TENNESSEE VALLEY AUTHORITY

DIVISION OF NUCLEAR POWER

SEQUOYAH NUCLEAR PLANT

MONTHLY OPERATING REPORT

JUNE 1, 1981 -JUNE 30, 1981

UNIT 1

DOCKET NUMBER 50-327

LICENSE NUMBER DPR-77

UNIT 2

DOCKET NUMBER 50-328

LICENSE NUMBER DPR-79

Submitted By: _____
Plant Superintendent

TABLE OF CONTENTS

Operations Summary

June, 1981

The following summary describes the significant operational activities for the month of June. In support of this summary, a chronological log of significant events is included in this report.

Unit 1 was critical for 430.6 hours, produced 441,880 MWH (gross) with 3.86 percent station use, resulting in an average hourly gross load of 1,072,568 KW during the month. The net heat rate for the month was 10,700 BTU/KWH. There are 211.35 full power days estimated remaining until the end of cycle 1 fuel. With a capacity factor of 85 percent the target EOC exposure would be reached May 22, 1982. The capacity factor for the month was 52.3 percent.

There was one scram during June.

Unit 1

At 001 hrs. on June 1 the reactor was in mode 3. The reactor was taken critical at 2014 hrs. on June 4 and tied on line at 2218 hrs. At 2206 hrs. on June 5 the reactor obtained 100% power producing 1132 mw(e). At 2307 hrs. on June 19 the load was dropped to 50% for the load rejection test (Start Up Test 9.3). At 2339 hrs. a load reduction was started to bring the unit off line for outage maintenance items and preoperational test W-6.1F. The turbine was tripped at 0057 hrs. June 20 and the unit entered mode 3 at 0145 hrs. At 1620 hrs. on June 20 the reactor entered mode 5. Reactor heatup was begun on June 25 at 1745 hrs. The reactor was taken critical at 0858 hrs. on June 27, and was tied on the line at 0038 hrs. June 28. One-hundred percent power was obtained at 2150 hrs. on June 30, 0146 hrs., the reactor tripped (Reactor trip #15) when main steam intercept valve 1-FCV-1-22 closed while the unit operator was attempting to open the valve by the hand switch on the control bench board. The valve closing caused a Lo-Lo steam generator level in the #3 steam generator and the reactor trip. At 2359 hrs. on June 30 the reactor was in mode 3.

Unit 2

Pre-fuel loading preoperational testing continued during the month. Unit 2 was issued at 5% power operation license on June 26. Preoperational test W-6.1F, Integrated Safety Injection Test, was performed during June.

PORV's and Safety Valves Summary

No PORV's or safety valves were challenged during the month.

Licensee Events and Special Reports

The following Licensee Event Reports (LER's) were sent during June, 1981, to the Assistant Director of Nuclear Power (Operations) for reporting to the Nuclear Regulatory Commission.

Licensee Events and Special Reports (Cont.)

SQRO-50-327/80209	No post maintenance testing performed on 1-FCV-70-156.
SQRO-50-327/81054	Chlorine analyzer 43-205A was declared inoperable twice after channel checks indicated electrolyte drip rate.
SQRO-50-327/81056	'A' train of ABGTS declared inoperable when fan bearing overheated.
SQRO-50-327/81057	Rad monitor 0-RM-90-212 declared inoperable when monitor failed to source check.
SQRO-50-327/81058	S/G Level Channel 1-L-3-38 Lo-Lo level bistable setpoints for reactor trip and safety features actuation below limits.
SQRO-50-327/81059	ABGT declared inoperable because railroad door to cask loading area was open without personnel present to close door if necessary.
SQRO-50-327/81060	'A' condensate storage tank level transmitter 0-LT-2-230 inoperable due to broken compression union.
SQRO-50-327/81061	RHR miniflow valve, 1-FCV-74-12, inoperable due to hypoid gear cocked on drive sleeve.
SQRO-50-327/81062	Turbine driven AFW PMP failed to deliver full flow due to speed control setpoint drift.
SQRO-50-327/81063	Containment hydrogen analyzer 1-43-210 found out of tolerance due to reagent air misadjustment.
SQRO-50-327/81064	Lower containment rad monitor 1-RM-90-106 inoperable when sample pump breaker tripped.
SQRO-50-327/81065	Turbine building sump discharge rad monitor 0-RM-90-212 inoperable due to broken sample pump motor.

The following special reports were sent during June 1981, to the Assistant Director of Nuclear Power (Operations) for reporting to the Nuclear Regulatory Commission.

Special Report Number	Subject
81-4	Safety injection on May 31, 1981.
81-5	Fire door inoperable for more than 7 days.

Offsite Dose Calculation Manual Changes

Changes in the Sequoyah Nuclear Plant ODCM are described in this section in accordance with Sequoyah Technical Specification 6.1.14.

Changes 1 through 7 were officially approved by the RARC on June 11, 1981.

See Appendix A at the end of this report for the approved ODCM changes.

Change 1

Description of Change

Section 2.3.2, Monthly Analysis, has been revised to reflect the use of 11 nuclides rather than 5 nuclides and a typographical error was corrected.

Analysis or Evaluation Justifying Change

ODCM as changed more accurately reflects nuclides being released from plant. Nuclides that were added had previously been evaluated on a quarterly basis rather than a monthly basis. Change is considered to be conservative as nuclides will be looked at more frequently.

Evaluation of Accuracy of Dose Calculations or Setpoint Determinations

Accuracy of dose calculation on a monthly basis is improved by change.

Change 2

Description of Change

Section 2.3.2.1, Water Ingestion, has been revised to reflect the use of 11 nuclides rather than 5.

Analysis or Evaluation Justifying Change

See Change 1.

Evaluation of Accuracy of Dose Calculations or Setpoint Determinations

See Change 1.

Change 3

Description of Change

Section 2.3.2.2, Fish Ingestion, has been revised to reflect the use of 11 nuclides rather than 5.

Analysis or Evaluation Justifying Change

See Change 1.

Evaluation of Accuracy of Dose Calculations or Setpoint Determinations

See Change 1.

Change 4

Description of Change

Added new column to Table 2.1, "Fish-Biological Half-Life (Days)".

Analysis or Evaluation Justifying Change

Added data to table.

Evaluation of Accuracy of Dose Calculations or Setpoint Determinations

Not applicable.

Change 5

Description of Change

Section 1.2.1, Noble Gases, has been revised to reflect the addition of Xe-131m and Xe-135 and to change the fraction of assumed dose contribution.

Analysis or Evaluation Justifying Change

ODCM as changed more accurately reflects nuclides being released from plant.

Evaluation of Accuracy of Dose Calculations or Setpoint Determinations

Accuracy of dose calculation is improved by change.

Change 6

Description of Change

Section 1.2.2, Iodine and Particulates, has been changed to revise assumptions used and to clarify equations.

Analysis or Evaluation Justifying Change

ODCM as changed more accurately reflects doses for Iodines and Particulates.

