APPENDIX B

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

NRC Inspection Report: 50-267/88-09 Operating License: DPR-34

Docket: 50-267

Licensee: Public Service Company of Colorado (PSC)
2420 W. 26th Avenue, Suite 15c
Denver, Colorado 80211

Facility Name: Fort St. Vrain Nuclear Generating Station (FSV)

Inspection At: FSV Site, Weld County, Platteville, Colorado

Inspection Conducted: April 11-15, 1988

Inspectors: J. Blair Nicholas 5/12/88
J. B. Nicholas, Senior Radiation Specialist Date
Facilities Radiological Protection Section

for J. Blair Nicholas 5/12/88
R. Wise, Radiation Specialist, Facilities Date
Radiological Protection Section

Approved: Gerald E. Baer 5/13/88
R. E. Baer, Acting Chief, Facilities Date
Radiological Protection Section

Inspection Summary

Inspection Conducted April 11-15, 1988 (Report 50-267/88-09)

Areas Inspected: Routine, unannounced inspection of the licensee's chemistry/radiochemistry program and water chemistry and radiochemistry confirmatory measurements.

Results: Within the areas inspected, one violation was identified (failure to use quality control charts to evaluate water chemistry laboratory instrument performance, paragraph 7). No deviations were identified. One previously identified open item was closed.

DETAILS

1. Persons Contacted

PSC

*R. O. Williams, Jr., Vice President, Nuclear Operations
H. E. Adamski, Senior Chemist
W. L. Alderman, Radiochemist
F. J. Borst, Manager, Nuclear Training
J. C. Brungardt, Senior Chemist
S. L. Chambers, Radiochemist
L. Dlug, Chemist
*M. J. Ferris, Manager, Operations Quality Assurance
D. L. Fetteroff, Senior Chemist
V. H. Frahm, Senior Radiochemist
*M. H. Holmes, Manager, Nuclear Licensing
*R. O. Hooper, Nuclear Training Administration Supervisor
L. C. Hutchins, Nuclear Training Specialist
*V. A. Lucero, Chemistry Supervisor
G. S. Madison, Radiochemist
*D. D. Miller, Radiochemistry Supervisor
*F. J. Novachek, Manager, Technical/Administrative Services
*T. E. Schleiger, Health Physics Supervisor
*L. D. Scott, Manager, Quality Assurance Services
*L. R. Sutton, Quality Assurance Auditing Supervisor
*P. F. Tomlinson, Manager, Quality Assurance
*D. O. Warembourg, Manager, Nuclear Engineering
J. E. Worley, Chemist

NRC

R. E. Farrell, Senior Resident Inspector, FSV
*P. W. Michaud, Resident Inspector, FSV

*Denotes those individuals present during the exit interview on April 15, 1988.

2. Followup on Previously Identified Inspection Findings (92701)

(Closed) Open Item 267/8421-03: Quality Assurance (QA) Program - This item was identified in NRC Inspection Report 50-267/84-21 and involved the lack of a comprehensive QA audit program for water chemistry and radiochemistry activities, which included the use of a technical specialist with expertise in water chemistry and radiochemistry as an audit team member. The licensee had performed a comprehensive audit of the water chemistry and radiochemistry programs in June 1987. The audit team included a technical specialist knowledgeable in water chemistry and radiochemistry activities at nuclear power facilities.

3. Open Items Identified During This Inspection

An open item is a matter that requires further review and evaluation by the NRC inspectors. Open items are used to document, track, and ensure adequate followup on matters of concern to the NRC inspectors. The following open item was identified:

Open Item	Title	Paragraph
267/8809-02	Water Chemistry Confirmatory Measurements	7

4. NRC Inspectors Observations

The following are observations the NRC inspectors discussed with the licensee during the exit interview on April 15, 1988. These observations are not violations, deviations, unresolved items, or open items. These observations were identified for licensee consideration for program improvement, but the observations have no specific regulatory requirements. The licensee stated that these observations would be evaluated.

a. Water Chemistry and Radiochemistry Personnel Training - The licensee had not completed the 1987 continuing training program for water chemistry and radiochemistry personnel as proposed in interoffice memos (see paragraph 6).

b. Water Chemistry Calibration Standards Verification - The licensee was not using two independent standard stock solutions for instrument calibration and measurement quality control (see paragraph 7).

c. Water Chemistry Instrument Calibration - The licensee was not generating multiple point calibration curves for the atomic absorption system, ultraviolet/visible (UV/VIS) spectrometer, and ion chromatograph (see paragraph 7).

5. Organization and Management Controls (83722/83522)

The NRC inspectors reviewed the licensee's organization, staffing, identification and correction of program weaknesses, audits and appraisals, communication to employees, and documentation and implementation of the water chemistry section (WCS) and radiochemistry section (RCS) programs to determine adherence to commitments in Chapter 12 of the Updated Safety Analysis Report (USAR) and the requirements in Section 7.1 of the Technical Specifications (TS).

