UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA ST., N.W.
ATLANTA, GEORGIA 30323

OCT 24 1988

Report Nos.: 50-269/88-31, 50-270/88-31, and 50-287/88-31

Licensee: Duke Power Company
422 South Church Street
Charlotte, NC 28242

Docket Nos.: 50-269, 50-270, and 50-287

License Nos.: DPR-38, DPR-47, and DPR-55

Facility Name: Oconee 1, 2, and 3

Inspection Conducted: September 12-16, 1988

Inspector: H. Bermudez — 10/19/88 Date Signed

Accompanying Personnel: T. Volk

Approved by: John B. Kahle, Section Chief, Division of Radiation Safety and Safeguards — 10/19/88 Date Signed

SUMMARY

Scope: This routine, unannounced inspection was conducted in the areas of confirmatory measurements and quality assurance for in-plant radiochemical analyses.

Results: Licensee and NRC measurements were generally in agreement, with the exceptions of measurements of two radionuclides in three counting geometries. In each of these cases, the disagreements could not be resolved during the inspection. An Inspector Followup Item was opened to request the NRC contract laboratory to send the licensee spiked samples for analysis. Licensee representatives agreed to analyze the samples, with results to be furnished to Region II for comparison. Also, a violation was identified for failure to provide an approved procedure for the sampling of the Unit 1 Condenser Offgas. Improper sampling techniques attributed to absence of an approved procedure resulted in at least two releases of radioactive gases into the sampling work station at the Unit 1 Turbine Building and subsequent unmonitored releases to the environment.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

*S. Coy, Supervising Scientist, Health Physics
*J. Davis, Superintendent, Technical Services
*E. Lampe, Associate Scientist, Health Physics
*F. Owens, Shift Supervisor, Compliance
*G. Rothenberger, Superintendent, Integrated Scheduling
*J. Sevic, Station Chemist
*R. Sweigart, Superintendent, Operations
*M. Thorne, General Supervisor, Health Physics
*M. Tuckman, Station Manager
*C. Yongue, Station Health Physicist

Other licensee employees contacted during this inspection included engineers, security force members, technicians, and administrative personnel.

NRC Resident Inspectors

P. Skinner
*L. Wert

*Attended exit interview

2. Action on Previous Inspection Findings

(Closed) Unresolved Item (URI) 86-19-01: Disagreements in results regarding the counting of gaseous geometries were not resolved during the previous Confirmatory Measurements inspection. The inspector verified the completion of commitments made to the NRC in the licensee's response dated July 7, 1986. Through interviews and review of records, the inspector determined that the intrinsic germanium detectors had been recalibrated, the new calibrations had been confirmed and an intercomparison study was performed. No discrepancies were found either between geometries for each detector or between detectors. This issue is considered closed.

3. Confirmatory Measurements (84725)

During the inspection, reactor coolant samples, a particulate aerosol filter, charcoal cartridges, and selected liquid and gaseous samples were obtained by or provided to the licensee for analysis using the station's gamma spectrometry systems. The licensee's results were compared against those obtained by the inspector from the same samples analyzed using the NRC Region II Mobile Laboratory gamma spectrometry system. The purpose of these comparative measurements was to verify the licensee's capability to

accurately identify and quantify gamma-emitting radionuclides in various plant systems and effluent streams. Comparisons were made against the six detectors located in the licensee's health physics counting room.

Sample types compared included the following:

(1) Unit 3 Low Pressure Injection (LPI) system reactor coolant; (2) Condenser Offgas; (3) Liquid waste monitor tank; (4) Charcoal cartridge calibration standards (one provided by the licensee and one provided by the NRC); and (5) Spiked particulate filter (provided by the NRC).

A more detailed description of the sample types and counting geometries along with a comparison of the NRC and licensee results is listed in Attachment 1. The methodology for determining agreement with licensee results is discussed in Attachment 2.

As indicated in Attachment 1, there was good agreement between the results of the particulate filter geometry among all of the licensee's detectors and the NRC's detector. In the 4400 cubic centimeter gas marinelli geometry, the agreement between licensee and NRC results was also good except for a disagreement in the determination of krypton-87 (Kr-87) concentrations in detector number 4. Biases on the low side (but within the acceptance criteria) for the same radionuclide were also noted in detectors 5 and 6. The inspector indicated to licensee management that since the disagreement was marginal for detector number 4, their systems should be evaluated for possible explanations. Licensee management acknowledged the inspector's comments.

Good agreement was also obtained in the charcoal cartridge geometry on all detectors for radionuclides measured except cadmium-109 (Cd-109). As indicated in Attachment 1, the licensee's Cd-109 measured activities were consistently about 30% lower than those measured by the NRC. After recounting the spiked charcoal cartridge several times and obtaining the same results, the inspector reviewed the licensee's quality control records associated with the operation of the gamma spectrometry systems. Details regarding the types of records reviewed are provided in Paragraph 5. Direct causes for the discrepancy could not be identified by record review.