Evaluation of Accuracy of Dose Calculations or Setpoint Determinations

See Change 5.

Offsite Dose Calculation Manual Changes (Cont.)

Change 7

Description of Change

Liver added to Table 2.1 as an organ of interest.

Analysis or Evaluation Justifying Change

Change reflects the consideration of the liver as a critical organ for certain isotopes.

Evaluation of Accuracy of Dose Calculations or Setpoint Determinations

Accuracy of dose calculations not affected.

Significant Operational Events

Unit 1

Date	Time	Event
06/01/81	0001	Reactor in mode 3.
06/04/81	2014	Reactor critical.
	2218	Unit 1 tied on line.
06/05/81	2206	Reactor at 100% RTP, 1132 mw(e)
06/19/81	2307	50% load drop - Start-up test 9.3
06/20/81	0057	Turbine Tripped - Unit manually shutdown for outage items maintenance and Preoperational Test W-6.1F.
	0145	Reactor in mode 3.
	1620	Reactor in mode 5.
06/25/81	1745	Reactor in mode 4 - Heatup began.
06/27/81	0858	Reactor critical.
06/28/81	0038	Unit tied on line.
	2150	Reactor at 100% RTP.
06/30/81	0146	Reactor Trip #15 - MSIV 1-FCV-1-22 closed creating a Lo-Lo steam generator level in #3 steam generator thus the reactor trip.
	2359	Reactor in mode 3.

OPERATING DATA REPORT

DOCKET NO. 50-327
DATE 7/8/81
COMPLETED BY David Dupree
TELEPHONE (615) 842-0295

OPERATING STATUS

1. Unit Name: Sequoyah One
2. Reporting Period: June
3. Licensed Thermal Power (MWt): 3411
4. Nameplate Rating (Gross MWe): 1220.58
5. Design Electrical Rating (Net MWe): 1128
6. Maximum Dependable Capacity (Gross MWe): 1163
7. Maximum Dependable Capacity (Net MWe): 1128
8. If Changes Occur in Capacity Ratings (Items Number 3 Through 7) Since Last Report, Give Reasons:
Unit derated due to turbine not meeting design specifications.
9. Power Level To Which Restricted, If Any (Net MWe):
10. Reasons For Restrictions, If Any:

Notes

		This Month	Yr-to-Date	Cumulative
11.	Hours in Reporting Period	720	4343	11688
12.	Number of Hours Reactor Was Critical	430.7	2481.5	4020.1
13.	Reactor Reserve Shutdown Hours	0	0	0
14.	Hours Generator On-Line	412	2295.7	3139.7
15.	Unit Reserve Shutdown Hours	0	0	0
16.	Gross Thermal Energy Generated (MWH)	1,323,863.5	6,976,933.5	8,648,963
17.	Gross Electrical Energy Generated (MWH)	441,880	2,368,033	2,925,354
18.	Net Electrical Energy Generated (MWH)	424,818	2,260,947	2,779,787
19.	Unit Service Factor	57.2	52.9	26.9
20.	Unit Availability Factor	57.2	52.9	26.9
21.	Unit Capacity Factor (Using MDC Net)	52.3	46.2	21.1
22.	Unit Capacity Factor (Using DER Net)	52.3	46.2	21.1
23.	Unit Forced Outage Rate	42.8	47.1	73.1

24. Shutdowns Scheduled Over Next 6 Months (Type, Date, and Duration of Each):
September, 1981 - Tech Spec required ice weighing
25. If Shut Down At End Of Report Period, Estimated Date of Startup: July 1, 1981
26. Units In Test Status (Prior to Commercial Operation):

	Forecast	Achieved
INITIAL CRITICALITY	7/4/80	7/5/80
INITIAL ELECTRICITY	8/21/80	7/22/80
COMMERCIAL OPERATION	5/1/80	7/1/81

(9/77)

AVERAGE DAILY UNIT POWER LEVEL

DOCKET NO. 50-327
UNIT Sequoyah One
DATE 7/8/81
COMPLETED BY David Dupree
TELEPHONE (615) 842-0295

MONTH June

DAY	AVERAGE DAILY POWER LEVEL (MWe-Net)	DAY	AVERAGE DAILY POWER LEVEL (MWe-Net)
1	0	17	1090
2	0	18	1081
3	0	19	1077
4	0	20	0
5	726	21	0
6	1115	22	0
7	1116	23	0
8	1116	24	0
9	1119	25	0
10	1108	26	0
11	1083	27	0
12	1069	28	1094
13	1112	29	1116
14	1103	30	0
15	1104	31	N/A
16	1093		

INSTRUCTIONS

On this format, list the average daily unit power level in MWe-Net for each day in the reporting month. Compute to the nearest whole megawatt.

(9/77)

UNIT SHUTDOWNS AND POWER REDUCTIONS

DOCKET NO. 50-327
UNIT NAME Sequoyah One
DATE 7/8/81
COMPLETED BY David Dupree
TELEPHONE (615) 842-0295

REPORT MONTH June

No.	Date	Type[1]	Duration (Hours)	Reason[2]	Method of Shutting Down Reactor[3]	Licensee Event Report #	System Code[4]	Component Code[5]	Cause & Corrective Action to Prevent Recurrence
15	81/05/31	F	94.3	G	4				Radio interference caused transmitters to the pressurizer level to oscillate causing the reactor to trip, (Reactor Trip #81-14).
16	81/06/20	S	1.83	B	5				Fifty percent load rejection test. Manual reduction for integrated safety injection test.
16	81/06/21	S	191.5	B	1				Manual shutdown for integrated safety injection test.
17	81/06/30	F	22.2	A	3				A MSIV closed which caused a Lo-Lo S/G level causing the Rx to trip (#81-15).

1
F: Forced
S: Scheduled

2
Reason:
A-Equipment Failure (Explain)
B-Maintenance or Test
C-Refueling
D-Regulatory Restriction
E-Operator Training & License Examination
F-Administrative
G-Operational Error (Explain)
H-Other (Explain)

3
Method:
1-Manual
2-Manual Scram.
3-Automatic Scram.
4-Cont. of Existing Outage
5-Reduction
9-Other

4
Exhibit G-Instructions for Preparation of Data Entry Sheets for Licensee Event Report (LER) File (NUREG-0161)

5
Exhibit I-Same Source

(9/77)

OPERATING DATA REPORT

DOCKET NO. 50-328
DATE 7/8/81
COMPLETED BY David Dupree
TELEPHONE (615) 842-0295

OPERATING STATUS

1. Unit Name: Sequoyah Two
2. Reporting Period: June
3. Licensed Thermal Power (MWt): 3411
4. Nameplate Rating (Gross MWe): 1220.58
5. Design Electrical Rating (Net MWe): 1148
6. Maximum Dependable Capacity (Gross MWe): 1183
7. Maximum Dependable Capacity (Net MWe): 1148
8. If Changes Occur in Capacity Ratings (Items Number 3 Through 7) Since Last Report, Give Reasons:

Notes

9. Power Level To Which Restricted, If Any (Net MWe): Five percent power
10. Reasons For Restrictions, If Any: Low power license (5%) granted by the NRC for start-up and low power testing.

