( $\mu\text{Ci/ml}$ ) according to "Calculation of Sample Activity and MDA" section of this procedure.
- f. Save labeled samples as needed for additional analysis (future counts).

C. Isotopic

1. General Isotopic Analysis

**NOTE**

Marinelli beakers are usually used to count samples with very low activity (i.e., environmental releases).

- a. Obtain a sample to be analyzed and place it in an appropriate sample container.
- b. Seal the sample and cover the detector with parafilm or plastic wrap to avoid contaminating the detector.
- c. Place the sample on the detector using the appropriate geometry and spacer.
- d. Start the MCA analysis utilizing the method specified in DP 2631, "Multichannel Analyzer" Section.
  - 1) If the "1-Sigma % Error" percentage error for a nuclide is greater than 50%, do not log that isotope as being present. (A longer count time may be necessary for better counting statistics.)
  - 2) When performing analysis of liquids for release from the RCA, do not log the isotope as being present if the 1-Sigma % Error in C.1.d.1) is greater than 33%.

APPENDIX B (Continued)

2. Reactor Coolant Isotopic

- a. Obtain the following 47mm filters:
  - One 0.45 micron Millipore filter
  - One Toray cation filter
  - One Toray anion filter
- b. Rinse the filter assembly with demineralized water.
- c. Arrange filters in the filter assembly such that the 0.45 micron filter is on top and the anion filter is on the bottom.
- d. Obtain a Reactor Coolant sample. (Step may be done previously.)
- e. Shake the sample bottle vigorously just prior to decanting.
- f. Filter 100 ml or other suitable volume through the filters. Adjust volume as needed to achieve a MCA dead time of  $\leq 10\%$ .
- g. Rinse filtration funnel.
- h. Separate the anion and cation filters into individual labeled petri dishes.
- i. Return the 0.45 micron filter to the filtration funnel.
- j. Shake the sample bottle vigorously just prior to decanting.
- k. Filter up to an additional 900 ml depending on coolant activity and resultant detector dead time through the 0.45 micron filter.
- l. Rinse the sample bottle and filtration funnel with approximately 200 ml of deionized water.
- m. Remove the 0.45 micron filter and place it in a labeled petri dish.
- n. Allow samples to decay 2 hours before counting (if sampled during power operations).
- o. Analyze on the MCA using the appropriate computer program.
  - 1) Log sample data on VYOPF 4612.02.

APPENDIX B (Continued)

- p. Store the labeled samples and VYOPF 4612.02 for eight days and then recount.
- q. Log 8-day sample data on VYOPF 4612.02 started for the 2-hour count.
- r. The following guide should be used when logging results:
- Do not log an isotope as being present if the "1-Sigma % Error" percentage error for that nuclide is greater than 50%. A longer count time may be necessary for better counting statistics.
  - Log nuclides with half-lives  $\leq 24$  hours from the two hour count.
  - Log nuclides with half-lives  $> 24$  hours from the eight day count that are not otherwise routinely identified (i.e.,  $I^{131}$ ).
  - Log only those nuclides which are not otherwise accounted for (i.e., iodines and gases).

3. Screening of Environmental Sediment Samples in 1 Quart Metal Cans

**NOTE**

This procedure provides an approximation of the source activity of sediment or other non-homogenous samples in 1 quart metal cans only. These corrected results should be used under the direction of Chemistry supervision to report sample activity to the Radwaste Coordinator for use in preparing shipping documentation.

- a. Obtain a sample to be counted and place it in a 1 quart metal can.
- b. Analyze sample on the MCA using:

**NOTE**

Using a sample volume of 0.25 forces the analysis results to be multiplied by a factor of 4, thus ensuring a close approximation of sample activity for this type of sample.

- 2" filter geometry with spacer
- sample volume of 0.25
- "source" as units
- minimum 1000 second count time

APPENDIX B (Continued)

- c. Label the sample as "radioactive material" if appropriate.
- d. Give corrected sample analysis print-out to the Chemistry Environmental Program Lead - Radiological for processing.

FINAL CONDITIONS

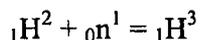
- 1. Results recorded and forms completed per DP 0641 and OP 4612 as appropriate.

## APPENDIX C

### TRITIUM MEASUREMENT

#### DISCUSSION

Tritium is produced in the reactor by fission in small but significant quantities, and by the absorption of a neutron by deuterium.