The NRC inspectors verified that the organizational structure of the WCS and RCS were as defined in the USAR and TS. The NRC inspectors reviewed the FSV management control procedures and position descriptions for the assignment of responsibilities for the management and implementation of

the FSV water chemistry and radiochemistry programs. The NRC inspectors verified that the administrative control responsibilities specified by the FSV procedures were being implemented.

The NRC inspectors reviewed the staffing of the WCS and RCS and noted that, since the previous NRC water chemistry/radiochemistry inspection in June 1986, the WCS had experienced no personnel changes and the RCS had lost the radiochemistry supervisor and three radiochemistry technicians. The radiochemistry supervisor's position had been filled with the former senior radiochemist and the three vacant radiochemistry technician positions had been filled with qualified personnel. The RCS staff turnover rate during the past 22 months had been approximately 60 percent. The WCS and RCS staffing were determined to be in accordance with licensee commitments.

No violations or deviations were identified.

6. Training and Qualifications (83723/83523)

The NRC inspectors reviewed the licensee's training and qualification program for WCS and RCS personnel including education and experience, adequacy and quality of training, employee knowledge, qualification requirements, new employees, Institute of Nuclear Power Operations (INPO) accreditation, and audits and appraisals to determine adherence to commitments in Chapter 12 of the USAR and the requirements in Section 7.1 of the TS.

The NRC inspectors reviewed the education and experience backgrounds of the present water chemistry and radiochemistry staffs and determined that all personnel met the qualifications specified in the USAR, TS, and ANSI N18.1-1971. The NRC inspectors determined that the licensee had an adequate staff to meet staffing requirements.

The NRC inspectors reviewed the licensee's training program for training and qualification of FSV WCS and RCS personnel including a review of the chemistry training instructor's qualifications, training facilities, water chemistry and radiochemistry technician training procedures, water chemistry and radiochemistry training schedules for 1987 and 1988, continuing training schedules and topics for 1987 and 1988, selected course lesson plans and job performance measures, and WCS and RCS personnel training records and qualification cards. It was determined that the chemistry and radiochemistry training programs were in the final stages of INPO accreditation.

The NRC inspectors reviewed the WCS and RCS individual staff training records and determined that the two recently hired radiochemistry technicians were in the process of completing the required qualification training. It was observed that the proposed 1987 continuing training programs for water chemistry and radiochemistry as outlined in interoffice memos PPC-87-1608 and PPC-87-1609 dated May 5, 1987, had not been completed as scheduled. It was determined that the WCS and RCS staffs had

difficulty in allocating scheduled time for training activities. Therefore, training had been conducted on a convenience basis. This observation was discussed with the licensee during the exit interview and more effort may need to be devoted to ensure that WCS and RCS personnel attend scheduled training. The licensee indicated that they would evaluate the NRC inspectors' concern and take corrective action as necessary.

No violations or deviations were identified.

7. Light Water Reactor Chemistry Control and Chemical Analysis (79701/79501)

The NRC inspectors reviewed the licensee's water chemistry program including establishment and implementation of a water chemistry control program, sampling, facilities and equipment, establishment and implementation of a quality control program for chemical measurements, and water chemistry confirmatory measurements to determine adherence to commitments in Chapter 10 of the USAR and the requirements in Sections 4.3 and 7.4 of the TS.

The NRC inspectors' review of the water chemistry program found that the licensee had revised and approved administrative procedures, surveillance procedures, chemical control procedures, instrument calibration and quality control procedures, and analytical procedures. A review of selected procedures revised and written since the previous NRC inspection in June 1986 indicated that the WCS and RCS had established sufficient programmatic procedures to meet the requirements of the USAR and TS.

The NRC inspectors inspected the facilities and equipment used by the WCS and RCS staff. The following facilities were inspected: water chemistry laboratory, radiochemistry laboratory, and radiochemistry counting room. The laboratories were equipped with the necessary chemicals, reagents, labware, and analytical instrumentation to perform the required analytical procedures. The water chemistry and radiochemistry facilities and analytical instrumentation appeared to be adequate to perform routine chemistry and radiochemistry requirements to support plant operation.

The NRC inspectors reviewed selected water chemistry procedures for operation, calibration, and quality control of the laboratory instrumentation used for analysis of the NRC water chemistry standards to determine the adequacy and effectiveness of the licensee's chemistry measurement quality control program. It was observed that the licensee was not using two independent standards for calibration and measurement of quality control of chemistry analytical instrumentation. The licensee could not verify the integrity of the standard solutions. The licensee had not initiated a program of two independent standard stock solutions prepared from independent sources, i.e., different vendors or different stock lots. This program would include one standard stock solution dedicated for instrument calibration and a second independent standard stock solution dedicated for quality control. The use of independent standards affords a crosscheck on the stability of the standards and

identifies a degenerated standard solution. The licensee was using only single point calibrations for instruments such as atomic absorption, spectrometry, and ion chromatography. The single point calibrations implied that the instrument results were linear with the standard concentration for all concentrations measured. The licensee was not able to identify slope changes in the calibration curves which would cause erroneous results. The licensee had not generated instrument calibration curves using a minimum of three data points, excluding zero, bracketing the concentration range for the expected analytical results. The calibration curves should be statistically fit to the data points. These observations were discussed with the licensee at the exit interview. The licensee agreed to evaluate the observations and consider actions for program improvements.

