Richard A. Uderitz
Vice President -
Nuclear

Public Service Electric and Gas Company P.O. Box 236, Hancocks Bridge, NJ 08038 609 935-6010

August 4, 1983

Mr. Thomas T. Martin, Director
Division of Engineering and Technical Programs
U. S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, Pennsylvania 19406

Dear Mr. Martin:

NRC INSPECTION 50-311/83-14
SALEM GENERATING STATION
NO. 2 UNIT
APRIL 17 THRU 20, 1983

The following is our response to the notice of violation identified as a result of the inspection conducted on April 17 - 22, 1983. This response was delayed in the interest of completeness as discussed with Mr. J. R. White of your staff.

ITEMS OF VIOLATION:

Item A

10CFR 20.103(a)(3) requires that licensees use suitable measurements of concentrations of radioactive material in air for detecting and evaluating airborne radioactivity for purposes of determining compliance with the requirements of 10CFR 20.103. 10CFR 20.103(a)(1) provides quarterly limits for intake of airborne radioactivity.

Contrary to the above:

> On April 16, 1983, during three separate drilling and cleaning operations of a nozzle dam stud located inside the No. 22 steam generator, no measurements of the concentrations of radioactive materials present therein were made for purposes of determining compliance with 10CFR 20.103. Personnel entered the steam generator immediately before and after the drilling to clean the area being drilled with an air gun. This is a Severity Level IV violation (Supplement IV).

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Reply to Item A

Elevated contamination levels in the No. 22 Steam Generator (SG) were the result of a Westinghouse Bolt Removal project. The loose debris from this and other work became airborne when the nearby No. 22 Reactor Coolant Pump (RCP) was test run. This RCP will draw 20,000 cubic feet of air per minute for cooling purposes. The RCP is located adjacent to the SG, and with the sudden change of air flow, the contamination from the SG and SG tent area was drawn out by the RCP motor toward the RCP area. The personnel that were in the vicinity of the RCP were exposed to unexpected radioactive airborne concentrations which were higher than normal.

It should be noted that an air sample from the waterbox was taken immediately prior to the drilling operation. Additionally, numerous samples had been taken previously in the SG tent, bowl, and platform areas during this outage and during previous outages revealing elevated airborne radionuclide concentrations in the SG waterbox. As a result of these observations, all SG "bowl" work is performed in multiple sets of protective clothing with airline-full face respiratory protective equipment. Since the SG "jumps" are of very short duration and the turn-around time is very large on determining activity levels from air samples when compared to jump times (several minutes, typically two minutes), the practicality of taking individual samples for each "jump" is limited.

The requirements of 10CFR 20.103(a)(b) state that suitable measurements of airborne concentrations of radioactivity must be made for determining compliance with the requirements of 10CFR 20.103(a)(1). It should be noted that measurements by themselves do not ensure compliance with the exposure limits, but rather the preventive action taken prior to the work dictates whether compliance is achieved. In other words, when airborne concentrations increase, various levels of respiratory protective equipment can be utilized to prevent exceedance of the regulatory limits. If the concentration levels exceed those levels for which the highest rated respiratory protective devices can protect against for a given exposure duration, then the activity must be terminated and the individuals must be removed to an area of lower airborne contamination.

Since the drilling operation workers were already employing air-supplied full-face respiratory protection (with a protection factor of 2000) and their "stay" time was restricted below 10 minutes (usually 6 minutes), the expected variations in airborne concentrations in the SG would not jeopardize our ability to limit the amount of radioactivity inhaled below the quarterly limits (520 MPC-hours). This conclusion is borne out by the whole body counts done on these "jumpers." The air concentration which would require us to suspend operations is several orders of magnitude greater than any observed air concentration at Salem station including the SG bowl (waterbox). The quantity of removable contamination to achieve such elevated concentrations is very high (on the order of tens of curies). Since the total potential source term for high airborne activity in the steam generator is finite and the waterbox had been hydrolazed prior to this evolution, it appears that our air sampling measurements were adequate to ensure compliance with 10CFR 20.103.