The beta radiation from  $\text{H}^3$  is so low in energy that it will not penetrate any window on a standard detector and windowless detectors are contaminated easily with  $\text{H}^3$  samples. Also, if the sample were dried the  $\text{H}^3$  would go off with  $\text{H}_2\text{O}$  vapor. The challenge is to get the  $\text{H}^3$  as close to the detecting medium as possible, and still retain a reasonable efficiency. Liquid scintillation does this very well since the sample and scintillation fluid are mixed together in a homogeneous solution.

Several scintillation fluids or "cocktails" are available both commercially and through on-site laboratory production. The Chemistry Superintendent will select and approve the scintillation cocktails that satisfy the criteria for scintillation counting and will assess the value and efficiency of the various available mixtures.

#### REFERENCES AND COMMITMENTS

1. Technical Specifications and Site Documents
  - a. ODCM Tables 4.2.1 and 4.3.1
2. Codes, Standards, and Regulations
  - a. None
3. Commitments
  - a. None
4. Supplemental References
  - a. Beckman LS-6500 TA Manual
  - b. OP 0630, Water Chemistry
  - c. DP 0641, Logging Results of Chemical Analysis
  - d. DP 2631, Radiochemical Instrumentation

## APPENDIX C (Continued)

### PRECAUTIONS/LIMITATIONS

1. Standard laboratory safety procedures should be used for chemicals specified in this procedure.
2. Wear lab coat, protective glasses, and proper gloves when handling hazardous material.

### PREREQUISITES

1. Apparatus required:
  - a. Liquid Scintillation Counter LS-6500TA
  - b. Distillation apparatus
  - c. Low background counting vials
2. Reagents
  - a. Prepared counting solutions approved by the Chemistry Superintendent.

### PROCEDURE

**NOTE**

If the sample is high purity water with no color or other organic interferences or phosphors, step 1 may be eliminated.

1. Distill the sample(s) to be analyzed.

**NOTE**

The actual volumes of sample(s) and cocktail vary with the geometry for the minimum detectable activity level required.

2. Pipet an appropriate aliquot of the cooled distillate (sample) to be counted into the counting vial(s).
  - Label vial covers appropriately.

APPENDIX C (Continued)

**NOTE**

Background not required if performed previously (as routine).

3. Pipet an equal amount of demineralized water into another counting vial to be used as background.
4. Add scintillation cocktail solution to each vial.
5. Mix the vial contents completely by shaking.
6. Count background (as needed) and sample(s) as follows:
  - a. Open LID and place sample in sample tray. BE SURE ALL SAMPLES ARE WIPED CLEAN.
  - b. Close lid.
  - c. Operate the LS-6500TA to count samples according to DP 2631.
7. Calculate tritium concentration ( $\mu\text{Ci/ml}$ ) according to "Calculation of Sample Activity and MDA" section of this procedure.

**FINAL CONDITIONS**

1. Results recorded per DP 0641.

## APPENDIX D

### PREPARATION AND ACCOUNTABILITY OF RADIOACTIVE STANDARDS

#### DISCUSSION

To properly calibrate the counting instrumentation, it is necessary to make standards of various disintegration rates (activity). Primary standards are usually nuclides which have a relatively long half-life, an uncomplicated decay spectrum, and are traceable to the National Institute of Standards and Technology (NIST).

Secondary radioactive standards are made up from primary standards of known disintegration rates. The secondary standards are made up so they don't exceed the limitations of the counter and are of a geometry similar to the unknown container.

At times there is a need for standards that are lower in activity than secondary standards. Due to the small amount of primary standard needed, it is more accurate to make a secondary standard and then use this standard to make a tertiary standard.

It may be necessary to order radionuclides which do not have long half-lives; therefore, it is important to order the nuclide in sufficient quantity to be used for instrument calibrations.

Chemistry sources utilized per this procedure section will be inventoried annually. Such sources are not considered Tech Spec licensed "sealed sources."

