Carolina Power & Light Company
Brunswick Steam Electric Plant
P. O. Box 10429
Southport, NC 28461

May 27, 1980

FILE: B09-13516.2 SERIAL: BSEP/80-844

Mr. James P. O'Reilly, Director
U. S. Nuclear Regulatory Commission
Region II, Suite 3100
101 Marietta Street N.W.
Atlanta, GA 30303

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 & 2
LICENSE NOS. DPR-71 AND DPR-62
DOCKET NOS. 50-325 AND 50-324
ADDENDUM TO NONROUTINE RADIOLOGICAL REPORT

Dear Mr. O'Reilly:

A letter addressed to you (SERIAL: BSEP/80-691, dated April 22, 1980) discussed an unplanned release of radioactive material from the No. 1 auxiliary boiler on February 22, 1980.

This letter is submitted as an addendum to the referenced report to satisfy the reporting requirements of Environmental Technical Specifications, Section 5.4.2b. The event description, analysis, evaluation, cause of event, and corrective actions were included in the previous report. In addition, this report includes a meteorological and off-site dose assessment of the incident using NRC approved source terms and dose conversion factors. The results of this analysis compare closely with actual sampling of real-dose pathways.

Very truly yours,

A. C. Tollison, Jr., General Manager
Brunswick Steam Electric Plant

JLK/sgb

Enclosure

cc: Director - Nuclear Reactor Regulation

C003
1/1
ADD.
HYDRO-METEOR
BR

AUXILIARY BOILER RELEASE : OFF-SITE DOSE CALCULATIONS

Dose calculations were performed for the following key off-site locations:

1. Orton Plantation - 30° at 11,900 meters
2. Snow's Cut - 39° at 13,607 meters
3. Kure Beach - 65° at 10,824 meters

The following pathways were considered (as per NRC):

1. Inhalation (Child)
2. Ground plane exposure
3. Leafy vegetable ingestion (1/6 Child annual consumption)

The following guidance and assumptions were utilized:

1. Release period = 12 hours
2. Cs^{137} release rate = 1.5×10^{-6} Ci/sec
3. Cs^{134} release rate = 1.23×10^{-6} Ci/sec
4. Inhalation rate = 3700 m^3/yr
5. Cs^{137} external dose factor = 4.20×10^{-9} $\frac{mr/hr}{pCi/m^2}$
6. Cs^{134} external dose factor = 1.20×10^{-8} $\frac{mr/hr}{pCi/m^2}$
7. Leafy vegetable ingestion rate = 26 kg/yr
8. Vegetable productivity = 2.0 kg/m^2
9. Fraction of activity retained on leafy vegetable = 0.25
10. Inhalation dose factors (Child)

Cs^{134}	Cs^{137}
2.74E-4 $\frac{mrem}{pCi}$ (liver)	2.45E-4 $\frac{mrem}{pCi}$ (bone)
6.07E-5 $\frac{mrem}{pCi}$ (whole body)	3.47E-5 $\frac{mrem}{pCi}$ (whole body)

11. Ingestion dose factors (Child)

Cs^{134}	Cs^{137}
3.84E-4 $\frac{mrem}{pCi}$ (liver)	3.27E-4 $\frac{mrem}{pCi}$ (bone)
8.10E-5 $\frac{mrem}{pCi}$ (whole body)	4.62E-5 $\frac{mrem}{pCi}$ (whole body)

X/Q and D/Q Values

Location	X/Q $(\frac{sec}{m^3})$	D/Q (m^{-2})
Orton Plantation	5.36×10^{-6}	7.47×10^{-9}
Snow's Cut	5.66×10^{-6}	7.86×10^{-9}
Kure Beach	3.26×10^{-6}	4.65×10^{-9}

DOSE SUMMARY

1. Inhalation Pathway

Location	Cs^{134} Dose	Cs^{137} Dose
Orton Plantation	9.3×10^{-3}mr (liver)	1.0×10^{-2}mr (bone)
	2.0×10^{-3}mr (whole body)	1.4×10^{-3}mr (whole body)
Snow's Cut	9.5×10^{-3}mr (liver)	1.1×10^{-2}mr (bone)
	2.1×10^{-3}mr (whole body)	1.5×10^{-3}mr (whole body)
Kure Beach	5.7×10^{-3}mr (liver)	6.1×10^{-3}mr (bone)
	1.2×10^{-3}mr (whole body)	8.5×10^{-4}mr (whole body)

2. Ground Plane Pathway

Orton Plantation	4.9×10^{-6} mr/hr	2.0×10^{-6} mr/hr
Snow's Cut	5.0×10^{-6} mr/hr	2.1×10^{-6} mr/hr
Kure Beach	3.0×10^{-6} mr/hr	1.3×10^{-6} mr/hr

3. Leafy Vegetable Ingestion Pathway

Orton Plantation	0.083 mr (liver)	0.086 mr (bone)
	0.017 mr (whole body)	0.012 mr (whole body)
Snow's Cut	0.084 mr (liver)	0.091 mr (bone)
	0.018 mr (whole body)	0.013 mr (whole body)
Kure Beach	0.051 mr (liver)	0.051 mr (bone)
	0.011 mr (whole body)	0.007 mr (whole body)

