An

Evaluation

of

the

Smith-Greenberg Impinger Method

for

Sampling Soluble Airborne Uranium

in

the

Environment

June 30, 1981

Nuclear Fuel Services, Inc.
Erwin, Tennessee

I. Background

For several years, Nuclear Fuel Services, Inc. (NFS) has utilized Smith-Greenberg impingers to sample soluble uranium particulate which is apparently dissolved in the water laden plume from stacks equipped with water circulating packed bed scrubbers. Some of the dissolved uranium passes through moist particulate filters and is absorbed in aqueous ammonia solutions contained in the impingers.

During an inspection in late 1980, an NRC inspector reasoned that the dissolved component might also be passing through environmental air sampler filters at the perimeter of the plant site and the air concentrations so measured could possibly be biased low. In order to test the null hypotheses, NFS agreed to install a Smith-Greenberg impinger series in two perimeter air sampling stations. Airborne radioactivity measurement data for these samplers were reported to the NRC Region II office in December, 1980 during a routine inspection.

From a review of these data, it became apparent that the measurements lacked the necessary sensitivity; i.e., a sufficiently low minium detectable level (MDL) to provide useful environmental airborne radioactivity measurements. Because the MDL was so high, the question arose to what levels of soluble radioactivity were passing through the membrane type filters, if any. Following discussions with Region II - NRC, a Confirmation of Action Letter (COA) dated March 17, 1981 was issued by Region II-NRC which contained six (6) action points to further evaluate the measurements of "soluble" uranium in the environment as follows:

1. Install and operate a filter/impinger sampling device at the control environmental sampling station along the Asheville Highway south of the plant. Begin operation by April 15, 1981.

2. Analyze two blank impinger solutions for gross alpha activity using the same procedure used for impinger sample analyses. Complete analyses by April 30, 1981.

3. Perform an alpha isotopic analyses of at least two sets of filter/impinger collections. Complete analyses by June 1, 1981.

4. Reevaluate the present analytical technique with emphasis placed upon analysis sensitivity. Complete reevaluation by June 15, 1981.

5. Reevaluate the sampling method by June 15, 1981.

6. Submit a report to Region II NRC Office of the results and your evaluation by June 30, 1981.

This report constitutes final compliance with that Confirmation of Action letter.

II. Summary and Conclusions (COA Item 6)

The general conclusions reached by the study are:

(1) The Smith Greenberg impinger method is not sufficiently sensitive to collect and measure alpha emitting radioactive particulate in air in the environment.

(2) The results of the analytical method used by NFS are comparable with an outside laboratory using alpha spectroscopy.

(3) A change of analytical method, either in sample preparation or counting procedures, will not yield results with greater sensitivity.

(4) Because the results measured by the Smith-Greenberg impinger due to natural alpha radioactivity in the collecting media and not to radioactivity in air which the impinger removed, it is concluded that no significant fraction of environmental air contains any "unmeasured" soluble uranium particulate.

(5) Based on the foregoing conclusions, it is recommended that this sampling method be discontinued.

III. "Control" Sampler Experience (COA Letter, Item 1)

NFS installed a Smith-Greenberg impinger on the Asheville Highway environmental air sampling station (No. 379) on March 23, 1981. The system has operated since that time with a weekly change-out and analysis of the impinger solution. This sampling station is located approximately four miles southwest of the plant site (a direction toward which the wind blows with approximately a three (3) percent frequency). The data collected thus far is summarized in Attachment I. It should be noted that the average activity for the nine (9) week period is slightly higher at that station than for the perimeter sampler impingers discussed below.

IV. "Blank" Impinger Solution Analysis (COA Letter, Item 7)

"Blank" solutions consisting only of deionized (D.I.) water were analyzed with the routine impinger solutions collected on March 23, March 30 and April 6, 1981. The results of these analyses are shown in Attachment I. Because the volume of impinger solution in the sampling station decreased by approximately 67% (due to evaporation) during the sampling period, appropriate mathematical adjustment was made on the first two impinger "blank" results. The third sample (April 6) was concentrated from 300 ml instead of the customary 100 ml to compensate for the evaporation loss. With these considerations, the results of the "blank" DI water samples do not vary significantly from the samples in actual collection.