However, we are investigating potential improvements in our means to detect changes in conditions within the SG bowl which might warrant suspension of work activities. As a result of our review of the events occurring on April 16, 1983, several areas of improvement in our containment air sampling program during outages have been identified. Although at least 17 air samples were taken during the period of interest, it appears that we can enhance our knowledge of changing conditions within containment. This improvement requires prompt recognition of conditions changing respiratory requirements for various operations in containment. The specific actions taken by PSE&G in regards to this matter are discussed below.

Actions to Prevent Recurrence:

1. The Radiation Protection Department will revise the procedure governing surveys (RPI 4.001) to ensure samples are taken from the containment building at least once per hour during routine containment outage conditions where the potential for high airborne radioactivity exists. This procedure will be revised by September 30, 1983.

2. Direct-indicating air monitoring devices will be evaluated for use to monitor changing airborne concentrations near sources of high contamination during the outages. For example, recording air monitor devices can be employed for the SG platform area in the future. Additionally, we are investigating other means to verify that the respiratory protection provided to workers within the SG bowl is suitable to maintain compliance with 10CFR 20. The improvements that will be adopted will conform to ALARA requirements as well as to proper sampling practices (e.g., the ability to differentiate between respirable contamination and gross large-particle contamination). These actions will be completed by the next refueling outage on Unit No. 2.

3. The ALARA program at Salem Generating Station (SGS) is being strengthened to provide better pre-job ALARA review for all jobs requiring a Radiation Exposure Permit. The enhanced pre-job ALARA review will include the incorporation of specific air sampling requirements for jobs having the potential for changing airborne concentrations. Improvements and procedural modifications are scheduled for implementation by January 19, 1984.

Item B

10CFR 20.103 states in paragraph (b), in part, "The licensee shall, as a precautionary procedure, use process or other engineering controls, to the extent practicable, to limit concentrations of radioactive materials in air to levels below those which delimit an airborne radioactivity area as defined in 20.203(d)(1)(ii) ..."

Contrary to the above:

> On April 16, 1983, an installed airborne radioactivity removal system was not used to limit airborne radioactivity concentrations inside the No. 22 Steam Generator or in the vicinity thereof. Airborne radioactivity concentrations measured in the work vicinity ranged from 52 to 168 times the value specified in 20.203(d)(1)(ii). This is a Severity Level IV violation (Supplement IV).

Reply to Item B

At 1650 on April 15, a Radiation Protection (R.P.) Supervisor requested that No. 22 Iodine Removal Unit (IRU) be placed in service for a test. As a result of a miscommunication between the Radiation Protection and Operations Departments, the IRU was never placed in service. However, the R.P. Department recorded the Public Address (PA) announcement by Operations in the shift log (the announcement was incorrect), as verification that the IRU was operating when SG work began approximately 20 hours later.

It is difficult to determine whether or not the IRU would have prevented the personnel contamination to those in the RCP area in this particular event. Personnel in the SG tent area were protected, however, by their respiratory equipment. Based on our evaluation of events, the Reactor Coolant Pump (RCP) motor test run may have rendered any available air removal units inadequate. Nevertheless, it is believed that proper engineering controls were not exercised. The most significant cause of the contamination spread appears to be the operation of the nearby RCP. The RCP motor test run should thus not be allowed to take place concurrently with any high contamination job within containment.

Actions to Prevent Recurrence:

1. A form has been developed to document requests to the Operations Department to place in service any system that the Radiation Protection Department feels will aid in maintaining exposures ALARA. This should assure the communications are complete.

2. Improved communications and a strengthened ALARA program should promote the scheduling of plant evolutions to avoid any adverse impact on maintenance work in progress.

The attachments to this letter contain more detailed material than our summary previously provided to the NRC inspectors. The attachments provide clarification regarding the interpretation of which MPC-hours were used from the various methods available.