A similar situation occurred during the determination of radionuclide concentrations in the 50 and 1000 milliliter (ml) liquid geometries. The samples were obtained from the Unit 3 Low Pressure Injection System (reactor coolant) and Liquid Waste Monitor Tank B, respectively. For both types of geometries, there was good agreement on all six detectors for all radionuclides measured, except for cobalt-60 (Co-60). The licensee's Co-60 measurements averaged approximately 37% lower than those of the NRC. The inspector reviewed the licensee's quality control records associated with Co-60 determinations in the 50 and 1000 ml liquid geometries and did not to find a cause for the disagreements in results.

The inspector determined that a discrepancy in Cd-109 determinations in the charcoal cartridge geometry was not safety-significant since Cd-109 is an activation product seldom detected in plant systems. Cd-109 is mainly used in calibration standards because its gamma energy of 88 KeV provides an adequate low energy calibration data point in the energy spectrum. On the other hand, Co-60 is a major contributor to the total activity in the plant's liquid systems. Since accurate Co-60 determinations in liquids are important, the NRC's approach to resolution of the noted disagreements will be to send the licensee liquid samples spiked with Co-60 prepared by the NRC contract laboratory in Idaho Falls. Licensee management agreed to analyze the samples and indicated that they will also cross-check the accuracy of their Co-60 determinations in liquid geometries with counting laboratories at other corporate facilities. The inspector indicated to licensee representatives that the evaluation of the measurements of the spiked samples would be considered an Inspector Followup Item.

(OPENED) IFI 50-269, 270, 287/88-31-01: Review licensee results of RESL spiked samples for Co-60.

No violations or deviations were identified.

4. Sampling Techniques (84725)

The inspector witnessed sampling of the Unit 3 LPI reactor coolant and of Liquid Waste Monitor Tank B. The inspector observed that sampling techniques and health physics practices were adequate.

Licensee representatives indicated that the main objective of sampling reactor coolant on a daily basis was to keep track of concentrations of radioactive iodines and noble gases. They indicated that these reactor coolant samples were not degassed. The inspector stated that determining concentrations of noble gases dissolved in liquids was difficult because noble gases tend to preferentially diffuse into the gas space of the sample container, changing the calibration geometry assumption of sample homogeneity. A licensee representative indicated that they had not experienced problems in that area.

The licensee's analysis procedure required that reactor coolant samples be counted one hour after sampling, plus or minus 15 minutes. The inspector requested that the Unit 3 LPI sample be counted 45 minutes after sampling and recounted on the same detector 75 minutes after sampling, in order to test the validity of the licensee's approach. Unfortunately, the sample was obtained from Unit 3, which had been in an outage for many days prior to the inspection. All noble gases had decayed to below detection limits and, therefore, no comparisons could be made.

The inspector also witnessed the sampling of Unit 1 condenser offgas at sampling station 1-RIA-40, located in the Unit 1 Turbine Building. The technician set up the sampling train and proceeded to take the sample by starting a vacuum pump and creating a flow of approximately 30 liters per minute by adjusting a rotameter. After approximately five minutes, the

inspector inquired as to the discharge point of the exhaust gas. Neither of the two licensee representatives who accompanied the inspector knew the answer. The inspector traced the sampling line from the two inlet valves attached to the gas header, through the different components of the sampling train, until the line passed under the sampling cart. The inspector reached under the sampling cart and felt a jet of air hitting his hand. The inspector indicated that the sampling train was exhausting to the work area and requested that the sampling be stopped. Licensee representatives investigated the situation and realized that the exhaust of the sampling line had not been connected to the return valves attached to the gas header located approximately seven feet above the sampling cart. A licensee representative made the connection and the sampling proceeded. At the end of the sampling, both valves on the inlet and exhaust return lines were closed.

Due to a heavy workload in the counting room, the licensee was unable to count the gas samples until the following day. Since the short-lived radionuclides had decayed, a second sample had to be taken.

On the next day, a different technician hooked up the sampling lines, turned on the sampling pump, and attempted to obtain the second sample. The technician failed to open one of the two valves on the exhaust return, which had been closed the day before. Since the gases were not able to flow through the closed valve, the return line was over-pressurized. This resulted in a loud, sudden release of the sampling hose in front of the inspector and two licensee representatives. The technician indicated that he normally left open the second valve on the return to the header. The hose was re-connected, the valve was opened and the sampling proceeded. The inspector also noted that the rotameter was inclined at an angle of approximately 15 to 25 degrees with respect to the vertical during the gas sampling. After moving the rotameter in the correct vertical position, the flowmeter indicator reading decreased by approximately 10%.