The licensee had implemented an instrument quality control program for water chemistry laboratory instruments in response to an INPO finding in 1986. The licensee's Water Chemistry Procedure (WCP) -356, "Analytical Control Charts," Issue 1, dated October 21, 1987, controls the development and implementation of water chemistry laboratory instrument quality control charts for the Dionex 2120i Ion Chromatograph, Perkin-Elmer Model 306 Atomic Absorption System, Perkin-Elmer Model 460 with HGA 500 Graphite Furnace, and UV/VIS Spectrometers. The above referenced procedure establishes criteria to identify and evaluate data biases of out-of-control situations identified in daily or periodic quality control analyses of chemical parameters. Paragraph 5.8.2 of WCP-356 establishes the criteria that when evaluating instrument control chart data either of the following three conditions would indicate an out-of-control situation:

a. Any point beyond the control limits (three standard deviations),

b. Seven successive points on the same side of the value x (arithmetic mean), or

c. Seven successive points falling between two standard deviations and three standard deviations.

If any of these three conditions exist, an investigation for possible instrument, standards, or procedural malfunctions is to be started. Paragraphs 5.8.3, 5.8.4, and 5.8.5 define corrective actions to be taken when out-of-control situations are identified. These include the following:

a. Analysis must be stopped until the problem has been identified and resolved after which the frequency should be increased for the next few quality control checks and the problem and solutions must be documented;

b. If after corrective action has been taken and the instrument is still out-of-control but determined to be functioning correctly, new control charts will be made utilizing new standards, duplicates, and spikes; and

c. All analyses since the last in-control point must be evaluated and appropriate actions, such as a memo to plant management, will be initiated.

The NRC inspectors reviewed instrument quality control charts for the water chemistry laboratory instruments for the time period November 11, 1987, through April 13, 1988. Contrary to the above procedural criteria for identifying and evaluating data biases or out-of-control situations in instrument quality control data, the NRC inspectors determined that out-of-control situations existed for chloride by ion chromatography, silica by spectroscopy, and iron and copper by graphite furnace atomic absorption without documented evaluation or corrective actions taken, such as analyses stopped, new control charts made, or memos to plant management written for notification of laboratory instrument problems.

Examples of out-of-control situations which existed and were not evaluated and corrective actions taken included the following:

a. The chloride 20 ppb standard had seven successive points above the arithmetic mean value between January 21 and 27, 1988, and eight successive points above the arithmetic mean value between March 24 and 31, 1988.

b. The chloride 5 ppb standard had 17 successive points below the arithmetic mean value with 1 of those points below three standard deviations between January 16 and February 7, 1988, and 10 successive points below the arithmetic mean value with 2 of those points below three standard deviations between April 5, and 13, 1988.

c. The silica 100 ppb standard had 8 successive points below the arithmetic mean value between January 19 and 26, 1988, and 11 successive points below the arithmetic mean value between March 15 and 25, 1988. On February 1, 1988, the 100 ppb standard result was below three standard deviations.

d. The silica 5 ppb standard had eight successive points above the arithmetic mean value between March 16 and 23, 1988.

e. The iron 50 ppb standard had eight successive points above the arithmetic mean value between February 10 and 18, 1988.

f. The iron 10 pbb standard had seven successive points below the arithmetic mean value between February 4 and 10, 1988.

g. The copper 25 ppb standard had seven successive points below the arithmetic mean value with one of those points below three standard deviations between January 31 and February 5, 1988, and seven successive points below the arithmetic mean value between April 4 and 12, 1988. On April 13, 1988, the 25 pbb standard result was above three standard deviations.

h. The copper 5 ppb standard had seven successive points below the arithmetic mean value between February 5 and 11, 1988, and ten successive points below the arithmetic mean value between April 2 and 12, 1988. On April 13, 1988, the 5 ppb standard result was above three standard deviations.

The failure to properly identify and evaluate water chemistry instrument quality control data out-of-control situations, take appropriate corrective actions, and document these conditions and solutions during the period November 11, 1987, through April 13, 1988, is an apparent violation of TS AC 7.4 and licensee's implementing quality control chart procedure. (267/8809-01)

During the inspection, standard chemical solutions were provided to the licensee for confirmatory measurements analyses. The standards were analyzed by the licensee using routine methods and equipment. The results of the measurements comparisons are summarized in Attachments 1, 2, and 3 to this report. The licensee's original analytical results indicated that 17 of the 36 results were in agreement giving a 47 percent agreement overall. After several attempts to resolve analytical problems including standard preparation and instrument calibration and quality control, the licensee's final analysis results showed 64 percent agreement with the Brookhaven National Laboratory (BNL) results based on 23 agreement results out of 36 total results compared. The NRC inspectors were concerned with the high percentage of disagreements in the confirmatory measurements analyses of the water chemistry standards. This is considered to indicate significant analytical problems in the water chemistry laboratory. This item is considered open (267/8809-02) pending the licensee being able to achieve a satisfactory performance of 90 percent or higher agreement on the water chemistry confirmatory measurements standards.

