U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Reports No. 50-315/88010(DRSS); 50-316/88011(DRSS)

Docket Nos. 50-315; 50-316 Licenses No. DRP-58; DRP-74

Licensee: Indiana Michigan Power Company
1 Riverside Plaza
Columbus, OH 43216

Facility Name: D.C. Cook Nuclear Plant, Units 1 and 2

Inspection At: D.C. Cook Site, Bridgeman, Michigan

Inspection Conducted: February 10-18, 1988

Inspector: R. B. Holtzman for — 3/11/88 Date

Approved By: M. C. Schumacher, Chief
Radiological Effluents and
Chemistry Section — 3/11/88 Date

Insspection on February 10-18, 1988 (Reports No. 50-315/88010(DRSS); No. 50-316/88011(DRSS))

Areas Inspected: Routine announced inspection of: (1) the chemistry program, including procedures, organization, and training; (2) primary and secondary systems water quality control program; (3) quality assurance/quality control program in the laboratory; and (4) nonradiological confirmatory measurements.

Results: No violations or deviations were identified.

DETAILS

1. Persons Contacted

[1]W. G. Smith, Jr., Plant Manager
[1]L. S. Gibson, Assistant Plant Manager-Technical
[1]A. A. Blind, Assistant Plant Manager-Operations and Administration
[1]T. Kriesel, Technical Superintendent, Physical Science
[1]J. Wojcik, Plant Chemical Supervisor
[1]D. Fitzgerald, Technical Physical Science Environmental Coordinator
[1]K. M. Haglund, Technical Physical Science, Chemistry Supervisor
[1]M. J. Gumns, Technical Physical Sciences, Administrative Compliance Coordinator
[1]R. T. Huerter, Site QA Supervisor/Auditor, AEPSC
[1]H. Jones, Rad Supervisor, Columbus (by phone)
A. Puppies, Senior Performance Engineer, Operations Department
S. McLea, Chemical Supervisor (QA)
G. Cook, Scientist
S. Coffing, Senior Chemical Technician
K. Vogel, Senior Chemical Technical
J. Shields, Senior Chemical Technician
[1]B. Jorgensen, Senior Resident Inspector, NRC
J. Heller, Resident Inspector, NRC

The inspectors also interviewed other licensee personnel in various departments in the course of the inspection.

[1]Denotes those present at the plant exit interview on February 18, 1988.

2. Licensee Action on Previous Inspection Findings

a. (Closed) Open Items (No. 50-315/85040-02; No. 50-316/85040-02): Licensee to consider modifications of the boron analysis procedure to include control standards and to check the effects of the pipetting procedure on the analytical accuracy. The boron procedure (12 THP 6020 LAB.003, "Determination of boron in aqueous solutions," Revision 6, January 21, 1988) was suitably modified so that the 0.1 N sodium hydroxide titrant was standardized with a standard acid (potassium acid phthalate) after which a 1000-ppm boron control standard is used to check the NaOH titer. The accuracy was further improved by the use of a semiautomatic Brinkmann Dosimat Titrator in which the the titrant is delivered from an electronically-controlled buret, but the end-point is determined by the analyst.

The licensee modified the above procedure to remove the nonstandard laboratory technique for the collection and dilution of boric acid samples in which a 500-ml volumetric flask was filled to the calibration mark with water, after which 25-ml was removed with a volumetric pipet. The boron sample was then added to the fill the

flask to the mark and the dilution factor was assumed to be 25.0/500. By the this procedure, the exact volume removed was somewhat uncertain because the pipet was calibrated "to deliver", while the procedure was designed for a "to contain" pipet. Tests by the licensee and the inspector showed that the bias introduced was less than 0.5 percent. Further the procedure was modified to use a 100-ml cassia type volumetric flask which has a 10-ml graduated volume above the calibration mark. In this procedure, water is added to the lower mark, the boron sample (at 135-145°F) is added to flask, allowed to cool to room temperature, and the volume noted. The dilution factor is then calculated and the sample analyzed. This procedure appears to be suitable for the analysis.