Technical Specification 6.4.1 states that written procedures with appropriate check-off lists and instructions shall be provided for: (1) actions taken to correct specific and forseen potential malfunctions of systems or components involving radiation levels; (2) preventive or corrective maintenance which could affect radiation exposure to personnel; and (3) personnel radiation protection procedures.

10 CFR Part 20.201(b) requires that each licensee shall make or cause to be made such surveys as are reasonable under the circumstances to evaluate the extent of radiation hazards that may be present.

Licensee representatives stated that Procedure HP/0/B/1000/57, Procedure for Quantifying Airborne Activity, revision dated June 6, 1988, was the procedure applicable to all in-plant air and gas sampling operations at the licensee's facility. The inspector noted that the procedure contained no written instructions or appropriate check-off lists for sampling from

sampling points 1 RIA-40, 2 RIA-40, or 3 RIA 40, which were the points of sampling for the condenser air ejector exhaust headers for Units 1,2 and 3, respectively. The licensee was notified that the absence of procedures or written instructions for the sampling of gases from 1-RIA-40 was considered to be a violation of Technical Specification 6.4.1.

Relative to the events described above, such surveys as may have been made were not reasonable under the circumstances, as specified in 10 CFR Part 20.201(b), and therefore inadequate, in that they failed to identify the absence of a gas sample return line to the system of origin as a potential radiation hazard to personnel and that they failed to identify the absences or lack of specific procedural instructions for the operation of valves controlling the venting of radioactive gaseous sampling discharges at 1-RIA-40. In both the instances noted above, radioactive gases were released in an uncontrolled manner to spaces occupied by plant personnel. While the radiation doses to exposed personnel were calculated to be negligible, the potential existed for substantially higher exposures and was not recognized. These circumstances were determined to represent multiple examples of violation of 10 CFR Part 20.201(b), for inadequate surveys. The licensee was notified of this determination in a telephone conversation on October 17, 1988.

Additional radiation protection concerns associated with this violation were the following:

- Releases of radioactive gases in the station's Turbine Building would reach the outside environment as unmonitored releases.
- The estimated activity released during the two events was on the order of 0.2 millicuries; in a tube rupture accident situation, releases could be several orders of magnitude higher.
- Licensee management did not provide assurance that the releases described in this report were isolated events.
- Activity levels in the Unit 1 Condenser Offgas at the time of the inspection were higher than rormal because the unit had been operating with defective fuel and known steam generator tube leaks.
- Assuming instantaneous homogeneous dispersion of released gases in a volume of 2.83×10^7 cubic centimeters (10 X 10 X 10 feet), and given the specified flow rate, release duration and radioactivity concentrations, a zone with an effective radioactivity concentration of 78% of the Maximum Permissible Concentration of radionuclides in air for radiation work areas was created (see 10 CFR 20, Appendix B, Table 1, Column 1).

One violation was identified.

5. Quality Assurance - Counting Room Operations (84725)

The inspector reviewed the Departmental Quality Assurance Audit #NP-88-01 (ON) and the 1986 and 1987 Duke Power Company's audits of counting room operations. The inspector determined that the audits were thorough, comprehensive, and performed by personnel with adequate knowledge of counting room operations. However, the inspector noted that the deficiency described in audit NP-88-01 (ON), performed in January 1988, had not been corrected as of the time of this inspection. The deficiency indicated that periodic samples were not being taken during the release of liquid effluents. The root cause for the deficiency was determined to be a misunderstanding associated with the acceptance and implementation of Duke Nuclear Guide 1.21. Licensee representatives indicated that the deficiency had become an issue of generic applicability to all of the company's facilities and that, as of the time of the inspection, the licensee's Corporate Office was in the process of resolving the issue in a way that would be applicable to all corporate facilities. The inspector noted that all other audit findings had been investigated and resolved in a timely manner.

The inspector reviewed the Quality Control charts which contained performance test data for detectors 4, 5, and 6. The data showed stable and adequate detector performance during calendar year 1988. The inspector also reviewed the licensee's gamma spectrometer calibration methodology with emphasis on Cd-109 calibration data in the charcoal cartridge geometry and on Co-60 in both 50 ml and 1000 ml liquid geometries. The calibration curves reviewed were computer-generated and the calibration data points were very close to the efficiency calculated from the exponential fit performed by the computer. The inspector verified that the information contained in the certificates of the calibration standards in the subject geometries had been entered correctly into the computer software.

The inspector and licensee representatives discussed the licensee's cross-check program. Licensee representatives indicated that they had recently participated in a corporate cross-check program for both liquid geometries with good results. They also indicated that after each calibration, they compared old versus new efficiencies to look for significant changes. No significant changes had been observed in the previous two years.