	This Month	Yr-to-Date	Cumulative
11. Hours in Reporting Period	N/A	N/A	N/A
12. Number of Hours Reactor Was Critical	N/A	N/A	N/A
13. Reactor Reserve Shutdown Hours	N/A	N/A	N/A
14. Hours Generator On-Line	N/A	N/A	N/A
15. Unit Reserve Shutdown Hours	N/A	N/A	N/A
16. Gross Thermal Energy Generated (MWH)	N/A	N/A	N/A
17. Gross Electrical Energy Generated (MWH)	N/A	N/A	N/A
18. Net Electrical Energy Generated (MWH)	N/A	N/A	N/A
19. Unit Service Factor	N/A	N/A	N/A
20. Unit Availability Factor	N/A	N/A	N/A
21. Unit Capacity Factor (Using MDC Net)	N/A	N/A	N/A
22. Unit Capacity Factor (Using DER Net)	N/A	N/A	N/A
23. Unit Forced Outage Rate	N/A	N/A	N/A

24. Shutdowns Scheduled Over Next 6 Months (Type, Date, and Duration of Each):

25. If Shut Down At End Of Report Period, Estimated Date of Startup: N/A
26. Units In Test Status (Prior to Commercial Operation):

	Forecast	Achieved
INITIAL CRITICALITY	8/5/81	N/A
INITIAL ELECTRICITY	9/5/81	N/A
COMMERCIAL OPERATION	12/5/81	N/A

(9/77)

AVERAGE DAILY UNIT POWER LEVEL

DOCKET NO. 50/328
UNIT Sequoyah Two
DATE 7/8/81
COMPLETED BY David Dupree
TELEPHONE (615) 842-0295

MONTH June

DAY	AVERAGE DAILY POWER LEVEL (MWe-Net)	DAY	AVERAGE DAILY POWER LEVEL (MWe-Net)
1	0	17	0
2	0	18	0
3	0	19	0
4	0	20	0
5	0	21	0
6	0	22	0
7	0	23	0
8	0	24	0
9	0	25	0
10	0	26	0
11	0	27	0
12	0	28	0
13	0	29	0
14	0	30	0
15	0	31	N/A
16	0		

INSTRUCTIONS

On this format, list the average daily unit power level in MWe-Net for each day in the reporting month. Compute to the nearest whole megawatt.

(9/77)

UNIT SHUTDOWNS AND POWER REDUCTIONS

DOCKET NO. 50-328
UNIT NAME Sequoyah Two
DATE 7/7/81
COMPLETED BY David Dupree
TELEPHONE (615) 842-0295

REPORT MONTH June

No.	Date	Type[1]	Duration (Hours)	Reason[2]	Method of Shutting Down Reactor[3]	Licensee Event Report #	System Code[4]	Component Code[5]	Cause & Corrective Action to Prevent Recurrence
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A Unit was given a 5% R.T.P. license on June 26, 1981.

1
F: Forced
S: Scheduled

2
Reason:
A-Equipment Failure (Explain)
B-Maintenance or Test
C-Refueling
D-Regulatory Restriction
E-Operator Training & License Examination
F-Administrative
G-Operational Error (Explain)
H-Other (Explain)

3
Method:
1-Manual
2-Manual Scram.
3-Automatic Scram.
4-Cont. of Existing Outage
5-Reduction
9-Other

4
Exhibit G-Instructions for Preparation of Data Entry Sheets for Licensee Event Report (LER) File (NUREG-0161)

5
Exhibit I-Same Source

(9/77)

Plant Maintenance Summary

The following significant maintenance items were completed during the month of June, 1981:

Mechanical Maintenance

1. Plugged five tubes in the Unit 1 excess letdown heat exchanger.
2. Adjusted a loose stem nut on 1-PCV-62-73.
3. Replaced the internals of 1-FCV-62-54.
4. Staking the "C" component cooling water heat exchange was completed.
5. Rebuilt the 2A-A and 2B-B centrifugal charging pumps.
6. Rebuilt the "I" Glycol chiller compressor.

Electrical Maintenance

1. Inspected the SMB-4 Limitorque operators for 4140 keys.
2. The unit 2 polar crane trolley motor regulator was setup for proper trolley operation.
3. Replaced the hand switch contact blocks on the main steam isolation valve 1-FCV-1-22.
4. Adjusted the base adjuster follower on main generator voltage regulator.

Instrument Maintenance

No instrument maintenance performed during the month.

Outage Maintenance

Unit 1

1. Modifications were completed on hangers H10-628, -687, and -328.
2. Work continued to eliminate hanger problems per IE Bulletin 79-14. Eighty-five repairs remain to be completed.
3. Repairs were completed on letdown safety relief valve 1-RV-62-662.
4. Modificaion was completed on hangers 1-CVCH-338, 1-CVCH-341, and 47A051-161.
5. Environmentally qualified train B solenoids were installed on containment vacuum relief valves 1-FSV-30-46B, -47B, and -48B.

Unit 2

1. Completed the modifications to the fuel transfer system wafer valve.

2. Completed the modifications of the purge air valves that allow the valves to operate at 50% travel instead of 90% travel.

3. Installed inspection ports in the three CVCS letdown flow orifices.

4. The preservice inspections of the 1/4, 1/2, and 1 inch snubbers are complete.

5. Completed the installation of the pump on the reactor coolant drain tank 2A.

6. Replaced the motor on the control rod drive mechanism 2C-A.

7. Completed various modifications to the manipulator crane.

8. The following was completed in preparation for fuel loading:

   A. Replaced the hold down rings.

   B. Installed flange protector rings.

   C. NDT tested the reactor vessel nozzles.

   D. Cleaned the cavity and vessel.

   E. Radiographed welds on the CRDM housing at the RPV head.

   F. Flushed and borescoped the upper internals.

   G. Installed the drive rods.

   H. Repaired and tested the cold leg safety injection check valves.

Unit 0 or Items Affecting Unit 1 and 2

1. Coating exposed surfaces of cable with flamastic in areas outside containment continued during the month.

2. To satisfy footcandle level deficiencies additonal permanent yard security lighting fixtures were installed.

3. Work continued to modify the Public Safety Services repeater system.

4. Security access screens were installed on the exhaust fan housings of the auxiliary building and diesel generator building.

5. Fire detectors have been installed above each ERCW pump.

Outage Maintenance (Cont.)

6. Repairs continue on ventilation dampers to reduce air inleakage.

7. Overload heaters have been installed in the spare compartments on the safety related 480V boards.

8. Work was completed to eliminate tube bundle vibration in the "C" component cooling heat exchanger.

9. An isolation valve was installed in the 6" high pressure fire protection standpipe on elevation 714 AB to allow another section of the fire protection system to be changed out without affecting rest of the systems.