b. (Closed) Open Items (No. 50-315/86037-01; No. 50-316/86037-01): Licensee to modify the water makeup system to improve water quality by the end of 1987. A licensee representative noted that extensive changes had been made to the makeup water system that improved the water quality. A tie-in was made to the Lake Township water system to assure the availability of clean water during storms when the Lake Michigan water had a high solids content. New, more accurate and reliable conductivity monitors and flow-totalizing meters were installed along with new bed resins. The administrative limits on the conductivity were lowered from 0.15 to 0.10 umho/cm and maintained at 0.06-0.08 umho/cm due to improved procedures and administrative controls.

The addition of a supervisor with specific responsibility for this system appears to have been a major contribution to the improvements. The representative estimated that the system was only about 40% complete and the plant would achieve about 80% completion by the end of the year. Since the water quality appears to be high, this item will be closed and progress will be followed when necessary in subsequent routine chemistry inspections.

c. (Open) Open Items (No. 50-315/87037-02; No. 50-316/87037-02): By 1987, the licensee to install new in-line instrumentation in the secondary system and a computer to monitor 150 parameters at different sampling locations. The licensee has upgraded many of the conductivity and pH monitors at various points of the secondary sampling system under RFC DC-12-2915 "Secondary Side Chemistry Instrumentation Upgrade." Output data are plotted on strip recorders. The steam generator blowdown sampling racks are to be rebuilt with additional sample chiller systems and new conductivity instrumentation. Additional pH instrumentation will be installed on condensate and feedwater systems and dissolve oxygen and hydrazine and control systems will be added with new chart recorders. Management expects to complete the instrumentation upgrade prior to the end of 1988. The licensee cancelled the previously-schedule central computer due to its high cost. They expect to replace it with data loggers used in conjunction with small computer systems for data collection and manipulation. This progress will be followed in subsequent routine chemistry inspections. This item will remain open pending completion of the instrumentation upgrade.

d. (Closed) Open Items (No. 50-315/86038-01; No. 50-315/86038-01): Determine sample size and calibrate geometry for tank content determination. The licensee satisfactorily solved this problem by discontinuing the use of the 30/30 geometry on November 11, 1986 and replacing it with the 1-liter geometry (Geometry 11) for which efficiency calibration data were already available. A program was added to the Batch Program File to allow the computer to automatically account for the sample dilutions (Chemical Section Update No. 313, January 28, 1987).

e. (Open) Open Items (No. 50-315/87030-03; No. 50-316/87030-03): Licensee to generate new nuclide libraries dedicated to EBAR requirements before the next required EBAR measurement and to apply the corrected values to the last two required EBAR determinations to determine that they complied with the T/S. Laboratory personnel corrected the errors in the calculation of the beta particle EBAR values and recalculated the values of EBAR for the previous three determinations. While they were substantially greater than previously determined, they were well within the T/S requirements. However, the inspector noted that the licensee had omitted the beta energies of several positron-emitting nuclides. To be in compliance with the T/S definition of EBAR ($E\sigma + E_b$) the energies of Sr-89, Sr-90 and Y-90 should also be included, along with factors relating them to some gamma-emitting nuclide, such as Cs-137. Licensee representatives agreed to revise the table within 60 days.

f. (Open) Open Items (No. 50-315/87030-02; No. 50-316/87030-02): Licensee will analyze for gross beta, H-3, Fe-55, Sr-89 and Sr-90 in split sample of a monitor tank and report the results to Region III for comparison with results from the NRC Reference Laboratory. The results of the analyses are presented in Table 1 and the comparison criteria for radiological analyses in Attachment 1. Four of the five analyses were in agreement. The gross beta results were substantially lower than those of the NRC. This appears to be due to the presence of a boron matrix in the sample that increased the sample self-absorption of the beta particles, a phenomenon that had not been taken into account. The licensee agreed to do another gross beta analysis in spiked sample to be supplied by the NRC Reference Laboratory and report the result to Region III for comparison.

