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OFFSITE DOSE CALCULATION MANUAL

Revision 0, Change 1

For The
Baltimore Gas And Electric Company
Calvert Cliffs Nuclear Power Plant

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I. PURPOSE

A. The ODCM lists the radiological effluent controls established at Calvert Cliffs Nuclear Power Plant (CCNPP) for the purpose of ensuring the amount of radioactive materials released to the environment are as low as reasonably achievable.

B. The ODCM defines parameters and methodologies for calculating doses and dose rates resulting from the release of radioactive materials in liquid and gaseous effluents.

C. The ODCM defines parameters and methodologies for calculating alarm and trip setpoints for Technical Specification related radiation effluent monitoring systems.

D. The ODCM defines and establishes controls for the Radiological Environmental Monitoring Program.

II. APPLICABILITY/SCOPE

A. The information presented in this procedure is applicable to any division, department, section, or unit within the Baltimore Gas And Electric Company (BG&E) which is either wholly or partly responsible for performing any of the activities listed in the PURPOSES section of this procedure. Responsible organizations include, but are not limited to, the following:

1. BG&E, Nuclear Energy Division (NED), CCNPP Department (CCNPPD), Chemistry Section
2. BG&E, Corporate Affairs Group, Environmental Programs Section | 1
3. BG&E, Fossil Energy Division, Technical Services Section, Chemistry Unit
4. BG&E, NED, CCNPPD, Electrical and Controls (E&C) Section
5. BG&E, NED, CCNPPD, Operations Section

B. This procedure is applicable to the determination of alarm and trip setpoints for the following radioactive gaseous effluent monitoring instrumentation:

1. 0-RE-2191
2. 1/2-RE-5415
3. 1/2-RE-5416

C. This procedure is applicable to the determination of alarm and trip setpoints for the following radioactive liquid effluent monitoring instrumentation:

1. 0-RE-2201
2. 1/2-RE-4014
3. 1/2-RE-4095

D. This procedure is applicable to the determination of the offsite doses and/or offsite dose rates due to the following:

1. Radioactive material in gaseous waste discharged from CCNPP

2. Radioactive material in liquid waste discharged from CCNPP

3. Radioactive material contained in outside storage tanks at CCNPP

E. This procedure is applicable to the determination of the radiological affects on the environment due to the presence of Calvert Cliffs Nuclear Power Plant.

F. The ODCM is based on Technical Specifications, BG&E's interpretation of industry standards, and recommendations made by Combustion Engineering.

III. DEFINITIONS

A. Abnormal and/or Unanticipated Radioactive Release:

Any unplanned or uncontrolled release of radioactive material from the site boundary.

B. Action:

That part of a control or specification which prescribes remedial measures required under designated conditions.

C. Channel Functional Test:

A analog CHANNEL FUNCTIONAL TEST shall be the injection of a simulated signal into the channel as close to the primary sensor as practicable to verify operability including alarm and/or trip functions. A bistable CHANNEL FUNCTIONAL TEST shall be the injection of a simulated signal into the channel sensor to verify operability including alarm and/or trip functions.

D. Batch Release:

A BATCH RELEASE is the discharge of liquid (or gaseous) waste of a discrete volume. (NUREG-0133, page 14)

E. Channel Calibration:

A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds with the necessary range and accuracy to known values of the parameter which the channel monitors. The CHANNEL CALIBRATION shall encompass the entire channel including the sensor and alarm and/or trip functions, and shall include the CHANNEL FUNCTIONAL TEST. The CHANNEL CALIBRATION may be performed by any series of sequential, overlapping or total channel steps such that the entire channel is calibrated.

F. **Channel Check:**

A CHANNEL CHECK shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter.

G. **Composite Sample:**

A COMPOSITE sample is a combination of individual samples obtained at intervals that are very short (e.g., hourly) in relation to the compositing time interval (e.g., monthly) to assure obtaining a representative sample. The sample volume should be proportionate to the volume of fluid, either liquid or gas, flowing through the system.

H. **Continuous Release:**

A CONTINUOUS release is the discharge of liquid (or gaseous) wastes of a nondiscrete volume; e.g., from a volume or system that has an input flow during the CONTINUOUS release. (NUREG-0133, page 14)

I. **Dominant Radionuclide:**

A DOMINANT RADIONUCLIDE is one whose activity is greater than 1% of the total activity found in a TYPICAL RELEASES of liquid or gaseous radwaste.

J. **Dose Equivalent Iodine-131:**

DOSE EQUIVALENT I-131 shall be that concentration of I-131 (microcuries per gram) which alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134, and I-135 actually present. The thyroid dose conversion factors used for this calculation shall be those listed in Table III of TID-14844, "Calculation of Distance Factors for Power and Test Reactor Sites."

K. **Frequency Notation:**

The frequency notation specified for the performance of Surveillance Requirements shall correspond to the intervals defined in the following Table.

Notation	Frequency
S	At least once per 12 hours
D	At least once per 24 hours
W	At least once per 7 days
M	At least once per 31 days
Q	At least once per 92 days
SA	At least once per 6 months
R	At least once per 18 months

S/U	Prior to each reactor startup
P	Completed prior to each release
N.A.	Not applicable
Refueling Interval	At least once per 24 months

L. **Gamma Isotopic Analysis:**

A GAMMA ISOTOPIC ANALYSIS is a analytical method of measurement used for the identification and quantification of gamma-emitting radionuclides.

M. **Gaseous Radwaste Treatment System:**

A GASEOUS RADWASTE TREATMENT SYSTEM is any system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system offgases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

N. **Less Dominant Radionuclide:**

A LESS DOMINANT RADIONUCLIDE is one whose activity is less than 1% of the total activity found in TYPICAL RELEASES of liquid or gaseous radwaste.

O. **Lower Limit of Detection:**

The LLD, as defined by Technical Specifications, is the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

P. **Members of the Public:**

MEMBERS OF THE PUBLIC shall include all persons who are not occupationally associated with the plant. This category does not include employees of the utility, its contractors, or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational, or other purposes not associated with the plant.

Q. **Offsite Dose Calculation Manual:**

The OFFSITE DOSE CALCULATION MANUAL (ODCM) shall contain the methodology and parameters used in the calculation of offsite doses resulting from radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring alarm and trip setpoints, and in the conduct of the Environmental Radiological Monitoring Program. The ODCM shall also contain (1) the Radioactive Effluent Controls (as specified by the Technical Specification Limiting Conditions of Operation), (2) the Radiological Environmental Monitoring Programs required by Technical Specification 3.12.1, and (3) a description of the information that should be included in the Annual Radiological Environmental Operating Report required by Technical Specification 6.9.1.7.

R. **Operability:**

A system, subsystem, train, component or device shall be operable or have OPERABILITY when it is capable of performing its specified function(s). Implicit in this definition shall be the assumption that all necessary attendant instrumentation, controls, normal and emergency electrical power sources, cooling or seal water, lubrication or other required auxiliary equipment that are required for the system, subcomponent or device to perform its function(s) are also capable of performing their related support function(s).

S. **Purge or Purging:**

PURGE or PURGING is the controlled process of discharging air or gas from a confinement to maintain temperature, humidity, concentration, or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.

T. **Rated Thermal Power:**

Rated thermal power shall be a total reactor core heat transfer rate to the reactor coolant of 2700 MWt.

U. **Simultaneous Releases:**

Simultaneous liquid releases are discharges of liquid radwaste which occur at the same time. Simultaneous gaseous releases are discharges of gaseous radwaste which occur at the same time.

V. **Site Boundary:**

The SITE BOUNDARY shall be that line beyond which the land is neither owned, nor leased, nor otherwise controlled by the licensee. (The SITE BOUNDARY is depicted on Attachment 18, "Environmental Monitoring Sites")

W. **Source Check:**

A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.

X. **Thermal Power:**

The THERMAL POWER shall be the total reactor core heat transfer rate to the reactor coolant.

Y. **Typical Radwaste Releases (or Typical Radwaste Effluents):**

TYPICAL RADWASTE RELEASES are defined as (1) all releases conducted during any calendar quarter while either Unit 1 or Unit 2 is in mode 1, and also includes (2) all releases conducted during any calendar quarter following mode 1 operation of either Unit 1 or Unit 2.

This definition of TYPICAL RADWASTE RELEASES is intended to ensure the concentrations of DOMINANT radionuclides represent realistic, maximum-expected values. This definition is also intended to ensure that the concentrations of DOMINANT radionuclides is not biased "low", as would be the case, if periods of extended outages--when the production of fission products is minimized--were included.

This definition may be modified by the GSC, however, the new definition shall be documented in accordance with the provisions outlined in the applicable section of the ODCM. (e.g., See the section which contains information related to documenting the fixed/adjustable setpoint.)

Z. **Unrestricted Area:**

An UNRESTRICTED AREA shall be any area at or beyond the SITE BOUNDARY access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, of any area within the SITE BOUNDARY used for residential quarters of for industrial, commercial, institutional, and/or recreational purposes.

AA. **Ventilation Exhaust Treatment System:**

A VENTILATION EXHAUST TREATMENT SYSTEM is any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and/or High Efficiency Particulate Air (HEPA) filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment. Such a system is not considered to have any effect on noble gas effluents. Engineered Safety Feature (ESF) atmospheric cleanup systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

BB. Venting:

Venting is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is not provided or required during venting. Vent, used in system names, does not imply a venting process.

CC. Waste Gas Holdup System:

See GASEOUS RADWASTE TREATMENT SYSTEM.

IV. REFERENCES

A. Development References

1. NUREG-0133, "Preparation Of Radiological Effluent Technical Specification For Nuclear Power Plants", Boegli, J.S., R.R. Bellamy, W. L. Britz, and R. L. Waterfield, (October 1978).

2. Regulatory Guide 1.109, "Calculation Of Annual Doses To Man From Routine Release Of Reactor Effluents For The Purpose Of Compliance With 10 CFR Part 50, Appendix I," Revision 1, (October 1977).

3. Regulatory Guide 1.111, "Methods For Estimating Atmospheric Transport And Dispersion Of Gaseous Effluents In Routine Releases From Light-Water-Cooled Reactors," Revision 1, (July 1977).

4. CCNPP System Description Number 14B, "Reactor Coolant Waste Processing System Description."

5. Updated Final Safety Analysis Report, Chapter 11, "Waste Processing And Radiation Protection."

6. CCNPP System Description Number 14D, "Miscellaneous Liquid Waste Processing System Description."

7. OI-17D, "Miscellaneous Waste Processing System"

8. OI-17C, "Reactor Coolant Waste Processing System"

9. Title 10 of the Code of Federal Regulations, Part 20

10. Title 10 of the Code of Federal Regulations, Part 50

11. Calvert Cliffs Nuclear Power Plant Semi-Annual Radiological Effluent Release Report (1986, 1987, 1988).

12. Radioactive Decay Data Tables, David C. Kocher, 1981.

13. Radiological Health Handbook, Bureau of Radiological Health, Jan. 1970.

14. TE-001, "Main Vent Stack Flow Measurement"

15. ETP-87-16, "Main Vent Stack Flow Measurement"

16. Verification And Validation Of The Gaseous Release Permit Portion Of The CCNPP EMS Computer Code, J. S. Bland And Associates, July 10, 1990.

17. Land Use Survey In The Vicinity Of The Calvert Cliffs Nuclear Power Plant September 1991, (for the year 1990), Baltimore Gas And Electric Company, Environmental Programs Section, C. Key, B. E. Helbing

18. CP-607, Revision 1, "Offsite Dose Calculation Manual"

19. CCI-302, Calvert Cliffs Alarm Manual

20. TID-14844, "Calculation of Distance Factors for Power and Test Reactor Sites"

21. "Plant Data Book", BG&E CCNPP Units 1 and 2, Bechtel Power Corporation, Volume 1, Job 6750.

22. Safety Analysis No. 2, FCR 82-1053, Supplement 1 (Component Cooling System) [B527] | 1

23. 50.59 Log No. 90-0-074-011-R1, Activity MASE 90-7 (Plant Nitrogen System) [B527] | 1

24. 50.59 Log No. 90-0-029-045-R0, Activity MASE 90-6 (Plant Heating System) [B527] | 1

25. 50.59 Log No. 90-0-037-044-R0, Activity MASE 90-5 (Demineralized Water System) [B527] | 1

26. 50.59 Log No. 90-B-012-043-R0, Activity MASE 90-5 (Service Water System) [B527] | 1

27. 50.59 Log No. 90-B-027-037-R1, Activity MASE 90-8 (Auxiliary Boiler System) [B527] | 1

28. Bechtel Power Corporation, Calculation Number M-90-20, "Allowable Radioactive Contamination Levels in the Plant Heating System" [B527] | 1

29. Bechtel Power Corporation, Calculation Number M-90-18, "Allowable Radioactive Contamination Levels in the Nitrogen System Header" [B527] | 1

30. Bechtel Power Corporation, Calculation Number M-90-04, "Allowable Radioactive Contamination Levels in Auxiliary Boiler Water" [B527] | 1

31. Bechtel Power Corporation, Calculation Number M-90-21, "Allowable Radioactive Contamination Levels in the Demineralized Water System" [B527] | 1

32. Bechtel Power Corporation, Calculation Number M-90-19, "Allowable Radioactive Contamination Levels in the Service Water System" [B527] | 1

33. Bechtel Power Corporation, Job Number 11865, Calculation Number 7.4.3-15, "Allowable Radioactive Contamination Levels in the Condensate Storage Tank" [B527] | 1

34. CCI-205, Setpoint Control Procedure

35. OI-8A, Blowdown System

36. NUREG-1301, "Offsite Dose Calculation Manual: Standard Radiological Effluent Controls for Pressurized Water Reactors", W.W. Meinke, and T.H. Essig, (Published April 1991).

37. Radiological Environmental Monitoring Program Annual Report for the Calvert Cliffs Nuclear Power Plant Units 1 and 2 January 1 - December 31, 1991", Baltimore Gas And Electric Company, March 1992

B. Performance References

1. TE-001, "Main Vent Stack Flow Measurement"

V. RADIOACTIVE LIQUID EFFLUENTS

A. Release Pathways [B527]

1. Introduction

   a) Radioactive liquid waste generated as a result of operating the Calvert Cliffs Nuclear Power Plant (CCNPP) may be released to the Chesapeake Bay[1].

   b) By design, there are four pathways by which all waste water, non-radioactive and radioactive, may be discharged from the site to the bay:

      (1) Outfall 001,

      (2) Outfall 002,

      (3) Outfall 003,

      (4) Outfall 004.

   c) A diagram which shows the location of each outfall is included as Attachment 1.