APPENDIX A

DOCUMENTATION FOR ODCM CHANGES

For example, for 2 release points and minimum dilution flow this becomes,

$$f_1\left[\left(\frac{S}{C_1}\times R_1\right)-1\right]+f_2\left[\left(\frac{S}{C_2}\times R_2\right)-1\right]<15{,}000 \qquad (2.10)$$

2.2.2 Post-Release Analysis

A post-release analysis will be done using actual release data to ensure that the limits specified in Section 2.1.1 were not exceeded.

A composite list of concentration (C_i), by isotope, will be used with the actual liquid radwaste (f) and dilution (F) flow rates (or volumes) during the release. The data will be substituted into Equation 2.3 to demonstrate compliance with the limits in Section 2.1.1. This data and setpoints will be recorded in auditable records by plant personnel.

2.3 Dose

2.3.1 RETS Requirement

Specification 3.11.1.2 of the Radiological Effluent Technical Specification (RETS) requires that the dose or dose commitment to an individual from radioactive materials in liquid effluents released to unrestricted areas from each reactor (see Figure 2.2.1-1) shall be limited:

a. During any calendar quarter to $\leq$ 1.5 mrem to the total body and to $\leq$ 5 mrem to any organ, and

b. During any calendar year to $\leq$ 3 mrem to the total body and to $\leq$ 10 mrem to any organ.

To ensure compliance, cumulative dose calculations will be performed at least once per month according to the following methodology.

2.3.2 Monthly Analysis

Principal radionuclides will be used to conservatively estimate the monthly contribution to the cumulative dose. If the projected dose exceeds the above limits, the methodology in Section 2.3.3 will be implemented. Rev

Calculated doses from liquid effluents (based upon historical release data) have been dominated by the Phosphorus-32 (P-32) dose to the bone. To further ensure accurate dose assessment, ten additional nuclides are considered. The 11 nuclides (listed below) contribute more than 95 percent of the dose to the total body and the two most critical organs (bone and gastro-intestinal tract (G.I. tract)) for both water and fish ingestion.

H-3	Co-58	Nb-95
P-32	Co-60	Xe-133
Mn-54	Sr-89	Ce-144
Fe-55	Sr-90	

Rev.

A conservative calculation of the monthly dose will be done according to the following procedure. First, the monthly operating report containing the release data will be obtained and the activities released of each of the above 11 radionuclides will be noted. This information will then be used in the following calculations. Re

2.3.2.1 Water Ingestion

The dose to an individual from ingestion of water is described by the following equation.

$$D_j = \frac{1}{0.95} \sum_{i=1}^{11} (DCF)_{ij} \times I_{i,\,rem} \qquad (2.11)$$

where:

D_j = dose for the j^{th} organ from 11 radionuclides, rem.

j = the organ of interest (bone, GI tract, or total body).

0.95 = conservative correction factor, considering only 11 radionuclides. Rev.

DCF_{ij} = adult ingestion dose commitment factor for the j^{th} organ from the i^{th} radionuclide, rem/μCi, see attached as Table 2.1

I_i = monthly activity ingested of the i^{th} radionuclide, μCi.

I_i is described by

$$I_i = \frac{A_i \, V \, (30)}{F \, d \, (7.34 \times 10^{10})}, \ \mu Ci \qquad (2.12)$$

A_i = activity released of i^{th} radionuclide during the month, μCi.

V = average rate of water consumption (730 ml/d per ICRP 23, p. 358)

30 = days per month

F = average river flow at Chickamauga Dam for the month (cubic feet per second)

d = fraction of river flow available for dilution (1/5)

7.34×10^{10} = conversion from cubic feet per second to milliliters per month.

The dose equation then becomes

$$D_j = \frac{1.57 \times 10^{-3}}{F} \sum_{i=1}^{11} (DCF)_{ij} \times A_i \ , \ mrem \qquad (2.13)$$

considering the conversion factor from rem to mrem.

2.3.2.2 Fish Ingestion

The dose to an individual from the consumption of fish is described by Equation 2.11. In this case the activity ingested of the i^{th} radionuclide (I_i) is described by

$$I_i = \frac{A_i \, B_i \, M}{F \, d \, (7.34 \times 10^{10})} \ , \ \mu Ci \qquad (2.14)$$

where:

A_i = activity released of i^{th} radionuclide during the month, μCi

B_i = effective fish concentration factor of i^{th} radionuclide, $\frac{\mu Ci/g}{\mu Ci/ml}$, see attached as Table 2.1.

M = amount of fish eaten monthly (1.9×10^{3} g)

F = average river flow at Chickamauga Dam for month (cubic feet per second)

d = fraction of river flow available for dilution (1/5)

7.34×10^{10} = conversion from cubic feet per second to milliliters per month.

The dose equation then becomes

$$D_j = \frac{1.36 \times 10^{-4}}{F} \sum_{i=1}^{11} A_i \times B_i \times DCF_{ij} \text{ , mrem} \qquad (2.15)$$

considering the conversion factor from rem to mrem. Rev

If these calculated monthly doses exceed limits specified in Section 2.3.1 then a more accurate and complete calculation will be done as described in Section 2.3.3. An annual check will be made to ensure that the monthly dose estimates account for at least 95 percent of the dose calculated by the method described in Section 2.3.3. If less than 95 percent of the dose has been estimated, a new list of principal isotopes will be prepared.

2.3.3 Quarterly and Annual Analysis

A complete dose analysis utilizing the total estimated liquid releases for each calendar quarter will be performed and reported as required in Specifications 6.9.1.8 and 6.9.1.9. This analysis will replace Rev previous estimates calculated in Section 2.3.2 and consists of the following approach. The dose to the j^{th} organ from m radionuclides, D_j, is described by

$$D_j = \sum_{i=1}^{m} D_{ij}, \text{ rem} \qquad (2.16)$$

$$= \sum_{i=1}^{m} (DCF)_{ij} \times I_i, \text{ rem} \qquad (2.17)$$

where:

D_{ij} = dose to the j^{th} organ from the i^{th} radionuclide, rem.

j = the organ of interest (bone, GI tract, thyroid, liver, or total body).

$(DCF)_{ij}$ = adult ingestion dose commitment factor for the j^{th} organ from the i^{th} radionuclide, rem/μCi, see Table 2.1.

I_i = activity ingested of the i^{th} radionuclide, μCi.

I_i for water ingestion is described by

$$I_i = \frac{A_i \, V \, n}{F \, d} \text{ , } \mu Ci \qquad (2.18)$$

for fish ingestion, I_i is described by

$$I_i = \frac{A_i \, B_i \, M}{F \, d} \text{ , } \mu Ci \qquad (2.19)$$

where

A_i = activity released of i^{th} radionuclide during the period, μCi.