No deviations were identified.

8. Quality Assurance and Confirmatory Measurements for In-Plant Radiochemical Analysis (84725/84525)

The NRC inspectors reviewed the licensee's radiochemical analysis program including procedures, facilities and equipment, implementation of a quality control program, postaccident sampling system (PASS), and radioanalytical confirmatory measurements to determine adherence to commitments in Chapter 4 of the USAR and the requirements in Sections 4.2 and 7.4 of the TS.

The NRC inspectors reviewed selected procedures revised and approved since the previous NRC inspection in June 1986 and determined that the licensee had established and implemented sufficient programmatic procedures to meet the USAR and TS requirements.

The NRC inspectors reviewed the licensee's records for the period January 1987 through March 1988 involving instrument calibration and quality control. It was verified that the radiochemistry counting room instruments had been calibrated according to procedures and an instrument quality control program had been implemented.

The NRC inspectors verified that the PASS equipment and associated procedures satisfied the requirements of NUREG-0737, Item II.B.3, for representative sampling and analysis of reactor coolant and containment atmosphere following a reactor incident. The NRC inspectors verified that the normal sampling points for reactor coolant and containment atmosphere are to be used and present analytical laboratory instrumentation would be used to determine required chemical and radiochemical isotopic concentrations of the reactor coolant and containment atmosphere. The RCS staff had received annual training and were qualified in operating the PASS equipment and calculating mitigating core damage from chemical and radiochemical analytical results. The licensee's procedures and analytical sensitivities of chemistry and radiochemistry parameters were consistent with PASS requirements.

During the inspection, radiological confirmatory measurements were performed on standards and split samples by the licensee and the NRC inspectors in the Region IV mobile laboratory. The standards and samples were analyzed by the licensee using routine methods and equipment. The results of the measurements comparisons are summarized in Attachments 1, 4, and 5.

No violations or deviations were identified.

9. Quality Assurance Program (79701/79501; 84725/84525)

The NRC inspectors reviewed the licensee's QA monitoring and audit programs regarding water chemistry and radiochemistry activities to determine adherence with commitments in Chapter 12 of the USAR and requirements in Section 7.1 of the TS.

The NRC inspectors reviewed the audit schedules for 1987 and 1988, QA audit plans and checklists, and the qualifications of monitoring inspectors and auditors. Monitoring reports and audit reports of QA activities performed during 1987 in the areas of water chemistry and radiochemistry were reviewed for scope to ensure thoroughness of program evaluation. The NRC inspectors noted that the QA audit was designed to determine compliance with the USAR, TS, and FSV procedures. The NRC inspectors verified that the audit findings had been reviewed by licensee's management and that responses and corrective actions to findings had been completed and documented in accordance with QA

procedures. It was noted that the audit team included a technical specialist trained and knowledgeable in water chemistry and radiochemistry activities at nuclear power facilities.

No violations or deviations were identified.

10. Contractor Activities (84725/84525)

The NRC inspectors determined that the licensee was not using contractor personnel or laboratories to perform chemical or radiochemical analyses.

11. Exit Interview

The NRC inspectors met with the NRC resident inspector and the licensee representatives identified in paragraph 1 of this report at the conclusion of the inspection on April 15, 1988. The NRC inspectors summarized the scope of the inspection and discussed the inspection findings, inspectors observations, open items, tem of noncompliance, and the results of the water chemistry and radiochemistry confirmatory measurements as presented in this report.

ATTACHMENT 1

Analytical Measurements

1. Water Chemistry Confirmatory Measurements

During the inspection, standard chemical solutions were provided to the licensee for analysis. The standard solutions were prepared by the Brookhaven National Laboratory (BNL), Safety and Environmental Protection Division, for the NRC. The standards were analyzed by the licensee using routine methods and equipment. The analysis of chemical standards is used to verify the licensee's capability to monitor chemical parameters in various plant systems with respect to Technical Specification (TS) requirements and other industry standards. In addition, the analyses of standards are used to evaluate the licensee's analytical procedures with respect to accuracy and precision.