2. Outfall 001

   a) Water from the Chesapeake Bay is pumped through the condensers and is discharged to the Chesapeake Bay through the circulating water discharge conduits, known as outfall 001.

   b) The liquid radioactive waste is mixed with and diluted by the circulating water prior to exiting the discharge conduit.

   c) The circulating water discharge conduit extends 850 feet into the Chesapeake bay.

   d) The circulating water discharge conduit may accept liquid radioactive waste from various sources. Sources which may contribute radioactive material to the circulating water discharge conduit are tabulated in Attachment 2.

3. Outfalls 002, 003, and 004

   a) There are three other potential pathways for the release of radioactive liquids to the bay. These pathways are designated outfall 002, outfall 003, and outfall 004.

   b) Sources which could potentially contribute radioactive material to each of these outfalls are tabulated in Attachment 3.

   c) No radioactive materials are expected to be discharged from outfall 002 unless there is a primary to secondary leak, or unless there is an unforeseen and catastrophic failure of a condensate storage tank (CST).

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[1] The federal controls and administrative limits associated with the release of radioactive materials from CCNPP are discussed elsewhere in this document.

d) No radioactive materials are expected to be released from outfalls 003 or 004 unless there is an unforeseen and catastrophic failure of a refueling water tank (RWT).

4. Unmonitored release paths not shown on Attachment 3 should be evaluated and added to the ODCM as necessary.

5. Safety evaluations have been conducted for operating the following systems after they have become contaminated:

a) component cooling water system

(1) In accordance with applicable safety evaluations (Ref. 22), continued operation of this system is allowed as long as the concentration of radionuclides in the component cooling water system is less than 3,000 MPCs.

b) plant heating system

(1) In accordance with applicable safety evaluations (Ref. 24 and Ref. 28), continued operation of this system is allowed as long as the concentration of radionuclides in the plant heating system is less than 0.3 MPCs.

c) auxiliary boiler system

(1) In accordance with applicable safety evaluations (Ref. 27 and Ref. 30) continued operation of this system is allowed as long as the concentration of radionuclides in the auxiliary boiler steam drum is less than 96 MPCs.

d) demineralized water system

(1) In accordance with applicable safety evaluations (Ref. 25 and Ref. 31), continued operation of this system is allowed as long as the concentration of radionuclides in the demineralized water system is less than 0.3 MPCs.

e) service water system

(1) In accordance with applicable safety evaluations (Ref. 26 and Ref. 32), continued operation of this system is allowed as long as the concentration of radionuclides in the service water system is less than 0.1 MPCs.

f) condensate storage tank

(1) In accordance with applicable safety evaluations (Ref. 33), continued operation of this system is allowed as long as the concentration of radionuclides in the condensate storage tank is less than 1.0 MPCs.

B. Types of Liquid Releases

1. All liquid radwaste releases are classified as either BATCH releases or CONTINUOUS releases.

2. The definition of "BATCH release" is included in the definitions section of the ODCM.

3. The definition of "CONTINUOUS release" is included in the definitions section of the ODCM.

4. Liquid radwaste discharges have been classified as CONTINUOUS or BATCH as shown on Attachments 2 and 3.

C. **Processing Equipment**

1. Simplified Flow Diagram

a) An overview of the liquid waste processing system, including major equipment and (normal) flow paths, is outlined on Attachment 4.

b) There is no processing equipment for wastes discharged through outfalls 002, 003, and 004; however, the waste shall be analyzed for radioactivity in accordance with the analysis frequencies contained in approved CCNPPD Chemistry Section procedures.

2. Modifications

a) Major changes or modifications to the liquid waste processing system shall be reported to the Commission in the Semi-annual Radioactive Effluent Release Report for the time interval in which the modification was completed (per Technical Specification 6.15.1).

b) A "major" change or modification includes, but is not limited to the removal or permanent bypass of any of the following:

(1) degassifier

(2) reactor coolant waste receiver tank

(3) reactor coolant waste monitor tank

(4) letdown filter

(5) reactor coolant waste ion exchanger

(6) miscellaneous waste ion exchanger

(7) miscellaneous waste filter

(8) miscellaneous waste receiver tank

(9) miscellaneous waste monitor tank

(10) evaporator

3. Detailed Description

a) A detailed description of the liquid waste processing system is beyond the scope of the ODCM.

b) For more information on the Miscellaneous Liquid Waste Processing System see System Description Number 14D, "Miscellaneous Liquid Waste Processing System Description."

c) For more information on the Reactor Coolant Waste Processing System see System Description Number 14B, "Reactor Coolant Waste Processing System Description."

d) For more information see the Updated Final Safety Analysis Report, Chapter 11, "Waste Processing And Radiation Protection."

D. Liquid Effluent Radiation Monitor Alarm and Trip Setpoints

1. Liquid Waste Discharge Radiation Monitor (0-RE-2201)

a) General description

(1) number of radiation elements: one

(2) type of radiation element: in-line scintillation detector

(3) output: analog

(4) radiation indicator: 0-RI-2201

(5) units for radiation indicator: counts per minute

(6) supplier: Westinghouse

b) Functions of 0-RE-2201

(1) continuously measure the activity contained in liquid waste discharge line (Technical Specification 3.3.3.10)

(2) continuously indicate (via 0-RI-2201) the activity of liquids contained in liquid waste discharge line (Technical Specification 3.3.3.10)

(3) alarm (via 0-RI-2201) prior to exceeding 10 CFR 20, Appendix B, Table II, Column 2 limits (per Technical Specification 3.11.1.1)

(4) automatically terminate discharges from the liquid waste processing system by closing the discharge isolation valves (MWS-2201-CV, and MWS-2202-CV) whenever the radiation indicator (0-RI-2201) exceeds the fixed high radiation trip setpoint

c) OPERABILITY of 0-RE-2201

(1) This monitor shall be operable (or have OPERABILITY) when it is capable of performing its specified function(s).[2]

(2) The functions of 0-RE-2201 are listed in paragraph (b) above.

d) Monitors equivalent to 0-RE-2201

(1) There are no equivalent monitors for 0-RE-2201.

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2 Technical Specification 1.6

e) Radiological effluent controls for 0-RE-2201

(1) Liquid waste discharges via this pathway may continue if any one of the following two conditions are satisfied (per Technical Specification 3.3.3.10).

(a) The liquid waste discharge monitor, 0-RE-2201, is operable AND the alarm and trip setpoint for this monitor is set to ensure the concentrations of radioactive materials released in liquid effluents to UNRESTRICTED AREAS are less than the concentrations specified in 10 CFR 20, Appendix B, Table II, Column 2, or

(b) two independent samples are analyzed in accordance with Technical Specification 4.11.1.1.1; AND at least two technically qualified members of the Facility Staff independently verify the release rate calculations; AND two qualified operators verify the discharge valve line up.

f) Surveillances for 0-RE-2201

(1) Technical Specification 4.3.3.10 requires demonstrating the OPERABILITY of 0-RE-2201 by satisfying the checks, calibrations, and tests listed below:

(a) CHANNEL CHECK within the past 24 hours[3]

(b) SOURCE CHECK prior to each release

(c) CHANNEL CALIBRATION within the past 18 months

(d) CHANNEL FUNCTIONAL TEST within the past 6 six months

g) Setpoints for 0-RI-2201

(1) There are three radiation alarm setpoints associated with, or otherwise related to, the liquid waste discharge monitor.

(a) 0-RI-2201 fixed high radiation alarm and automatic control trip setpoint

(b) 0-RI-2201 adjustable plant computer high radiation alarm and manual control trip setpoint

(c) 0-RI-2201 low radiation alarm setpoint

(2) In order to simplify the setpoint terminology, eliminate ambiguity, and minimize the possibility of misinterpretation, the ODCM will refer to these setpoints as follows:

(a) The 0-RI-2201 fixed high radiation alarm and automatic control trip setpoint will be referred to as the fixed setpoint.

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3 Technical Specifications Table 1.2

(b) The 0-RI-2201 adjustable plant computer high radiation alarm and manual control trip setpoint will be referred to as the adjustable setpoint.

(c) The 0-RI-2201 low radiation alarm setpoint will be referred to as the low setpoint.

(3) Each of these alarm setpoints is described below.

h) Fixed setpoint for 0-RI-2201

(1) General information

(a) This setpoint is considered to be a fixed setpoint. This setpoint is not adjusted for each release.

(b) Whenever the fixed setpoint is exceeded, discharges from the liquid waste processing system will be automatically suspended.

(c) The fixed setpoint corresponds to the maximum concentration of radionuclides allowed in liquid waste discharged from the liquid waste processing system.

(d) The current value for the fixed setpoint is specified in the CCNPP Alarm Manual.

(e) The CCNPP Alarm Manual refers to this alarm and trip setpoint as the 0-RI-2201 Liquid Waste Discharge High Alarm.

(f) The fixed setpoint is integral to the liquid release discharge monitor, as purchased from the supplier.

(g) The fixed setpoint is administratively controlled by CCI-205.

(h) The fixed setpoint shall be calculated as described below[4].

(2) Calculating the fixed setpoint for 0-RI-2201

(a) The fixed alarm and trip setpoint for 0-RI-2201 shall be calculated as follows:

FIXED ALARM AND TRIP SETPOINT FOR 0-RI-2201

$$S_{fix} \leq K_{sf}\{(F_d / F_u)\sum[(A_{iLn})(e_i)] + Bkg\} \qquad \text{Eq. 1L}^{5}$$

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4 Per Technical Specification 3.3.3.10.

5 This formula has been derived from NUREG-0133, Addendum, page AA-1.

S_{fix} = the fixed alarm and trip setpoint for 0-RI-2201 (cpm)

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP activity limit to the 10 CFR 20 MPC limit (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the fixed setpoint is always less than or equal to the limits of 10 CFR 20.

A safety factor of 1.00 will yield a fixed setpoint which corresponds to 1.0 MPC.

A safety factor of 0.500 will yield a fixed setpoint which corresponds to 0.5 MPCs.

It is recommended that a safety factor of 0.5 be used for calculating the fixed setpoint, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

The use of a "safety margin" is in accordance with the provisions of NUREG-0133, section 4.1.1, which states, "The alarm and trip setpoints ... should correspond to a value(s) which represents a safe margin of assurance that the instantaneous liquid release limit of 10 CFR Part 20 is not exceeded."

This safety margin will prevent minor fluctuations in the nominal circulating water flow rate (and other statistical aberrations) from adversely impacting the calculated fixed setpoint.

F_d = the dilution water flow rate (gpm) prior to the point of release to UNRESTRICTED AREAS

The dilution water flow rate is actually the sum of the minimum circulating water flow rate, the minimum salt water flow rate, and the maximum undiluted radwaste flow rate.

The dilution water flow rate shall be calculated in accordance with equation 2L.

DILUTION WATER FLOW RATE

$$F_d = F_{cw} + F_{sw} + F_u \qquad \text{Eq. 2L}$$

F_{cw} = the minimum circulating water system flow rate necessary to conduct liquid releases

A minimum of two circulating water pumps per unit (one circulating water pump per conduit) shall be operable when discharging liquid radwaste to outfall 001.

Additional circulating water pumps may be required as specified in approved Chemistry Procedures. (See applicable "CP" series procedures.)

If a release of liquid radwaste is to be conducted using less than minimum circulating water flow rate necessary to conduct liquid releases, the release shall not be allowed until a new setpoint has been calculated and entered into 0-RI-2201.

F_{sw} = the minimum salt water system flow rate necessary to release liquid radwaste

If the minimum salt water flow rate available for liquid releases is unknown, difficult to predict, or may decrease during a liquid release, a minimum salt water flow rate of 0 gpm should be used when calculating the fixed setpoint.

If a release of liquid radwaste is to be conducted using less than the minimum salt water flow rate necessary to conduct liquid releases, the release shall not be allowed until a new setpoint has been calculated and entered into 0-RI-2201.

F_u = maximum undiluted radwaste flow rate (gpm)

Values of maximum undiluted radwaste flow rates for various waste streams are tabulated in Attachments 2 and 3.

Since the flow rate of undiluted liquid waste (120 gpm maximum) is insignificant relative to the circulating water flow rate (200,000 gpm per circulating water pump), the flow rate of undiluted liquid waste need not be considered when calculating the dilution water flow rate.

Since the maximum undiluted radwaste flow rate is used for calculating the fixed setpoint, a flow setpoint is not required--for the flow measuring device (0-FE-2199) in the effluent line--to verify compliance with Technical Specification 3.3.3.10.

A_{iLn} = specific activity limit for the release of radionuclide, i, to UNRESTRICTED AREAS (calculated in accordance with 10 CFR 20, Appendix B, Table II, Note 1 as described below; microcuries per milliliter).

In order to calculate a meaningful and accurate fixed setpoint, the specific radionuclides, i, chosen for calculating the fixed setpoint should correspond to those DOMINANT AND LESS DOMINANT RADIONUCLIDES found in TYPICAL RADWASTE RELEASES from CCNPP.

Attachment 5 provides further guidance for determining the identity of those radionuclides, i, to be used to calculate a fixed setpoint.

Values for A_{iLp} shall be calculated, as described below, for each DOMINANT RADIONUCLIDE and for the collective total of all LESS DOMINANT RADIONUCLIDEs.

SPECIFIC ACTIVITY LIMIT FOR RADIONUCLIDE i

$$A_{iLn} = (f_i)(A_{TLn}) \qquad \text{Eq. 3L}$$

f_i = a fraction which represents the relative activity contribution of nuclide i to the average total effluent activity (unitless)

The average total effluent activity does not include tritium or dissolved and entrained noble gases.

This value may be obtained using the guidance provided on Attachment 5.

A_{TLn} = the sum of the total specific activities of all radionuclides found in a TYPICAL LIQUID RADWASTE RELEASE (microcuries/cm^3)

This value corresponds to 1 MPC.

A_{TLn} shall be calculated as shown below.

TOTAL SPECIFIC ACTIVITY EQUIVALENT TO 1 MPC

$$\sum [(f_i) (A_{TLn}) / A'_{iLi}] = 1 \qquad \text{Eq. 4L}^6$$

A_{iLi} = the specific activity limit for radionuclide, i, as obtained from 10 CFR 20, Appendix B, Table II, Column 2 (microcuries/cm^3)

For all the DOMINANT RADIONUCLIDEs found in TYPICAL RADWASTE EFFLUENTS, use the value from 10 CFR 20, Appendix B, Table II, Column 2.

For each of the LESS DOMINANT RADIONUCLIDEs found in TYPICAL RADWASTE EFFLUENTS, use 3E-8 microcuries per milliliter as the value for A_{iLi} (per 10 CFR 20, Appendix B, Note 2).

1 = the MPC limit (MPCs) for unrestricted areas

This value is based on the MPC limit from 10 CFR 20, Table II, Note 1.

e_i = absolute detector efficiency for nuclide, i (cpm/microcuries per milliliter)

The detector efficiency for each radionuclide may be calculated from data collected during calibration of the radiation monitor.

Bkg = an approximation of the detector background prior to initiating the liquid release (cpm)

If the average background for 0-RI-2201 is insignificant relative to the calculated value of the fixed setpoint, the background count rate may be assumed to be zero.