V. Isotopic Analysis of Impinger Solution (COA Letter Item 3)

Complete isotopic analyses of perimeter air sample filters, impingers and "blank" DI water were performed on both perimeter samplers equipped with impingers for weekly collection periods ending March 23 and March 30, 1981. The results of these analyses are contained in Attachment II. Results are expressed in dpm/sample and for uranium isotopes in μCi/ml. The isotopic analyses, performed by an outside laboratory, also indicate the presence of high "background" uranium in the impinger solution is causing an unacceptably high MDL in the sampling method.

VI. Analytical Technique Evaluation (COA Letter Item 4)

The analytical technique was evaluated by having an outside laboratory perform an isotopic analysis on impinger samples and "blank" solution and comparing the results with those analyses (gross alpha) performed by NFS. The results of these intercomparison analyses are shown in Attachment I for the weeks ending March 23 and March 30, 1981. A linear regression analysis of the data indicates a correlation coefficient of 0.74. This is considered to be reasonably comparable.

VII. Reevaluation of Sampling Method (COA Letter Item 5)

In order to reduce the sensitivity of the Smith-Greenberg impinger sampling system to a reasonably meaningful level; e.g. 5×10^{-15} μCi/ml gross alpha radioactivity in air, the maximum naturally occurring alpha radioactivity permitted in the water from which the sampling solution is prepared is 0.06 picocuries per liter.

The normal potable water supplies in this area contain from 1 to 10 micrograms per liter of natural uranium in nominal equilibium with its daughters. This activity would represent from 1.2 to 12 picocuries per liter. Passage through a normal laboratory type demineralization (ion exchange) column does little to further reduce the already low concentration.

The normal background of naturally occurring alpha emitting radionuclides in the impinger solutions would indicate airborne concentrations of 9×10^{-14} μCi/ml. Therefore, it is concluded that, due to natural radioactivity in the water used in the impinger, the impinger method is not suitable for very low level environmental air measurements.

ATTACHMENT I

PERIMETER SMITH-GREENBERG IMPINGER SAMPLE DATA

Units: μCi/ml x 10^{-12}

Week Ending	Perimeter No. 173	Perimeter No. 174	Asheville Highway No. 379	Blank
3/23/81	0.0152(0.0472)	0.0174(0.0278)		0.0125 (0.0536)
3/30/81	0.0612(0.0618)	0.0408(0.0409)	0.0233	0.1026 (0.0963)
4/6/81	0.1305	0.1542	0.1614	0.1542
4/13/81	0.0791	0.0297	0.1385	
4/20/81	0.0099	<0.0099	0.0198	
4/27/81	0.0593	<0.0099	0.1978	
5/4/81	0.1286	0.4451	0.0593	
5/11/81	0.2275	0.1484	0.0989	
5/18/81	0.2374	0.1286	0.4945	
Average	0.1167	0.1184	0.1492	

NOTE: Numbers in parenthesis are based on outside laboratory analysis

For samples and blanks for weeks ending 3/23/81 and 3/30/81 a 500 ml volume was plated in order to supply sufficient activity for isotopic analysis. For all other samples a 100 ml volume was plated.

Concentrations calculated for blanks are based on a plated volume of 3 times that of the sampling volume. This is done since the total volume of D.I. water added to the impingers averages 3 liters but the total volume remaining after the sampling period is 1 liter, so that 100 ml of impinger solution represents 300 ml of D. I. water.