3. Management Controls, Organization and Training (IP 84722, IP 84723)

The Chemistry Department has been reorganized since the previous inspection in this area.[1] Four Chemical Supervisors, each with a responsibility in one of the areas of primary-secondary, environmental, counting room and QA, and a Scientist and a Training Specialist report to the Plant Chemical Supervisor. He, in turn, reports to the Technical

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[1]Region III Inspection Reports (No. 50-315/86037; No. 50-316/86037)

Superintendent-Physical Sciences. Another Chemical Supervisor, in charge of the plant makeup water system, is on loan to the Operations Department. The laboratory has 19 house and ten contract technicians. The Chemistry Department staffing is stable with chemists' employment in the plant ranging from 7-15 years and the technicians averaging 4.2 years. It appears to be adequately staffed to perform the required chemical analyses for plant operation.

The licensee's Chemical Technician training program was accredited by INPO in April 1987.

No violations or deviations were identified.

4. Water Chemistry Control Program (IP 79701)

The inspector reviewed the water chemistry control program based on Procedure No. 12 THP 6020 LAB.041, "Data Sheet Instruction," Revision 10, December 17, 1987. The specifications of the administrative limits on the parameters of the various systems given in Appendix B, "Chemical Constituent Specifications" are mostly consistent with the relevant EPRI Steam Generator Owners Guidelines (SGOG). Exceptions are limits of silica concentrations in the steam generators (S/G) of 500 ppb at >30% power compared to 300 ppb in the Guidelines and minimum pH levels of 7.0 or 7.5 with a range of 8.2-9.2.

The licensee is working on various aspects of the problems in the secondary system to improve water chemistry. A boric acid addition program is used in the secondary system (5-10 ppm at power) which appears to have contributed to the slowing of S/G tube corrosion, especially in the Unit 2 S/Gs, which have somewhat different construction than the Unit 1 S/Gs. Because the system does not have condensate demineralizers, the chloride levels are in the 5-10 ppb range, which while below the 20 ppb Action Level 1 of the SGOG, is greater than normally found in similar system. The levels are maintained as low as possible by increased S/G blowdown. The licensee is spending considerable effort to determine the source(s) of the chloride ingress, such as condenser leakage or makeup water.

In general, the various parameters representing contamination are maintained in an apparently satisfactory manner. The plant has not been out of Technical Specifications limits for chemistry. They maintain the performance indicator out-of-specification times on various parameters and, including S/G chloride and sodium, dissolved oxygen, pH, and conductivity.

The parameters are trended graphically only by corporate headquarters quarterly, which the inspector noted is not useful to the chemists in the short term. The parameter data, including pH, conductivity, and concentrations of boron, chloride, lithium-7 are stored in computer files which may be printed out and plotted on a line printer for better

assessment of the results. Licensee representatives demonstrated computer output and agreed for the near future to print the files and graphs on a timely basis. Progress in this and the improvements in water quality will be followed in future inspections under Open Items (No. 50-315/88010-01; No. 50-316/88011-01).

The licensee is putting considerable effort into improving and maintaining water quality.

No violations or deviations were identified.

5. Implementation of the Chemistry Program (IP 79701)

The inspector reviewed the chemistry programs, including the physical facilities and laboratory operations. Housekeeping was adequate. Most analyses, except for the environmental ones, are done in the hot laboratory, which may be crowded at times.

No changes in the space and facilities have occurred since the previous inspection in this area.[2] The Dionex Ion Chromatograph (IC) in the hot laboratory is in regular use and has had an automatic sample changer added for improved accuracy and versatility. A second IC unit in the cold laboratory is being prepared as for backup use for nonradioactive samples. The boron analytical method was modified to use a Dosimat partially automated titrator (Section 2a).