No violations or deviations were identified.

6. Exit Interview

The inspection scope and results were summarized on September 16, 1988, with those persons indicated in Paragraph 1. The inspector described the areas inspected and discussed in detail the inspection results. Although proprietary information was reviewed during this inspection, none is contained in this report. Dissenting comments were not received from the licensee, except for the licensee management's questioning of the

radiation protection significance associated with the violation described in this report. On September 16, 1988, subsequent to the exit, senior licensee management contacted Region II management and indicated that exception would be taken to the violation on the basis of safety significance.

ATTACHMENT 1

NRC-LICENSEE SAMPLE COMPARISION EVALUATION

SAMPLE	ISOTOPE	CONCENTRATION LICENSEE	NRC	RESOLUTION	LICENSEE/NRC	COMPARISON
Particulate Filter NRC Spike						
Detector #1	Co-60	4.72 E-2	4.99 ± 0.06 E-2	83	0.95	Agremeent
	Sr-85	5.80 E-2	6.01 ± 0.61 E-2	10	0.96	Agreement
	Cd-109	2.46 E-1	2.83 ± 0.04 E-1	71	0.87	Agreement
	Sn-113	4.46 E-2	4.51 ± 0.18 E-2	25	0.99	Agreement
	Ce-139	1.26 E-2	1.25 ± 0.05 E-2	25	1.01	Agreement
	Co-57	1.04 E-2	1.02 ± 0.02 E-2	51	1.02	Agreement
	Y-88	9.42 E-2	9.89 ± 0.32 E-2	31	0.95	Agreement
	Cs-137	4.27 E-2	4.17 ± 0.05 E-2	83	1.02	Agreement
Detector #2	Co-60	4.78 E-2	4.99 ± 0.06 E-2	83	0.96	Agremeent
	Sr-85	5.92 E-2	6.01 ± 0.61 E-2	10	0.98	Agreement
	Cd-109	2.50 E-1	2.83 ± 0.04 E-1	71	0.88	Agreement
	Sn-113	4.51 E-2	4.51 ± 0.18 E-2	25	1.00	Agreement
	Ce-139	1.27 E-2	1.25 ± 0.05 E-2	25	1.02	Agreement
	Co-57	1.07 E-2	1.02 ± 0.02 E-2	51	1.05	Agreement
	Y-88	9.70 E-2	9.89 ± 0.32 E-2	31	0.98	Agreement
	Cs-137	4.23 E-2	4.17 ± 0.05 E-2	83	1.01	Agreement
Detector #3	Co-60	4.82 E-2	4.99 ± 0.06 E-2	83	0.96	Agreement
	Sr-85	6.25 E-2	6.01 ± 0.61 E-2	10	1.04	Agreement
	Cd-109	2.50 E-1	2.83 ± 0.04 E-1	71	0.88	Agreement
	Sn-113	4.62 E-2	4.51 ± 0.18 E-2	25	1.02	Agreement
	Ce-139	1.26 E-2	1.25 ± 0.05 E-2	25	1.01	Agreement
	Co-57	1.04 E-2	1.02 ± 0.02 E-2	51	1.02	Agreement
	Y-88	9.64 E-2	9.89 ± 0.32 E-2	31	0.97	Agreement
	Cs-137	4.42 E-2	4.17 ± 0.05 E-2	83	1.06	Agreement
Detector #4	Co-60	4.73 E-2	4.99 ± 0.06 E-2	83	0.95	Agremeent
	Sr-85	4.95 E-2	6.01 ± 0.61 E-2	10	0.82	Agreement
	Cd-109	2.65 E-1	2.83 ± 0.04 E-1	71	0.94	Agreement
	Sn-113	4.46 E-2	4.51 ± 0.18 E-2	25	0.99	Agreement
	Ce-139	1.23 E-2	1.25 ± 0.05 E-2	25	0.98	Agreement
	Co-57	9.80 E-2	1.02 ± 0.02 E-2	51	0.96	Agreement
	Y-88	8.88 E-2	9.89 ± 0.32 E-2	31	0.90	Agreement
	Cs-137	4.04 E-2	4.17 ± 0.05 E-2	83	0.97	Agreement