CP&L
Carolina Power & Light Company
Brunswick Steam Electric Plant
P. O. Box 10429
Southport, NC 28461

April 22, 1980

FILE: B09-13516.2 SERIAL: BSEP/80-691

Mr. James P. O'Reilly, Director
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, Suite 3100
Atlanta, GA 30303

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 & 2
LICENSE NOS. DPR-71 AND DPR-62
DOCKET NOS. 50-325 AND 50-324
30-DAY NONROUTINE RADIOLOGICAL ENVIRONMENTAL EVENT REPORT

Dear Mr. O'Reilly:

Results of two confirmatory environmental terrestrial vegetation samples made available on March 26, 1980, indicated Cs^{137} concentrations of 3.66 and 2.37 pCi/gm wet weight. These samples were obtained near Carolina Beach, North Carolina, as part of a nonroutine, follow-up environmental sampling program following an airborne release of radioactive material from the No. 1 auxiliary boiler on February 22, 1980. Additionally, the quarterly composite air sample obtained from Environmental Sample Station No. 23 indicated a Cs^{137} concentration of 2.68×10^{-2} pCi/meter^3. The Cs^{137} concentrations detected in these samples constitute a 30-day reportable event (effective March 26, 1980) in accordance with the Brunswick Plant Technical Specifications, Appendix B, Section 5.4.2b, pertinent to environmental sampling.

As a result of the auxiliary boiler release, calculations have revealed a maximum release rate of 3.76×10^{-6} Ci/sec. This release rate constitutes a violation of the instantaneous release rate limit specified in Section 2.5.2.a(2) of the Brunswick Plant Technical Specifications, Appendix B.

Additionally, the average release rate from the site for the first quarter of 1980 of I^{131} and particulates with half-lives greater than eight days exceeds the reporting level specified in Section 2.5.2.c(2) of the Brunswick Plant Technical Specifications, Appendix B.

Corrective Actions

1. Both auxiliary boilers were shut down and will not be returned to operation until the following items are accomplished:

   a. Inspection of boilers
   b. Repair of leaks
   c. Decontamination of boilers

2. A temporary package boiler has been installed for interim use.

3. The auxiliary steam and condensate pipes are being flushed and cleaned.

4. Operating procedures have been revised to prohibit operation of the auxiliary steam system with known leakage of radioactivity into the system.

5. Procedures have been revised to eatablish a maximum operating concentration of radioactivity in the auxiliary boilers.

6. A sampling program has been established for radioactivity in the boiler and condensate on at least a daily basis.

7. A radiation monitor will be installed in the auxiliary steam system condensate return to the boilers.

8. Other plant systems are being evaluated to assure there are no unknown potential pathways of radioactivity to the environment.

9. The 20 GPM waste evaporator, a source of leakage to the auxiliary boilers, will not be returned to operation until its integrity is assured.

10. An engineering investigation has been initiated to study means of reducing the potential for auxiliary steam system contamination and unplanned releases from the system.

11. Expanded environmental sampling beyond Technical Specification requirements will be continued on an as-needed basis.

12. This incident will be reviewed by all Operations personnel and included in the operator retraining program.

13. This incident will be reviewed at the next Plant Management Meeting.

A summary of total release rates for the first quarter (including those associated with the auxiliary boiler spill) and environmental sample data is included in an enclosure to this report. Off-site dose projections will be addressed in a future report.

Very truly yours,

A. C. Tollison, Jr., General Manager
Brunswick Steam Electric Plant

JLK/sgb

Enclosures

SUMMARY OF ENCLOSURES

1. Auxiliary Boiler Spill: Chronology of Events
2. Summary of Environmental Sample Results
3. Estimation of Total Auxiliary Boiler Release
4. Summary of 1st Quarter 1980 Releases

1. Auxiliary Boiler Spill: Chronology of Events

Date	Time	Description
2-21-80	All day 2000	#1 boiler operated without incident. Last observation noted for 2-21; boiler operating satisfactorily.
2-22-80	0100	Auxiliary operator noted a light steam wisp from the boiler stack. This was indicative of either a fuel-air mixture or rain in the stack (a light rain was falling at the time).
	0300	Shift Foreman observed the boiler; confirmed the 0100 observation.
	0400	Auxiliary operator noted water dripping from beneath the #1 boiler firebox; a light wisp continued from the stack. A sample of the leaking water was requested.
	0600	1000 dpm of activity was detected on the water leak (dip smear). Steam was observed coming from the stack. The Shift Operating Supervisor instructed the Shift Foreman to shut down the boiler and bleed off pressure with the Containment Atmospheric Control (CAC) vaporizer to inert prior to boiler shutdown.
	0630-0700	Water observed leaking from the drain nipple at the bottom of the stack. Boiler still operating due to problems with the CAC vaporizer (valve frozen). Steam still observed coming from the boiler stack. Shift Operating Supervisor ordered an immediate boiler shutdown.
	0700-0710	Boiler shutdown (fire cut off); steam continued out of the stack until ~0800 when the boilers were cooled.
	1900	BSEP General Manager notified NRC Region II by phone (Mr. Paul Kellogg).
2-22-80-2-24-80		Extensive on-site sampling program conducted for contaminated soil and water associated with the boiler spill.