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(3) Documenting the fixed setpoint for 0-RI-2201

(a) Whenever the fixed setpoint is calculated, the specific values chosen for each of the parameters shall be documented in accordance with CCI-205.

(4) Changing the fixed setpoint for 0-RI-2201

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6 This formula has been derived from 10 CFR 20, Table II, Notes 1, 2, and 3.

(a) If the fixed setpoint calculated in accordance with equation 1L exceeds the maximum range of the monitor, the fixed setpoint shall be adjusted to a value which falls within the normal operating range of the monitor.

(b) The fixed alarm and trip setpoint for 0-RI-2201 may be established at values lower than the maximum allowable setpoint, if desired.

(c) A setpoint change should be initiated whenever any of the parameters identified in equation 1L have changed.

(d) The fixed setpoint should not be changed unless one of the following occurs:

i) the radionuclide mixture (i.e., the fractional activities[7] in equation 3L above) in the "typical" liquid effluent has changed by greater than 10%,

ii) the minimum dilution water flow rate is not available for a liquid release,

iii) the values listed in 10 CFR 20, Table II, column 2 have changed,

iv) the radiation monitor has been recently calibrated, repaired, or otherwise altered, or

v) the monitor is not conservative in its function (the functions of 0-RE-2201 are listed in section V.D.1.b, "Functions of 0-RE-2201").

(e) CCI-205 contains the administrative controls associated with changing and approving the fixed setpoint.

i) The adjustable alarm and trip setpoint for 0-RI-2201

(1) General information

(a) This setpoint is an adjustable setpoint. The adjustable setpoint is calculated and adjusted prior to each release from the liquid waste processing system.

(b) The adjustable setpoint is based on the specific activities of the radionuclides present in the undiluted liquid waste (as determined by radiochemical analysis per Technical Specification 4.11.1.1.1).

(c) Whenever the adjustable setpoint is exceeded, discharges from the liquid waste processing system will be manually suspended.

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7 As determined in accordance with Attachment 5.

(d) See OI-17C, "Reactor Coolant Waste Processing System", or OI-17D, "Miscellaneous Waste Processing System," for a full list of operator actions taken in response to this alarm.

(e) The adjustable setpoint corresponds to the maximum concentration of radionuclides anticipated or expected in discharges from the liquid waste processing system.

(f) The value for the adjustable setpoint is recorded on the liquid release permit in accordance with Chemistry section procedures.

(g) This alarm is not integral to the liquid release discharge monitor, as purchased from the supplier.

(h) This alarm is generated by the plant computer, which monitors output from 0-RI-2201, and provides an alarm to plant operators when the adjustable alarm and trip setpoint has been exceeded.

(i) A value for the adjustable alarm and trip setpoint shall be calculated prior to each release as shown below.

(2) Calculating the adjustable setpoint for 0-RI-2201

(a) The adjustable setpoint is based on the specific activities of the radionuclides in the undiluted liquid waste (as determined by radiochemical analysis per Technical Specification 4.11.1.1.1), and shall be calculated as shown below.

ADJUSTABLE SETPOINT FOR 0-RI-2201

$$S_{adj} \leq 1.50 \left[\sum (A_{iu})(e_i) + Bkg \right] \qquad \text{Eq. 5L}$$

S_{adj} = the adjustable alarm and trip setpoint for 0-RI-2201 (cpm)

1.50 = a constant, actually a safety factor, which allows for fluctuations in radiation monitor response (unitless)

This safety factor helps ensure the release is not unnecessarily terminated due to (1) electronic anomalies which cause spurious monitor responses, (2) statistical fluctuations in disintegration rates, (3) statistical fluctuations in detector efficiencies, (4) errors associated with sample analysis, or (5) errors associated with monitor calibrations.[8]

A_{iu} = specific activity of radionuclide, i, in the undiluted waste stream (microcuries per milliliter)

[8] The "analysis errors" and "calibration errors" refer to errors which are within established quality assurance and quality control limits.

e_i = absolute detector efficiency for nuclide, i (cpm/microcuries per milliliter)

The detector efficiency for each radionuclide may be calculated from data collected during calibration of the radiation monitor.

Bkg = an approximation of the detector background (cpm)

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(3) Documenting the adjustable alarm and trip setpoint for 0-RI-2201

(a) Whenever the adjustable setpoint is calculated, the specific values chosen for each of the variables shall be documented in accordance with approved chemistry section procedures (e.g., CP-601).

(4) Changing the adjustable alarm and trip setpoint for 0-RI-2201

(a) In all cases, the adjustable alarm setpoint shall be set to a value which is less than or equal to the fixed setpoint.

(b) If the adjustable alarm and trip setpoint exceeds the maximum range of the monitor, the setpoint shall be adjusted to a value which falls within the normal operating range of the monitor.

(c) Chemistry section procedures (e.g., CP-601) contain administrative controls associated with calculating and approving an adjustable setpoint.

(d) The calculated value for the adjustable setpoint shall be entered into the plant computer prior to each release from the liquid waste processing system.

(e) Plant Operating Instructions (e.g., OI-17C and OI-17D) contain administrative controls associated with entering the adjustable setpoint into the plant computer.

j) The low radiation alarm for 0-RI-2201

(1) This alarm is integral to the liquid release discharge monitor, as purchased from the supplier.

(2) The current value for the low alarm setpoint is specified in the CCNPP Alarm Manual.

(3) The low alarm setpoint may be used to determine the OPERABILITY of this monitor (per Technical Specification 4.3.3.10, CHANNEL FUNCTIONAL TEST).

(4) The alarm generated by the low alarm setpoint may be used to terminate a release in the event 0-RE-2201 fails (i.e., downscale failure or circuit failure) in accordance with Technical Specification 4.3.3.10.

(5) The low alarm setpoint calculations are not described in the ODCM.

(6) Changes to the low alarm setpoint are controlled by CCI-205.

2. **Steam Generator Blowdown Effluent Radiation Monitors (1/2-RE-4095)**

a) General description of 1/2-RE-4095

(1) number of radiation elements: one per unit

(2) Type of radiation elements: in-line scintillation detectors

(3) output: analog

(4) Designations for radiation indicators

(a) 1-RI-4095

(b) 2-RI-4095

(5) units for radiation indicator: counts per minute

(6) supplier: Westinghouse

b) Functions of 1/2-RE-4095

(1) continuously measure the activity contained in steam generator blowdown effluent line (Technical Specification 3.3.3.10)

(2) continuously indicate (via 1/2-RI-4095) the activity of liquids contained in the steam generator blowdown effluent line (Technical Specification 3.3.3.10)

(3) alarm (via 1/2-RI-4095) prior to exceeding 10 CFR 20, Appendix B, Table II, Column 2 limits (per Technical Specification 3.11.1.1) (Note: A technical evaluation shall be conducted to ensure compliance with UFSAR 10.2.2.4.)

(4) automatically terminate steam generator blowdown releases to UNRESTRICTED AREAS when the radiation indicator (1/2-RI-4095) exceeds the fixed alarm setpoint

c) OPERABILITY of 1/2-RE-4095

(1) This monitor shall be operable (or have OPERABILITY) when it is capable of performing its specified function(s).[9]

(2) The functions of this monitor are listed in section (b) above.

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9 Technical Specification 1.6

(3) It should be noted that if the steam generator blowdown processing system heat exchangers are bypassed, it is possible for blowdown flow to bypass 1/2-RE-4095. If blowdown flow is allowed to bypass 1/2-RE-4095, the minimum channels operability requirement of Specification 3.3.3.10 may not be satisfied.

d) Monitors equivalent to 1/2-RE-4095

(1) 1/2-RE-4014 is normally considered the PRIMARY MONITOR for measuring activity released via the steam generator blowdown processing system, and 1/2-RE-4095 is normally considered the BACKUP MONITOR for measuring activity released via the steam generator blowdown processing system.

(2) In the event PRIMARY MONITOR (1/2-RE-4014) is inoperable or otherwise unavailable, the BACKUP MONITOR (1/2-RE-4095) is able to fulfill the measuring, indicating, and alarming functions normally provided by the PRIMARY MONITOR.

(3) 1/2-RE-4014, Steam Generator Blowdown Tank Radiation Monitor is considered to be "equivalent" monitor to 1/2-RE-4095 as specified below.

(4) 1/2-RE-4014, Steam Generator Blowdown Tank Radiation Monitor, is able to perform measurement, indication, alarm, and isolation functions (see "Functions of 1/2-RE-4014", section V.D.2.b) which limit the concentration of radioactive materials released to UNRESTRICTED AREAS in accordance with Technical Specification 3.11.1.1 as long as the following conditions are satisfied:

(a) the OPERABILITY of 1/2-RE-4014 must be demonstrated in accordance with Technical Specification 4.3.3.10, Table 3.3.13(1b), and

(b) the blowdown ion exchangers are isolated (or the decontamination factors for all radionuclides are verified to be greater than or equal to one for the duration of the release), and

(c) the specific activities of radionuclides in the blowdown tank radiation monitor are representative of the activities of the radionuclides in the blowdown effluent line.

e) Radiological effluent controls for 1/2-RE-4095

(1) Steam generator blowdown releases via this pathway may continue if any one of the following two conditions are satisfied (per Technical Specification 3.3.3.10):

(a) A steam generator blowdown monitor (either 1/2-RE-4095 or 1/2-RE-4014) is OPERABLE (see section V.D.2.c, "OPERABILITY of 1/2-RE-4095"; and section V.D.3.c, "OPERABILITY of 1/2-RE-4014") AND the alarm and trip setpoint for this monitor is set to ensure the concentrations of radioactive materials released in liquid effluents to UNRESTRICTED AREAS are less than the concentrations specified in 10 CFR 20, Appendix B, Table II, Column 2, or

(b) a grab sample is collected AND analyzed in accordance with the provisions described below:

i) analysis shall determine EITHER the gross gamma activity or gross beta activity of the sample

ii) sampling and analysis shall be completed at least once per 12 hours if the specific activity of the steam generator blowdown is greater than 0.01 microcuries per gram IODINE DOSE EQUIVALENT

iii) sampling and analysis shall be completed at least once per 48 hours if the specific activity of the steam generator blowdown is less than or equal to 0.01 microcuries per gram IODINE DOSE EQUIVALENT

iv) the LOWER LIMITS OF DETECTION (LLDs) for the gross gamma and/or gross beta analyses are in accordance with the LLDs of Technical Specification 4.11.1.1.1

f) Surveillances for 1/2-RE-4095

(1) Technical Specification 4.3.3.10 requires demonstrating the OPERABILITY of 1/2-RE-4095 by satisfying the checks, calibrations, and tests listed below

(a) CHANNEL CHECK within the past 24 hours[10]

(b) SOURCE CHECK prior to each release

(c) CHANNEL CALIBRATION within the past 18 months

(d) CHANNEL FUNCTIONAL TEST within the past 6 six months

g) Setpoints for 1/2-RI-4095

(1) There are three radiation alarm setpoints associated with the Steam Generator Blowdown Effluent Radiation Monitor.

(a) 1/2-RI-4095 fixed high radiation alarm and automatic control trip setpoint

(b) 1/2-RI-4095 adjustable plant computer high radiation alarm and manual control trip setpoint

(c) 1/2-RI-4095 low radiation alarm setpoint

(2) In order to simplify the setpoint terminology, eliminate ambiguity, and minimize the possibility of misinterpretation, the ODCM will refer to these setpoints as follows:

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10 Technical Specifications Table 1.2

(a) The 1/2-RI-4095 fixed high radiation alarm and automatic control trip setpoint will be referred to as the fixed setpoint.

(b) The 1/2-RI-4095 adjustable plant computer high radiation alarm and manual control trip setpoint will be referred to as the adjustable setpoint.

(c) The 1/2-RI-4095 low radiation alarm setpoint will be referred to as the low setpoint.

(3) Each of these alarm setpoints are described below.

h) The fixed setpoint for 1/2-RI-4095

(1) General information

(a) This setpoint is considered to be a fixed alarm and trip setpoint. The fixed setpoint is not adjusted for each release.

(b) Whenever the fixed setpoint is exceeded, discharges from the from the steam generator blowdown processing system to UNRESTRICTED AREAS will be automatically suspended.

(c) The fixed setpoint corresponds to the maximum concentration of radionuclides allowed in liquid waste discharged from the steam generator blowdown processing system.[11]

(d) The current value for the fixed setpoint is specified in the CCNPP Alarm Manual.

(e) The CCNPP Alarm Manual refers to this alarm and trip setpoint as the 1/2-RI-4095 Steam Generator Blowdown Recovery High Alarm.

(f) This setpoint is integral to the steam generator blowdown discharge monitor, as purchased from the manufacturer.

(g) The fixed setpoint is administratively controlled by CCI-205.

(h) The fixed alarm and trip setpoint shall be calculated as described below[12].

(2) Calculating the fixed setpoint for 1/2-RI-4095

(a) The fixed alarm setpoint for 1/2-RI-4095 shall be calculated in accordance with equation 1L.

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[11] It should be noted that the UFSAR (section 10.2.2.4) states, "the blowdown liquid monitor has an alarm setpoint selected to allow an annual average continuous blowdown past the monitor of 10 gpm without exceeding one curie discharged per year, excluding tritium."

[12] Per Technical Specification 3.3.3.10.

FIXED SETPOINT FOR 1/2-RI-4095

$$S_{fix} \leq K_{sf}\{(F_d/F_u)\sum[(A_{iLn})(e_i)] + Bkg\} \quad \text{Eq. 1L}^{13}$$

S_{fix} = the fixed alarm and trip setpoint for 1/2-RI-4095 (cpm)

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP activity limit to the 10 CFR 20 MPC limit (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the fixed setpoint is always less than or equal to the limits of 10 CFR 20.

A safety factor of 1.00 will yield a fixed setpoint which corresponds to 1.0 MPC.

A safety factor of 0.500 will yield a fixed setpoint which corresponds to 0.5 MPCs.

It is recommended that a safety factor of 0.5 be used for calculating the fixed setpoint, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

The use of a "safety margin" is in accordance with the provisions of NUREG-0133, section 4.1.1, which states, "The alarm and trip setpoints ... should correspond to a value(s) which represents a safe margin of assurance that the instantaneous liquid release limit of 10 CFR Part 20 is not exceeded."

This safety margin will prevent minor fluctuations in the nominal circulating water flow rate (and other statistical aberrations) from adversely impacting the calculated fixed setpoint.

F_d = the dilution water flow rate (gpm) prior to the point of release to UNRESTRICTED AREAS

the dilution water flow rate is actually the sum of the minimum circulating water flow rate, the minimum salt water flow rate, and the maximum undiluted radwaste flow rate.

The dilution water flow rate shall be calculated in accordance with equation 2L.