SAMPLE	ISOTOPE	CONCENTRATION LICENSEE	CONCENTRATION NRC	RESOLUTION	LICENSEE/NRC	COMPARISON
Detector #5	Co-60	4.59 E-2	4.99 ± 0.06 E-2	83	0.92	Agremeent
	Sr-85	4.86 E-2	6.01 ± 0.61 E-2	10	0.81	Agreement
	Cd-109	2.43 E-1	2.83 ± 0.04 E-1	71	0.86	Agreement
	Sn-113	4.47 E-2	4.51 ± 0.18 E-2	25	0.99	Agreement
	Ce-139	1.28 E-2	1.25 ± 0.05 E-2	25	1.02	Agreement
	Co-57	9.53 E-2	1.02 ± 0.02 E-2	51	0.93	Agreement
	Y-88	9.48 E-2	9.89 ± 0.32 E-2	31	0.96	Agreement
	Cs-137	3.95 E-2	4.17 ± 0.05 E-2	83	0.95	Agreement
Detector #6	Co-60	4.88 E-2	4.99 ± 0.06 E-2	83	0.98	Agremeent
	Sr-85	5.69 E-2	6.01 ± 0.61 E-2	10	0.95	Agreement
	Cd-109	2.52 E-1	2.83 ± 0.04 E-1	71	0.89	Agreement
	Sn-113	4.43 E-2	4.51 ± 0.18 E-2	25	0.98	Agreement
	Ce-139	1.26 E-2	1.25 ± 0.05 E-2	25	1.01	Agreement
	Co-57	9.90 E-2	1.02 ± 0.02 E-2	51	0.97	Agreement
	Y-88	9.33 E-2	9.89 ± 0.32 E-2	31	0.94	Agreement
	Cs-137	4.15 E-2	4.17 ± 0.05 E-2	83	1.00	Agreement
Charcoal Cartridge Face Loaded, NRC Spike						
Detector #1	Co-60	4.60 E-2	5.06 ± 0.07 E-2	72	0.91	Agremeent
	Cd-109	1.34 E-0	1.95 ± 0.01 E-0	195	0.69	Disagreement
	Sn-113	6.16 E-2	6.66 ± 0.14 E-2	48	0.92	Agreement
	Ce-139	2.95 E-2	3.36 ± 0.06 E-2	56	0.88	Agreement
	Hg-203	8.77 E-2	8.52 ± 0.64 E-2	13	1.03	Agreement
	Co-57	2.97 E-2	3.14 ± 0.03 E-2	105	0.94	Agreement
	Y-88	1.15 E-1	1.24 ± 0.03 E-1	41	0.93	Agreement
	Cs-137	4.36 E-2	4.53 ± 0.05 E-2	91	0.96	Agreement
Detector #2	Co-60	4.56 E-2	5.06 ± 0.07 E-2	72	0.90	Agremeent
	Cd-109	1.31 E-0	1.95 ± 0.01 E-0	195	0.67	Disagreement
	Sn-113	6.18 E-2	6.66 ± 0.14 E-2	48	0.93	Agreement
	Ce-139	2.91 E-2	3.36 ± 0.06 E-2	56	0.87	Agreement
	Hg-203	8.35 E-2	8.52 ± 0.64 E-2	13	0.98	Agreement
	Co-57	2.87 E-2	3.14 ± 0.03 E-2	105	0.91	Agreement
	Y-88	1.08 E-1	1.24 ± 0.03 E-1	41	0.87	Agreement
	Cs-137	4.39 E-2	4.53 ± 0.05 E-2	91	0.97	Agreement
Detector #3	Co-60	4.73 E-2	5.06 ± 0.07 E-2	72	0.93	Agremeent
	Cd-109	1.38 E-0	1.95 ± 0.01 E-0	195	0.71	Disagreement
	Sn-113	6.21 E-2	6.66 ± 0.14 E-2	48	0.93	Agreement
	Ce-139	2.98 E-2	3.36 ± 0.06 E-2	56	0.89	Agreement
	Hg-203	8.75 E-2	8.52 ± 0.64 E-2	13	1.03	Agreement
	Co-57	3.01 E-2	3.14 ± 0.03 E-2	105	0.96	Agreement
	Y-88	1.15 E-1	1.24 ± 0.03 E-1	41	0.92	Agreement
	Cs-137	4.50 E-2	4.53 ± 0.05 E-2	91	0.99	Agreement