Date	Time	Description
2-22-80	Afternoon	Filter pulled from air particulate sampler approximately 1000 yds. downwind from the site. Analysis conducted on-site was inconclusive; filter sent to the New Hill lab for analysis.
2-25-80	Afternoon	Filter pulled from the same air sampler and sent to New Hill for analysis.
2-27-80	Afternoon	Analysis of the two filters was completed. The results indicated higher than normal background concentrations; additional samples deemed necessary.
2-28-80	Day	Three terrestrial vegetation (pine needle) samples pulled at 500 yd. intervals from the plant (500, 1000, and 1500 yds) in the downwind direction.
3-4-80	Day	Analysis of the vegetation samples completed. Indicated levels of radionuclides (present in the auxiliary boiler spill) somewhat higher than normal. Additional samples deemed necessary.
3-5-80	Day	Six terrestrial vegetation (pine needle) samples pulled. Two of these samples were repeated from the previous sampling, two were sampled in the 1 - 2 mile downwind distance, and two on Carolina Beach.
3-12-80	Day	Analysis of the vegetation samples was completed. Indicated essentially unchanged activities on the repeat samples and some activity above background on the four new samples. Additional sampling deemed necessary.
3-17-80	Day	Seven terrestrial vegetation (pine needles-broad leaf) samples obtained. Five were obtained on the New Hanover County peninsula between Snow's Cut (north of Carolina Beach) and Kure Beach. Two additional samples were obtained ~1 mile from the site in the upwind direction.
3-26-80	Day(a.m.)	Analysis of the vegetation samples was completed. Analyses indicated some Cs^{137} activity on the peninsula samples (the two northernmost samples showed the highest activity; these levels are reportable by Tech. Specs. (App. B, Section 5.4.2b). The upwind samples showed no Cs^{137} levels above background.

Date	Time	Description
3-26-80	Day	Notifications of the event were made to the NRC Resident Inspector, NRC Region II office, and the North Carolina State Radiological Protection Branch. Additionally, the Brunswick and New Hanover County Civil Preparedness Directors were notified.
3-26-80	Day	An extensive off-site monitoring program was initiated. This consisted of twenty-eight terrestrial vegetation samples in all sectors around the plant (concentrating in the NE direction), seven soil samples, and all of the environmental TLD's.
3-31-80	Day	Analysis of the last set of samples completed. All but four of the vegetation samples were well within normal background levels. The TLD readings were normal.
4-3-80	Day	Ten additional terrestrial vegetation samples were obtained, primarily in the sectors north and west of the site.
4-11-80	Day	CP&L personnel conducted an extensive land use survey on the New Hanover County peninsula to locate any potential real dose pathways and sample available vegetation.
4-14-80	Day	Land use survey completed. Survey indicated several gardens in use at the time of the incident, but very few people actually consumed from these gardens (determined by interview). Dose analyses indicate exposures <0.1 mrem for standard consumption rates.

SUMMARY OF ENVIRONMENTAL SAMPLE RESULTS

A. AIR SAMPLES - 2/22/80 and 2/25/80

The weekly weighted gross beta concentration (2/18-2/25) at the PMAC was .46 pCi/m^3. This compares with the gross beta control station concentration of .0327 pCi/m^3. The principal isotope detected at the PMAC was Cs^{137}.

B. TERRESTRIAL VEGETATION SAMPLES - 2/28/80

TV-1 (500 yds. downwind)

Mn^{54} :3.69 pCi/gm (wet)
Co^{60} :.907 pCi/gm (wet)
I^{131} :.449 pCi/gm (wet)
Cs^{134}:7.80 pCi/gm (wet)
Cs^{137}:9.97 pCi/gm (wet)

TV-3 (1500 yds. downwind)

Mn^{54} :.358 pCi/gm (wet)
Co^{60} :.157 pCi/gm (wet)
Cs^{134}:.735 pCi/gm (wet)
Cs^{137}:.928 pCi/gm (wet)

TV-2 (1000 yds. downwind)

Mn^{54} :.618 pCi/gm (wet)
Co^{60} :.176 pCi/gm (wet)
Cs^{134}:1.24 pCi/gm (wet)
Cs^{137}:2.16 pCi/gm (wet)

C. TERRESTRIAL VEGETATION SAMPLES - 3/5/80

TV-1 (500 yds. NE)

Cr^{51} :2.56 pCi/gm (wet)
Mn^{54} :3.31 pCi/gm (wet)
Co^{60} :.784 pCi/gm (wet)
Cs^{134}:6.07 pCi/gm (wet)
Cs^{137}:8.08 pCi/gm (wet)

TV-2 (1500 yds. NE)

Mn^{54} :.252 pCi/gm (wet)
I^{131} :.0978 pCi/gm (wet)
Cs^{134}:.542 pCi/gm (wet)
Cs^{137}:.703 pCi/gm (wet)