Sincerely,

R. G. Vollertz

Attachments

CC: Director, Office of Inspection and Enforcement
Nuclear Regulatory Commission
Washington, D.C. 20555

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Licensing Project Manager

Mr. Leif Norrholm
Senior Resident Inspector

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R. G. Vetlutz

Attachments

CC: Director, Office of Inspection and Enforcement
Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. Donald C. Fischer
Licensing Project Manager

Mr. Leif Norrholm
Senior Resident Inspector

DOSE CALCULATION RESULTS
and CALCULATIONAL METHOD

Name	Count Time/Date	50 Year* Whole Body Dose (mrem)	50 Year** Lung Dose (mrem)
A	13:49, 4/17	4.4	344
B	16:17, 4/17	2.9	241
C	16:07, 4/17	1.8	207
D	17:07, 4/17	1.8	175
E	15:05, 4/17	0.7	53
F	9:37, 4/18	0.7	12
G	12:33, 4/17	2.1	121
H	15:18, 4/17	0.7	22
I	17:04, 4/16	0.4	34
J	16:09, 4/17	0.5	20
K	10:03, 4/17	0.7	17

* Based on the assumption that particles inhaled are soluble.

** Based on the assumption that particles inhaled are insoluble.

The bioassays performed in the week following the exposures supported the assumption that the airborne activity was in the form of insoluble particulates. With insoluble particulates, the lung will receive most of the dose and therefore become the organ of concern. To be conservative, calculations were performed with the assumption that 100 percent of the radioactive particulates were in an insoluble form. In addition, another calculation was performed in order to ascertain an estimate of the dose which would be delivered if the particulates were (or became) soluble. In this situation, the radionuclides would be distributed throughout the body and make the whole body the "organ of concern". The following page defines the equation used for these calculations.

In accordance with 10 CFR 2.790 the names of individuals and their social security numbers have been removed to avoid an unwarranted invasion of personal privacy.

The equation below taken from ANSI-N343, was used to calculate the doses resulting from this event.

$$D = \frac{51.2\ q(t) f_2 \exp(\lambda t)\ E[1-\exp(-18250\lambda)]}{\lambda m}$$

D = 50 year dose based on a single in-vivo measurement

51.2 = conversion factor; (g-rad/MeV) x (dis/uCi-day)

q(t) = radioactivity in total body at time of measurement

f_2 = fraction in organ of reference of the radioactivity in total body

E = effective absorbed energy per disintegration of a radionuclide (Table 4, ANSI-N343)

λ = 0.693/T-eff ($days^{-1}$), ICRP-2 values used for soluble, and 120 day biological halflife used for insoluble (ICRP-10 assumption)

m = mass of organ of reference

18250 = days per 50 years

t = time between intake and in-vivo measurement (days)

MPC - HOUR ASSIGNMENTS FOR INDIVIDUALS INTERNALLY CONTAMINATED ON APRIL 16, 1983

Individuals Name	MPC - hrs based on Stay-time and Air Samples	MPC-hrs. based on Whole Body Counts
A	24.3	43.0
B	1.0	29.5
C	38.2	25.5
E	11.5	22.9
D	0.6	21.7
F	2.3	17.9
G	21.7	14.5
H	4.6	10.4
I	<0.1	6.5
J	12.3	2.6
K	1.2	2.2

MPC - HOUR ASSIGNMENT METHODS

Methods of assigning MPC - hrs to the dose records of internally contaminated individuals are described below:

A. Stay-Time Method

This method is included in the Radiation Protection Procedure Number RP 11.011. The formula used is as follows:

$$\text{MPC - hours} = \frac{\text{Time spent* in the area} \times \dfrac{\text{airborne activity**}}{\text{MPC}}}{\text{Protection factor for respiratory equipment}}$$

* The time spent in the area is obtained from the appropriate REP Sign-In Sheet.

** After GeLi analysis a "percent MPC" number is included on the computer printout. This number is calculated by dividing MPC values into each respective radionuclide activity and summing to give a total "percent MPC". The percent MPC number is used whenever possible in the above formula.

In accordance with 10 CFR 2.790 the names of individuals and their social security numbers have been removed to avoid an unwarranted invasion of personal privacy.