The results of the measurements comparison are listed in Attachment 2. Attachment 3 contains the criteria used to compare results. All standards were analyzed in triplicate. The licensee's original analytical results indicated that 17 of the 36 results were in agreement. The chloride midrange concentration result analyzed by ion chromatography was found in disagreement and biased high. The licensee's chloride quality control standards did not indicate a data bias. The chloride results analyzed by selective ion electrode were statistically in agreement according to the NRC acceptance criteria; however, the precision and accuracy of the results were totally unacceptable. The selective ion electrode method of analysis for chloride should not be used routinely without proper electrode conditioning and satisfactory calibration. The analysis result for the low concentration of sulfate was in disagreement due to the instrument calibration based on a 20.0 ppb standard and the instrument calibration not linear at low concentrations. The sulfate 5.0 ppb quality control standard showed a data bias of approximately 60 percent high which was also reflected in the sample analysis. The copper results analyzed by graphite furnace atomic absorption were all biased low over the entire concentration range. The copper low and midrange concentration results were in disagreement. This was possibly due to the licensee using only a one point calibration at a concentration of 50.0 ppb which had not been independently verified to be 50.0 ppb and the instrument calibration not linear at low concentrations. The licensee's results for all concentrations of iron analyzed by flame atomic absorption were in disagreement and approximately 23 percent low. This indicated an instrument systematic bias or calibration problem. The licensee prepared new dilutions of the BNL standards and reran the iron analyses. The rerun results for iron showed no changes from the original results. The licensee's original low and high concentration results for copper analyzed by flame atomic absorption were in disagreement and biased low as were the copper quality control standards. The licensee prepared new copper calibration and quality control standards and recalibrated the flame atomic absorption system for copper. After recalibration the licensee reran the copper BNL standards and all results were in

agreement. The chromium results for the low and midrange concentrations analyzed by flame atomic absorption were in disagreement and biased high as were the chromium quality control standards. The licensee prepared new chromium calibration and quality control standards and recalibrated the flame atomic absorption system for chromium. After recalibration the licensee reran the chromium BNL standards and the chromium low concentration result was in agreement but the midrange concentration result remained in disagreement. The licensee's original sodium results were all in disagreement, biased high, and showed very poor precision and accuracy. The results indicated poor sample preparation and possible sample contamination. The licensee prepared new dilutions of the BNL standards and reran the sodium analyses. The rerun results for sodium showed very little improvement from the original results and were still in disagreement. A third series of dilutions was prepared from the BNL standards and the sodium analyses rerun. The second rerun results for sodium were in agreement. The licensee's original silica results for the low and midrange concentrations were in disagreement and biased low. The licensee prepared new silica calibration and quality control standards and recalibrated the spectroscopy system. After recalibration the licensee reran the silica BNL standards and the silica results were all in disagreement approximately 12 percent low. This indicated an instrument systematic bias or calibration problem resulting from a one point calibration performed with a standard which had not been independently verified. The licensee's final analytical results after retests showed 64 percent agreement with the BNL results based on 23 agreement results out of 36 total results compared. The high percentage of disagreements in the confirmatory measurements comparisons of the water chemistry standards is considered to indicate significant analytical problems in the water chemistry laboratory.

2. Radiological Confirmatory Measurements

Confirmatory measurements were performed on the following standards and samples in the Region IV mobile laboratory at Fort St. Vrain Nuclear Station during the inspection:

(1) Primary Coolant Gas Sample (125 cc Serum Gas Vial)

(2) Waste Gas Sample (125 cc Serum Gas Vial)

(3) Particulate Filter Standard (24838-109)

(4) Cesco Charcoal Cartridge Standard (24840-109)

(5) Simulated Gas Standard, 125 cc Serum Gas Vial (25714-109)

(6) Simulated Gas Standard, 1 liter Gas Marinelli (25716-109)

(7) Tritium Sample (20 ml Scintillation Vial)

(8) 1987 Radiological Environmental Sciences Laboratory (RESL) Quality Control Sample

The confirmatory measurements tests consisted of comparing measurements made by the licensee and the NRC mobile laboratory. The NRC's mobile laboratory measurements are referenced to the National Bureau of Standards by laboratory intercomparisons. Confirmatory measurements are made only for those nuclides identified by the NRC as being present in concentrations greater than 10 percent of the respective isotopic values for liquid and gas concentrations as stated in 10 CFR Part 20, Appendix B, Table II. Attachment 5 contains the criteria used to compare results.

At the time of the inspection, the licensee had three detectors in the radiochemistry counting room. One of the radiochemistry counting room detectors was recently placed into service and was not currently calibrated for all geometries. All three detectors are used for routine isotopic analysis of radioactive samples to demonstrate compliance with TS and regulatory requirements. The detectors labeled (1), (2) and (4) are located and maintained in the radiochemistry counting room and are primarily used for isotopic analysis of primary system samples. The licensee performed the tritium analysis on their liquid scintillation counting system. The individual sample analyses and comparison of analytical results of the confirmatory measurements are tabulated in Attachment 4.

The licensee's radiochemistry section gamma isotopic results from the listed samples in Attachment 4 showed 100 percent agreement with the NRC's analyses results. The licensee's tritium result was in agreement with the NRC's analysis result.

Confirmatory measurements were performed by the licensee on a liquid radiochemistry sample prepared by RESL in Idaho Falls, Idaho. The sample was provided to the licensee in July 1987. The analytical results were compared to the known sample activities and the results of the comparisons are presented in Attachment 4, sample 8. The licensee's results were in 86 percent agreement with the certified activities.