The inspector observed several technicians analyze the confirmatory measurements samples for boron by titration, metals by atomic absorption flameless spectrophotometry (furnace), chloride and sulfate by IC, and fluoride by specific ion electrode. They appeared to be generally knowledgeable about the work and followed the procedures. They appeared to do well in the analyses.

Overall, the laboratory appeared to be adequate for the proper operation of the plant and to be operating satisfactorily.

No violations or deviations were identified.

6. Nonradiological Confirmatory Measurements (IP 79701)

The inspectors submitted chemistry samples to the licensee for analysis as part of a program to evaluate the laboratory's capabilities to monitor nonradiological chemistry parameters in various plant systems with respect to various Technical Specification and other regulatory and administrative requirements. These samples had been prepared, standardized, and periodically reanalyzed (to check for stability) for the NRC by the Safety and Environmental Protection Division of Brookhaven National Laboratory (BNL). The samples were analyzed by the licensee using routine methods and equipment.

The samples were diluted by licensee personnel as necessary to bring the concentrations within the ranges normally analyzed by the laboratory, and run in triplicate in a manner similar to that of routine samples. The results are presented in Table 2 and the criteria for agreement in Attachment 2. These criteria for agreement are based on comparisons of the mean values and estimates of the standard deviations (s.d.) of the measurements. Consideration was given to the fact that the uncertainties (s.d.) of the licensee's results were not necessarily representative of the laboratory's because they were obtained by one analyst over a short period of time. Consequently when the licensee s.d. was less than that of BNL, and a disagreement resulted, the BNL value was substituted for that of the licensee in calculating the s.d. of the ratio Z (S_z in Attachment 2).

The licensee also prepared two samples to be split with BNL. To these were added analytes supplied by the inspectors. Reactor water was spiked with the anions, chloride and sulfate, and samples of feedwater were spiked with copper, iron, and chromium ions. The licensee will determine the concentrations of the analytes in each and the results will be sent to Region III for comparison with the values determined by BNL. This will be followed under the Open Items (No. 50-315/88010-02; No. 50-316/88011-02).

The licensee determined ten analytes at three concentrations each. Of the initial 30 analyses, 25 of the results (83%) were in agreement with those of BNL. The disagreements included the three fluoride, the high chloride and the two lower concentration ammonia results. The consistently low bias of the fluoride values indicated a bias in the calibration standard, which was supported by the results of a rerun with a different standard. Two difficulties with this analysis were that an independent control standard was not used to check the calibration and the meter had a sensitivity of only one millivolt, rather than 0.1 mv recommended for the specific ion electrode used in this analysis. The licensee representative noted that they would replace the meter with a more sensitive one and consider the conscious use of independent calibration and control standards.

The disagreements in the ammonia analysis may have resulted from the low concentrations of the samples run; i.e., the resultant optical absorptions on the UV/vis spectrometer were very small, less than 5%, resulting in a very poor accuracy in the analysis. The laboratory agreed to revise the procedure, so that in the future they would use 50-mm path length cells when the absorption was low with the 10-mm cells usually used. Although the sodium results were in agreement, the considerable imprecision of the analysis indicated the presence of a problem. This appeared to be due to the very low concentrations of the sodium samples with a resultant high sensitivity to sample contamination. The licensee is looking into this problem.

Progress in the improvements in the fluoride, ammonia and sodium analyses will be followed in subsequent inspections under Open Items (No. 50-315/88010-03; No. 50-316/88011-03).

No violations or deviations were identified.

7. Implementation of the QA Program in the Chemistry Laboratory

The inspector reviewed the nonradiological QA/QC program in the laboratory based on Procedure No. 12 THP 6020 LAB.044, "Laboratory Quality Assurance, "Revision 8, August 13, 1987. Control charts with 3-sigma control and 2-sigma warning limits were maintained for most of the analytical methods, including hardness, fluoride, chloride (both at ppm and ppb levels), sulfate, pH, hydrazine, lithium, and silica. In many cases two controls were used, one near the lower, and one near the upper end of the calibration range, e.g., silica at 0.1 and 1.0 ppm.