B. Whole Body Count Method

This method is based on assumptions given in ICRP2 and ANSI - N343. The formula used and the assumptions made are given below.

$$\text{MPC - hours} = \frac{\text{uCi in the lung}}{(\text{uCi/cc per MPC}) \times 1.25\text{E6 cc/hr} \times 0.125}$$

- This calculation is repeated for each radionuclide with the results summed to give an MPC-hour assignment.
- 1.25E6 is the standard working breathing rate.
- 0.125 is based on the assumption that 12.5 percent of the radioactive particles inhaled are left in the lungs after 24 hours.
- The uCi number is obtained from whole body count data on the lung burden, approximately 24 hours after the initial exposure.

C. Whole Body Count Printout

The formula described in Section B above is included in the Whole Body Counter computer program and, as a result, an MPC-hour value is given on the Whole Body Count Report (printout). However, a "time since exposure" value is not incorporated into the computer formula. The Radiation Protection staff has determined that since the "12.5 percent assumption" should only be used after 24 hours, the only MPC-hour value for the Whole Body Counter computer printout, which can be considered accurate, is the computer number calculated from the lung activity 24 hours after exposure.

NOTE

Standard practice at Salem is to assign MPC-hours based on the stay-time Method. In this case the 11 individuals with internal exposures above the procedural action level for further bioassay analysis were assigned MPC hours based on the (manually calculated) Whole-Body Count Method versus the stay-time method to improve accuracy.

ATTACHMENT 3

Name	SSN	Co.	Initial WBC	Assigned MPC-Hrs. Based on Stay Time
1.		Catalytic	4/17	3.65
2.		Catalytic	4/18	0.20
3.		Catalytic	4/17	2.76
4		PSE&G	4/17	2.76
D		Hydro Nuclear Ser.	4/16	21.7*
5		Rad Services Inc.	4/18	13.76
6		Catalytic	4/17	0.20
7		Catalytic	4/17	0.20
8		HAP	4/17	4.30
9		HAP	4/17	< 0.1
10		Westinghouse	4/16	3.67
11		Westinghouse	4/17	4.27
12		Catalytic	4/17	< 0.1
13		Catalytic	4/17	0.20
14		Catalytic	4/17	3.09
15		Catalytic	4/17	4.75
16		Catalytic	4/17	< 0.1
17		Catalytic	4/17	1.30
18		Hydro Nuclear Ser.	4/17	1.89
19		Catalytic	4/17	4.70
20		Rad Services Inc.	4/18	< 0.1
21		Rad Services Inc.	4/17	3.99
22		Catalytic	4/17	< 0.1
23		Rad Services Inc.	4/18	< 0.1
24		PSE&G	4/17	1.20
25		Catalytic	4/17	1.44
26		Catalytic	4/16	1.41
27.		Catalytic	4/17	5.67
28		Catalytic	4/18	1.40
29		Catalytic	4/17	1.24
30		PSE&G	4/18	< 0.1
31		PSE&G	4/17	0.24
32		Catalytic	4/17	1.50
33		Westinghouse	4/16	1.54

In accordance with 10 CFR 2.790 the names of individuals and their social security numbers have been removed to avoid an unwarranted invasion of personal privacy.