PERIMETER SMITH-GREENBERG IMPINGER SAMPLE DATA

Isotopic Analysis

Sample Identification	Date Collected	Type of Analysis	Ci/ml (x 10^{-})	dpm/sample
173 (filter)	3/23/81	U-234	.1665	4.4 ± 1.6
		U-235	.0091	0.24 ± 0.33
(dpm x 6) x factor		U-238	.0416)	1.1 ± 0.7
		Th-228		0.047 ± 0.209
		Th-230		0.047 ± 0.209
		Th-232		0.047 ± 0.247
		Pu-238		-0.099 ± 0.198
		Pu-239		-0.20 ± 0.21
174 (filter)	3/23/81	U-234	.1476	3.9 ± 1.1
		U-235	.0136	0.36 ± 0.42
		U-238	.0193	0.51 ± 0.56
		Th-228		-0.045 ± 0.200
		Th-230		0.045 ± 0.179
		Th-232		0.045 ± 0.090
		Pu-238		0.19 ± 0.25
		Pu-239		-0.40 ± 0.24
173 (impinger)	3/23/81	U-234	0.0320	2.7 ± 1.2
		U-235	0.0012	0.10 ± 0.44
		U-238	0.0082	0.69 ± 0.58
dpm x .25 x 30 x .001582		Th-228		0.086 ± 0.298
		Th-230		0.22 ± 0.29
		Th-232		0.086 ± 0.298
		Pu-238		0.000 ± 0.091
		Pu-239		0.097 ± 0.112
174 (impinger)	3/23/81	U-234	0.0308	2.6 ± 1.6
		U-235	0	-0.38 ± 0.91
		U-238	0.0021	0.18 ± 0.64
		Th-228		0.049 ± 0.049
		Th-230		0.098 ± 0.138
		Th-232		0.000 ± 0.049
		Pu-238		-0.24 ± 0.31
		Pu-239		0.036 ± 0.192
Blank #1	3/23/81	U-234	0.0131	1.1 ± 0.5
		U-235	0	-0.083 ± 0.202
dpm x .25 x 30		U-238	0.0063	0.53 ± 0.31
		Th-228		0.049 ± 0.098
		Th-230		0.000 ± 0.049
		Th-232		0.049 ± 0.098
		Pu-238		0.059 ± 0.119
		Pu-239		0.24 ± 0.27
Blank #2	3/23/81	U-234	0.0045	0.38 ± 0.031
		U-235	0.0006	0.047 ± 0.131
		U-238	0.0045	0.38 ± 0.31
		Th-228		0.045 ± 0.090
		Th-230		-0.045 ± 0.090
		Th-232		0.045 ± 0.156
		Pu-238		0.093 ± 0.107
		Pu-239		0.12 ± 0.12

PERIMETER SMITH-GREENBERG IMPINGER SAMPLE DATA

Isotopic Analysis

Sample Identification	Date Collected	Type of Analysis		dpm/sample
173 (filter)	3/30/81	U-234	.1324	3.5 ± 1.0
		U-235	.0025	0.067 ± 0.133
		U-238	.0125	0.33 ± 0.29
		Th-228		0.000 ± 0.057
		Th-230		-0.12 ± 0.28
		Th-232		0.000 ± 0.057
		Pu-238		0.044 ± 0.066
		Pu-239		0.059 ± 0.059
174 (filter)	3/30/81	U-234	.1287	3.4 ± 1.0
		U-235	.0028	0.075 ± 0.149
		U-238	.0144	0.38 ± 0.40
		Th-228		0.057 ± 0.230
		Th-230		0.063 ± 0.177
		Th-232		0.063 ± 0.177
		Pu-238		0.040 ± 0.226
		Pu-239		0.040 ± 0.212
173 (impinger)	3/30/81	U-234	0.0593	5.0 ± 1.5
		U-235	0	0.00 ± 0.21
		U-238	0.0084	0.71 ± 0.53
dpm x .25 x 30		Th-228		0.000 ± 0.055
		Th-230		0.055 ± 0.248
		Th-232		-0.11 ± 0.16
		Pu-238		0.15 ± 0.25
		Pu-239		-0.073 ± 0.252
174 (impinger)	3/30/81	U-234	0.0344	2.9 ± 0.8
		U-235	0.0011	0.089 ± 0.215
		U-238	0.0025	0.21 ± 0.36
		Th-228		0.072 ± 0.144
		Th-230		0.22 ± 0.56
		Th-232		-0.22 ± 0.43
		Pu-238		0.13 ± 0.14
		Pu-239		0.047 ± 0.095
Blank (impinger)	3/30/81	U-234	0.0178	1.5 ± 0.6
		U-235	0.0014	0.12 ± 0.17
		U-238	0.0058	0.49 ± 0.33
		Th-228		0.058 ± 0.116
		Th-230		0.23 ± 0.23
		Th-232		0.23 ± 0.49
		Pu-238		0.048 ± 0.056
		Pu-239		0.032 ± 0.137

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Nuclear Fuel Services, Inc. ERWIN, TENNESSEE 37650

(615) 743-9141

November 30, 1981

U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, Suite 3100
Atlanta, Georgia 30303

Attention: Mr. J.P. O'Reilly
Director

Reference: 1) Docket No. 70-143

2) Inspection Report No. 70-143/81-27

Gentlemen:

Pursuant to item 13 of the referenced inspection report 2) above, we hereby submit an outline and schedule for training off-shift supervisors and radiation monitoring personnel in off-normal occurrence recognition and response. As you will note, this training is scheduled to begin on December 11 and will be completed by December 21, 1981.