TV-3 (River Road-Walden's Creek 2.1 mi. NE)

Mn^{54} :.439 pCi/gm (wet)
Cs^{134}:.693 pCi/gm (wet)
Cs^{137}:1.23 pCi/gm (wet)

TV-4 (River Road-Intake Canal 1.6 mi. ENE)

Cs^{137}:.071 pCi/gm (wet)

SUMMARY OF ENVIRONMENTAL SAMPLE RESULTS (CONT'D)

C. TERRESTRIAL VEGETATION SAMPLES - 3/5/80 (Cont'd)

TV-5 (Carolina Beach 8.1 mi. NE)

Cs^{137}:.944 pCi/gm (wet)

TV-6 (Carolina Beach 8.1 mi. NE)

Cs^{137}:.556 pCi/gm (wet)

D. TERRESTRIAL VEGETATION SAMPLES - 3/17/80

TV-1 (Snow's Cut 9 mi. NE)

Cs^{137}:3.66 [illegible] pCi/gm (wet)

TV-2 (Carolina Beach State Park 8.5 mi. NE)

Cs^{137}:2.37 pCi/gm (wet)

TV-3 (Carolina Beach 8 mi. NE)

Cs^{137}:2.33 E-1 pCi/gm (wet)

TV-4 (Wilmington Beach 7.5 mi. ENE)

Cs^{137}:4.40 E-2 pCi/gm (wet)

TV-5 (Kure Beach 6 mi. ENE)

Cs^{137}:7.34 E-2 pCi/gm (wet)

TV-6 (Discharge Canal 1 mi. W)

Cs^{137}:<MDA (4.96 E-2 pCi/gm)

TV-7 (Discharge Canal 1 mi. W)

Cs^{137}:4.99 E-2 pCi/gm (wet)

E. ENVIRONMENTAL SAMPLING - 3/26/80

1.	US 421 & NC 132 (14.5 mi. NNE)	: Cs^{137} 3.89 $\pm$ 034E-1 pCi/gm (possible trace of Co^{60})
2.	Myrtle Grove (14.5 mi. NNE)	: Cs^{137} 1.64 $\pm$ 0.23E-1 pCi/gm Co^{60} 7.37 $\mp$ 3.33 E-2 pCi/gm
3.	NC 1100 at Snow's Cut (9 mi. NE)	: Cs^{137} 8.66 $\pm$ 0.35E-1 pCi/gm
4.	NC 1100 (3 mi. north of Snow's Cut) (10.5 mi. NNE)	: Cs^{137} 3.49 $\pm$ 3.02E-2 pCi/gm (trace of Co^{60})
5.	US 421 & NC 1492 (11.3 mi. NE)	: Cs^{137} 1.82 $\pm$ 0.31E-1 pCi/gm Co^{60} 1.24 $\pm$ 0.25E-1 pCi/gm
6.	Wrightsville Beach Road near CP&L Garage (Wilmington ~20 mi. NNE)	: CS^{137} 2.70 $\pm$ 0.32E-1 pCi/gm (trace of Co^{60})

E. ENVIRONMENTAL SAMPLING - 3/26/80 (Cont'd)

7.	NC 133 at Town Creek (12.5 mi. N)	: <MDA	
8.	Env. Station #7 (Olde Brunswick Towne) (7.2 mi. NNE)	: Cs^{137}	3.39 ± 0.24E-1 pCi/gm
9.	Env. Station #16 (River Road At Construction Entrance) (1.1 mi. SE)	: Cs^{137} Co^{60}	2.67 ± 0.19E-1 pCi/gm 5.11 ± 1.49E-2 pCi/gm
10.	Emerg. Env. Station #20 (1.2 mi. WNW)	: Cs^{137} Co^{60}	5.27 ± 0.30E-1 pCi/gm 5.05 ± 2.75E-2 pCi/gm
11.	NC 1100 at Mott Creek (13 mi. NNE)	: Co^{60} Cs^{137}	5.96 ± 1.54E-2 pCi/gm 3.99 ± 0.24E-1 pCi/gm
12.	NC 1573 at Kure Beach (6.3 mi. ENE)	: Co^{60} Cs^{137}	5.92 ± 2.35E-2 pCi/gm 3.35 ± 0.25E-1 pCi/gm
13.	Hugh McRae Park (Wilmington) (~20 mi. NNE)	: Cs^{137} Co^{60}	1.23 ± 0.26E-1 pCi/gm 7.37 ± 3.38E-2 pCi/gm
14.	NC 1573 at Wilmington Beach (7.3 mi. ENE)	: Co^{60} Cs^{137}	7.02 ± 2.80E-2 pCi/gm 5.12 ± 0.29E-1 pCi/gm
15.	Federal Point (4.5 mi. E)	: Co^{60} Cs^{137}	1.07 ± 0.24E-1 pCi/gm 3.77 ± 0.31E-1 pCi/gm
16.	Pretty Pond (8.8 mi. N)	: Co^{60} Cs^{137}	8.98 ± 2.58E-2 pCi/gm 1.44 ± 0.05E+0 pCi/gm
17.	Emerg. Env. Station #24 (1.4 mi. NNE)	: Co^{60} Cs^{137}	7.38 ± 2.47E-2 pCi/gm 8.02 ± 3.02E-2 pCi/gm
18.	Emerg. Env. Station #22 (1.2 mi. NNW)	: Cs^{137}	1.92 ± 0.18 pCi/gm
19.	Emerg. Env. Station #40 (2.5 mi. N)	: Co^{60} Cs^{137}	2.04 ± 0.17E-1 pCi/gm 1.04 ± 0.04E+0 pCi/gm
20.	Emerg. Env. Station #39 (3.5 mi. NNW)	: Co^{60} Cs^{137}	1.01 ± 0.20E-1 pCi/gm 1.27 ± 0.16E-1 pCi/gm
21.	Env. Station #14 (River Road) (1.3 mi. ESE)	: Co^{60} Cs^{137}	8.75 ± 2.68E-2 pCi/gm 3.16 ± 0.27E-1 pCi/gm