V = average water consumption (730 ml/d)

n = number of days during the release period

F = total river flow at location of interest for period (ml).

d = fraction of river flow available for dilution (= 1/5 above Chickamauga Dam, = 1 below the dam)

B_i = fish concentration factor $\frac{(\mu Ci/g)}{(\mu Ci/ml)}$

M = amount of fish eaten during period (= fraction of year x 50 lb/year x 453.6 g/lb)

At the end of the year an annual dose analysis will be performed by calculating the sum of the quarterly doses to the critical receptors.

2.4 Operability of Liquid Radwaste Equipment

Specification 3.11.1.3 of the Radiological Effluent Technical Specifications requires that the liquid radwaste system should be used to reduce

the radioactive materials in liquid wastes prior to their discharge when the projected dose due to liquid effluent releases to unrestricted areas (see Figure 2.1.1-1) when averaged over 31 days would exceed 0.06 mrem to the total body or 0.21 mrem to any organ. Doses will be projected monthly to assure compliance.

TABLE 2.1
INGESTION DOSE FACTORS AND FISH CONCENTRATION FACTORS

NUCLIDE	***** HALF-LIFE (DAYS) *****			*** HUMAN DOSE COMMITMENT FACTORS (REM/UCI) ***					********** FISH **********		
									CONCENTRATION FACTORS		BIOLOGICAL HALF-LIFE
	RADIOLO.	BIOLOGICAL	EFFECTIVE	BONE	GI TRACT	THYROID	TOTAL BODY	LIVER	STABLE	EFFECTIVE	(DAYS)
H-3	4.48E+03	1.00E+01	9.98E+00	9.77E-05	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.00E+00	1.00E+00	0.0
C-14	2.09E+06	1.00E+01	1.00E+01	2.84E-03	5.68E-04	5.68E-04	5.68E-04	5.68E-04	4.55E+03	4.55E+03	0.0
NA-24	6.33E-01	1.10E+01	5.99E-01	1.70E-03	1.70E-03	1.70E-03	1.70E-03	1.70E-03	1.00E+02	1.00E+02	0.0
P-32	1.43E+01	2.57E+02	1.35E+01	1.92E-01	2.17E-02	7.47E-03	7.46E-03	1.20E-02	1.00E+05	1.00E+05	0.0
K-40	4.60E+11	5.80E+01	5.80E+01	3.45E-02	0.0	3.45E-02	3.45E-02	3.45E-02	2.50E+03	2.50E+03	0.0
CR-51	2.78E+01	6.16E+02	2.66E+01	3.21E-06	6.69E-04	1.59E-06	2.66E-06	2.66E-06	2.00E+02	2.00E+02	0.0
MN-54	3.03E+02	1.70E+01	1.61E+01	8.83E-04	1.40E-02	8.83E-04	8.72E-04	4.57E-03	4.00E+02	4.00E+02	0.0
MN-56	1.07E-01	1.70E+01	1.06E-01	2.04E-05	3.67E-03	2.04E-05	2.04E-05	1.15E-04	4.00E+02	4.00E+02	0.0
FE-55	9.50E+02	8.00E+02	4.34E+02	2.75E-03	1.09E-03	2.74E-04	4.43E-04	1.90E-03	1.00E+02	1.00E+02	0.0
FE-59	4.56E+01	8.00E+02	4.31E+01	4.34E-03	3.40E-02	3.81E-03	3.91E-03	1.02E-02	1.00E+02	1.00E+02	0.0
CO-58	7.13E+01	9.50E+00	8.38E+00	1.69E-03	1.51E-02	1.69E-03	1.67E-03	7.45E-04	5.00E+01	2.08E+01	1.00E+02
CO-60	1.92E+03	9.50E+00	9.45E+00	4.73E-03	4.02E-02	4.73E-03	4.72E-03	2.14E-03	5.00E+01	4.75E+01	1.00E+02
NI-65	1.07E-01	6.67E+02	1.07E-01	5.28E-04	1.74E-03	3.27E-05	3.13E-05	6.86E-05	1.00E+02	1.00E+02	0.0
CU-64	5.31E-01	8.00E+01	5.27E-01	3.91E-05	7.10E-03	3.91E-05	3.91E-05	8.33E-05	5.00E+01	5.00E+01	0.0
ZN-65	2.45E+02	9.33E+02	1.94E+02	4.84E-03	9.70E-03	7.13E-03	6.96E-03	1.54E-02	2.00E+03	1.42E+03	1.00E+02
ZN-69M	5.75E-01	9.33E+02	5.75E-01	1.55E-04	2.91E-03	3.64E-05	3.64E-05	4.09E-04	2.00E+03	1.14E+01	1.00E+02
ZN-69	3.96E-02	9.33E+02	3.96E-02	1.03E-05	2.96E-06	1.37E-06	1.37E-06	1.97E-05	2.00E+03	7.92E-01	1.00E+02
BR-82	1.48E+00	8.00E+00	1.25E+00	2.26E-03	2.59E-03	2.26E-03	2.26E-03	2.26E-03	4.20E+02	4.20E+02	0.0
BR-83	1.00E-01	8.00E+00	9.88E-02	3.55E-05	5.79E-05	3.55E-05	4.02E-05	4.02E-05	4.20E+02	4.20E+02	0.0