ATTACHMENT 2

Water Chemistry Confirmatory Measurements Results

Fort Saint Vrain Nuclear Station

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1. Chloride Analysis (2-20 ppb) Ion Chromatograph

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87A	4.85±0.33	4.60±0.02	1.05±0.07	Agreement
87B	11.43±0.69	9.32±0.08	1.23±0.07	Disagreement
87C	19.71±1.33	19.13±0.30	1.03±0.03	Agreement

2. Chloride Analysis (5-20 ppb) Selective Ion Electrode

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87A	9.60±6.40	4.60±0.02	2.09±1.39	Agreement
87B	5.60±4.90	9.32±0.08	0.60±0.53	Agreement
87C	21.80±9.90	19.13±0.30	1.14±0.52	Agreement

3. Sulfate Analysis (5-20 ppb) Ion Chromatograph

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87A	7.98±0.16	4.88±0.35	1.64±0.12	Disagreement
87B	12.24±2.40	9.58±0.68	1.28±0.27	Agreement
87C	20.07±1.33	19.50±0.58	1.03±0.07	Agreement

4. Iron Analysis (10-50 ppb) Graphite Furnace Atomic Absorption

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87G	12.7±3.1	12.4±0.3	1.02±0.25	Agreement
87H	22.0±1.0	26.5±0.3	0.83±0.04	Disagreement
87I	35.3±1.5	39.0±1.0	0.91±0.05	Agreement

5. Copper Analysis (10-50 ppb) Graphite Furnace Atomic Absorption

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87G	11.3±0.6	13.3±0.2	0.85±0.05	Disagreement
87H	23.3±0.6	26.9±1.0	0.87±0.04	Disagreement
87I	36.7±1.2	40.0±1.0	0.92±0.04	Agreement

6. Iron Analysis (100-1000 ppb) Flame Atomic Absorption

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87G	141.7±15.3	186.0± 5.0	0.76±0.08	Disagreement
87H	313.0± 8.9	398.0± 5.0	0.78±0.02	Disagreement
87I	454.3±14.6	585.0±15.0	0.77±0.03	Disagreement

Retest - on 4/13/88 on same BNL standard dilutions.

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87G	141.7± 6.7	186.0± 5.0	0.76±0.08	Disagreement
87H	310.0±25.1	98.0± 5.0	0.78±0.02	Disagreement
87I	451.3± 8.1	585.0±15.0	0.77±0.03	Disagreement

7. Copper Analysis (100-1000 ppb) Flame Atomic Absorption

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87G	187.3±1.5	200.0± 3.0	0.94±0.02	Disagreement
87H	373.7±4.0	403.0±15.0	0.93±0.04	Agreement
87I	572.0±1.0	600.0±15.0	0.95±0.02	Disagreement

Retest - on 4/13/88 on same BNL standard dilutions.

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87G	194.0±3.6	200.0± 3.0	0.97±0.02	Agreement
87H	392.7±1.5	403.0±15.0	0.97±0.04	Agreement
87I	596.7±4.9	600.0±15.0	0.99±0.03	Agreement

8. Chromium Analysis (100-1000 ppb) Flame Atomic Absorption

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87G	275.0± 3.6	198.0± 5.0	1.38±0.04	Disagreement
87H	435.3± 4.2	385.0± 5.0	1.13±0.02	Disagreement
87I	592.3±11.6	580.0±10.0	1.02±0.03	Agreement

Retest - on 4/13/88 on same BNL standard dilutions.

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87G	204.7±1.2	198.0± 5.0	1.03±0.03	Agreement
87H	403.0±1.0	385.0± 5.0	1.05±0.01	Disagreement
87I	569.7±2.5	580.0±10.0	0.98±0.02	Agreement

9. Sodium Analysis (10-100 ppm) Flame Atomic Absorption

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87J	54.7±28.3	20.2±2.3	2.71	Disagreement
87K	102.7±31.5	53.0±3.0	1.93	Disagreement
87L	120.3±18.5	79.0±4.5	1.52	Disagreement

Retest - New standard dilutions were made from new BNL standards.

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87J	25.3±18.6	20.2±2.3	1.25±0.10	Disagreement
87K	76.7± 3.5	53.0±3.0	1.45±0.10	Disagreement
87L	104.7± 1.5	79.0±4.5	1.33±0.08	Disagreement

Retest - New standard dilutions were prepared from 86 series BNL standards.

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
86J	32.0±11.4	15.2±1.7	2.11±0.78	Agreement
86K	44.0± 2.0	46.2±4.0	0.95±0.09	Agreement
86L	64.7± 3.1	72.0±4.0	0.90±0.07	Agreement

10. Ammonia Analysis (0.5-10 ppm) Selective Ion Electrode

Sample	FSV Results (ppm)	NRC Results (ppm)	FSV/NRC Ratio	Comparison Decision
86M	0.62±0.33	0.52±0.03	1.19±0.64	Agreement
86N	1.97±0.67	1.51±0.02	1.30±0.44	Agreement
860	4.35±0.18	4.92±0.23	0.88±0.05	Disagreement

11. Hydrazine Analysis (10-100 ppb) Spectroscopy

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87P	19.3±0.6	19.9±0.3	0.97±0.03	Agreement
87Q	45.7±0.6	49.9±0.5	0.92±0.02	Disagreement
87R	93.0±4.6	100.0±1.0	0.93±0.05	Agreement

12. Silica Analysis (5-100 ppb) Spectroscopy

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87S	12.3±0.6	17.6±0.9	0.70±0.05	Disagreement
87T	30.0±1.0	34.7±1.3	0.86±0.04	Disagreement
87T	80.3±0.6	86.7±1.0	0.93±0.04	Agreement

Retest - on 4/13/88 on same BNL standard dilutions.