SUMMARY OF ENVIRONMENTAL SAMPLE RESULTS (cont'd)

E. ENVIRONMENTAL SAMPLING - 3/26/80 (cont'd)

22.	Env. Station #11 (E. end of Bethel Church Road) (1.6 mi. NNE)	: Co^{60}	5.68 ± 3.37E-2 pCi/gm
		Cs^{137}	2.24 ± 0.31E-1 pCi/gm
23.	NC 1573 & Carolina Beach (8 mi. NE)	: Co^{60}	1.04 ± 0.22E-1 pCi/gm
		Cs^{137}	1.48 ± 0.04E+0 pCi/gm
24.	Jabbertown Road (1.3 mi. SSW)	: Cs^{137}	1.04 ± 0.23E-1 pCi/gm
		Co^{60}	7.23 ± 2.04E-2 pCi/gm
25.	River Road & Intake Canal (1.6 mi. ENE)	: Cs^{137}	1.19 ± 0.28E-1 pCi/gm
		Co^{60}	4.27 ± 1.96E-2 pCi/gm
26.	Emerg. Env. Station #41 (2.4 mi. NNE)	: Cs^{137}	1.28 ± 0.21E-1 pCi/gm
		Co^{60}	1.25 ± 0.19E-1 pCi/gm
27.	Emerg. Env. Station #42 (2.5 mi. NE)	: Cs^{137}	9.89 ± 2.03E-2 pCi/gm
		Co^{60}	8.47 ± 2.00E-2 pCi/gm
28.	Emerg. Env. Station #43 (2.7 mi. ENE)	: Cs^{137}	2.60 ± .30E-1 pCi/gm
		Cs^{134}	8.66 ± 3.19E-2 pCi/gm
		Mn^{54}	5.78 ± 1.78E-2 pCi/gm
		Co^{60}	4.44 ± 3.51E-2 pCi/gm

SOIL SAMPLES (pCi/gm dry)

1.	Pretty Pond	: Cs^{137}	1.80E-1 pCi/gm
2.	Env. Mon. Station #7	: Cs^{137}	1.53E-1 pCi/gm
3.	Env. Mon. Station #11	: Cs^{137}	7.77E-2 pCi/gm
4.	Federal Point	: Cs^{137}	6.23E-2 pCi/gm
5.	River Road at Discharge Canal	: <MDA (Cs^{137} : 2.80E-2 pCi/gm MDA)	
6.	SR 1100 at Snow's Cut	: Cs^{137}	4.43E-1 pCi/gm
7.	Emerg. Env. Station #20	: Cs^{137}	1.94E-1 pCi/gm

SUMMARY OF ENVIRONMENTAL SAMPLE RESULTS (CONT'D)

F. TERRESTRIAL VEGETATION SAMPLES - 4/1/80-4/4/80

1. Camp Pretty Pond : Cs^{137} 2.44E-1 pCi/gm (wet)
2. US 17 and NC 87 (Bell Swamp) : Cs^{137} 2.76E-2 pCi/gm (wet)
3. US 17 at Lanvale Rd. : Co^{60} 7.85E-2 pCi/gm (wet)
   Cs^{137} 8.16E-2 pCi/gm (wet)
4. NC 133 NE of Boiling Spring Lakes : Cs^{137} 5.04E-1 pCi/gm (wet)
5. NC 87 at Emer. Station #61: Co^{60} 4.40E-2 pCi/gm (wet)
   Cs^{137} 5.41E-2 pCi/gm (wet)
6. NC 1500 at Emergency Station #62 : Cs^{137} 6.61E-1 pCi/gm (wet)
7. NC 211 and NC 1112 at Emergency Station #63 : Cs^{137} 5.98E-2 pCi/gm (wet)
8. Sunset Harbor near Emergency Station #50 : Co^{60} 6.49E-2 pCi/gm (wet)
   Cs^{137} 2.32E-1 pCi/gm (wet)
9. Long Beach near Emergency Station #52 : Cs^{137} 2.31E-1 pCi/gm (wet)
10. Ward's Corner on US 421 : All nuclides <MDA