SAMPLE	ISOTOPE	CONCENTRATION LICENSEE	CONCENTRATION NRC	RESOLUTION	LICENSEE/NRC	COMPARISON
Detector #4	Co-60	4.62 E-2	5.06 ± 0.07 E-2	72	0.91	Agremeent
	Cd-109	1.44 E-0	1.95 ± 0.01 E-0	195	0.74	Disagreement
	Sn-113	6.27 E-2	6.66 ± 0.14 E-2	48	0.94	Agreement
	Ce-139	3.06 E-2	3.36 ± 0.06 E-2	56	0.91	Agreement
	Hg-203	9.40 E-2	8.52 ± 0.64 E-2	13	1.10	Agreement
	Co-57	2.92 E-2	3.14 ± 0.03 E-2	105	0.93	Agreement
	Y-88	1.12 E-1	1.24 ± 0.03 E-1	41	0.90	Agreement
	Cs-137	4.28 E-2	4.53 ± 0.05 E-2	91	0.94	Agreement
Detector #5	Co-60	4.75 E-2	5.06 ± 0.07 E-2	72	0.94	Agremeent
	Cd-109	1.39 E-0	1.95 ± 0.01 E-0	195	0.71	Disagreement
	Sn-113	6.21 E-2	6.66 ± 0.14 E-2	48	0.93	Agreement
	Ce-139	3.07 E-2	3.36 ± 0.06 E-2	56	0.91	Agreement
	Hg-203	8.78 E-2	8.52 ± 0.64 E-2	13	1.03	Agreement
	Co-57	2.93 E-2	3.14 ± 0.03 E-2	105	0.93	Agreement
	Y-88	1.11 E-1	1.24 ± 0.03 E-1	41	0.90	Agreement
	Cs-137	4.26 E-2	4.53 ± 0.05 E-2	91	0.94	Agreement
Detector #6	Co-60	4.57 E-2	5.06 ± 0.07 E-2	72	0.90	Agremeent
	Cd-109	1.41 E-0	1.95 ± 0.01 E-0	195	0.72	Disagreement
	Sn-113	6.32 E-2	6.66 ± 0.14 E-2	48	0.95	Agreement
	Ce-139	3.00 E-2	3.36 ± 0.06 E-2	56	0.89	Agreement
	Hg-203	9.31 E-2	8.52 ± 0.64 E-2	13	1.09	Agreement
	Co-57	2.98 E-2	3.14 ± 0.03 E-2	105	0.95	Agreement
	Y-88	1.09 E-1	1.24 ± 0.03 E-1	41	0.88	Agreement
	Cs-137	4.25 E-2	4.53 ± 0.05 E-2	91	0.94	Agreement
Condenser Offgas 4400 cc gas Marinelli						
Detector #1	Ar-41	1.50 E-5	1.33 ± 0.05 E-5	27	1.13	Agremeent
	Kr-85M	2.70 E-5	2.62 ± 0.04 E-5	66	1.03	Agreement
	Kr-87	2.38 E-5	2.66 ± 0.06 E-5	44	0.89	Agreement
	Xe-133M	1.54 E-5	1.42 ± 0.21 E-5	7	1.08	Agreement
	Xe-133	5.32 E-4	6.10 ± 0.02 E-4	>200	0.87	Agreement
	Xe-135	1.79 E-4	1.90 ± 0.01 E-4	190	0.94	Agreement
Detector #2	Ar-41	1.52 E-5	1.33 ± 0.05 E-5	27	1.14	Agremeent
	Kr-85M	2.61 E-5	2.62 ± 0.04 E-5	66	1.00	Agreement
	Kr-87	2.27 E-5	2.66 ± 0.06 E-5	44	0.85	Agreement
	Xe-133M	1.31 E-5	1.42 ± 0.21 E-5	7	0.92	Agreement
	Xe-133	5.47 E-4	6.10 ± 0.02 E-4	>200	0.90	Agreement
	Xe-135	1.69 E-4	1.90 ± 0.01 E-4	190	0.89	Agreement
Detector #3	Ar-41	1.52 E-5	1.33 ± 0.05 E-5	27	1.14	Agremeent
	Kr-85M	2.54 E-5	2.62 ± 0.04 E-5	66	0.97	Agreement
	Kr-87	2.34 E-5	2.66 ± 0.06 E-5	44	0.88	Agreement
	Xe-133M	1.23 E-5	1.42 ± 0.21 E-5	7	0.87	Agreement
	Xe-133	5.18 E-4	6.10 ± 0.02 E-4	>200	0.85	Agreement
	Xe-135	1.73 E-4	1.90 ± 0.01 E-4	190	0.91	Agreement