BR-84	2.21E-02	8.00E+00	2.20E-02	6.04E-05	4.09E-10	6.04E-05	5.21E-05	5.21E-05	4.20E+02	4.20E+02	0.0
BR-85	2.08E-03	8.00E+00	2.08E-03	5.17E-07	1.00E-21	5.17E-07	2.14E-06	2.14E-06	4.20E+02	4.20E+02	0.0
KR-83M	7.75E-02	1.00E+00	7.19E-02	0.0	1.46E-04	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
KR-85M	1.83E-01	1.00E+00	1.55E-01	0.0	3.30E-03	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
KR-85	3.93E+03	1.00E+00	1.00E+00	0.0	4.62E-02	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
RB-86	1.87E+01	4.50E+01	1.32E+01	9.83E-03	4.16E-03	9.83E-03	9.83E-03	2.11E-02	2.00E+03	2.00E+03	0.0
RB-88	1.24E-02	4.50E+01	1.24E-02	3.34E-05	8.36E-16	3.34E-05	3.21E-05	6.05E-05	2.00E+03	2.00E+03	0.0
RB-89	1.07E-02	4.50E+01	1.07E-02	2.86E-05	2.33E-18	2.86E-05	2.82E-05	4.01E-05	2.00E+03	2.00E+03	0.0
SR-89	5.27E+01	1.30E+04	5.25E+01	3.08E-01	4.94E-02	9.22E-03	8.84E-03	8.84E-03	3.00E+01	1.04E+01	1.00E+02
SR-90	1.01E+04	1.30E+04	5.68E+03	7.58E+00	2.19E-01	1.76E+00	1.86E+00	1.86E+00	3.00E+01	2.97E+01	1.00E+02
SR-91	4.03E-01	1.30E+04	4.03E-01	5.67E-03	2.70E-02	1.92E-04	2.29E-04	2.29E-04	3.00E+01	1.20E-01	1.00E+02
SR-92	1.13E-01	1.30E+04	1.13E-01	2.15E-03	4.26E-02	6.89E-05	9.30E-05	9.30E-05	3.00E+01	3.39E-02	1.00E+02
SR-93	5.56E-03	1.30E+04	5.56E-03	6.39E-05	1.89E-03	8.90E-06	8.90E-06	8.90E-06	3.00E+01	1.67E-03	1.00E+02
Y-90	2.67E+00	1.40E+04	2.67E+00	9.62E-06	1.02E-01	2.57E-07	2.58E-07	2.58E-07	2.50E+01	2.50E+01	0.0
Y-91M	3.47E-02	1.40E+04	3.47E-02	9.09E-08	2.67E-07	1.72E-09	3.52E-09	3.52E-09	2.50E+01	2.50E+01	0.0
Y-91	5.86E+01	1.40E+04	5.86E+01	1.41E-04	7.76E-02	3.66E-06	3.77E-06	3.77E-06	2.50E+01	2.50E+01	0.0
Y-92	1.47E-01	1.40E+04	1.47E-01	8.45E-07	1.48E-02	2.47E-08	2.47E-08	2.47E-08	2.50E+01	2.50E+01	0.0
Y-93	4.29E-01	1.40E+04	4.29E-01	2.68E-06	8.50E-02	5.51E-08	7.40E-08	7.40E-08	2.50E+01	2.50E+01	0.0
ZR-95	6.55E+01	4.50E+02	5.72E+01	3.04E-05	3.09E-02	6.38E-06	6.60E-06	9.75E-06	3.33E+00	3.33E+00	0.0
ZR-97	7.08E-01	4.50E+02	7.07E-01	1.68E-06	1.05E-01	1.55E-07	1.55E-07	3.39E-07	3.33E+00	3.33E+00	0.0
NB-95M	3.75E+00	7.60E+02	3.73E+00	5.86E-07	3.55E-02	2.88E-07	2.88E-07	4.63E-07	3.00E+04	3.00E+04	0.0
NB-95	3.50E+01	7.60E+02	3.35E+01	6.22E-06	2.10E-02	1.83E-06	1.86E-06	3.46E-06	3.00E+04	3.00E+04	0.0
NB-97	5.00E-02	7.60E+02	5.00E-02	4.90E-08	2.10E-03	4.60E-09	4.60E-09	1.27E-08	3.00E+04	3.00E+04	0.0
MO-99	2.78E+00	5.00E+00	1.79E+00	8.47E-04	5.49E-03	8.47E-04	8.20E-04	4.31E-03	1.00E+01	1.00E+01	0.0
TC-99M	2.52E-01	1.00E+00	2.01E-01	2.47E-07	4.13E-04	9.37E-06	8.89E-06	6.98E-07	1.50E+01	1.50E+01	0.0
TC-99	7.74E+07	1.00E+00	1.00E+00	1.27E-04	1.89E-02	5.06E-05	5.06E-05	1.86E-04	1.50E+01	1.50E+01	0.0
TC-101	9.93E-03	1.00E+00	9.83E-03	2.54E-07	1.10E-18	3.60E-06	3.59E-06	3.66E-07	1.50E+01	1.50E+01	0.0
RU-103	3.96E+01	7.30E+00	6.16E+00	1.85E-04	2.16E-02	7.98E-05	7.95E-05	7.97E-05	1.00E+01	1.00E+01	0.0
RU-106	3.68E+02	7.30E+00	7.16E+00	2.75E-03	1.78E-01	3.50E-04	3.48E-04	3.48E-04	1.00E+01	1.00E+01	0.0
RH103M	3.96E-02	7.30E+00	3.94E-02	1.67E-07	1.21E-04	4.99E-08	4.99E-08	7.21E-07	1.00E+01	1.00E+01	0.0
AG110M	2.53E+02	5.00E+00	4.90E+00	1.60E-04	6.04E-02	8.78E-05	8.79E-05	1.48E-04	2.00E+00	2.00E+00	0.0
SB-124	6.02E+01	3.80E+01	2.33E+01	2.80E-03	7.95E-02	6.79E-06	1.11E-03	5.30E-05	1.00E+00	1.00E+00	0.0
SB-125	9.96E+02	3.80E+01	3.66E+01	1.79E-03	1.97E-02	1.82E-06	4.26E-04	2.40E-05	1.00E+00	1.00E+00	0.0