#### REFERENCES AND COMMITMENTS

1. Technical Specifications and Site Documents
  - a. None
2. Codes, Standards, and Regulations
  - a. None
3. Commitments
  - a. None
4. Supplemental References
  - a. DP 2630, Analytical Instrumentation
  - b. EN-AD-103, Document Control and Records Management Activities

ILPCL

## APPENDIX D (Continued)

### PRECAUTIONS/LIMITATIONS

1. Wear lab coat, protective glasses, and proper gloves when handling hazardous material.
2. Make sure the glassware is disposed of properly after use.
3. Use only certified standards traceable to NIST for primary standards.
4. Standards should be corrected for radioactive decay.

### PREREQUISITES

1. Apparatus required:
  - a. Radionuclide standard
  - b. Analytical balance
  - c. Heat Lamp or hot plate
  - d. Hypodermic syringes
  - e. Planchets, vials, Marinelli beakers with covers
  - f. Parafilm and plastic wrap
  - g. Epoxy adhesive and plastic tape
  - h. Charcoal cartridges
  - i. Gloves
  - j. Silicone grease
  - k. Glass filter papers
  - l. Petri dishes
2. Reagents
  - a. The solutions used in preparing the secondary standards should be the same chemical strength and composition as the primary standard, e.g., 10% nitric acid.

## APPENDIX D (Continued)

### PROCEDURE

#### A. Preparation of Liquid Radioactive Standards

##### 1. Planchets

- a. Grease the vertical inside edge of the planchet with silicone grease.
- b. Don gloves.
- c. Wash and dry gloved hands to remove any powder.
- d. Fill a syringe with standard.
- e. Weigh the filled syringe on the analytical balance.
- f. Dispense the desired amount of standard into the planchet.
- g. Re-weigh the syringe.
- h. Calculate the weight of standard by subtracting the weight determined in Step g. from that measured in Step e.
- i. Add water or solution similar to that in which the standard was shipped to cover bottom of the planchet and evenly disperse standard.
- j. Place planchet under heat lamp or on a hot plate and evaporate to dryness.
- k. Wrap planchet with parafilm after it has cooled (unless planchet is an alpha standard).
- l. Label planchet with preparation date and Control Number. (See Section B. - Recording Procedures)

##### 2. Vials and Marinelli Beakers

- a. Don gloves.
- b. Wash and dry gloved hands to remove any powder.
- c. Fill a syringe with standard.
- d. Weigh the filled syringe on the analytical balance.
- e. Dispense the desired amount of standard into the vial or beaker.

## APPENDIX D (Continued)

- f. Re-weigh the syringe.
  - g. Calculate the weight of standard by subtracting the weight determined in Step F. from that measured in Step d.
  - h. Add water or solution similar to that in which the standard was shipped to fill the vial or beaker to the normal volume for that container, i.e. 8 ml in a 2 dram vial or 1000 ml in a 1 liter Marinelli.
  - i. Secure cover or stopper on container using epoxy or similar adhesive and tape to seal against leaks.
  - j. Label container with preparation date and Control Number. (See Section B. - Recording Procedures)
3. Charcoal Cartridges (Face Loaded)
- a. Remove screening from one end of the charcoal cartridge.
  - b. Remove approximately  $\frac{1}{4}$  inch of charcoal.
  - c. Install a glass fiber filter in the cartridge to cover remaining charcoal.
  - d. Deposit a thin layer of charcoal in the cartridge.
  - e. Don rubber gloves.
  - f. Wash and dry gloved hands to remove any powder.
  - g. Fill a syringe with standard.
  - h. Weigh the filled syringe on the analytical balance.
  - i. Proportionally dispense the standard onto the charcoal in layers until the cartridge is filled to its normal level.
  - j. Re-weigh the syringe.
  - k. Calculate the weight of standard by subtracting the weight determined in Step j. from that measured in Step h.
  - l. Install the screening removed in Step a.
  - m. Wrap the cartridge with parafilm.
  - n. Label cartridge with preparation date and Control Number. (See Section B. - Recording Procedures)

APPENDIX D (Continued)

4. Filter Papers

- a. Place filter paper(s) in a plastic petri dish.
- b. Don rubber gloves.
- c. Wash and dry gloved hands to remove any powder.
- d. Fill a syringe with standard.
- e. Weigh the filled syringe on the analytical balance.
- f. Dispense the desired amount of standard onto the filter paper.
- g. Re-weigh the syringe.
- h. Calculate the weight of standard by subtracting the weight determined in Step g. from that measured in Step e.
- i. If standard does not saturate filter paper, add water or solution similar to that in which the standard was shipped to cover the bottom of the petri dish and evenly disperse standard.
- j. Allow petri dish to evaporate to near dryness.
- k. Cover petri dish and wrap with parafilm after it has cooled.
- l. Label petri dish with preparation date and Control Number. (See Section B. - Recording Procedures)

B. Recording Procedures (perform steps as needed)

1. Complete VYOPF 0631.01 of this procedure with the information requested.

Where: Primary standard bottle number = Isotope/Year  
produced/Month/Day

Example: A mixed radionuclide standard was produced by Amersham on  
March 15, 1999. The primary standard number will be MR  
99/3/15.