G. TERRESTRIAL VEGETATION - FOOD CROP SAMPLES - 4/11/80

1. 500 Yds. NE from Plant (Terrestrial Vegetation)

   Cr^{51} 1.41×10^{0} pCi/gm (wet)
   Mn^{54} 3.63×10^{0} pCi/gm (wet)
   Co^{58} 1.59×10^{-1} pCi/gm (wet)
   Co^{60} 1.26×10^{0} pCi/gm (wet)
   Cs^{134} 4.47×10^{0} pCi/gm (wet)
   Cs^{137} 6.23×10^{0} pCi/gm (wet)

2. Mustard Greens at Kure Beach - All radionuclides <MDA

G. TERRESTRIAL VEGETATION - FOOD CROP SAMPLES - 4/11/80

3. Collard Greens at Kure Beach
   Cs^{137} 3.26×10^{-2} pCi/gm (washed)

4. Carolina Beach (Terrestrial Vegetation)
   Cs^{137} 7.14×10^{-1} pCi/gm (wet)

5. Carolina Beach (Soil)
   Cs^{137} 2.37×10^{-1} pCi/gm (dry)

6. Snow's Cut (Terrestrial Vegetation)
   Cs^{137} 7.50×10^{-2} pCi/gm (wet)

7. Snow's Cut (Soil)
   Cs^{134} 2.88×10^{-2} pCi/gm (dry)
   Cs^{137} 2.15×10^{-1} pCi/gm (dry)

8. Emergency Station #40 (Terrestrial Vegetation)
   Cs^{137} 2.19×10^{0} pCi/gm (wet)

9. Emergency Station #42 (Terrestrial Vegetation)
   Cs^{137} <MDA

10. Jones's Farm (Fodder)
    Cs^{137} 2.90×10^{-2} pCi/gm (wet)

11. Jones's Farm (Soil)
    Cs^{137} 3.54×10^{-1} pCi/gm (wet)

12. Freeman's Market - Carolina Beach Road (Collard Greens)
    Cs^{137} 3.22×10^{-2} pCi/gm (washed)

13. Carolina Beach (Collard Greens)
    All radionuclides <MDA

ESTIMATION OF AUXILIARY BOILER RELEASE (2/22/80)

I. ACTIVITY BASIS - No. 1 MUD Drum Analyais of 1/24/80

Cr^{51} : 1.83E-3 μCi/ml
Mn^{54} : 2.52E-4 μCi/ml
Co^{58} : 2.58E-5 μCi/ml
Co^{60} : 3.08E-4 μCi/ml
I^{131} : 1.17E-3 μCi/ml
Cs^{134} : 4.22E-3 μCi/ml
Cs^{137} : 5.14E-3 μCi/ml

II. LEAK TIME ESTIMATE

The last "normal" observed auxiliary boiler operation was ~2000 hours on 2/21/80. The boiler was shut down and steaming ceased by 0800 hours on 2/22/80. Conservatively assuming the leak began at 2000 on 2/21/80, a total leak time of 12 hours is estimated.

III. LEAK RATE ESTIMATE

Following the incident, inspection of the No. 1 boiler uncovered a pinhole tube leak of approximately 1/8" diameter. By examining the shape and "texture" of the leak site, it appears that the inner tube wall was gradually eroded away by steam until an actual perforation of the tube occurred (see attached drawings). The smoothness around the leak site indicates the steam gradually caused the pinhole to enlarge and "smooth-out" to its final size and shape.

To best model this phenomenon, it is conservatively assumed that at 2000 hours on 2/21/80, the outer tube wall was penetrated by the steam. The leak continued to enlarge until boiler shutdown (~0800 hours on 2/22/80), when the leak reached its final size. For the 12 hour period, it is postulated that the leak rate increased linearly. By engineering calculation (for the operating conditions of the boiler), the maximum leak rate for an 1/8" diameter hole is 4.6 gpm. The following table shows the predicted leak rate as a function of time.

Time (hours)	Leak Rate (gpm)
0 (start of leak)	0
1	0.38
2	0.77
3	1.15
4	1.53
5	1.92
6	2.3
7	2.68
8	3.07
9	3.45
10	3.83
11	4.21
12 (end of leak)	4.60