* Based on Whole Body Count Data and formula given in Attachment 2, Part B

Attachment 3

Name	SSN	Co.	Initial WBC	Assigned MPC-Hrs. (Based on Stay Time)
34		Rad Services Inc.	4/18	1.55
35		PSE&G	4/18	0.58
36		Combustion Eng.	4/17	4.10
37		Catalytic	4/17	0.42
38		Catalytic	4/17	3.90
39		Catalytic	4/17	0.74
40		Catalytic	4/17	0.68
41		Catalytic	4/17	4.1
42		Catalytic	4/16	8.5
43		Combustion Eng.	4/17	0.20
44		Catalytic	4/17	1.10
45		Catalytic	4/18	7.74
46		Catalytic	4/18	0.40
47		Catalytic	4/17	1.11
48		Westinghouse	4/15	<0.1
49		Kemper Ins.	4/18	<0.1
50		PSE&G	4/18	1.20
51		Rad Services Inc.	4/18	<0.1
52		Catalytic	4/16	3.76
53		Cooperheat	4/18	0.36
54		Rad Services Inc.	4/18	<0.1
55		Catalytic	4/17	<0.1
56		Rad Services Inc.	4/18	4.95
57		Rad Services Inc.	4/17	3.59
58		Catalytic	4/16	4.63
59		Catalytic	4/17	<0.1
60		Catalytic	4/17	0.95
61		Westinghouse	4/17	0.70
C		Hydro Nuclear Ser.	4/18	25.5*
62		Catalytic	4/17	0.20
63		Catalytic	4/17	1.13
64		Cooper Heat	4/17	4.59
G		Rad Services Inc.	4/16	14.5*
65		Catalytic	4/18	<0.1
66		Catalytic	4/16	<0.1

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Rev 1

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67		Rad Services Inc.	4/18	2.65
68		Catalytic	4/17	<0.1
69		Catalytic	4/16	1.39
70		Westinghouse	4/16	<0.1
71		Catalytic	4/17	1.02
72		Catalytic	4/17	0.41
73		Combustion Eng.	4/17	0.20
74		Catalytic	4/17	0.20
75		Catalytic	4/17	<0.1
76		Rad Services Inc.	4/17	1.61
77		Westinghouse	4/17	4.12
K		PSE&G	4/17	2.2*
78		PSE&G	4/18	1.68
79		Catalytic	4/20	0.30
80		Catalytic	4/17	1.14
81		Catalytic	4/16	3.34
82		Catalytic	4/17	<0.1
83		PSE&G	4/16	2.73
84		Catalytic	4/17	3.04
85		PSE&G	4/17	0.67
86		Catalytic	4/17	<0.1
87		Catalytic	4/17	0.20
88		Rad Services Inc.	4/18	<0.1
89		Catalytic	4/18	0.61
90		Catalytic	4/18	<0.1
91		Catalytic	4/17	1.32
92		Catalytic	4/17	2.87
93		Catalytic	4/18	<0.1
94		Catalytic	4/18	4.30
95		Catalytic	4/17	3.90
96		Combustion Eng.	4/17	0.20
97		Catalytic	4/17	2.08
98		PSE&G	4/17	2.14

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99		Catalytic	4/18	<0.1
100		Catalytic	4/17	<0.1
101		Rad Services Inc.	4/16	4.67
102		Catalytic	4/15	<0.1
103		Catalytic	4/17	2.59
104		Catalytic	4/18	0.30
105		Rad Services Inc.	4/19	0.17
106		PSE&G	4/17	3.34
H		Catalytic	4/17	10.4*
107		Catalytic	4/17	<0.1
108		Catalytic	4/17	<0.1
109		Combustion Eng.	4/18	<0.1
110		PSE&G	4/17	1.50
111		PSE&G	4/18	<0.1
112		Westinghouse	4/17	1.10
113		Hydro Nuclear Ser.	4/18	1.54
114		Catalytic	4/16	3.28
115		PSE&G	4/18	<0.1
116		Catalytic	4/17	0.20
117		Catalytic	4/18	1.43
118		Catalytic	4/17	0.35
119		Catalytic	4/16	1.67
120		Catalytic	4/18	3.65
121		Catalytic	4/17	<0.1
122		Catalytic	4/17	3.48
123		Catalytic	4/17	0.79