2. Secondary standards will be recorded as follows: Primary standard bottle  
number/number of the first standard produced from the primary standard.

Example: MR 99/3/15/1

APPENDIX D (Continued)

**NOTE**

Tertiary standards are not utilized for calibrations unless authorized by Chemistry supervision.

3. Tertiary standards will be recorded as follows: secondary standard bottle number/number of standards produced from the secondary standard.  
  
Example: MR 99/3/15/1/1. Where a MR 99/3/15/1 tertiary standard was made from the secondary standard. This standard in turn was prepared from the primary (NIST traceable) standard MR 99/3/15.
4. File all current source accountability forms (VYOPF 0631.01) and standard certificates in the Chemistry Lab file drawer. When the standards are discarded, the completed forms and attached certificates will be sent to the Chemistry supervision for review and filing.
5. Annually, or as otherwise directed by Chemistry supervision, physically locate all primary, secondary and tertiary standards listed on current VYOPF 0631.01.

FINAL CONDITIONS

- LPC#1 1. Information recorded on VYOPF 0631.01 and records retained per EN-AD-103.

## APPENDIX E

### CALCULATION OF SAMPLE ACTIVITY AND MDA

#### DISCUSSION

This procedure details the methods for Chemistry Department personnel to calculate sample activities as microcuries per milliliter ( $\mu\text{Ci/ml}$ ) from tritium, alpha and gross gamma (well counter) instrumentation data. Instructions are included to calculate minimum detectable (MDA) activity from minimum detectable counts at the 95% confidence level.

#### REFERENCES AND COMMITMENTS

1. Technical Specifications and Site Documents
  - a. ODCM Table 4.2.1 as "LLD"
2. Codes, Standards, and Regulations
  - a. None
3. Commitments
  - a. None
4. Supplemental References
  - a. NCRP Report No. 58
  - b. EN-AD-103, Document Control and Records Management Activities

ILPC1

APPENDIX E (Continued)

PROCEDURE

1. Obtain analysis data:

- Sample gross counts per minute ( $R_g$ )
- Background cpm ( $R_b$ )
- Counting efficiency (E) of the sample
- Sample volume in ml or cc (V)
- Sample count time in minutes ( $t_s$ )
- Background count time in minutes ( $t_b$ )
- Conversion factor dpm/ $\mu$ Ci ( $K$ ) =  $2.22 \times 10^6$

2. Calculate sample specific activity and 1 sigma standard deviation as needed as follows:

$$\text{Specific Activity } (\mu\text{Ci/ml}) = \frac{(R_g) - (R_b)}{(E)(V)(K)} + \frac{\sqrt{\frac{(R_g)}{t_s} + \frac{(R_b)}{t_b}}}{(E)(V)(K)}$$

3. For those samples with gross cpm approximately equal to background cpm, report sample activity as less than the minimum detectable activity (MDA) from the minimum detectable count rate (MDCR) as follows:

**NOTE**

Background and sample count times must be equal to apply the following MDCR formula.

a. For background count rates of less than 10 cpm:

$$MDCR = \frac{2.71}{t_b} + 4.66 \sqrt{\frac{R_b}{t_b}}$$

b. For background count rates of greater than or equal to 10 cpm.

$$MDCR = 4.66 \sqrt{\frac{R_b}{t_b}}$$

## APPENDIX E (Continued)

These equations yield values for lower levels of detectability with a 95% level of confidence for false detection and false rejection.

- c. Use the MDCR from 3.a or b. above to calculate MDA according to Step 2 by substituting MDCR for  $[(R_g - (R_b))]$ . It is not necessary to calculate the standard deviation of MDA values.