DILUTION WATER FLOW RATE

$$F_d = F_{cw} + F_{sw} + F_u \quad \text{Eq. 2L}$$

F_{cw} = the minimum circulating water system flow rate necessary to conduct liquid releases

13 Equation 1L has been derived from NUREG-0133, Addendum, page AA-1.

A minimum of two circulating water pumps per unit (one circulating water pump per conduit) shall be operable when discharging liquid radwaste to outfall 001.

The flow rate of each circulating water pump is 200,000 gallons per minute.

Additional circulating water pumps may be required as specified in approved chemistry section procedures.

If a release of liquid radwaste from the steam generator blowdown system is to be conducted using less than minimum circulating water flow rate necessary to conduct liquid releases, the release shall not be allowed until a new setpoint has been calculated and entered into 1/2-RI-4095.

F_{sw} = the minimum salt water system flow rate necessary to release liquid radwaste

If the minimum salt water flow rate available for liquid releases is unknown, difficult to predict, or may decrease during a liquid release, a minimum salt water flow rate of 0 gpm should be used when calculating the fixed setpoint.

The maximum flow rate for one salt water pump is listed on Attachment 2.

If a release of liquid radwaste is to be conducted using less than the minimum salt water flow rate necessary to conduct liquid releases, the release shall not be allowed until a new setpoint has been calculated and entered into 1/2-RI-4095.

F_u = maximum undiluted radwaste flow rate (gpm)

Values of maximum undiluted radwaste flow rates for various waste streams are tabulated in Attachments 2 and 3.

Since the steam generator blowdown flow rate (225 gpm maximum) is insignificant relative to the circulating water flow rate (200,000 gpm per circulating water pump), the steam generator blowdown flow rate need not be considered when calculating the dilution water flow rate.

Since the maximum undiluted radwaste flow rate is used for calculating the fixed setpoint, a flow setpoint is not required--for the flow measuring device in the effluent line--to verify compliance with Technical Specification 3.3.3.10.

A_{iLn} = specific activity limit for the release of radionuclide, i, to UNRESTRICTED AREAS (calculated in accordance with 10 CFR 20, Appendix B, Table II, Note 1 as described below; microcuries per milliliter)

In order to calculate a meaningful and accurate fixed setpoint, the specific radionuclides, i, chosen for calculating the fixed setpoint should correspond to those DOMINANT AND LESS DOMINANT RADIONUCLIDES found in TYPICAL RADWASTE RELEASES from CCNPP.

Attachment 5 provides further guidance for determining which radionuclides, i, should be used to calculate a fixed setpoint.

Values for A_{iLn} shall be calculated, as described below, for each DOMINANT RADIONUCLIDE and for the collective total of all LESS DOMINANT RADIONUCLIDEs.

SPECIFIC ACTIVITY LIMIT FOR EACH RADIONUCLIDE i

$$A_{iLn} = (f_i)(A_{TLn}) \qquad \text{Eq. 3L}$$

f_i = a fraction which represents the relative activity contribution of nuclide i to the average total effluent activity (unitless)

The average total effluent activity does not include tritium or dissolved and entrained noble gases.

This value may be obtained using the guidance provided on Attachment 5.

e_i = absolute detector efficiency for nuclide, i (cpm/microcuries per milliliter)

The detector efficiency for each radionuclide may be calculated from data collected during calibration of the radiation monitor.

A_{TLn} = the sum of the total specific activities of all radionuclides found in a TYPICAL LIQUID RADWASTE RELEASE (microcuries/cm^3)

This value corresponds to 1 MPC.

A_{TLn} shall be calculated as shown below.

TOTAL SPECIFIC ACTIVITY EQUIVALENT TO 1 MPC

$$\sum [(f_i)(A_{TLn}) / A_{iLi}] = 1 \qquad \text{Eq. 4L}^{14}$$

A_{iLi} = the specific activity limit for radionuclide, i, as obtained from 10 CFR 20, Appendix B, Table II, Column 2 (microcuries/cm^3)

For all the DOMINANT RADIONUCLIDEs found in TYPICAL RADWASTE EFFLUENTS, use the value from 10 CFR 20, Appendix B, Table II, Column 2.

For each of the LESS DOMINANT RADIONUCLIDEs found in TYPICAL RADWASTE EFFLUENTS, use 3E-8 microcuries per milliliter as the value for A_{iLi} (per 10 CFR 20, Appendix B, Note 2).

1 = the MPC limit (MPCs) for unrestricted areas

This value is based on the MPC limit from 10 CFR 20, Table II, Note 1.

Bkg = an approximation of the detector background (cpm)

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14 This formula has been derived from 10 CFR 20, Table II, Notes 1, 2, and 3.

If the average background for 0-RI-2201 is insignificant relative to the calculated value of the fixed setpoint, the background count rate may be assumed to be zero.

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(3) Documenting the fixed setpoint for 1/2-RI-4095

(a) Whenever the fixed setpoint is calculated, the specific values chosen for each of the variables shall be documented in accordance with CCI-205.

(4) Changing the fixed setpoint for 1/2-RI-4095

(a) If the fixed setpoint calculated in accordance with equation 1L exceeds the maximum range of the monitor, the fixed setpoint shall be adjusted to a value which falls within the normal operating range of the monitor.

(b) The fixed setpoint may be established at values lower than the maximum allowable setpoint, if desired.

(c) A setpoint change should be initiated whenever any of the parameters identified in equation 1L have changed.

(d) The fixed setpoint should not be changed unless one of the following occurs:

i) the relative activity[15] of any radionuclide in TYPICAL LIQUID EFFLUENTS has changed by greater than 10%,

ii) the minimum dilution water flow rate is not available for a liquid release,

iii) the values listed in 10 CFR 20, Table II, column 2 have changed,

iv) the radiation monitor has been recently calibrated, repaired, or otherwise altered, or

v) the monitor is not conservative in its function (see section V.D.2.b, "Functions of 1/2-RE-4095").

(e) CCI-205 contains the administrative controls associated with changing and approving the fixed alarm and trip setpoint.

i) The adjustable alarm and trip setpoint for 1/2-RI-4095

(1) General information

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15 As determined in accordance with Attachment 5.

(a) This setpoint is an adjustable setpoint. The adjustable setpoint is calculated and adjusted prior to each release from the steam generator blowdown processing system.

(b) The adjustable setpoint is based on the specific activities of the radionuclides present in the undiluted liquid waste (as determined by radiochemical analysis per Technical Specification 4.11.1.1.1).

(c) Whenever the adjustable setpoint is exceeded, discharges from the steam generator blowdown processing system will be manually suspended.

(d) See OI-8A and the CCNPP Alarm Manual for a full list of operator actions taken in response to this alarm.

(e) The adjustable setpoint corresponds to the maximum concentration of radionuclides anticipated or expected in discharges from the steam generator blowdown processing system.

(f) The value for the adjustable setpoint is recorded on the liquid release permit in accordance with Chemistry section procedures.

(g) This alarm is not integral to the steam generator blowdown effluent monitor, as purchased from the supplier.

(h) This alarm is generated by the plant computer which monitors output from 1/2-RI-4095, and provides an alarm to plant operators when the adjustable alarm and trip setpoint has been exceeded.

(i) A value for the adjustable alarm and trip setpoint shall be calculated prior to each release as shown below.

(2) Calculating the adjustable setpoint for 1/2-RI-4095

(a) The adjustable setpoint is based on the specific activities of radionuclides in the undiluted liquid waste (as determined by radiochemical analysis per Technical Specification 4.11.1.1.1), and shall be calculated as shown below.

ADJUSTABLE SETPOINT FOR 1/2-RI-4095

$$S_{adj} \leq 1.50 \left[\sum (A_{iu})(e_i) + Bkg \right] \qquad \text{Eq. 5L}^{16}$$

Where,

S_{adj} = the adjustable alarm and trip setpoint for 1/2-RI-4095 (cpm)

16 This formula may be derived from NUREG-0133, Addendum, page AA-1.

1.50 = a constant, actually a safety factor, which allows for fluctuation in radiation monitor response (unitless)

This safety factor helps ensure the release is not unnecessarily terminated due to (1) electronic anomalies which cause spurious monitor responses, (2) statistical fluctuations in disintegration rates, (3) statistical fluctuations in detector efficiencies, (4) errors associated with sample analysis, or (5) errors associated with monitor calibrations.[17]

A_{iu} = specific activity of radionuclide, i, in the undiluted waste stream (microcuries per milliliter)

e_i = absolute detector efficiency for nuclide, i (cpm/microcuries per milliliter)

The detector efficiency for each radionuclide may be calculated from data collected during calibration of the radiation monitor.

Bkg = an approximation of the detector background prior to initiating the liquid release (cpm)

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(3) Documenting the adjustable setpoint, 1/2-RI-4095

(a) Whenever the adjustable setpoint is calculated, the specific values chosen for each of the variables shall be documented in accordance with approved chemistry section procedures.

(4) Changing the adjustable alarm and trip setpoint for 1/2-RI-4095

(a) If the adjustable setpoint exceeds the maximum range of the monitor, the setpoint shall be adjusted to a value which falls within the normal operating range of the monitor.

(b) In all cases, the adjustable setpoint shall be set to a value which is less than or equal to the fixed setpoint.

(c) Chemistry procedures contain administrative controls associated with calculating and approving an adjustable setpoint.

(d) The calculated value for the adjustable setpoint shall be entered into the plant computer prior to each release from the liquid waste processing system.

(e) Plant Operating Instructions (e.g., OI-17C and OI-17D) contain administrative controls associated with entering the adjustable setpoint in the plant computer.

j) The low setpoint for 1/2-RI-4095

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17 The "analysis errors" and "calibration errors" refer to errors which are within established quality assurance and quality control limits.

(1) This alarm is integral to the steam generator blowdown effluent monitor, as purchased from the manufacturer.

(2) The current value for the low alarm setpoint is specified in the CCNPP Alarm Manual.

(3) The low alarm setpoint may be used to determine OPERABILITY of this monitor (per Technical Specification 4.3.3.10, CHANNEL FUNCTIONAL TEST).

(4) The low alarm setpoint may be used to terminate a release in the event 1/2-RE-4095 fails (i.e., downscale failure or circuit failure).

(5) Changes to the low alarm setpoint are controlled by CCI-205.

(6) The ODCM does not address the calculations associated with the low alarm setpoint.

3. **Steam Generator Blowdown Tank Radiation Monitors (1/2-RE-4014)**

a) General description of 1/2-RE-4014

(1) number of radiation elements: one per unit

(2) Type of radiation element: off-line scintillation detector

(3) output: analog

(4) Designations for radiation indicators

(a) 1-RI-4014

(b) 2-RI-4014

(5) units for radiation indicator: counts per minute

(6) supplier: Westinghouse

(7) A 3 gallon per minute sample is cooled, passed through the detector, and pumped back into the steam generator blowdown tank.

b) Functions of 1/2-RE-4014

(1) continuously measure the activity contained in an off-line sample of the steam generator blowdown tank (Technical Specification 3.3.3.10)

(2) continuously indicate (via 1/2-RI-4014) the specific activity in an off-line sample of the steam generator blowdown tank (Technical Specification 3.3.3.10)

(3) alarm (via 1/2-RI-4014) prior to exceeding the 10 CFR 20, Appendix B, Table II, Column 2 limits (per Technical Specification 3.11.1.1) (Note: A technical evaluation shall be conducted to ensure compliance with UFSAR 10.2.2.4.)

(4) automatically terminate steam generator blowdown releases to UNRESTRICTED AREAS when the radiation indicator (1/2-RI-4014) exceeds the fixed alarm setpoint.

c) OPERABILITY of 1/2-RE-4014

(1) This monitor shall be operable (or have OPERABILITY) when it is capable of performing its specified function(s)[18]

(2) The functions of this monitor are listed in section (b) above.

d) Monitors equivalent to 1/2-RE-4014

(1) 1/2-RE-4014 is normally considered the PRIMARY MONITOR for measuring activity released via the steam generator blowdown processing system, and 1/2-RE-4095 is normally considered the BACKUP MONITOR for measuring activity released via the steam generator blowdown processing system.

(2) In the event PRIMARY MONITOR (1/2-RE-4014) is inoperable or otherwise unavailable, the BACKUP MONITOR (1/2-RE-4095) is able to fulfill the measuring, indicating, and alarming functions normally provided by the PRIMARY MONITOR.

(3) 1/2-RE-4095, Steam Generator Blowdown Effluent Radiation Monitor, performs measurement, indication, alarm, and isolation functions equivalent to 1/2-RE-4014 (see section V.D.3.b, "Function of 1/2-RE-4014"), unless 1/2-RE-4095 is bypassed as described below.

(4) It should be noted that if the steam generator blowdown processing system heat exchangers are bypassed, it is possible for blowdown flow to bypass 1/2-RE-4095 (the steam generator blowdown effluent radiation monitor). If blowdown flow is allowed to bypass 1/2-RE-4095, the minimum channels operability requirement of Specification 3.3.3.10 may not be satisfied (unless 1/2-RE-4014 is operable).

e) Radiological effluent controls for 1/2-RE-4014

(1) Steam generator blowdown releases via this pathway may continue if any one of the following two conditions are satisfied (per Technical Specification 3.3.3.10):

(a) A steam generator blowdown monitor (either 1/2-RE-4095 or 1/2-RE-4014) is OPERABLE (see section V.D.2.c, "OPERABILITY of 1/2-RE-4095"; and section V.D.3.c, "OPERABILITY of 1/2-RE-4014") AND the alarm and trip setpoint for this monitor is set to ensure the concentrations of radioactive materials released in liquid effluents to UNRESTRICTED AREAS are less than the concentrations specified in 10 CFR 20, Appendix B, Table II, Column 2, or

18 Technical Specification 1.6

(b) a grab sample is collected AND analyzed in accordance with the provisions described below:

i) analysis shall determine EITHER the gross gamma activity or gross beta activity of the sample

ii) sampling and analysis shall be completed at least once per 12 hours if the specific activity of the steam generator blowdown is greater than 0.01 microcuries per gram IODINE DOSE EQUIVALENT

iii) sampling and analysis shall be completed at least once per 48 hours if the specific activity of the steam generator blowdown is less than or equal to 0.01 microcuries per gram IODINE DOSE EQUIVALENT

iv) the LOWER LIMITS OF DETECTION for the gross gamma and/or gross beta analyses are in accordance with the LLDs of Technical Specification 4.11.1.1.1

f) Surveillances for 1/2-RE-4014

(1) Technical Specification 4.3.3.10 requires demonstrating the OPERABILITY of 1/2-RE-4014 by satisfying the checks, calibrations, and tests listed below

(a) CHANNEL CHECK within the past 24 hours[19]

(b) SOURCE CHECK prior to each release

(c) CHANNEL CALIBRATION within the past 18 months

(d) CHANNEL FUNCTIONAL TEST within the past 6 six months

g) Setpoints for 1/2-RI-4014

(1) There are three radiation alarm setpoints associated with the Steam Generator Blowdown Tank Radiation Monitor

(a) 1/2-RI-4014 fixed high radiation alarm and automatic control trip setpoint

(b) 1/2-RI-4014 adjustable plant computer high radiation alarm and manual control trip setpoint

(c) 1/2-RI-4014 low radiation alarm setpoint

(2) In order to simplify the setpoint terminology, eliminate ambiguity, and minimize the possibility of misinterpretation, the ODCM will refer to these setpoints as follows:

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19 Technical Specifications Table 1.2

(a) The 1/2-RI-4014 fixed high radiation alarm and automatic control trip setpoint will be referred to as the fixed setpoint.