Sample	FSV Results (ppb)	NRC Results (ppb)	FSV/NRC Ratio	Comparison Decision
87S	14.0±1.0	17.6±0.9	0.80±0.07	Disagreement
87T	30.7±1.2	34.7±1.3	0.88±0.05	Disagreement
87T	76.0±1.0	86.7±3.3	0.88±0.04	Disagreement

ATTACHMENT 3

CRITERIA FOR COMPARING ANALYTICAL MEASUREMENTS

This attachment provides criteria for comparing results of capability tests. In these criteria the judgement limits are based on the uncertainty of the ratio of the licensee's value to the NRC value. The following steps are performed:

(1) The ratio of the licensee's value to the NRC value is computed

$$(\text{ratio} = \frac{\text{Licensee's Value}}{\text{NRC VALUE}}); \text{ and}$$

(2) the uncertainty of the ratio is propagated.[1]

If the absolute value of one minus the ratio is less than or equal to twice the ratio uncertainty, the results are in agreement.

$$(|1-\text{ratio}| \leq 2 \times \text{uncertainty})$$

$$Z = \frac{x}{y}, \text{ then } \frac{S_z^2}{Z^2} = \frac{S_x^2}{x^2} + \frac{S_y^2}{y^2}$$

[1] (From: Bevington, P. R., Data Reduction and Error Analysis for the Physical Sciences, McGraw-Hill, New York, 1969)

ATTACHMENT 4

Radiological Confirmatory Measurements Results

Fort St. Vrain Nuclear Station

NRC Inspection Report: 50-267/88-09

1. Primary Coolant (125cc Gas Serum Vial)
(Sampled: 13:00, MST, April 13, 1988)

Sample analyzed on detector (1).

Nuclide	FSV Results (uCi/cc)	NRC Results (uCi/cc)	FSV/NRC Ratio	Comparison Decision
Xe-131m	5.24±0.92E-5	7.222±1.589E-5	0.73	Agreement
Xe-133m	2.60±0.31E-5	3.076±0.376E-5	0.85	Agreement
Xe-133	1.05±0.10E-3	9.389±0.059E-4	1.12	Agreement

2. Waste Gas Sample (125cc Serum Gas Vial)
(Sampled: 10:04, MST, April 12, 1988)

Sample analyzed on detector (1).

Nuclide	FSV Results (uCi/cc)	NRC Results (uCi/cc)	FSV/NRC Ratio	Comparison Decision
Xe-133	1.18±0.12E-4	1.142±0.013E-4	1.03	Agreement

3. Particulate Filter Standard (24838-109)

No comparison was made on this standard. The licensee's particulate filter geometry was different from the NRC standard geometry provided.

4. Cesco Charcoal Cartridge Standard (24840-109)

No comparison made on this standard. The licensee's cartridge media was different from the NRC charcoal cartridge provided.

5. Simulated Gas Standard, 125cc Gas Vial(25714-109)
(Standardized: 08:00, MST, April 12, 1988)

Standard analyzed on detectors (1), (2) and (4).

Nuclide	FSV Results (uCi/sample)	NRC Results (uCi/sample)	FSV/NRC Ratio	Comparison Decision
Cd-109	1.39±0.12E+0	1.477±0.008E+0	0.94	Agreement
	1.41±0.11E+0		0.95	Agreement
	1.33±0.10E+0		0.90	Agreement
Co-57	2.56±0.18E-2	2.732±0.028E-2	0.94	Agreement
	2.61±0.19E-2		0.96	Agreement
	2.42±0.17E-2		0.88	Agreement
Ce-139	2.12±0.21E-2	2.190±0.027E-2	0.97	Agreement
	2.12±0.21E-2		0.97	Agreement
	2.14±0.21E-2		0.98	Agreement
Hg-203	2.26±0.20E-2	2.313±0.036E-2	0.98	Agreement
	2.27±0.21E-2		0.98	Agreement
	2.20±0.20E-2		0.95	Agreement
Sn-113	3.98±0.25E-2	4.149±0.063E-2	0.96	Agreement
	4.06±0.27E-2		0.98	Agreement
	4.07±0.25E-2		0.98	Agreement
Sr-85	2.67±0.17E-2	2.845±0.049E-2	0.94	Agreement
	2.76±0.22E-2		0.97	Agreement
	2.78±0.18E-2		0.98	Agreement
Cs-137	4.81±0.31E-2	5.179±0.049E-2	0.93	Agreement
	4.91±0.40E-2		0.95	Agreement
	4.81±0.32E-2		0.93	Agreement
Y-88	6.69±0.38E-2	7.012±0.092E-2	0.95	Agreement
	6.59±0.44E-2		0.94	Agreement
	6.46±0.39E-2		0.92	Agreement
Co-60	5.38±0.35E-2	5.280±0.087E-2	1.02	Agreement
	5.13±[illegible]9E-2		0.97	Agreement
	5.19±[illegible]36E-2		0.98	Agreement

6. Simulated Gas Standard, 1 Liter Gas Marinelli (25716-109)
(Standardized: 08:00, MST, April 12, 1988)

Standard analyzed on detectors (1), (2) and (4).