The inspector noted some concerns to licensee representatives. The control limits were determined approximately yearly, so that many of the controls showed substantial drift in on direction or jumps in the mean values. There was no evidence that adjustments were made to the charts (recalculation or recalibration of the procedure). Many of the control data sets were well within the 2-sigma limits, which meant that these limits no longer represented the analytical variabilities. The limits should be recalculated at more frequent intervals, e.g., monthly or possibly quarterly bases (approximately after the collection of every 30-60 data points). Further, it appeared that the data were not assessed regularly; e.g., when the boron control standard value jumped from an apparent concentration of 1003 to greater than 1010 ppm (control limit 1008, and the manufacturer's value was given on the bottle as 997 ppm) no apparent action was taken. Another weakness of the system was that all of the analyses of a given type were logged in serial order in the respective logbook, so that the control data were difficult to scan. They would be much more amenable to assessment if the results were tabulated on a data sheet, with each control having its own column. The data would then be tabulated for new calculations at the end of the accumulation period.

The licensee appears to have a good technician performance testing program. Semiannually, they analyze approximately different 14 unknowns which cover most of the laboratory analyses, including boron, silica, chloride, fluoride, sulfate, lithium, and hydrazine. These appear to be extensively assessed by the supervisors with agreement criteria (usually within 10% of the known value) and corrective actions, appraisal sheets for each technician, listings by technician and by analysis, and summaries of the results. Agreement criteria have been set at ±10% of the known value.

The licensee's QA/QC program has the basic elements of a satisfactory program, but it needs some adjustments to make the QC charts useful tools to demonstrate the credibility of the laboratory results. Licensee representatives will consider the above concerns and submit a letter to Region III on their resolution. This will be followed under Open Items (No. 50-315-88010-04; No. 50-316/88011-04).

No violations or deviations were identified.

8. Environmental Monitoring: TLD Collocations (IP 80721, TI 2500/22)

The inspectors examined NRC and licensee environmental TLD's at selected field locations. No badge were missing. Three NRC TLDs (Location 2, 19, and 20) required adjustment as they were partially shadowed by their mounting poles from direct line of sight toward the plant.

Review of the licensee's records showed that TLD system appeared to lack an inner ring dosimeter in Sector G and the one in the outer ring in Sector J was only approximately two miles from the plant, considerably short of the four to five miles recommended. Licensee TLD locations in reference to the plant have not been precisely established on accurate maps. Several apparent discrepancies were noted in location designations, and directions were described simply by sector (e.g., E., ENE, etc.) rather than by azimuth angle. Licensee representatives indicated these weaknesses would be addressed. Resolution of these problems will be followed in subsequent routine environmental inspections.

No violations or deviations were identified.

9. Open Items

Open items are matters which have been discussed with the licensee, which will be reviewed further by the inspector, and which involve some action on the part of the NRC or licensee, or both. Open items disclosed during the inspection are discussed in Sections 2 and 6.

10. Exit Interview

The scope and findings of the inspection were reviewed with licensee representatives (Section 1) at the conclusion of the inspection on February 18, 1988. The inspectors discussed the Open Items in Section 2 and observations on the quality control program and the confirmatory measurements. Licensee representatives agreed to consider modification of the QC charts and to consider other modifications of the program, as discussed in Section 7 and report their conclusions to Region III within 60 days. The inspectors noted the significant progress in the QA/QC program since the previous inspections.

During the exit interview, the inspectors discussed the likely informational content of the inspection report with regard to documents or processes reviewed by the inspectors during the inspection. Licensee representatives did not identify any such documents or processes as proprietary.