### FINAL CONDITIONS

1. None.

## APPENDIX F

### MOISTURE CARRYOVER/IODINE TRANSPORT DETERMINATIONS

#### DISCUSSION

This Appendix provides directions on how to determine steam moisture carryover and iodine transport from the reactor to the turbine.

Steam moisture content is defined as the portion of liquid phase water in the steam-water mixture leaving the BWR pressure vessel. The BWR steam separators and steam dryers, positioned in series, are designed to remove a significant amount of liquid from the steam-water mixture exiting the reactor core. Moisture carryover can be measured to verify performance characteristics of the steam dryer under a variety of operating conditions. Steam Quality is measured by simultaneously monitoring Sodium-24 in the reactor coolant and in the main condenser hotwell, following a period of equilibrium. Steam moisture measurements from BWR/4 and later design plants indicate that moisture content is almost an order of magnitude below the dryer design specification of 0.1% based on Original Licensed Power (OLP).

The normal concentration of Na-24 in the reactor coolant is near the mid  $10E-4$  range while the concentration in the hotwell (CPD) is in the upper  $10E-8$  range. For this reason it is imperative that good counting statistics are used when measuring the CPD Na-24 concentration as well as ensuring that this sample is not contaminated with any reactor coolant. The 1 sigma error for the CPD cation measurement can be reduced to approximately 15% and an overall counting error of 22% by filtering a 2 liter volume through a cation paper and counting the cation paper on the MCA for a minimum of 3,000 seconds after approximately a 2 hour decay time. A 1 sigma error of >33% for the CPD Na-24 activity voids the analysis. Decay time for the CPD sample should be <4 hours due to the short half-life of this nuclide. Refer to procedure section for specific analysis recommendations.

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Moisture carryover measurements are typically performed twice per week but may need to be performed more often under power uprate conditions. Elevated moisture carryover values of >0.16% to 0.3% may be indicative of a problem with the steam dryer and require a CR to be written.

LPC

Iodine transport calculations will be performed as requested by supervision. It is normally about 2-3% in a BWR and is measured by comparing one or more of the common iodine radionuclides (I-131 - I-135) in the reactor coolant to those found in the CPD. The data is useful in analyzing fuel failure data to determine the size of the leaks.

## APPENDIX F (Continued)

### REFERENCES AND COMMITMENTS

1. Technical Specifications and Site Documents
  - a. None
2. Codes, Standards, and Regulations
  - a. None
3. Commitments
  - a. CR-VTY-2006-00201 CA-0001, Contaminated sample resulted in a high moisture carryover calculation.
  - b. CR-VTY-2006-1260 CA-1, Operability Evaluation
4. Supplemental References
  - a. GE Nuclear Energy, SIL No. 639, Steam Moisture Content
  - b. GE Nuclear Energy, SIL No. 644 R1 BWR, Steam Dryer Integrity, 11/09/2004
  - c. Strategic Plan for Mitigation Chemistry, 11/29/2004
  - d. DP 0641, Logging Results of Chemical Analysis
  - e. ON 3178, Increased Moisture Carryover

LPC1

### PRECAUTIONS/LIMITATIONS

1. Label samples and dispose of them properly after analysis is completed.
2. Do not use a CPD Na-24 value where the "1 sigma % error" is >33%.
3. Ensure that dedicated equipment is used to filter the CPD sample to prevent cross-contamination. (CR-VTY-2006-00201)

### PREREQUISITES

1. Vacuum flask and filter apparatus
2. Millipore and cation filter papers
3. Graduated cylinder
4. 500 ml Marinelli

APPENDIX F (Continued)

PROCEDURE

A. Moisture Carryover

1. Obtain a Reactor Coolant sample (250ml minimum for this analysis or as required by MCA % dead time).
2. Obtain a CPD Sample (2 liters minimum) within one hour of collecting the reactor coolant sample.

**NOTES**

- Steps 3 through 9 are performed for both RV and CPD samples.
- When processing CPD samples, use dedicated lab equipment to prevent contamination of the sample. (CR-VTY-2006-0201)

3. Rinse dedicated filter assembly with demineralized water.
4. Arrange filters in dedicated filter assembly with the 0.45 micron filter on top and the cation filter on bottom.
5. Shake sample bottle vigorously just prior to decanting.
6. Filter required volume of sample through dedicated filter funnel.
7. Rinse filtration funnel.
8. Place cation filter into a labeled petri dish.
9. Discard 0.45 micron filter, unless otherwise needed (i.e., metals, isotopic).
10. Allow sample to decay for approximately 2 hours.
11. Analyze on MCA using the appropriate computer program:
  - CPD for 3,000 seconds or less to achieve 1 sigma error  $\leq 33\%$  for Na-24
  - RV for a minimum of 1,000 seconds
12. Verify 1 sigma error for the CPD Na-24 analysis is  $\leq 33\%$ .
13. Complete VYOPF 0631.02.