SAMPLE	ISOTOPE	CONCENTRATION LICENSEE	CONCENTRATION NRC	RESOLUTION	LICENSEE/NRC	COMPARISON
Detector #4	Ar-41	1.35 E-5	1.33 ± 0.05 E-5	27	1.02	Agremeent
	Kr-85M	3.18 E-5	2.62 ± 0.04 E-5	66	1.21	Agreement
	Kr-87	1.97 E-5	2.66 ± 0.06 E-5	44	0.74	Disagreement
	Xe-133M	1.32 E-5	1.42 ± 0.21 E-5	7	0.93	Agreement
	Xe-133	5.27 E-4	6.10 ± 0.02 E-4	>200	0.86	Agreement
	Xe-135	1.55 E-4	1.90 ± 0.01 E-4	190	0.82	Agreement
Detector #5	Ar-41	1.48 E-5	1.33 ± 0.05 E-5	27	1.11	Agremeent
	Kr-85M	3.27 E-5	2.62 ± 0.04 E-5	66	1.25	Agreement
	Kr-87	2.06 E-5	2.66 ± 0.06 E-5	44	0.77	Agreement
	Xe-133M	1.32 E-5	1.42 ± 0.21 E-5	7	0.93	Agreement
	Xe-133	5.50 E-4	6.10 ± 0.02 E-4	>200	0.90	Agreement
	Xe-135	1.63 E-4	1.90 ± 0.01 E-4	190	0.86	Agreement
Detector #6	Ar-41	1.45 E-5	1.33 ± 0.05 E-5	27	1.09	Agremeent
	Kr-85M	3.28 E-5	2.62 ± 0.04 E-5	66	1.25	Agreement
	Kr-87	2.10 E-5	2.66 ± 0.06 E-5	44	0.79	Agreement
	Xe-133M	1.28 E-5	1.42 ± 0.21 E-5	7	0.90	Agreement
	Xe-133	5.46 E-4	6.10 ± 0.02 E-4	>200	0.90	Agreement
	Xe-135	1.67 E-4	1.90 ± 0.01 E-4	190	0.88	Agreement
Waste Monitor Tank 1000 ml bottle						
Detector #1	Co-58	1.48 E-5	1.49 ± 0.06 E-5	25	0.99	Agreement
	Co-60	4.69 E-6	6.63 ± 0.60 E-6	11	0.71	Agreement
	Sb-125	3.44 E-4	3.30 ± 0.04 E-4	82	1.04	Agreement
	I-131	4.62 E-6	4.71 ± 0.64 E-6	7	0.98	Agreement
Detector #2	Co-58	1.27 E-5	1.49 ± 0.06 E-5	25	0.85	Agreement
	Co-60	3.50 E-6	6.63 ± 0.60 E-6	11	0.53	Disagreement
	Sb-125	3.09 E-4	3.30 ± 0.04 E-4	82	0.94	Agreement
	I-131	4.68 E-6	4.71 ± 0.64 E-6	7	0.99	Agreement
Detector #3	Co-58	1.38 E-5	1.49 ± 0.06 E-5	25	0.93	Agreement
	Co-60	4.40 E-6	6.63 ± 0.60 E-6	11	0.66	Agreement
	Sb-125	3.25 E-4	3.30 ± 0.04 E-4	82	0.98	Agreement
	I-131	5.57 E-6	4.71 ± 0.64 E-6	7	1.18	Agreement
Detector #4	Co-58	1.48 E-5	1.49 ± 0.06 E-5	25	0.99	Agreement
	Co-60	3.94 E-6	6.63 ± 0.60 E-6	11	0.59	Disagreement
	Sb-125	3.18 E-4	3.30 ± 0.04 E-4	82	0.96	Agreement
	I-131	5.74 E-6	4.71 ± 0.64 E-6	7	1.21	Agreement
Detector #5	Co-58	1.37 E-5	1.49 ± 0.06 E-5	25	0.92	Agreement
	Co-60	4.02 E-6	6.63 ± 0.60 E-6	11	0.61	Agreement
	Sb-125	3.27 E-4	3.30 ± 0.04 E-4	82	0.99	Agreement
	I-131	4.99 E-6	4.71 ± 0.64 E-6	7	1.06	Agreement