Nuclide	FSV Results (uCi/sample)	NRC Results (uCi/sample)	FSV/NRC Ratio	Comparison Decision
Cd-109	1.88±0.16E+0	1.774±0.010E+0	1.06	Agreement
	1.77±0.11E+0		1.00	Agreement
	1.83±0.14E+0		1.03	Agreement
Co-57	3.37±0.33E-2	3.339±0.026E-2	1.01	Agreement
	3.29±0.22E-2		0.99	Agreement
	3.25±0.23E-2		0.97	Agreement
Ce-139	2.67±0.26E-2	2.668±0.023E-2	1.00	Agreement
	2.58±0.17E-2		0.97	Agreement
	2.70±0.27E-2		1.01	Agreement
Hg-203	2.74±0.24E-2	2.727±0.032E-2	1.00	Agreement
	2.61±0.26E-2		0.96	Agreement
	2.65±0.24E-2		0.97	Agreement
Sn-113	5.12±0.31E-2	5.048±0.054E-2	1.01	Agreement
	4.92±0.45E-2		0.97	Agreement
	5.15±0.34E-2		1.02	Agreement
Sr-85	3.52±0.22E-2	3.498±0.043E-2	1.01	Agreement
	3.40±0.23E-2		0.97	Agreement
	3.52±0.25E-2		1.01	Agreement
Cs-137	6.41±0.40E-2	6.292±0.068E-2	1.02	Agreement
	6.14±0.46E-2		0.98	Agreement
	6.32±0.44E-2		1.00	Agreement
Y-88	8.36±0.82E-2	8.443±0.083E-2	0.99	Agreement
	8.20±0.57E-2		0.97	Agreement
	8.15±0.52E-2		0.97	Agreement
Co-60	6.58±0.44E-2	6.589±0.078E-2	1.00	Agreement
	6.51±0.46E-2		0.99	Agreement
	6.35±0.48E-2		0.96	Agreement

7. Tritium Sample (20 ml Scintillation Vial)
(Sampled: 14:00, MST, April 14, 1988)

Nuclide	FSV Results (uCi/ml)	NRC Results (uCi/ml)	FSV/NRC Ratio	Comparison Decision
H-3	1.57±0.005E-3	1.64±0.05E-3	0.96	Agreement

8. RESL Unknown Liquid Sample
(Standardized: 12:00, MST, January 11, 1987)

Nuclide	FSV Results (uCi/ml)	NRC Results (uCi/ml)	FSV/NRC Ratio	Comparison Decision
Mn-54	2.94±0.54E-5	2.86±0.06E-5	1.03	Agreement
Co-60	2.81±0.53E-5	2.75±0.05E-5	1.02	Agreement
Cs-137	4.09±0.87E-5	4.03±0.12E-5	1.01	Agreement
Fe-55	1.00±0.42E-4	1.03±0.02E-4	0.97	Agreement
Sr-89	2.11±0.10E-4	2.30±0.07E-4	0.92	Agreement
Sr-90	3.08±0.07E-5	2.09±0.08E-5	1.47	Disagreement
H-3	1.56±0.02E-4	1.68±0.03E-4	0.93	Agreement

NRC results were taken from the standard certification supplied to the NRC Region IV office as prepared by RESL and traceable to the National Bureau of Standards.

ATTACHMENT 5

CRITERIA FOR COMPARING ANALYTICAL MEASUREMENTS

The following are the criteria used in comparing the results of capability tests and verification measurements. The criteria are based on an empirical relationship established through prior experience and this program's analytical requirements.

In these criteria, the judgement limits vary in relation to the comparison of the resolution.

$$\text{Resolution} = \frac{\text{NRC VALUE}}{\text{NRC UNCERTAINTY}}$$

$$\text{Ratio} = \frac{\text{LICENSEE VALUE}}{\text{NRC VALUE}}$$

Comparisons are made by first determining the resolution and then reading across the same line to the corresponding ratio. The following table shows the acceptance values.

RESOLUTION	AGREEMENT RATIO
<4	0.40 - 2.50
4 - 7	0.50 - 2.00
8 - 15	0.60 - 1.66
16 - 50	0.75 - 1.33
51 - 200	0.80 - 1.25
>200	0.85 - 1.18

The above criteria are applied to the following analyses:

(1) Gamma Spectrometry

(2) Tritium in liquid samples

(3) Iodine on adsorbers

(4) ^{89}Sr and ^{90}Sr determinations

(5) Gross Beta where samples are counted on the same date using the same reference nuclide.