(b) The 1/2-RI-4014 adjustable plant computer high radiation alarm and manual control trip setpoint will be referred to as the adjustable setpoint.

(c) The 1/2-RI-4014 low radiation alarm setpoint will be referred to as the low setpoint.

(3) Each of these alarms is described below.

h) The fixed alarm and trip setpoint for 1/2-RI-4014

(1) General Information

(a) This alarm and trip setpoint is considered to be a fixed setpoint. The fixed setpoint is not adjusted for each release.

(b) Whenever the fixed setpoint is exceeded, discharges from the steam generator blowdown processing system to UNRESTRICTED AREAS will be automatically suspended.

(c) The fixed setpoint corresponds to the maximum concentration of radionuclides allowed in liquid waste discharged from the steam generator blowdown processing system.[20]

(d) The current value for the fixed alarm and trip setpoint is specified in the CCNPP Alarm Manual.

(e) The CCNPP Alarm Manual refers to the fixed setpoint as the 1/2-RI-4014 Steam Generator Blowdown High Alarm.

(f) The fixed setpoint is integral to the liquid release discharge monitor, as purchased from the manufacturer.

(g) The fixed alarm and trip setpoint is administratively controlled by CCI-205.

(h) The fixed alarm and trip setpoint shall be calculated as described below[21].

(2) Calculating the fixed alarm and trip setpoint for 1/2-RI-4014

(a) The fixed alarm and trip setpoint for 1/2-RI-4014 shall be calculated as follows:

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20 It should be noted that the UFSAR (section 10.2.2.4) states, "the blowdown liquid monitor has an alarm setpoint selected to allow an annual average continuous blowdown past the monitor of 10 gpm without exceeding one curie discharged per year, excluding tritium."

21 Per Technical Specification 3.3.3.10.

FIXED ALARM AND TRIP SETPOINT FOR 1/2-RI-4014

$$S_{fix} \leq K_{sf}\{(F_d / F_u)\sum[(A_{iLn})(e_i)] + Bkg\} \quad \text{Eq. 1L}^{22}$$

Where,

S_{fix} = the fixed alarm and trip setpoint for 1/2-RI-4014 (cpm)

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP activity limit to the 10 CFR 20 MPC limit (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the fixed setpoint is always less than or equal to the limits of 10 CFR 20.

A safety factor of 1.00 will yield a fixed setpoint which corresponds to 1.0 MPC.

A safety factor of 0.500 will yield a fixed setpoint which corresponds to 0.5 MPCs.

It is recommended that a safety factor of 0.5 be used for calculating the fixed setpoint, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

The use of a "safety margin" is in accordance with the provisions of NUREG-0133, SECTION 4.1.1, which states, "The alarm and trip setpoints ... should correspond to a value(s) which represents a safe margin of assurance that the instantaneous liquid release limit of 10 CFR Part 20 is not exceeded."

This safety margin will prevent minor fluctuations in the nominal circulating water flow rate (and other statistical aberrations) from adversely impacting the calculated fixed setpoint.

F_d = the dilution water flow rate (gpm) prior to the point of release to UNRESTRICTED AREAS

The dilution water flow rate is actually the sum of the minimum circulating water flow rate, the minimum salt water flow rate, and the maximum undiluted radwaste flow rate.

The dilution water flow rate shall be calculated in accordance with equation 2L.

DILUTION WATER FLOW RATE

$$F_d = F_{cw} + F_{sw} + F_u \quad \text{Eq. 2L}$$

F_{cw} = the minimum circulating water system flow rate necessary to conduct liquid releases

22 Equation 1L has been derived from NUREG-0133, Addendum, page AA-1.

A minimum of two circulating water pumps per unit (one circulating water pump per conduit) shall be operable when discharging liquid radwaste to outfall 001.

The flow rate of each circulating water pump is 200,000 gallons per minute.

Additional circulating water pumps may be required as specified in approved chemistry section procedures.

If a release of liquid radwaste from the steam generator blowdown system is to be conducted using less than minimum circulating water flow rate necessary to conduct liquid releases, the release shall not be allowed until a new setpoint has been calculated and entered into 1/2-RI-4014.

F_{sw} = the minimum salt water system flow rate necessary to release liquid radwaste

If the minimum salt water flow rate available for liquid releases is unknown, difficult to predict, or may decrease during a liquid release, a minimum salt water flow rate of 0 gpm should be used when calculating the fixed setpoint.

The maximum flow rate for one salt water pump is listed on Attachment 2.

If a release of liquid radwaste is to be conducted using less than the minimum salt water flow rate necessary to conduct liquid releases, the release shall not be allowed until a new setpoint has been calculated and entered into 1/2-RI-4014.

F_u = maximum undiluted radwaste flow rate (gpm)

Values of maximum undiluted radwaste flow rates for various waste streams are tabulated in Attachments 2 and 3.

Since the steam generator blowdown flow rate (225 gpm maximum) is insignificant relative to the circulating water flow rate (200,000 gpm per circulating water pump), the steam generator blowdown flow rate need not be considered when calculating the dilution water flow rate.

Since the maximum undiluted radwaste flow rate is used for calculating the fixed setpoint, a flow setpoint is not required--for the flow measuring device in the effluent line--to verify compliance with Technical Specification 3.3.3.10.

A_{iLn} = specific activity limit for the release of radionuclide, i, to UNRESTRICTED AREAS (calculated in accordance with 10 CFR 20, Appendix B, Table II, Note 1 as described below; microcuries per milliliter)

In order to calculate a meaningful and accurate fixed setpoint, the specific radionuclides, i, chosen for calculating the fixed setpoint should correspond to those DOMINANT AND LESS DOMINANT RADIONUCLIDES found in TYPICAL RADWASTE RELEASES from CCNPP.

Attachment 5 provides further guidance for determining which radionuclides, i, should be used to calculate a fixed setpoint.

Values for A_{iLn} shall be calculated, as described below, for each DOMINANT RADIONUCLIDE and for the collective total of all LESS DOMINANT RADIONUCLIDEs.

SPECIFIC ACTIVITY LIMIT FOR RADIONUCLIDE, i

$$A_{iLn} = (f_i)(A_{TLn}) \qquad \text{Eq. 3L}$$

f_i = a fraction which represents the relative activity contribution of nuclide i to the average total effluent activity (unitless)

The average total effluent activity does not include tritium or dissolved and entrained noble gases.

This value may be obtained using the guidance provided on Attachment 5.

A_{TLn} = the sum of the total specific activities of all radionuclides found in a TYPICAL LIQUID RADWASTE RELEASE (microcuries/cm^3)

This value corresponds to 1 MPC.

Calculate the value of A_{TLn} as shown below.

TOTAL SPECIFIC ACTIVITY CORRESPONDING TO 1 MPC AT THE SITE BOUNDARY

$$\sum [(f_i)(A_{TLn}) / A_{iLi}] = 1 \qquad \text{Eq. 4L}^{23}$$

A_{iLi} = the specific activity limit for radionuclide, i, as obtained from 10 CFR 20, Appendix B, Table II, Column 2 (microcuries/cm^3)

For all the DOMINANT RADIONUCLIDEs found in TYPICAL RADWASTE EFFLUENTS, use the value from 10 CFR 20, Appendix B, Table II, Column 2.

For each of the LESS DOMINANT RADIONUCLIDEs found in TYPICAL RADWASTE EFFLUENTS, use 3E-8 microcuries per milliliter as the value for A_{iLi} (per 10 CFR 20, Appendix B, Note 2).

1 = the MPC limit (MPCs) for unrestricted areas

This value is based on the MPC limit from 10 CFR 20, Table II, Note 1.

e_i = absolute detector efficiency for nuclide, i (cpm/microcuries per milliliter)

The detector efficiency for each radionuclide may be calculated from data collected during calibration of the radiation monitor.

Bkg = an approximation of the detector background (cpm)

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23 This formula has been derived from 10 CFR 20, Table II, Notes 1, 2, and 3.

If the average background for 0-RI-2201 is insignificant relative to the calculated value of the fixed setpoint, the background count rate may be assumed to be zero.

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(3) Documenting the fixed setpoint for 1/2-RI-4014

(a) Whenever the fixed setpoint is calculated, the specific values chosen for each of the variables shall be documented in accordance with CCI-205.

(4) Changing the fixed setpoint for 1/2-RI-4014

(a) If the fixed setpoint calculated in accordance with equation 1L exceeds the maximum range of the monitor, the fixed setpoint shall be adjusted to a value which falls within the normal operating range of the monitor.

(b) The fixed alarm setpoint may be established at values lower than the maximum allowable setpoint, if desired.

(c) A setpoint change should be initiated whenever any of the parameters identified in equation 1L (identified in this section of the ODCM) have changed.

(d) The fixed setpoint should not be changed unless one of the following occurs:

i) the relative activity[24] of any radionuclide in TYPICAL LIQUID EFFLUENTS has changed by greater than 10%,

ii) the minimum dilution water flow rate is not available for a liquid release,

iii) the values listed in 10 CFR 20, Table II, column 2 have changed,

iv) the radiation monitor has been recently calibrated, repaired, or otherwise altered, or

v) the monitor is not conservative in its function (see section V.D.3.b, "Functions of 1/2-RE-4014").

(e) CCI-205 contains the administrative controls associated with changing and approving the fixed setpoint.

i) The adjustable alarm and trip setpoint for 1/2-RI-4014

(1) General information

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[24] As determined in accordance with Attachment 5.

(a) This setpoint is an adjustable setpoint. The adjustable setpoint is calculated and adjusted prior to each release from the steam generator blowdown processing system.

(b) The adjustable setpoint is based on the specific activities of the radionuclides present in the undiluted liquid waste (as determined by radiochemical analysis per Technical Specification 4.11.1.1.1).

(c) Whenever the adjustable setpoint is exceeded, discharges from the steam generator blowdown processing system will be manually suspended.

(d) See OI-8A and the CCNPP Alarm Manual for a full list of operator actions taken in response to this alarm.

(e) The adjustable setpoint corresponds to the maximum concentration of radionuclides anticipated or expected in discharges from the steam generator blowdown processing system.

(f) The value for the adjustable setpoint is recorded on the liquid release permit in accordance with Chemistry section procedures.

(g) This alarm is not integral to the steam generator blowdown tank radiation monitor, as purchased from the supplier.

(h) This alarm is generated by the plant computer which monitors output from 1/2-RI-4014, and provides an alarm to plant operators when the 1/2-RI-4014 adjustable setpoint has been exceeded.

(i) A value for the adjustable alarm and trip setpoint shall be calculated prior to each release as shown below.

(2) Calculating the adjustable setpoint for 1/2-RI-4014

(a) The adjustable alarm and trip setpoint is based on the specific activity of the radionuclides in the undiluted liquid waste (as determined by radiochemical analysis per Technical Specification 4.11.1.1.1), and the alarm and trip setpoint is calculated as shown below.

ADJUSTABLE ALARM AND TRIP SETPOINT FOR 1/2-RI-4014

$$S_{adj} \leq 1.50 \left[\sum (A_{iu})(e_i) + Bkg \right] \qquad \text{Eq. 5L}^{25}$$

S_{adj} = the adjustable alarm and trip setpoint for 1/2-RI-4014 (cpm)

25 Equation 5L has been derived from NUREG-0133, Addendum, page AA-1.

1.50 = a constant, actually a safety factor, which allows for fluctuation in radiation monitor response (unitless)

This safety factor helps ensure the release is not unnecessarily terminated due to (1) electronic anomalies which cause spurious monitor responses, (2) statistical fluctuations in disintegration rates, (3) statistical fluctuations in detector efficiencies, (4) errors associated with sample analysis, and (5) errors associated with monitor calibrations.[26]

A_{iu} = specific activity of radionuclide, i, in the undiluted waste stream (microcuries per milliliter)

e_i = absolute detector efficiency for nuclide, i (cpm/microcuries per milliliter)

The detector efficiency for each radionuclide may be calculated from data collected during calibration of the radiation monitor.

Bkg = an approximation of the detector background (cpm)

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(3) Documenting the adjustable setpoint for 1/2-RI-4014

(a) Whenever the adjustable setpoint is calculated, the specific values chosen for each of the variables shall be documented in accordance with approved chemistry section procedures.

(4) Changing the adjustable setpoint for 1/2-RI-4014

(a) If the adjustable setpoint exceeds the maximum range of the monitor, the setpoint shall be adjusted to a value which falls within the normal operating range of the monitor.

(b) In all cases, the adjustable setpoint shall be set to a value which is less than or equal to the fixed setpoint.

(c) Chemistry procedures contain administrative controls associated with calculating and approving an adjustable setpoint.

(d) The calculated value for the adjustable setpoint shall be entered into the plant computer prior to each release from the liquid waste processing system.

(e) Plant Operating Instructions (e.g., OI-17C and OI-17D) contain administrative controls associated with entering the adjustable setpoint in the plant computer.

j) The low alarm setpoint for 1/2-RI-4014

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[26] The "analysis errors" and "calibration errors" refer to errors which are within established quality assurance and quality control limits.

(1) This alarm is integral to the steam generator blowdown tank monitor, as purchased from the manufacturer.

(2) The current value for the low alarm setpoint is specified in the CCNPP Alarm Manual.

(3) Changes to the low alarm setpoint are controlled by CCI-205.

(4) The ODCM does not address the calculations associated with the low alarm setpoint.

E. Limits On Radionuclide Concentrations In Liquid Effluents

1. Introduction

a) 10 CFR 20, Appendix B, specifies concentration limits associated with the release of radioactive materials to UNRESTRICTED AREAS.

b) Radiological effluent controls have been established to implement the requirements of 10 CFR 20.

c) These radiological effluent controls are described below.

2. Radiological Effluent Controls

a) The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS shall be limited to the concentrations specified in 10 CFR 20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases (per Technical Specification 3.11.1.1).

b) It should be noted that NUREG-0133 specifies that the concentration of radioactive materials in liquid effluents to UNRESTRICTED AREAS shall be limited to 2 E-4 microcuries per milliliter for dissolved or entrained noble gases, this control has not been incorporated into the CCNPP Technical Specifications, and as a result, the ODCM does not include calculations for same.

c) The routine surveillances which are performed to verify compliance with these radiological effluent controls are described below.