LPC1

APPENDIX F (Continued)

B. Iodine Transport

1. Obtain a Reactor Coolant sample.

**NOTE**

Condensate Pump Discharge sample shall be collected within one hour of collection of the reactor coolant sample.

2. Obtain a Condensate Pump Discharge sample.

**NOTE**

Steps 3 through 7 are for both the reactor coolant and the Condensate Pump Discharge samples.

3. Filter a portion of each sample through a 0.45 micron filter and one Toray cation filter paper.

**NOTE**

It may be necessary to dilute the filtrate with demineralized water to ensure dead time does not exceed 10%.

4. Decant the filtrate into a 500 ml Marinelli beaker or other approved geometry container and dilute as necessary.

**NOTE**

2-hour decay following collection is only required for reactor coolant samples during power operation.

5. Using the MCA analyzer, count the samples for a minimum of 1000 seconds approximately two (2) hours after collection.

6. Calculate Iodine Transport % =

$$\frac{\text{I-131 CPD}}{\text{I-131 RV}} \times 100$$

7. Complete VYOPF 0631.02.

APPENDIX F (Continued)

FINAL CONDITIONS

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LPC 1  
I )
1. Information recorded on VYOPF 0631.02 and records retained per EN-AD-103.
  2. Issue a CR and notify the Shift Manager if the moisture carryover is determined to be  $\geq 0.16\%$ . (Control Room actions are in ON 3178)
  3. Notify a Chemistry Supervisor if the 1 sigma error for the CPD Na-24 measurement is  $>33\%$ .

## RADIOACTIVE STANDARD ACCOUNTABILITY

### PRIMARY/SECONDARY STANDARD (Circle One)

1. Isotope \_\_\_\_\_
2. Date Prepared \_\_\_\_\_ Vendor Name \_\_\_\_\_
3. Primary/Secondary Standard Control No. \_\_\_\_\_
4. Total Grams \_\_\_\_\_
5. Total Activity \_\_\_\_\_
6. Activity/gram \_\_\_\_\_
7. Date Discarded \_\_\_\_\_ To (location) \_\_\_\_\_
8. Inventory of Primary \_\_\_\_\_ Amount \_\_\_\_\_  
Date/Init \_\_\_\_\_

### SECONDARY/TERTIARY STANDARDS (Circle One)

Control Number	Grams of Standard Used	Geometry	Grams of Standard Remaining	Date Prepared/ Initials	Inventory Date/Init	Date Discarded/ Initials	Location Discarded

Reviewed By: \_\_\_\_\_ / \_\_\_\_\_  
Chemistry Supervision (Print/Sign)
Date

MOISTURE CARRYOVER/IODINE TRANSPORT CALCULATIONS

Sample Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Spectrum Numbers: \_\_\_\_\_

1-Sigma Error of CPD Na-24 measurement = \_\_\_\_\_

MOISTURE CARRYOVER

$$\text{Moisture Carryover \%} = \frac{\text{Na24 CPD}_{\text{CATION}}}{\text{Na24 RV}_{\text{CATION}}} \times 100$$

$$\text{Moisture Carryover \%} = \frac{\text{_____}}{\text{_____}} \times 100 = \text{_____ \%}$$

IODINE TRANSPORT

$$\text{Iodine Transport \%} = \frac{\text{I-131 CPD}}{\text{I-131 RV}} \times 100$$

$$\text{Iodine Transport \%} = \frac{\text{_____}}{\text{_____}} \times 100 = \text{_____ \%}$$

CLPC1 Acceptance Criteria = moisture carryover <0.16%

Performed By: \_\_\_\_\_ Date: \_\_\_\_\_  
(Print/Sign)

Reviewed By: \_\_\_\_\_ Date: \_\_\_\_\_  
Chemistry Supervision (Print/Sign)