TABLE 2.1 (continued)

NUCLIDE	***** HALF-LIFE (DAYS) *****			*** HUMAN DOSE COMMITMENT FACTORS (REM/UCI) ***					********** FISH **********		
									CONCENTRATION FACTORS		BIOLOGICAL HALF-LIFE
	RADIOLO.	BIOLOGICAL	EFFECTIVE	BONE	GI TRACT	THYROID	TOTAL BODY	LIVER	STABLE	EFFECTIVE	(DAYS)
TE125M	5.80E+01	1.50E+01	1.19E+01	2.68E-03	1.07E-02	8.06E-04	3.59E-04	9.71E-04	4.00E+02	4.00E+02	0.0
TE127M	1.0 E+02	1.50E+01	1.32E+01	6.77E-03	2.27E-02	1.73E-03	8.25E-04	2.42E-03	4.00E+02	4.00E+02	0.0
TE-127	3.·2E-01	1.50E+01	3.82E-01	1.10E-04	8.68E-03	8.15E-05	2.38E-05	3.95E-05	4.00E+02	4.00E+02	0.0
TE129M	3.41E+01	1.50E+01	1.04E+01	1.15E-02	5.79E-02	3.95E-03	1.82E-03	4.29E-03	4.00E+02	4.00E+02	0.0
TE-129	4.77E-02	1.50E+01	4.75E-02	3.14E-05	2.37E-05	2.41E-05	7.65E-06	1.18E-05	4.00E+02	4.00E+02	0.0
TE131M	1.25E+00	1.50E+01	1.15E+00	1.73E-03	8.40E-02	1.34E-03	7.05E-04	8.46E-04	4.00E+02	4.00E+02	0.0
TE-131	1.72E-02	1.50E+01	1.72E-02	1.97E-05	2.79E-06	1.62E-05	6.22E-06	8.23E-06	4.00E+02	4.00E+02	0.0
TE-132	3.24E+00	1.50E+01	2.66E+00	2.52E-03	7.71E-02	1.80E-03	1.53E-03	1.63E-03	4.00E+02	4.00E+02	0.0
TE-134	2.92E-02	1.50E+01	2.91E-02	2.10E-05	8.93E-05	2.00E-05	1.57E-05	2.13E-05	4.00E+02	4.00E+02	0.0
I-129	6.21E+09	1.38E+02	1.38E+02	3.10E-03	0.0	9.61E+00	1.24E-02	2.81E-03	5.00E+01	5.00E+01	1.00E+00
I-130	5.17E-01	1.38E+02	5.17E-01	7.56E-04	1.92E-03	1.89E-01	8.80E-04	2.23E-03	5.00E+01	1.70E+01	1.00E+00
I-131	8.05E+00	1.38E+02	7.61E+00	4.16E-03	1.57E-03	1.95E+00	3.41E-03	5.95E-03	5.00E+01	4.45E+01	1.00E+00
I-132	9.42E-02	1.38E+02	9.41E-02	2.03E-04	1.02E-04	1.90E-02	1.90E-04	5.43E-04	5.00E+01	4.30E+00	1.00E+00
I-133	8.46E-01	1.38E+02	8.41E-01	1.42E-03	2.22E-03	3.63E-01	7.53E-04	2.47E-03	5.00E+01	2.29E+01	1.00E+00
I-134	3.61E-02	1.38E+02	3.61E-02	1.06E-04	2.51E-07	4.99E-03	1.03E-04	2.88E-04	5.00E+01	1.74E+00	1.00E+00
I-135	2.78E-01	1.38E+02	2.77E-01	4.43E-04	1.31E-03	7.65E-02	4.28E-04	1.16E-03	5.00E+01	1.09E+01	1.00E+00
XE133M	2.26E+00	1.00E+00	6.93E-01	0.0	2.45E-02	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
XE-133	5.27E+00	1.00E+00	8.41E-01	0.0	2.58E-02	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
XE135M	1.08E-02	1.00E+00	1.·7E-02	0.0	3.29E-04	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
XE-135	3.83E-01	1.00E+00	2.77E-01	0.0	1.00E-02	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
CS-134	7.47E+02	7.00E+01	6.40E+01	6.22E-02	2.59E-03	1.20E-01	1.21E-01	1.48E-01	2.00E+03	2.00E+03	1.00E+00
CS-135	1.10E+09	7.00E+01	7.00E+01	1.96E-02	0.0	8.06E-03	8.06E-03	1.80E-02	2.00E+03	2.00E+03	1.00E+00
CS-136	1.37E+01	7.00E+01	1.15E+01	6.51E-03	2.92E-03	2.03E-02	1.85E-02	2.57E-02	2.00E+03	1.86E+03	1.00E+00
CS-137	1.10E+04	7.00E+01	6.96E+01	7.97E-02	2.11E-03	1.28E-02	7.14E-02	1.09E-01	2.00E+03	2.00E+03	1.00E+00
CS-138	2.24E-02	7.00E+01	2.24E-02	5.52E-05	4.65E-10	5.72E-05	5.40E-05	1.09E-04	2.00E+03	4.38E+01	1.00E+00
BA-139	5.76E-02	6.50E+01	5.75E-02	9.70E-05	1.72E-·4	3.07E-06	2.84E-06	6.91E-08	4.00E+00	4.00E+00	0.0
BA-140	1.28E+01	6.50E+01	1.07E+01	2.03E-02	4.18E-02	1.23E-03	1.33E-03	2.55E-05	4.00E+00	4.00E+00	0.0
LA-140	1.68E+00	5.00E+02	1.67E+00	2.50E-06	9.25E-02	3.09E-07	3.33E-07	1.26E-06	2.50E+01	2.50E+01	0.0
LA-141	1.63E-01	5.00E+01	1.62E-01	3.90E-07	9.60E-03	2.03E-08	2.03E-08	9.91E-08	2.50E+01	2.50E+01	0.0
CE-141	3.25E+01	5.63E+02	3.07E+01	9.36E-06	2.42E-02	7.72E-07	7.18E-07	6.33E-06	2.50E+01	2.50E+01	0.0
CE-143	1.38E+00	5.63E+02	1.38E+00	1.65E-06	4.56E-02	3.56E-08	1.35E-07	1.22E-03	2.50E+01	2.50E+01	0.0
CE-144	2.84E+02	5.63E+02	1.89E+02	4.88E-04	1.65E-01	2.64E-05	2.62E-05	2.04E-04	2.50E+01	2.50E+01	0.0
PR-143	1.36E+01	7.50E+02	1.34E+01	9.20E-06	4.03E-02	4.60E-07	4.56E-07	3.69E-06	2.50E+01	2.50E+01	0.0
PR-144	1.20E-02	7.50E+02	1.20E-02	3.01E-08	4.33E-15	1.54E-09	1.53E-09	1.25E-08	2.50E+01	2.50E+01	0.0
ND-147	1.11E+01	6.56E+02	1.09E+01	6.29E-06	3.49E-02	4.55E-07	4.35E-07	7.27E-06	2.50E+01	2.50E+01	0.0
PM-147	9.57E+02	6.56E+02	3.89E+02	7.60E-05	1.33E-02	2.89E-06	2.89E-06	7.10E-·6	2.50E+01	2.50E+01	0.0
PM-149	2.21E+00	6.56E+02	2.20E+00	1.54E-06	4.86E-02	8.87E-08	8.87E-08	2.15E-07	2.50E+01	2.50E+01	0.0
PM-151	1.16E+00	6.56E+02	1.16E+00	6.74E-07	3.17E-02	5.91E-08	5.91E-08	1.17E-07	2.50E+01	2.50E+01	0.0
SM-151	3.18E+04	6.56E+02	6.43E+02	6.09E-05	4.37E-03	1.56E-06	1.56E-06	1.19E-05	2.50E+01	2.50E+01	0.0
SM-153	1.95E+00	6.56E+02	1.94E+00	1.03E-06	3.58E-02	6.66E-08	6.66E-08	7.16E-07	2.50E+01	2.50E+01	0.0
SM-156	3.92E-01	6.56E+02	3.92E-01	4.63E-07	5.86E-03	5.33E-08	5.33E-08	5.33E+05	2.50E+01	2.50E+01	0.0
EU-155	6.61E+02	6.35E+02	3.24E+02	5.75E-05	1.35E-02	3.35E-06	3.35E-06	1.22E-05	2.50E+01	2.50E+01	0.0
EU-156	1.54E+01	6.35E+02	1.50E+01	1.31E-05	1.02E-01	1.65E-06	1.65E-06	1.06E-05	2.50E+01	2.50E+01	0.0
W-187	9.96E-01	1.00E+00	4.99E-01	1.03E-04	2.82E-02	2.70E-05	3.01E-05	1.03E-04	1.20E+03	1.20E+03	0.0
NP-239	2.35E+00	3.90E+04	2.35E+00	1.19E-06	2.40E-02	7.74E-08	6.45E-08	1.19E-06	1.00E+01	1.00E+01	0.0

1.2.1 Noble Gases

Step 1

Doses will be calculated using the methodology described in this step. If any limits are exceeded, step 2 will be performed.