3. Surveillance Requirements

a) Routine surveillances for BATCH releases

(1) Sample each "BATCH" of radioactive liquid waste prior to its release (per Technical Specification 4.11.1.1.1).

(2) Determine the concentrations of principle gamma emitters (including, but not limited to, Mn-54, Fe-59, Co-58, Co-60, Zn-65, Cs-134, Cs-137, Ce-141, I-131, Mo-99, and Ce-144) in the "BATCH" sample, prior to the "BATCH" release (per Technical Specification 4.11.1.1.1).

(3) Determine the concentration of tritium contained in a monthly COMPOSITE sample at least once per month (per Technical Specification 4.11.1.1.1).

(4) Determine the concentrations of Sr-89 and Sr-90 contained in a quarterly COMPOSITE sample at least once per quarter (per Technical Specification 4.11.1.1.1).

(5) Calculate the concentrations of radionuclides in the receiving waters at the point the liquid radioactive waste is released to UNRESTRICTED AREAS (per Technical Specification 4.11.1.1.2).

b) Routine surveillances for CONTINUOUS releases

(1) Sample CONTINUOUS releases of radioactive liquid waste at least once per month (per Technical Specification 4.11.1.1.1).

(2) Determine the concentrations of principle gamma emitters (including, but not limited to, Mn-54, Fe-59, Co-58, Co-60, Zn-65, Cs-134, Cs-137, Ce-141, I-131, Mo-99, and Ce-144) in the undiluted, CONTINUOUS waste stream sample (per Technical Specification 4.11.1.1.1).

(3) Calculate the concentrations of radionuclides in the receiving waters at the point the liquid radioactive waste is released to UNRESTRICTED AREAS (per Technical Specification 4.11.1.1.2).

4. Responsible Plant Organizations

a) The Chemistry Section is responsible for performing the sampling, analysis, and calculations required by the above surveillances.

b) These conditions which initiate the required surveillances are contained in the following section.

5. Initiating Conditions

a) The surveillances for BATCH releases shall be performed prior to each BATCH release[27] and may be performed more often as specified in approved chemistry section procedures.

b) The surveillances for CONTINUOUS releases shall be performed at least monthly[28] (until the CONTINUOUS release has been terminated) and, if activity is identified[29] in the CONTINUOUS waste stream, the surveillances may be performed more often as specified in approved chemistry section procedures.

6. Calculation Methodology

a) At CCNPP, there are two methodologies for calculating the concentrations of radionuclides in the receiving waters, at the point of release to UNRESTRICTED AREAS, resulting from the discharge of liquid waste.

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27 Per Technical Specification 4.11.1.1.1.

28 Per Technical Specification 4.11.1.1.1.

29 The LOWER LIMITS OF DETECTION shall conform to Technical Specification 4.11.1.1.1, Table 4.11-1.

(1) The rigorous method shall be used IF a computer system and the appropriate software are available.

(2) The simplified method may be used IF a computer system and the appropriate software are NOT available.

(3) These methods, as well as additional supporting information, are presented in the following sections.

b) Rigorous method

(1) Solution of the following equation may prove too rigorous for routine use unless a computer system and appropriate software are available.

(2) If a computer system and the appropriate software are available, ensure the concentrations of radionuclides in UNRESTRICTED AREAS are less than one MPC by verifying the following inequality is true:

LIMIT ON CONCENTRATIONS OF RADIONUCLIDES IN UNRESTRICTED AREAS (RIGOROUS METHOD)

$$(F_u / F_d) \sum (A_{iu} / A_{iLi}) \leq 1 \qquad \text{Eq. 6L}^{30}$$

F_d = the minimum dilution water flow rate (gpm) prior to the point of release to UNRESTRICTED AREAS

The dilution water flow rate is actually the sum of the minimum circulating water flow rate, the minimum salt water flow rate, and the maximum undiluted radwaste flow rate.

The dilution water flow rate shall be calculated in accordance with equation 2L.

DILUTION WATER FLOW RATE

$$F_d = F_{cw} + F_{sw} + F_u \qquad \text{Eq. 2L}$$

F_{cw} = the minimum circulating water system flow rate necessary to conduct liquid releases

A minimum of two circulating water pumps per unit (one circulating water pump per conduit) shall be operable when discharging liquid radwaste to outfall 001.

The flow rate of each circulating water pump is 200,000 gallons per minute.

30 Equation 6L has been derived from 10 CFR 20, Appendix B, Table II, Note 1.

Additional circulating water pumps may be required as specified in approved chemistry section procedures.

F_{sw} = the minimum salt water system flow rate necessary to release liquid radwaste

If the minimum salt water flow rate available for liquid releases is unknown, difficult to predict, or may decrease during a liquid release, a minimum salt water flow rate of 0 gpm should be used when calculating the fixed setpoint.

The maximum flow rate for one salt water pump is listed on Attachment 2.

If a release of liquid radwaste is to be conducted using less than the minimum salt water flow rate necessary to conduct liquid releases, the release shall not be allowed until a new radiation monitor setpoint has been calculated approved.

F_u = maximum undiluted radwaste flow rate (gpm)

Values of maximum undiluted radwaste flow rates for various waste streams are tabulated in Attachments 2 and 3.

A_{iLt} = the specific activity limit for radionuclide, i, as obtained from 10 CFR 20, Appendix B, Table II, Column 2 (microcuries/cm^3)

A_{iu} = the specific activity of nuclide, i, in the undiluted liquid radwaste (microcuries per milliliter)

1 = the MPC limit (MPCs) for unrestricted areas

This value is based on the MPC limit from 10 CFR 20, Table II, Note 1.

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c) Simplified method

(1) Whenever a computer system and appropriate software are unavailable to perform the rigorous calculations described in the previous section, ensure the concentrations of radionuclides in UNRESTRICTED AREAS are less than one MPC by verifying the following inequality is true.

LIMIT ON CONCENTRATIONS OF RADIONUCLIDES IN UNRESTRICTED AREAS (SIMPLIFIED METHOD)

$$\{F_u / [(F_d)(A_{I131Lt})(K_{sf})]\} \sum A_{iu} \leq 1 \qquad \text{Eq. 7L}^{31}$$

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31 this equation has been derived from 10 CFR 20, Appendix B, Table II, Note 1.

F_u = maximum undiluted radwaste flow rate (gpm)

Values of maximum undiluted radwaste flow rates for various waste streams are tabulated in Attachments 2 and 3.

F_d = the minimum dilution water flow rate (gpm) prior to the point of release to UNRESTRICTED AREAS

The dilution water flow rate is actually the sum of the minimum circulating water flow rate, the minimum salt water flow rate, and the maximum undiluted radwaste flow rate.

DILUTION WATER FLOW RATE

$$F_d = F_{cw} + F_{sw} + F_u \qquad \text{Eq. 2L}$$

F_{cw} = the minimum circulating water system flow rate necessary to conduct liquid releases

A minimum of two circulating water pumps per unit (one circulating water pump per conduit) shall be operable when discharging liquid radwaste to outfall 001.

The flow rate of each circulating water pump is 200,000 gallons per minute.

Additional circulating water pumps may be required as specified in approved chemistry section procedures.

F_{sw} = the minimum salt water system flow rate necessary to release liquid radwaste

If the minimum salt water flow rate available for liquid releases is unknown, difficult to predict, or may decrease during a liquid release, a minimum salt water flow rate of 0 gpm should be used when calculating the fixed setpoint.

The maximum flow rate for one salt water pump is listed on Attachment 2.

If a release of liquid radwaste is to be conducted using less than the minimum salt water flow rate necessary to conduct liquid releases, the release shall not be allowed until a new radiation monitor setpoint has been calculated approved.

A_{1131Li} = the specific activity limit for I-131 corresponding to the limiting concentration specified in 10 CFR 20, Appendix B, Table II, Column 2

This value is 3E-7 microcuries per milliliter.

A_{iu} = the specific activity of nuclide, i, in the undiluted liquid radwaste (microcuries per milliliter)

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP activity limit to the activity limit of 10 CFR 20, Appendix B, Table II, Column 2, (unitless) (per Technical Specification 3.11.1.1)

The safety factor chosen shall be less than or equal to 1.00. This ensures the activity is always less than or equal to the activity limit of 10 CFR 20, Appendix B, Table II, Column 2.

A safety factor of 1.00 will yield a activity which corresponds to the 10 CFR 20, Appendix B, Table II, Column 2 activity limit.

A safety factor of 0.500 will yield an activity which corresponds to one-half the activity limit of 10 CFR 20, Appendix B, Table II, Column 2.

It is recommended that a safety factor of 1.0 be used for calculating the activity, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

The particular value selected for the safety factor is somewhat arbitrary, however a safety factor does provide plant personnel with a degree of administrative control over the use of simplified equations for generating radioactive liquid release permits. This administrative control is designed to minimize the possibility of violating 10 CFR 20, Appendix B, Table II, Column 2 limits whenever simplifying assumptions are used.

The use of a safety factor is consistent with 10 CFR 20.1(c) which states that the licensees should, "... in addition to complying with the limits set forth in this part [10 CFR 20], make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to UNRESTRICTED AREAS, as low as is reasonably achievable."

This safety factor has been included in equation 7L to account for any potential nonconservatism associated with applying the I-131 MPC limit to all radionuclides identified in the liquid release. Such nonconservatism could conceivable be present whenever radionuclides which have an MPC value higher than the I-131 MPC limit are present in a liquid release.

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d) Once the rigorous or simplified calculations have been completed, the calculation results are compared to the applicable limits and corrective actions are initiated as described below.

7. Corrective Actions

a) Chemistry Section surveillance procedures (e.g., CP-212) shall contain/and or reference administrative and/or Technical Specification limits for concentration of radionuclides in liquid effluents and shall specify corrective actions to be initiated when these limits are exceeded.

b) Refer to Technical Specification Technical Specification 3.11.1.1 for actions to be taken in the event the concentrations of radionuclides in UNRESTRICTED AREAS exceed one MPC.

F. Limits On Cumulative Total Body Doses And Cumulative Organ Doses For Liquid Effluents

1. Introduction

   a) Appendix I to 10 CFR 50 specifies total body dose limits and organ dose limits associated with the release of radioactive liquids to UNRESTRICTED AREAS.

   b) Radiological effluent controls have been established to implement the requirements of 10 CFR 50, Appendix I.

   c) These radiological effluent controls are described below.

2. Radiological Effluent Controls

   a) The total body dose to MEMBERS OF THE PUBLIC, from liquid waste discharged to UNRESTRICTED AREAS, shall be less than 3 mrems per calendar quarter and 6 mrems per calendar year (Technical Specification 3.11.1.2).

   b) The organ doses to MEMBERS OF THE PUBLIC, from liquid waste discharged to UNRESTRICTED AREAS, shall be less than 10 mrems per calendar quarter and 20 mrems per calendar year (Technical Specification 3.11.1.2).

   c) The routine surveillances which are performed to verify compliance with these radiological effluent controls are described below.

3. Surveillance Requirement(s)

   a) Cumulative total body doses to MEMBERS OF THE PUBLIC in UNRESTRICTED AREAS--for the current calendar month, the calendar quarter, the current calendar year, and the previous 92 days--shall be calculated, in accordance with equation 8L, at least once per 60 days (per Technical Specification 4.11.1.2 and 4.11.1.3).

   b) Cumulative organ doses to MEMBERS OF THE PUBLIC in UNRESTRICTED AREAS--for the current calendar month, the current calendar quarter, the current calendar year, and the previous 92 days--shall be calculated, in accordance with equation 8L, at least once per 60 days (per Technical Specification 4.11.1.2 and 4.11.1.3).

4. Responsible Plant Organizations

   a) The Chemistry Section is responsible for performing the surveillances, listed above, whenever the appropriate initiating conditions, listed below, are present.

5. Initiating Conditions

   a) Perform the surveillances, listed above, at least once per 60 days (per Technical Specification 4.11.1.2).

   b) For BATCH releases, perform the surveillances, listed above, prior to each BATCH release of radioactive liquid waste in accordance with approved chemistry section procedures.

c) For CONTINUOUS releases, perform the surveillances, listed above, at least monthly (until the CONTINUOUS release has been terminated) and, if activity is identified[32] in the CONTINUOUS waste stream, the surveillances may be performed more often as specified in approved chemistry section procedures.

d) Whenever the correct initiating conditions are present, the calculations required by the above mentioned surveillance(s) shall be completed in accordance with the methodology listed in the next section.

6. Calculation Methodology

a) The cumulative total body dose and the cumulative organ doses (for the current calendar month, current calendar quarter, previous 92 days, and current calendar year) shall be calculated as follows:

CUMULATIVE TOTAL BODY OR ORGAN, o, DOSE FROM LIQUID RELEASES, r

$$D_{Tot.} = \sum D_{or} \qquad \text{Eq. 8L}$$

$D_{Tot.}$ = the sum total of the total body or organ, o, dose for all liquid releases discharged during the applicable time interval

D_{or} = the organ or total body dose resulting from release, r

Calculate the values of D_{or} for each liquid release as described below.

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b) At CCNPP, two methods exist for calculating D_{or} (i.e., the total body and organ doses resulting from any single release of radioactive liquid to an UNRESTRICTED AREA).

(1) The rigorous method shall be used IF a computer system and the appropriate software are available.

(2) The simplified method may be used IF a computer system and the appropriate software are NOT available.

(3) These methods, as well as additional supporting information, are presented in the following sections.

c) Rigorous method

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32 The LOWER LIMITS OF DETECTION shall conform to Technical Specification 4.11.1.1.1, Table 4.11-1.

(1) Solution of the following equation may prove too rigorous for routine use unless a computer system and appropriate software are available.

(2) If a computer system and the appropriate software are available, the dose commitments due to each release of radioactive liquid to an UNRESTRICTED AREA shall be calculated in accordance with the following equation:

DOSE TO THE TOTAL BODY OR ORGAN, o, FROM A LIQUID RELEASE (RIGOROUS EQUATION)

$$D_o = \{ V_u / [(60)(F_d)] \} \sum \{ (A_{iu})(C_{io}) \} \quad \text{Eq. 9L}^{33}$$

Where,

F_d = minimum dilution water flow rate (gpm) prior to the point of release to UNRESTRICTED AREAS

The dilution water flow rate is actually the sum of the minimum circulating water flow rate, the minimum salt water flow rate, and the maximum undiluted radwaste flow rate.

The dilution water flow rate shall be calculated in accordance with equation 2L.

DILUTION WATER FLOW RATE

$$F_d = F_{cw} + F_{sw} + F_u \quad \text{Eq. 2L}$$

F_{cw} = minimum circulating water system flow rate necessary to conduct liquid releases

A minimum of two circulating water pumps per unit (one circulating water pump per conduit) shall be operable when discharging liquid radwaste to outfall 001.

The flow rate of each circulating water pump is 200,000 gallons per minute.