Attachments:
1. Table 1, Confirmatory Measurements Program Results, 4th Quarter 1987
2. Attachment 1, Criteria for Comparing Analytical Measurements (Radiological)
3. Table 2, Nonradiological Interlaboratory Test Results, February 10-18, 1988
4. Attachment 2, Criteria for Comparing Analytical Measurements (Nonradiological)

TABLE 1

U S NUCLEAR REGULATORY COMMISSION

OFFICE OF INSPECTION AND ENFORCEMENT

CONFIRMATORY MEASUREMENTS PROGRAM
FACILITY: D. C. COOK
FOR THE 4 QUARTER OF 1987

		------NRC-------		----LICENSEE----		---LICENSEE:NRC----		
SAMPLE	ISOTOPE	RESULT	ERROR	RESULT	ERROR	RATIO	RES	T
L WASTE	G BETA	7.1E-05	2.0E-06	1.3E-06	4.8E-06	1.8E-02	3.6E 01	D
	H-3	2.1E-02	3.0E-04	2.2E-02	4.9E-05	1.1E 00	7.1E 01	A
	FE-55	4.2E-06	1.0E-07	3.4E-06	3.4E-07	8.3E-01	4.2E 01	A
	SR-89	2.5E-08	9.0E-09	1.5E-08	4.3E-09	6.0E-01	2.8E 00	A
	SR-90	4.0E-09	4.0E-09	<3.6E-09	0.0E-01	9.0E-01	1.0E 00	A

T TEST RESULTS:
A=AGREEMENT
D=DISAGREEMENT
*=CRITERIA RELAXED

ATTACHMENT 1

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 these criteria, the judgment limits are variable in relation to the comparison of the NRC's value to its associated one sigma uncertainty. As that ratio, referred to in this program as "Resolution", increases, the acceptability of a licensee's measurement should be more selective. Conversely, poorer agreement should be considered acceptable as the resolution decreases. The values in the ratio criteria may be rounded to fewer significant figures reported by the NRC Reference Laboratory, unless such rounding will result in a narrowed category of acceptance.

RESOLUTION	RATIO = LICENSEE VALUE/NRC REFERENCE VALUE
	Agreement
<4	0.4 - 2.5
4 - 7	0.5 - 2.0
8 - 15	0.6 - 1.66
16 - 50	0.75 - 1.33
51 - 200	0.80 - 1.25
200 -	0.85 - 1.18

Some discrepancies may result from the use of different equipment, techniques, and for some specific nuclides. These may be factored into the acceptance criteria and identified on the data sheet.

TABLE 2
Nonradiological Interlaboratory Test Results
D.C. Cook Nuclear Plant, Units 1 and 2
February 10-18, 1988