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126		Catalytic	4/18	4.6
127		Catalytic	4/17	2.65
128		Catalytic	4/17	4.16
129		Hydro Nuclear Ser.	4/17	2.67
130		Catalytic	4/17	.2
131		Catalytic	4/17	.3
132		PSE&G	4/17	.93
133		Catalytic	4/17	<0.1
134		Catalytic	4/17	.2
135		Catalytic	4/17	1.19
136		Catalytic	4/19	1.03
137		Catalytic	4/17	<0.1
138		Catalytic	4/17	1.84
139		Catalytic	4/19	1.5
E		Catalytic	4/15	22.9*
J		Catalytic	4/16	2.6*
140		Catalytic	4/15	1.65
141		PSE&G	4/18	1.84
142		Catalytic	4/18	1.7
143		Combustion Eng.	4/18	1
A		Hydro Nuclear Ser.	4/16	43.0*
144		Catalytic	4/17	0.1
L		Westinghouse	4/16	6.5*
145		Rad Services Inc.	4/16	4.15
146		Westinghouse	4/16	2.78
147		PSE&G	4/17	.9
148		Catalytic	4/17	.2
149		PSE&G	4/17	1.5
150		Catalytic	4/19	<0.1
151		Catalytic	4/16	6.49

In accordance with 10 CFR 2.790 the names of individuals and their social security numbers have been removed to avoid an unwarranted invasion of personal privacy.

*Based on Whole Body count Data and formula given in Attachment 2, Part B

Rev.

Attachment 3

Name	SSN	Co.	Initial WBC	MPC-Hrs. (Based on Stay Time)
152		Catalytic	4/17	.2
153		Catalytic	4/17	6.36
154		Rad Services Inc.	4/19	2.57
155		Rad Services Inc.	4/18	.26
156		PSE&G	4/18	2.76
157		PSE&G	4/17	1.35
158		Rad Services Inc.	4/17	.54
159		Catalytic	4/17	<0.1
160		Catalytic	4/17	3.04
161		Catalytic	4/18	1.64
162		Rad Services Inc.	4/18	1.8
163		Rad Services Inc.	4/18	<0.1
164		Catalytic	4/16	4.6
165		Catalytic	4/17	.37
166		Traid		.36
167		Catalytic	4/17	5.56
168		Catalytic	4/17	1.14
169		Catalytic	4/17	2.76
170		Catalytic	4/17	3.11
171		Catalytic	4/18	5.07
172		Catalytic	4/17	.61
173		Catalytic	4/17	1.1
174		Catalytic	4/17	.2
175		Wisco	4/17	1.1
176		Rad Services Inc.	4/17	5.67
177		Catalytic	4/17	1.1
178		Catalytic	4/17	<0.1
F		Rad Services Inc.	4/18	17.9*
179		Catalytic	4/17	.2
B		Hydro Nuclear Ser.	4/16	29.5*
180		Catalytic	4/17	.2
181		Catalytic	4/17	1.06
182		Catalytic	4/17	1.54
183		Catalytic	4/18	3.62
184		Catalytic	4/17	1.12

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*Based on Whole Body Count Data and formula given in Attachment 2, Part B

Name	SSN	Co.	Initial WBC	Assigned MPC-Hrs. (Based on Stay Time)
185		Catalytic	4/17	.73
186		HAP	4/17	4.3
187		Catalytic	4/16	3.02
188		Catalytic	4/17	3.45
189		Catalytic	4/18	.79
190		Catalytic	4/17	1.84
191		Catalytic	4/19	1.8
192		Rad Services Inc.	4/19	.92
193		Catalytic	4/18	3.5
194		HAP	4/17	4.1
195		PSE&G	4/17	1.5
196		Catalytic	4/16	10.73
197		Catalytic	4/17	.37
198		Catalytic	4/17	<0.1
199		PSE&G	4/18	<0.1
200		Rad Services Inc.	4/19	.43
201		Catalytic	4/17	<0.1
202		Bartlett	4/17	.9
203		Catalytic	4/16	.2
204		Catalytic	4/18	1.8
205		Catalytic	4/18	4.73
206		Catalytic	4/17	1.2
207		Catalytic	4/17	<0.1
208		Catalytic	4/17	6.94
209		Rad Services Inc.	4/17	.46
210		Catalytic	4/18	4.31
211		Catalytic	4/17	.46
212		Catalytic	4/18	.2
213		Catalytic	4/18	.2
214		Catalytic	4/18	.2
215		Westinghouse	4/17	1.25
216		Catalytic	4/17	5.29
217		Westinghouse	4/15	3.14
218		Catalytic	4/17	7.4
219		Catalytic	4/17	5.19

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