SAMPLE	ISOTOPE	CONCENTRATION LICENSEE	NRC	RESOLUTION	LICENSEE/NRC	COMPARISON
Detector #6	Co-58	1.36 E-5	1.49 ± 0.06 E-5	25	0.91	Agreement
	Co-60	3.90 E-6	6.63 ± 0.60 E-6	11	0.59	Disagreement
	Sb-125	3.33 E-4	3.30 ± 0.04 E-4	82	1.01	Agreement
	I-131	4.87 E-6	4.71 ± 0.64 E-6	7	1.03	Agreement
Reactor Coolant Sample 50 ml bottle						
Detector #1	Cr-51	2.14 E-3	2.94 ± 0.41 E-3	7	0.73	Agreement
	Co-58	7.73 E-3	8.26 ± 0.12 E-3	69	0.94	Agreement
	Co-60	1.03 E-3	1.54 ± 0.06 E-3	26	0.67	Disagreement
	I-131	1.12 E-3	1.22 ± 0.06 E-3	20	0.92	Agreement
	Cs-134	4.68 E-3	4.98 ± 0.10 E-3	50	0.94	Agreement
	Cs-137	6.19 E-3	6.26 ± 0.11 E-3	57	0.99	Agreement
Detector #2	Cr-51	3.90 E-3	2.94 ± 0.41 E-3	7	1.32	Agreement
	Co-58	8.31 E-3	8.26 ± 0.12 E-3	69	1.01	Agreement
	Co-60	1.02 E-3	1.54 ± 0.06 E-3	26	0.66	Disagreement
	I-131	1.29 E-3	1.22 ± 0.06 E-3	20	1.06	Agreement
	Cs-134	5.13 E-3	4.98 ± 0.10 E-3	50	1.03	Agreement
	Cs-137	6.50 E-3	6.26 ± 0.11 E-3	57	1.04	Agreement
Detector #3	Cr-51	3.56 E-3	2.94 ± 0.41 E-3	7	1.21	Agreement
	Co-58	7.94 E-3	8.26 ± 0.12 E-3	69	0.96	Agreement
	Co-60	1.03 E-3	1.54 ± 0.06 E-3	26	0.67	Disagreement
	I-131	1.19 E-3	1.22 ± 0.06 E-3	20	0.98	Agreement
	Cs-134	4.71 E-3	4.98 ± 0.10 E-3	50	0.94	Agreement
	Cs-137	6.15 E-3	6.26 ± 0.11 E-3	57	0.98	Agreement
Detector #4	Cr-51	3.70 E-3	2.94 ± 0.41 E-3	7	1.26	Agreement
	Co-58	7.58 E-3	8.26 ± 0.12 E-3	69	0.92	Agreement
	Co-60	9.68 E-3	1.54 ± 0.06 E-3	26	0.63	Disagreement
	I-131	9.90 E-3	1.22 ± 0.06 E-3	20	0.81	Agreement
	Cs-134	4.23 E-3	4.98 ± 0.10 E-3	50	0.85	Agreement
	Cs-137	5.28 E-3	6.26 ± 0.11 E-3	57	0.84	Agreement
Detector #5	Cr-51	4.26 E-3	2.94 ± 0.41 E-3	7	1.44	Agreement
	Co-58	7.61 E-3	8.26 ± 0.12 E-3	69	0.92	Agreement
	Co-60	8.88 E-3	1.54 ± 0.06 E-3	26	0.58	Disagreement
	I-131	1.13 E-3	1.22 ± 0.06 E-3	20	0.93	Agreement
	Cs-134	4.56 E-3	4.98 ± 0.10 E-3	50	0.92	Agreement
	Cs-137	5.76 E-3	6.26 ± 0.11 E-3	57	0.92	Agreement
Detector #6	Cr-51	3.33 E-3	2.94 ± 0.41 E-3	7	1.13	Agreement
	Co-58	8.23 E-3	8.26 ± 0.12 E-3	69	1.00	Agreement
	Co-60	1.08 E-3	1.54 ± 0.06 E-3	26	0.70	Disagreement
	I-131	1.20 E-3	1.22 ± 0.06 E-3	20	0.98	Agreement
	Cs-134	4.73 E-3	4.98 ± 0.10 E-3	50	0.95	Agreement
	Cs-137	5.90 E-3	6.26 ± 0.11 E-3	57	0.94	Agreement

ATTACHMENT 2

CRITERIA FOR COMPARING ANALYTICAL MEASUREMENTS

This attachment provides criteria for comparing results of capability tests and verification measurements. The criteria are based on an empirical relationship which combines prior experience and the accuracy needs of this program.

In this criteria, the judgement limits denoting agreement or disagreement between licensee and NRC results are variable. This variability is a function of the NRC's value relative to its associated uncertainty. As the ratio of the NRC value to its associated uncertainty referred to in this program as "Resolution"[1] increases, the range of acceptable differences between the NRC and licensee values should be more restrictive. Conversely, poorer agreement between NRC and licensee values must be considered acceptable as the resolution decreases.

For comparison purposes, a ratio[2] of the licensee value to the NRC value is computed. This ratio is then evaluated for agreement based on the calculated resolution. The corresponding resolution and calculated ratios which denote agreement are listed in Table 1 below. Values outside of the agreement ratios are considered in disagreement.

$$^{1}\text{Resolution} = \frac{\text{NRC Reference Value}}{\text{Associated Uncertainty for the Value}}$$

$$^{2}\text{Comparison Ratio} = \frac{\text{Licensee Value}}{\text{NRC Reference Value}}$$

TABLE 1

CONFIRMATORY MEASUREMENTS ACCEPTANCE CRITERIA

RESOLUTION VS. COMPARISON RATIO

Resolution	Comparison Ratio for Agreement
<4	.4 - 2.5
4 - 7	.5 - 2.0
8 - 15	.6 - 1.66
16 - 50	.75 - 1.33
51 - 200	.80 - 1.25
>200	.85 - 1.18