A SUMMARY OF ISOTOPIC RELEASE RATES AS A FUNCTION OF TIME

Time (Hrs)	0	1	2	3	4	5	6	7	8	9	10	11	12
Isotopes	Release Rates (μCi/Sec)												
Cr^{51}	0	4.43E-2	8.86E-2	1.33E-1	1.77E-1	2.22E-1	2.66E-1	3.10E-1	3.55E-1	3.99E-1	4.43E-1	4.88E-1	5.32E-1
Mn^{54}	0	6.11E-3	1.22E-2	1.83E-2	2.44E-2	3.05E-2	3.67E-2	4.28E-2	4.89E-2	5.50E-2	6.11E-2	6.72E-2	7.33E-2
Co^{58}	0	6.25E-4	1.25E-3	1.88E-3	2.50E-3	3.13E-3	3.75E-3	4.38E-3	5.00E-3	5.63E-3	6.25E-3	6.88E-3	7.50E-3
Co^{60}	0	7.47E-3	1.49E-2	2.24E-2	2.99E-2	3.73E-2	4.48E-2	5.23E-2	5.97E-2	6.72E-2	7.47E-2	8.21E-2	8.96E-2
I^{131}	0	2.83E-2	5.67E-2	8.50E-2	1.13E-1	1.42E-1	1.70E-1	1.98E-1	2.27E-1	2.55E-1	2.83E-1	3.12E-1	3.40E-1
Cs^{134}	0	1.03E-1	2.05E-1	3.08E-1	4.10E-1	5.13E-1	6.15E-1	7.18E-1	8.20E-1	9.23E-1	1.03E+0	1.13E+0	1.23E+0
Cs^{137}	0	1.24E-1	2.48E-1	3.73E-1	4.97E-1	6.21E-1	7.45E-1	8.69E-1	9.93E-1	1.12E+0	1.24E+0	1.37E+0	1.49E+0
TOTAL	0	3.13E-1	6.27E-1	9.40E-1	1.25E+0	1.57E+0	1.88E+0	2.19E+0	2.51E+0	2.82E+0	3.13E+0	3.45E+0	3.76E+0

ESTIMATION OF AUXILIARY BOILER RELEASE (2/22/80) (CONT'D)

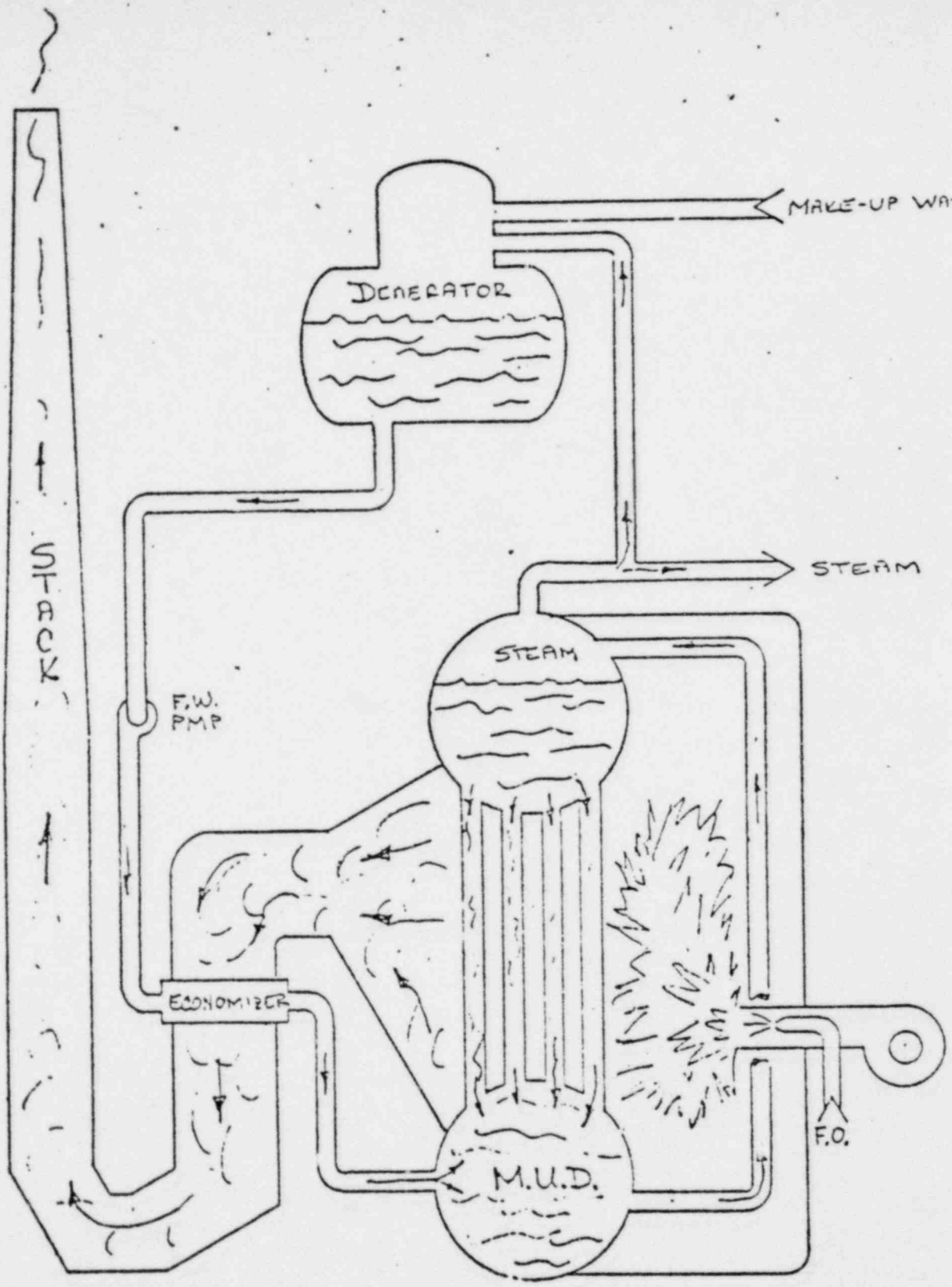
IV. TOTAL ACTIVITY LEAKED

Average release rate : 1.88 μCi/sec
(Based on 12 hr. linear average)

$$(1.88\ \mu Ci/sec)\ (\frac{3600\ sec}{hr})\ (12\ hr)\ (\frac{1\ mCi}{10^3\ \mu Ci}) = 81.2\ mCi$$