Additional circulating water pumps may be required as specified in approved chemistry section procedures.

F_{sw} = minimum salt water system flow rate necessary to release liquid radwaste

If the minimum salt water flow rate available for liquid releases is unknown, difficult to predict, or may decrease during a liquid release, a minimum salt water flow rate of 0 gpm should be used when calculating the fixed setpoint.

The maximum flow rate for one salt water pump is listed on Attachment 2.

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33 Equation 9L has been derived from NUREG-0133, 4.3.

If a release of liquid radwaste is to be conducted using less than the minimum salt water flow rate necessary to conduct liquid releases, the release shall not be allowed until a new radiation monitor setpoint has been calculated approved.

F_u = maximum undiluted radwaste flow rate (gpm)

Values of maximum undiluted radwaste flow rates for various waste streams are tabulated in Attachments 2 and 3.

V_u = volume of undiluted radwaste (gallons)

A_{iu} = specific activity of nuclide, i, in the undiluted liquid radwaste (microcuries per milliliter)

C_{io} = liquid release dose factor for nuclide, i, and organ, o (mrem/hr per microcurie/ml)

The liquid release dose factors for principal gamma and beta emitters are listed in Attachment 6.

The liquid release dose factors for principal gamma and beta emitters were obtained in accordance with the methodology of NUREG-0133, section 4.3.1 (for salt water sites).

60 = a constant, the number of minutes per hour

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(3) In the event a computer system is unavailable, a simplified equation may be used to calculate the total body and organ dose commitments due to individual liquid releases.

(4) The simplified method is presented below.

d) Simplified methods

(1) Whenever a computer system is unavailable to perform the rigorous total body dose calculations described in the previous section, the total body dose commitments--due to each release of radioactive liquid to an UNRESTRICTED AREA--may be calculated in accordance with equation 10L.

(2) Whenever a computer system is unavailable to perform the rigorous organ dose calculations described in the previous section, the dose commitments--to the maximum exposed organ, due to each release of radioactive liquid to an UNRESTRICTED AREA--may be calculated in accordance with equation 10L.

TOTAL BODY DOSE FROM A LIQUID RELEASE (SIMPLIFIED EQUATION)

$$D_{th} = \{ [(58.6)(V_u)] / [(K_{sf})(F_d)] \} \sum A_{iu} \qquad \text{Eq. 10L}^{34}$$

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34 Equations 10L has been derived from NUREG-0133, 4.3.

D_{tb} = dose commitment, to the total body, due to each release of radioactive liquid to an UNRESTRICTED AREA

58.6 = a conversion constant which includes:

1) 1.33E4 mrem/hr per microcurie/ml (the dose factor for Cs-134 to the lower gastrointestinal tract)

2) 1.000 hr/60.00 min

3) 1.000 gallons/3.785 liters

V_u = volume of undiluted radwaste (liters)

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP total body dose limit to the total body dose limit of Specification 3.11.1.2, (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the total body dose is always less than or equal to the total body dose limit of Specification 3.11.1.2.

A safety factor of 1.00 will yield a total body dose which corresponds to the total body dose limit of Specification 3.11.1.2.

A safety factor of 0.500 will yield an total body dose which corresponds to one-half the total body dose limit of Specification 3.11.1.2.

It is recommended that a safety factor of 1.0 be used for calculating the total body dose, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

The particular value selected for the safety factor is somewhat arbitrary, however a safety factor does provide plant personnel with a degree of administrative control over the use of simplified equations for generating radioactive liquid release permits. This administrative control is designed to minimize the possibility of violating Technical Specification 3.11.1.2 when simplifying assumptions are used.

The use of a safety factor is consistent with 10 CFR 20.1(c) which states that the licensees should, "... in addition to complying with the limits set forth in this part [10 CFR 20], make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to UNRESTRICTED AREAS, as low as is reasonably achievable."

This safety factor has been included in equation 10L to account for any potential nonconservatism associated with applying the Cs-134 gastrointestinal dose conversion factor to all radionuclides identified in the liquid release. Such nonconservatism could conceivable be present whenever radionuclides having a dose conversion factor greater than that of Cs-134 are present in a liquid release.

F_d = minimum dilution water flow rate (gpm) prior to the point of release to UNRESTRICTED AREAS

The dilution water flow rate is actually the sum of the minimum circulating water flow rate, the minimum salt water flow rate, and the maximum undiluted radwaste flow rate.

The dilution water flow rate shall be calculated in accordance with equation 2L.

DILUTION WATER FLOW RATE

$$F_d = F_{cw} + F_{sw} + F_u \qquad \text{Eq. 2L}$$

F_{cw} = minimum circulating water system flow rate necessary to conduct liquid releases

A minimum of two circulating water pumps per unit (one circulating water pump per conduit) shall be operable when discharging liquid radwaste to outfall 001.

The flow rate of each circulating water pump is 200,000 gallons per minute.

Additional circulating water pumps may be required as specified in approved chemistry section procedures.

F_{sw} = minimum salt water system flow rate necessary to release liquid radwaste

If the minimum salt water flow rate available for liquid releases is unknown, difficult to predict, or may decrease during a liquid release, a minimum salt water flow rate of 0 gpm should be used in equation 2L.

The maximum flow rate for one salt water pump is listed on Attachment 2.

F_u = maximum undiluted radwaste flow rate (gpm)

Values of maximum undiluted radwaste flow rates for various waste streams are tabulated in Attachments 2 and 3.

A_{iu} = specific activity of nuclide, i, in the undiluted liquid radwaste (microcuries per milliliter)

DOSE TO THE ORGAN, o, FROM A LIQUID RELEASE (SIMPLIFIED EQUATION)

$$D_o = \{ [(449)(V_u)] / [(K_{sf})(F_d)] \} \sum A_{iu} \qquad \text{Eq. 11L}^{35}$$

D_o = the dose commitment to the maximum exposed ORGAN due to each release of radioactive liquid waste to an UNRESTRICTED AREA

449 = a conversion constant which includes:

35 Equations 11L has been derived from NUREG-0133, 4.3.

1) 1.02E5 mrem/hr per microcurie/ml (the dose factor for I-131 to the thyroid)

2) 1.000 hr/60.00 min

3) 1.000 gallons/3.785 liters

V_u = volume of undiluted radwaste (liters)

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP organ dose limit to the organ dose limit of Specification 3.11.1.2, (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the organ dose is always less than or equal to the organ dose limit of Specification 3.11.1.2.

A safety factor of 1.00 will yield a organ dose which corresponds to the organ dose limit of Specification 3.11.1.2.

A safety factor of 0.500 will yield an organ dose which corresponds to one-half the organ dose limit of Specification 3.11.1.2.

It is recommended that a safety factor of 1.0 be used for calculating the organ dose, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

The particular value selected for the safety factor is somewhat arbitrary, however a safety factor does provide plant personnel with a degree of administrative control over the use of simplified equations for generating radioactive liquid release permits. This administrative control is designed to minimize the possibility of violating Technical Specification 3.11.1.2 when simplifying assumptions are used.

The use of a safety factor is consistent with 10 CFR 20.1(c) which states that the licensees should, "... in addition to complying with the limits set forth in this part [10 CFR 20], make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to UNRESTRICTED AREAS, as low as is reasonably achievable."

This safety factor has been included in equation 11L to account for any potential nonconservatism associated with applying the I-131 thyroid dose conversion factor to all radionuclides identified in the liquid release. Such nonconservatism could conceivable be present whenever radionuclides having a dose conversion factor greater than that of I-131 are present in a liquid release.

F_d = minimum dilution water flow rate (gpm) prior to the point of release to UNRESTRICTED AREAS

The dilution water flow rate is actually the sum of the minimum circulating water flow rate, the minimum salt water flow rate, and the maximum undiluted radwaste flow rate.

The dilution water flow rate shall be calculated in accordance with equation 2L.

DILUTION WATER FLOW RATE

$$F_d = F_{cw} + F_{sw} + F_u \qquad \text{Eq. 2L}$$

F_{cw} = minimum circulating water system flow rate necessary to conduct liquid releases

A minimum of two circulating water pumps per unit (one circulating water pump per conduit) shall be operable when discharging liquid radwaste to outfall 001.

The flow rate of each circulating water pump is 200,000 gallons per minute.

Additional circulating water pumps may be required as specified in approved chemistry section procedures.

F_{sw} = minimum salt water system flow rate necessary to release liquid radwaste

If the minimum salt water flow rate available for liquid releases is unknown, difficult to predict, or may decrease during a liquid release, a minimum salt water flow rate of 0 gpm should be used when in equation 2L.

The maximum flow rate for one salt water pump is listed on Attachment 2.

F_u = maximum undiluted radwaste flow rate (gpm)

Values of maximum undiluted radwaste flow rates for various waste streams are tabulated in Attachments 2 and 3.

A_{iu} = specific activity of nuclide, i, in the undiluted liquid radwaste (microcuries per milliliter)

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7. Corrective Actions

a) Chemistry Section surveillance procedures (e.g., CP-212) shall contain/and or reference administrative and/or Technical Specification limits for cumulative total body doses or cumulative organ doses resulting from liquid effluents and shall specify corrective actions to be initiated when these limits are exceeded.

b) Refer to Technical Specification 3.11.1.2 for actions to be taken in the event the calculated cumulative total body dose exceeds 3 mrem per calendar quarter or 6 mrem per calendar year.

c) Refer to Technical Specification 3.11.1.2 for actions to be taken in the event the calculated cumulative organ dose--for any organ--exceeds 10 mrem per calendar quarter or 20 mrem per calendar year.

G. Limits For The Liquid Waste Processing System

1. Introduction

a) 10 CFR 50.36a requires licensees to maintain and use the equipment installed in the liquid waste processing system for the purpose of controlling effluents to the environment.

b) Radiological effluent controls have been established to implement the requirements of 10 CFR 50.36a.

c) These radiological effluent controls are described below.

2. Radiological Effluent Controls

a) The liquid radwaste processing system shall be used to reduce the quantity of radioactive materials in liquid waste released to the environment whenever the total body dose to MEMBERS OF THE PUBLIC, from liquid waste discharged to UNRESTRICTED AREAS, is greater than 0.36 mrem for the previous 92 days (per Technical Specification 3.11.1.3).

b) The liquid radwaste processing system shall be used to reduce the quantity of radioactive materials in liquid waste released to the environment whenever the organ doses to MEMBERS OF THE PUBLIC, from liquid waste discharged to UNRESTRICTED AREAS, is greater than 1.20 mrem for the previous 92 days (per Technical Specification 3.11.1.3).

c) The routine surveillances which are performed to verify compliance with this radiological effluent controls are described below.

3. Surveillance Requirement(s)

a) The previous 92-day, cumulative, total body dose--to MEMBERS OF THE PUBLIC in UNRESTRICTED AREAS--shall be calculated, as described in the ODCM, at least once per 60 days (per Technical Specification 4.11.1.3).

b) The previous 92-day, cumulative, organ doses--to MEMBERS OF THE PUBLIC in UNRESTRICTED AREAS--shall be calculated, as described in the ODCM, at least once per 60 days (per Technical Specification 4.11.1.3).

c) The CCNPP organization(s) responsible for performing these surveillances are identified in the next section.

4. Responsible Plant Organization(s)

a) The Chemistry Section is responsible for performing the surveillances, listed above, whenever the appropriate initiating conditions, listed below, are present.

5. Initiating Conditions

a) Perform the surveillances, listed above, at least once per 60 days (per Technical Specification 4.11.1.2).

b) For BATCH releases, perform the surveillances, listed above, prior to each BATCH release of radioactive liquid waste in accordance with approved chemistry section procedures.

c) For CONTINUOUS releases, perform the surveillances, listed above, at least monthly (until the CONTINUOUS release has been terminated) and, if activity is identified[36] in the CONTINUOUS waste stream, the surveillances may be performed more often as specified in approved chemistry section procedures.

d) Whenever the correct initiating conditions are present, the calculations required by the above mentioned surveillance(s) shall be completed in accordance with the methodology contained in the following section.

6. Calculation Methodology

a) The cumulative total body dose and the cumulative organ doses for the previous 92 days shall be calculated in accordance with equation 8L found in the section, "Limits On Cumulative Total Body Doses And Cumulative Organ Doses For Liquid Effluents", found elsewhere in the ODCM.

7. Corrective Actions

a) Chemistry Section surveillance procedures (e.g., CP-212) shall contain/and or reference administrative and/or Technical Specification limits for cumulative total body doses or cumulative organ doses resulting from liquid effluents and shall specify corrective actions to be initiated when these limits are exceeded.

b) Refer to Technical Specification 3.11.1.3 for actions to be taken in the event the calculated cumulative total body dose exceeds 0.36 mrem for the previous 92 days.

c) Refer to Technical Specification 3.11.1.3 for actions to be taken in the event the calculated cumulative organ dose--for any organ--exceeds 1.2 mrem for the previous 92 days.

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36 The LOWER LIMITS OF DETECTION shall conform to Technical Specification 4.11.1.1.1, Table 4.11-1.

VI. RADIOACTIVE GASEOUS EFFLUENTS

A. Release Pathways [B527] | 1

1. Introduction

a) Radioactive gaseous waste generated from operation of CCNPP may be released to the atmosphere.

b) By design (i.e., in the absence of primary-to-secondary leaks), there are 2 pathways by which waste gas from the site may be discharged to the atmosphere. These pathways are listed below. General information related to each of these potential release pathways is contained on Attachment 7.

(1) Unit 1 main vent stack

(2) Unit 2 main vent stack

c) Depending on plant conditions, (e.g., primary-to-secondary leaks) a potential exists for the release of radioactive materials from other pathways. These pathways are listed below. General information related to each of these potential release pathways is contained on Attachment 8.

(1) auxiliary boiler deaerator

(2) steam generator atmospheric steam dump system

(3) plant nitrogen system

(4) turbine building ventilation exhaust

(5) emergency air lock

(6) plant compressed air

(7) main steam line penetrations

d) All of these pathways are described below.

2. Unit 1 Main Vent Stack

a) Dilution air and radioactive gaseous waste are discharged to the atmosphere through the Unit 1 main vent stack.

b) The radioactive gaseous waste is mixed with and diluted by the outside air and building exhausts prior to exiting the Unit 1 main vent stack.

c) The Unit 1 main vent stack is secured to the Unit 1 reactor containment building.

d) The top of the Unit 1 main vent stack is at elevation 203.5 feet (mean sea level, MSL), and as such is 10.1 feet above the top of the reactor containment building dome. As a result, the Unit 1 main vent stack does not qualify as a "free-standing" stack greater than 80 meters tall[37].

e) The Unit 1 main vent stack is designed to accept gaseous radioactive waste from various sources. Sources which may contribute radioactive material to the Unit 1 main vent stack are tabulated in Attachment 7.