Also, the revised procedures for operation of the ALPHA-5 alarming stack monitor and hydrolysis of uranium hexafluoride, forwarded to you by letter dated November 9, 1981, will be implemented, including the training of personnel as to these procedures, when final equipment modifications are in place and operational. This is expected to be completed by December 15, 1981.

If you have any questions about this program, please call us.

Very truly yours,

W.C. Manser, Jr.
General Manager

WCM:jp
Attachments

cc: U.S. Nuclear Regulatory Commission
Division of Fuel Cycle and Material Safety
Washington, D.C. 20555

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TRAINING

OUTLINE

QUALIFICATION CRITERIA

AND

SCHEDULE

SUPERVISORS

AND

RADIATION MONITORS

RECOGNITION OF, AND REACTION TO

OFF-NORMAL RADIOLOGICAL OCCURRENCES

November 30, 1981

1. GENERAL

Supervisors, including temporary foremen, and Radiation Monitors must be able to recognize, properly respond to and report off-normal radiological occurrences and situations. Although operating and Radiation Monitoring procedures require reporting such occurrences, there is some misconception and disagreement as to what constitutes an off-normal occurrence, what response should be taken and to whom and when it should be reported. This plan is intended to provide for initital training and the scheduling of such training and for re-training to assure that proficiency in this area of individual responsibility is maintained.

2. TRAINING METHODS

The method used in training will include an audio-visual presentation (video tape) and personal instruction by a health physicist and a process engineer in the form of questions and answers. At least one (the first) training session will be video recorded in its entirity for possible re-use in subsequent sessions. The video tape format will involve a round table discussion between a health physicist(s), a process engineer, the building or area manager and nuclear safety specialist in which each process phase, work station, or work area is discussed briefly with foreseeable off-normal situations identified together with a discussion of the proper responses and reporting. General site emergencies such as a criticality accident or a major fire will be discussed in detail. The edited tape should be no longer than one hour.

Following the presentation of the video tape, a health physicist, process engineer and nuclear safety specialist will conduct a question and answer session of up to one hour. A list of typical questions, generated initially by the presentors and modified as indicated by the early sessions will be used to stimulate discussion.

3. Qualifications Criteria

No formal testing or other recorded measure of individual qualifications will occur. During the course of the training described in (2) above, the presentors will present hypothetical, but realistic, off-normal situations. Personnel will be requested to evaluate the situation describe the corrective action they would take (immediate, short-term and long-term), the reporting requirements (to whom and the time-frame for reporting), and the followup actions required. When, in the opinion of both the health physics and process engineering representatives, personnel response is adequate to demonstrate an understanding of, and proficiency in, proper responses to the hypothetical situations they shall certify that such personnel have been emergency response trained and qualified to serve as an off-shift Supervisor or Radiation Monitor. Temporary foreman shall not be assigned to shift (alone) until he has undergone this training and so qualified.

4. Retraining

Each qualified Supervisor (Production Foremen, SNM Supervisors and Laboratory Supervisors) and Radiation Monitor shall receive retraining in order to remain qualified for off-shift assignment. Personnel who have not had such training for two years shall not be assigned to an off-shift alone until such training is attended.

5. <u>Personnel to Receive Training</u>

The following personnel must be trained:

a.	All Building 302/303 Foremen (including temporary)	12
b.	All H. E. Scrap Building Foremen (including temporary)	4
c.	All L. E. Scrap (Chemical-Metals) Building Foremen (including temporary).	4
d.	All Maintenance Foremen/Superintendent(s)	7
e.	All Process Building Managers	3
f.	All Shift SNM Foremen	12
g.	WWTF Foremen	2
h.	All Laboratory Shift Supervisors	4
i.	Building 111 Utility Operator	1
j.	All Technical Services Engineers	4
k.	All Building Process Engineers	6
l.	All Radiation Monitors	18
m.	Health and Safety Supervisors	2
n.	Yard Foreman	1
o.	Security Shift Supervisors	6
p.	Decommissioning Foremen	1
q.	Material Control Superintendents	4
r.	Warehouse Supervisors	2
	Total	93

TRAINING SCHEDULE

"Recognition of, and Response to Off-Normal Radiological Occurrences"

12/11/81	12:30 - 14:30 hours
12/14/81	07:30 - 09:30 hours
12/14/81	12:30 - 14:30 hours
12/15/81	07:30 - 09:30 hours
12/16/81	15:30 - 17:30 hours
12/17/81	12:30 - 14:30 hours
12/18/81	07:30 - 09:30 hours
12/21/81	15:30 - 17:30 hours