On an isotpoic basis:

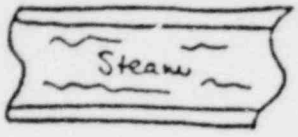
Cr^{51} : 11.5 mCi
Mn^{54} : 1.58 mCi
Co^{58} : 0.16 mCi
Co^{60} : 1.94 mCi
I^{131} : 7.34 mCi
Cs^{134} : 26.6 mCi
Cs^{137} : 32.2 mCi

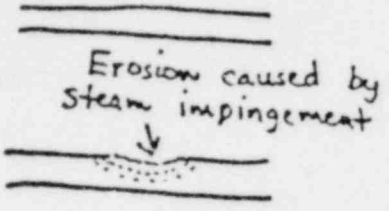


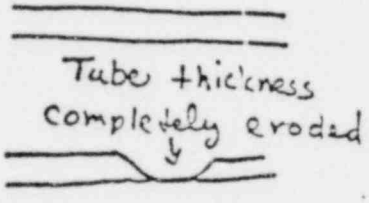
AUX. BOILER

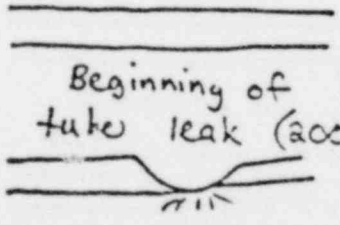
SAE
4-11-80

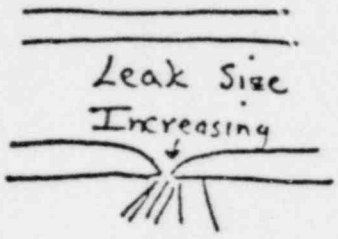
CHRONOLOGY OF TUBE LEAK

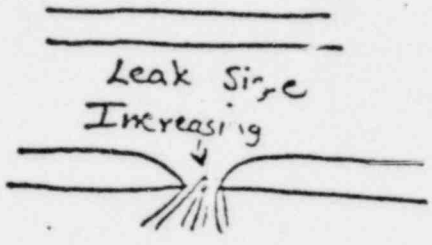
① 

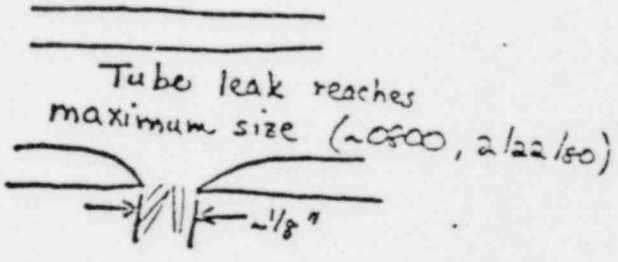
② 

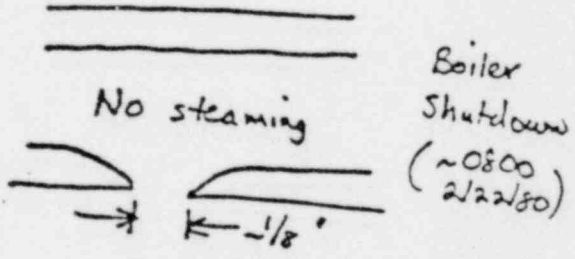
③ 

④ 

⑤ 

⑥ 

⑦ 

⑧ 

RELEASE RATE OF I^{131} AND PARTICULATES

FIRST QUARTER 1980

WEEK	STACK ($\frac{Ci}{sec}$)	ALL VENTS ($\frac{Ci}{sec}$)	WEEKLY % CONCENTRATIONS TO QUARTERLY LIMIT
1/1-1/7	6.65E-8	3.83E-8	12.69
1/7-1/14	3.56E-8	2.98E-8	9.47
1/14-1/21	1.75E-8	5.51E-9	2.02
1/21-1/28	1.04E-8	6.71E-9	2.19
1/28-2/4	9.08E-9	5.85E-9	1.91
2/4-2/11	4.90E-8	1.27E-8	4.88
2/11-2/18	2.03E-7	5.11E-8	19.79
2/18-2/25	3.20E-8	1.47E-7	43.09*
2/25-3/3	1.42E-8	7.02E-9	2.38
3/3-3/10	6.44E-9	3.15E-9	1.07
3/10-3/17	2.25E-9	4.09E-9	1.23
3/17-3/24	1.59E-9	4.90E-9	1.45
3/24-3/31	1.12E-9	4.52E-9	1.33
AVERAGE	3.45E-8	2.47E-8	103.5%

*Approximately 92% of this amount was a result of the No. 1 Auxiliary Boiler leak of 2/22/80.