Analyte	Analysis Method[b]	Dilution 1:x	NRC Y ± s.d.(n)	Licensee[a] X ± s.d.(n)	Ratio Z ± s.d.	Comparison[c] ±2 s.d.	
			Concentration, ppb				
F^-	SIP	1000	23.10 ± 0.50	18.00 ± 0.00	0.779 ± 0.024	D*	
		1000	43.50 ± 1.90	37.00 ± 0.00	0.851 ± 0.053	D*	
F^- (Rerun)	SIP	1000	23.10 ± 0.50	21.00 ± 3.00	0.909 ± 0.131	A	
		1000	43.50 ± 1.90	41.00 ± 0	0.942 ± 0.041	A	
		1000	83.50 ± 2.80	78.3 ± 3.5	0.938 ± 0.052	A	
Cl^-	IC	2000	12.05 ± 1.55	12.50 ± 1.60	1.037 ± 0.188	A	
		2000	18.70 ± 0.60	20.50 ± 1.30	1.096 ± 0.078	A	
		2000	40.20 ± 1.10	48.80 ± 1.30	1.212 ± 0.046	D	
Sulf-	IC	2000	10.00 ± 0.45	12.20 ± 1.00	1.220 ± 0.114	A	
		2000	20.50 ± 1.20	20.90 ± 1.90	1.020 ± 0.110	A	
		2000	40.50 ± 1.50	42.40 ± 1.70	1.050 ± 0.057	A	
ilica	Spec	250	217.20 ± 22.40	183.00 ± 21.00	0.843 ± 0.130	A	
		250	436.00 ± 28.00	387.00 ± 23.00	0.888 ± 0.078	A	
		250	640.00 ± 20.00	600.00 ± 0.00	0.938 ± 0.041	A*	
Cu	AAS	250	18.72 ± 0.96	18.00 ± 0.00	0.962 ± 0.049	A	
		250	38.64 ± 1.96	39.30 ± 0.60	1.017 ± 0.054	A	
		250	58.00 ± 2.40	59.30 ± 1.20	1.022 ± 0.047	A	
Fe	AAS	250	19.56 ± 1.40	18.70 ± 0.60	0.956 ± 0.075	A	
		250	38.20 ± 1.36	39.30 ± 2.30	1.029 ± 0.070	A	
		250	58.80 ± 1.68	59.00 ± 1.70	1.003 ± 0.041	A	
Na	AAS	1000	4.58 ± 0.50	6.80 ± 3.30	1.485 ± 0.739	A	
		1000	9.23 ± 0.80	12.40 ± 3.00	1.343 ± 0.345	A	
		1000	14.40 ± 0.80	15.60 ± 3.30	1.083 ± 0.237	A	
Hydra- zine	Spec	2000	11.15 ± 0.70	10.30 ± 0.60	0.924 ± 0.079	A	
		2000	28.45 ± 0.35	27.30 ± 2.30	0.960 ± 0.082	A	
		2000	52.00 ± 0.50	51.30 ± 2.30	0.987 ± 0.045	A	
NH_3	Spec	500	175.20 ± 10.60	58.00 ± 14.00	0.331 ± 0.082	D	
		500	628.00 ± 52.00	450.00 ± 50.00	0.717 ± 0.084	D*	
		500	1876.00 ± 170.00	1900.00 ± 100.00	1.013 ± 0.106	A	

Analyte	Analysis Method[b]	Dilution 1:x	NRC Y ± s.d.(n)	Licensee[a] X ± s.d.(n)	Ratio Z ± s.d.	Comparison[c] ±2 s.d.	
				Concentration, ppb			
B	Titr	1	1000 ± 10	1001.06 ± 4.0	1.002 ±	0.011	A
		1	3024 ± 46	2957 ± 18	0.978 ±	0.016	A
		1	4947 ± 61	5122 ± 73	1.035 ±	0.020	A

a. Value ± standard deviation (s.d.); n is number of BNL analyses. The number of licensee analyses is 3 unless otherwise noted.

b. Analytical methods: Titr - titration
IC - Ion chromatography
Spec - Spectrophotometric
SIP - Specific ion probe
AAS - Atomic Absorption Spectroscopy (furnace)

c. A = Agreement
D_+ = Disagreement
A^+ = Borderline Agreement

* Substituted the BNL uncertainty for licensee's uncertainty.

ATTACHMENT 2

Criteria for Comparing Analytical Measurements

This attachment provides criteria for comparing results of the capability tests. The acceptance limits are based on the uncertainty (standard deviation) of the ratio of the licensee's mean value (X) to the NRC mean value (Y), where

(1) $Z = X/Y$ is the ratio, and

(2) S_z is the uncertainty of the ratio determined from the propagation of the uncertainties of licensee's mean value, S_x, and of the NRC's mean value, S_y.[1] Thus,

$$\frac{S_z^2}{Z^2} = \frac{S_x^2}{X^2} + \frac{S_y^2}{Y^2}, \text{ so that}$$

$$S_z = Z \bullet \left(\frac{S_x^2}{X^2} + \frac{S_y^2}{Y^2} \right)^{\frac{1}{2}}$$

The results are considered to be in agreement when the bias in the ratio (absolute value of difference between unity and the ratio) is less than or equal to twice the uncertainty in the ratio, i.e.

$$|1-Z| \leq 2 \bullet S_z .$$

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1. National Council on Radiation Protection and Measurements, A Handbook of Radioactivity Measurements Procedures, NCRP Report No. 58, Second Edition, 1985, Pages 322-326 (see Page 324).

4/6/87