Equations and assumptions for calculating doses from releases of noble gases are as follows:

Assumptions

1. Doses to be calculated are gamma and beta air doses.
2. The highest annual-average χ/Q based on licensing meterology for ground-level releases for any offsite location will be used.
3. No credit is taken for radioactive decay.
4. For gamma doses, releases of Xe-131m, Xe-133, Xe-135, Ar-41, and Kr-88 are considered. Rev
5. For beta doses, releases of Xe-131m, Xe-133, Xe-135, Ar-41, and Kr-85 are considered.
6. Dose factors are calculated using data from TVA's nuclide library.
7. The calculations extrapolate doses assuming that only 90 percent of total dose was contributed. Rev.
8. A semi-infinite cloud model is used.
9. Building wake effects on effluent dispersion are considered.

Equations

For determining the gamma dose to air:

$$D_\gamma = \frac{(\chi/Q)}{0.9} \left(\frac{10^6}{3.15 \times 10^7} \right) \sum_i Q_i \, DFY_i \qquad (1.13)$$

where:

D_γ = gamma dose to air, mrad.

χ/Q = highest annual-average relative concentration, 5.13×10^{-6} s/m^3

10^6 = $\mu Ci/Ci$.

0.9 = fraction of total gamma dose expected to be contributed by these nuclides.

3.15×10^7 = s/yr.

Q_i = monthly release of radionuclide i, Ci.

$DF\gamma_i$ = gamma-to-air dose factor for radionuclide i, mrad/yr per $\mu Ci/m^3$ (Table 1.5).

Rev.

This equation then reduces to

$$D_\gamma = 1.81 \times 10^{-7} \sum_i Q_i \, DF\gamma_i \qquad (1.14)$$

For determining the beta dose to air:

$$D_\beta = \frac{(\chi/Q)}{0.9} \left(\frac{10^6}{3.15 \times 10^7} \right) \sum_i Q_i \, DF\beta_i \qquad (1.15)$$

where:

D_β = beta dose to air, mrad.

χ/Q = highest annual-average relative concentration, 5.13×10^{-6} s/m^3

10^6 = $\mu Ci/Ci$.

0.9 = fraction of total beta dose expected to be contributed by these nuclides.

3.15×10^7 = s/yr.

Q_i = monthly release of radionuclide i, Ci.

$DF\beta_i$ = beta-to-air dose factor for radionuclide i, mrad/yr per $\mu Ci/m^3$ (Table 1.5).

Rev.

This equation then reduces to:

$$D_\beta = 1.81 \times 10^{-7} \sum_i Q_i \, DF\beta_i \qquad (1.16)$$

χ_{ni} = air concentration of radionuclide i in sector n, $\mu Ci/m^3$

$DF\gamma_i$ = gamma-to-air dose factor for radionuclide i, mrad/yr per $\mu Ci/m^3$ (Table 1.5).

t_m = time period considered, yr

For determining the beta dose to air:

$$D_{\beta n} = t_m \sum \chi_{ni} \, DF\beta_i \qquad (1.25)$$

where:

$D_{\beta n}$ = beta dose to air for sector n, mrad.

χ_{ni} = air concentration of radionuclide i in sector n, $\mu Ci/m^3$

$DF\beta_i$ = beta to air dose factor for radionuclide i, mrad/yr per $\mu Ci/m^3$

t_m = time period considered, yr

The sector having the highest total dose is then used to check compliance with specification 3.11.2.2.

1.2.2 Iodines and Particulates

Step 1

Doses will be calculated using the methodology described in this step. If any limits are exceeded, step 2 will be performed.

Equations and assumptions for calculating doses from releases of iodines and particulates are as follows:

Assumptions

1. Doses are to be calculated for the infant thyroid from milk ingestion and for the child bone from vegetable ingestion.
2. Real cow locations are considered for the milk pathway and nearest-resident locations with home-use gardens are considered for the vegetable pathway.

Rev.

3. The highest annual-average D/Q's based on licensing meteorology for ground-level releases will be used for I-131 and Sr-90 doses.

4. The highest annual-average X/Q's based on licensing meteorology for ground-level releases will be used for C-14 doses. Rev

5. No credit is taken for radioactive decay.

6. Releases of I-131 and C-14 are considered for the milk pathway. Sr-90 releases are considered for the vegetable pathway. Rev

7. The calculations extrapolate doses assuming that only 90 percent of the total dose was contributed.

8. Releases of C-14 are based on the design source term.

9. The cow is assumed to graze on pasture grass for the whole year.

Equations

For determining the thyroid dose from milk ingestion of I-131:

$$DTH_{131} = \frac{Q_{131}\ DF_{131}\ D/Q}{3.15\times10^{7}} \times 10^{6} \qquad (1.26)$$

where:

DTH_{131} = thyroid dose from I-131, mrem.

Q_{131} = monthly release of I-131, Ci.

DF_{131} = I-131 milk ingestion dose factor to infant, mrem/yr per $\mu Ci/m^2$-s (Table 1.7)

D/Q = relative deposition rate, $2.94\times10^{-9}\ m^{-2}$. Rev.

3.15×10^{7} = s/yr.

10^{6} = μCi/Ci.

For determining the thyroid dose from milk ingestion of C-14:

$$DTH_{14} = \frac{Q_{14}\ DF_{14}\ \chi Q}{3.15\times10^{7}} \qquad (1.27)$$

where:

DTH_{14} = thyroid dose from C-14, mrem.

Q_{14} = monthly release of C-14, Ci.

DF_{14} = C-14 milk ingestion dose factor, mrem/yr per $\mu Ci/cm^3$ (Table 1.7)

Rev

X/Q = relative dispersion factor, 1.76×10^{-6} s/m^3.

3.15×10^7 = s/yr.

For determining the total thyroid dose:

$$DTH = \frac{DTH_{131} + DTH_{14}}{0.9} \qquad (1.28)$$

where:

DTH = thyroid dose, mrem.

DTH_{131} = thyroid dose from release of I-131, mrem.

DTH_{14} = thyroid dose from release of C-14, mrem.

0.9 = fraction of total thyroid dose expected to be contributed by these radionuclides.

Rev

For determining the bone dose from vegetable ingestion:

$$DBC_s = \frac{Q_s \, DF_s \, D/Q}{3.15 \times 10^7 (0.9)} \times 10^6 \qquad (1.29)$$

where:

DBC_s = bone dose to child from Sr-90, mrem.

Rev

Q_s = monthly release of Sr-90, Ci.

DF_s = Sr-90 vegetable ingestion dose factor to child, 1.62×10^{12} mrem/yr per $\mu Ci/m^2$-s.

D/Q = relative deposition rate, $7.32 \times 10^{-9} m^{-2}$.

3.15×10^7 = s/yr.

10^6 = μCi/Ci.

0.9 = fraction of total bone dose expected to be contributed by Sr-90.

Step 2

This methodology is to be used if the calculations in step 1 yield doses that exceed applicable limits.

Doses for releases of iodines and particulates shall be calculated using the methodology in Section 1.1.1, step 1, part B, with the following exceptions:

1. All measured radionuclide releases will be used.
2. Dose will be evaluated at real cow locations and will consider actual grazing information.

The receptor having the highest total dose is then used to check compliance with specification 3.11.2.3.