3. Unit 2 Main Vent Stack

a) Dilution air and radioactive gaseous waste are discharged to the atmosphere through the Unit 2 main vent stack.

b) The Unit 2 main vent stack is designed to accept radioactive gaseous waste from various sources.

c) The radioactive gaseous waste is mixed with and diluted by the outside air and building exhausts prior to exiting the Unit 2 main vent stack.

d) The Unit 2 main vent stack is secured to the Unit 2 reactor containment building.

e) The top of the Unit 2 main vent stack is at elevation 203.5 feet (MSL), and as such is 10.1 feet above the top of the reactor containment building dome. As a result, the Unit 2 main vent stack does not qualify as a "free-standing" stack greater than 80 meters tall.

f) The Unit 2 main vent stack is designed to accept gaseous radioactive waste from various sources. Sources which may contribute radioactive material to the Unit 2 main vent stack are tabulated in Attachment 7.

4. Auxiliary Boiler Deaerator

a) Radioactive gases may be vented from the auxiliary boiler deaerator during periods of primary to secondary leakage.

b) Steam from the Moisture Separator Reheater (MSR) may be used in the deaerator. In the event of a primary to secondary leak, the MSR steam could become contaminated. Therefor, a potential exists for the release of radioactive gases in steam discharged from the auxiliary boiler deaerator.

c) The discharge of steam is accomplished via a relief vent, 0-VBV-1891, which allows excess pressure to be vented to atmosphere.

d) In the event the auxiliary boiler deaerator were to become contaminated, the amount of radioactivity released and the resulting doses/dose rates at the site boundary can be estimated if the following parameters are known:

(1) the MSR steam activity obtained from a sample,

(2) the duration of the discharge,

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37 As defined by Regulatory Guide 1.111

(3) the estimated steam discharge flow rate, and

(4) the measured or average annual metrological conditions.

5. Steam Generator Atmospheric Steam Dump System

a) Radioactive gases are not normally vented from this pathway.

b) Radioactive gases may be vented from the steam generator atmospheric steam dump system during periods of primary to secondary leakage.

c) If a primary to secondary leak is present and the steam dump valves are opened, the amount of radioactivity released and the resulting doses/dose rates at the site boundary can be estimated if the following parameters are known (per UFSAR, 10.1.2.1):

(1) the specific activity of a main steam sample as determined by GAMMA ISOTOPIC ANALYSIS,

(2) the duration of discharge,

(3) the estimated steam discharge flow rate, and

(4) the measured or average annual metrological conditions.

d) The total capacity of the atmospheric steam dump valve is 5 percent of steam flow with the reactor at full power (per UFSAR, 10.1.2.1).

6. Plant Nitrogen System

a) Radioactive gases are not normally vented from this pathway.

b) Nitrogen is supplied to various components which contain radioactive materials (e.g., VCT).

c) In the event the plant nitrogen system were to become contaminated, the amount of radioactivity released and the resulting doses/dose rates at the site boundary can be estimated if the following parameters are known:

(1) the specific activity of the gas in the plant nitrogen system as determined by GAMMA ISOTOPIC ANALYSIS,

(2) the pressure of the nitrogen system,

(3) the volume of the nitrogen system, and

(4) the measured or average annual metrological conditions.

d) It should be noted that the amount of radioactivity released could be estimated based on knowledge of other related parameters.

7. Turbine Building Exhaust

a) Radioactive gases are not normally vented from this pathway.

b) In the event radioactive gases were to be released through the turbine building exhaust, the amount of radioactivity released and the resulting doses/dose rates at the site boundary can be estimated if the following parameters are known:

(1) the specific activity of the turbine building air,

(2) the duration of the discharge,

(3) the estimated flow rate during the discharge, and

(4) the measured or average annual metrological conditions.

8. Emergency Air Lock

a) Radioactive gases are not normally vented from this pathway.

b) In the event radioactive gases were to be released through the emergency air lock, the amount of radioactivity released and the resulting doses/dose rates at the site boundary can be estimated if the following parameters are known:

(1) the containment air activity obtained from a sample,

(2) the volume of the air lock (9.558 cubic meters),

(3) the measured or average annual metrological conditions.

9. Plant Compressed Air

a) Radioactive gases are not normally vented from this pathway.

b) In the event the plant compressed air system were to become contaminated, the amount of radioactivity released and the resulting doses/dose rates at the site boundary can be estimated if the following parameters are known:

(1) the specific activity of the compressed air system,

(2) the pressure of the compressed air system,

(3) the volume of the compressed air system, and

(4) the measured or average annual metrological conditions.

10. Main Steam Line Penetrations

a) Radioactive gases are not normally vented from this pathway.

b) This penetration is cooled by outside air.

c) Gases may be released to the atmosphere through safety vents to the roof at elevation 91.5 feet.

d) See UFSAR 9.8.2.3.

11. Other unmonitored release paths should be evaluated and added to the ODCM as necessary.

12. Safety evaluations have been conducted for operating the following systems after they have become contaminated:

    a) plant nitrogen system

        (1) In accordance with applicable safety evaluations[38], continued operation of this system is allowed as long as the concentration of radionuclides in the system is less than 13,400 MPCs.

    b) auxiliary boiler deaerator

        (1) In accordance with applicable safety evaluations[39], continued operation of this system is allowed as long as the concentration of radionuclides in the auxiliary boiler steam drum is less than 96 MPCs.

B. Types of Gaseous Releases

1. All gaseous radwaste releases are classified as either BATCH releases or CONTINUOUS releases.

2. The definition of BATCH release is included in the definitions section of the ODCM.

3. The definition of CONTINUOUS release is included in the definitions section of the ODCM.

4. Liquid radwaste discharges have been classified as CONTINUOUS or BATCH as shown on Attachments 7 and 8.

C. Processing Equipment

1. Simplified Flow Diagram

    a) An overview of the gaseous waste processing system, including major equipment and (normal) flow paths, is outlined on Attachment 9.

2. Modifications

    a) Major changes or modifications to the gaseous waste processing system shall be reported to the Commission in the Semi-annual Radioactive Effluent Release Report for the time interval in which the modification was completed (per Technical Specification 6.18.1).

    b) A "major" change or modification includes, but is not limited to, the removal or permanent bypass of any of the following:

        (1) waste gas decay tank

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38 See 50.59 Log No. 90-0-074-011-R1.

39 See 50.59 Log No. 90-0-027-037-R1.

(2) waste gas surge tank

3. Detailed Description

a) A detailed description of the gaseous waste processing system is beyond the scope of the ODCM.

b) For more information on the Waste Gas System, see the CCNPP System Description Number 14A, "Waste Gas System."

c) For more information on the Waste Gas System, see the CCNPP Updated Final Safety Analysis Report, Chapter 11, "Waste Processing And Radiation Protection."

D. Gaseous Effluent Radiation Monitors And Setpoints

1. Wide Range Gas Monitor (1-RE-5416)

a) General description

(1) The Wide Range Gas Monitor (WRGM) contains 3 radiation elements

(a) low-range noble gas detector

i) Designation of radiation element: 1-RE-5416

ii) type of radiation element: Off-line scintillation

iii) output: digital

iv) Radiation indicator: 1-RIC-5415

v) units for radiation indicator are user programmable and are normally set to microcuries per cubic centimeter

vi) supplier: Sorrento Electronics (formerly General Atomics)

(b) mid-range, noble gas detector

i) Designation of radiation element: 1-RE-5417

ii) type of radiation element: Solid state

iii) This noble gas monitor is used to measure the release of radioactivity from unit 1 main vent in the event of an accident. (UFSAR, 11.2.3.2.12)

iv) setpoints for the mid-range detector will not be addressed in the ODCM

(c) high-range, noble gas detector

i) Designation of radiation element: 1-RE-5418

ii) type of radiation element: Solid state

iii) This detector is used to measure the release of radioactivity from unit 1 main vent in the event of an accident. (UFSAR, 11.2.3.2.12)

iv) setpoints for the high-range detector will not be addressed in the ODCM

(2) The low range detector will be the only detector addressed further in the ODCM.

b) Functions of 1-RE-5416

(1) continuously measure the release rate of noble gases emanating from the Unit 1 main vent stack (Technical Specification 4.11.2.1.1 or 4.11.2.1.2, Table 4.11-2)

(2) continuously indicate (via 1-RIC-5415) the release rate of noble gases emanating from the Unit 1 main vent stack (Technical Specification 4.11.2.1.1 or Technical Specification 4.11.2.1.2, Table 4.11-2)

(3) alarm (via 1-RIC-5415) prior to exceeding the site-boundary, noble-gas, total-body-dose-rate limit of 500 mr/yr (per Technical Specification 3.11.2.1.a)

(4) alarm (via 1-RIC-5415) prior to exceeding the site-boundary, noble-gas, skin-dose-rate limit of 3000 mr/yr (per Technical Specification 3.11.2.1.a)

(5) maintain a LLD of 1E-6 microcuries per cubic centimeter (Technical Specification 4.11.2.1.2, Table 4.11-2).

c) OPERABILITY of 1-RE-5416

(1) This monitor shall be operable (or have OPERABILITY) when it is capable of performing its specified function(s)[40].

(2) The functions of this monitor are listed in section (b) above.

d) Monitors equivalent to 1-RE-5416

(1) 1-RE-5415 [the "Westinghouse Plant Vent Stack Monitor"] has the capability of providing the measurement and alarm functions of 1-RE-5416 during times when 1-RE-5416 is declared inoperable.

(2) 1-RE-5415 provides redundant monitoring [for 1-RE-5416] at the low end of the concentration ranges (UFSAR 11.2.3.2.12).

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[40] Technical Specification 1.6

(3) 1-RE-5415 is normally considered the PRIMARY MONITOR for measuring noble gas activity released via the Unit 1 Plant Vent Stack, and 1-RE-5416 is normally considered the BACKUP MONITOR for measuring noble gas activity released via the Unit 1 Plant Vent Stack.

(4) In the event PRIMARY MONITOR (1-RE-5415) is inoperable or otherwise unavailable, the BACKUP MONITOR (1-RE-5416) is able to fulfill the measuring, indicating, and alarming functions normally provided by the PRIMARY MONITOR.

e) Radiological effluent controls for 1-RE-5416

(1) Technical Specification 3.3.3.9 states that releases via the plant vent stack may continue if any one of the following three conditions are satisfied:

(a) 1-RE-5415 is operable AND the alarm and trip setpoint(s) for 1-RI-5415 are set to ensure the annual dose rates due to noble gases at the SITE BOUNDARY are less than 500 mr/yr to the total body and are less than 3000 mr/yr to the skin (per Technical Specification 3.11.2.1.a), or

(b) an "equivalent monitor" (see section VI.D.1.d, "Monitors Equivalent to 1-RE-5416") is operable AND the alarm and trip setpoint(s) for the "equivalent monitor" are set to ensure annual dose rates due to noble gases at the SITE BOUNDARY are less than 500 mr/yr to the total body and are less than 3000 mr/yr to the skin (per Technical Specification 3.11.2.1.a), or

(c) grab samples are obtained and analyzed for gross activity at least once per 24 hours in accordance with Specifications 3.11.2.1.a, 4.11.2.1.1, and 4.11.2.1.2 (per Technical Specification 4.3.3.9, Table 3.3-12, ACTION 37).

f) Surveillances for 1-RE-5416

(1) Technical Specification 4.3.3.9 requires demonstrating the OPERABILITY of 1-RE-5416 by satisfying the checks, calibrations, and tests listed below:

(a) CHANNEL CHECK within the past 24 hours[41]

(b) SOURCE CHECK within the past 31 days

(c) CHANNEL CALIBRATION within the past 18 months

(d) CHANNEL FUNCTIONAL TEST within the past 6 six months

g) Setpoints for 1-RIC-5415

(1) Requirements and commitments

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[41] Technical Specifications Table 1.2

(a) The alarm and trip setpoints ... shall be determined and adjusted in accordance with the methodology and parameters of the ODCM. (Technical Specification 3.3.3.9)

(b) The method for calculating fixed or adjustable setpoints shall be provided in the ODCM (per NUREG-0133, 5.1.1).

(2) There are three radiation alarm setpoints associated with, or otherwise related to, the WRGM.

(a) 1-RIC-5415 fixed high-high radiation alarm setpoint

(b) 1-RIC-5415 fixed high radiation alarm setpoint

(c) 1-RIC-5415 adjustable plant computer high radiation alarm setpoint

(3) In order to simplify the setpoint terminology, eliminate ambiguity, and minimize the possibility of misinterpretation, the ODCM will refer to these setpoints as follows

(a) The 1-RIC-5415 high-high radiation alarm setpoint will be referred to as the fixed high-high setpoint

(b) The 1-RIC-5415 high radiation alarm setpoint will be referred to as the fixed high setpoint

(c) The 1-RIC-5415 adjustable plant computer high radiation alarm setpoint will be referred to as the adjustable setpoint

(4) Each of these alarm setpoints are described below.

h) Fixed high-high setpoint for 1-RIC-5415

(1) General information

(a) The high-high alarm setpoint is considered to be a fixed setpoint. The fixed high-high setpoint is not adjusted for each release.

(b) Whenever the fixed high-high setpoint is exceeded, an alarm will be generated.

(c) The fixed high-high setpoint currently corresponds to a SITE BOUNDARY noble gas concentration of approximately 2 MPCs (this is approximately 40% of T.S. 3.11.2.1 total body dose rate limit).

(d) The current value for the fixed high-high setpoint is specified in the CCNPP Alarm Manual.

(e) The CCNPP Alarm Manual[42] refers to the fixed high-high setpoint as the 1-RIC-5415 Plant Ventilation Effluent Radiation Monitor high-high radiation alarm setpoint.

(f) The fixed high-high setpoint is integral to the WRGM, as purchased from the supplier.

(g) The fixed high-high setpoint is administratively controlled by CCI-205.

(h) The fixed high-high setpoint shall be calculated as described below.

(2) Calculating the fixed high-high alarm setpoint for 1-RIC-5415

(a) The fixed, high-high setpoint for 1-RIC-5415 (WRGM) shall be calculated in accordance with equation 1G.[43]

FIXED HIGH-HIGH ALARM SETPOINT FOR 1-RIC-5415

$$S_{fixhh} \leq [c' / (x/Q)] [F_{dx} / (F_{d1} + F_{d2})] [A_{TLn}] \qquad \text{Eq. 1G}^{44}$$

Where,

S_{fixhh} = the fixed high-high radiation alarm setpoint for 1-RIC-5415 (microcuries per second)

c' = a conversion constant (1E6 cubic centimeters per cubic meter)

x/Q = the highest calculated annual average relative concentration for any area at or beyond the UNRESTRICTED AREA boundary (2.2E-6 seconds per cubic meter)

Unit 1 main vent releases are considered "long-term" releases[45], and as such, the highest historical annual average dispersion factor, (x/Q), is used in the setpoint calculations.

The highest annual average dispersion factor (x/Q) is 2.2E-6 (UFSAR, 2.3.6.3) for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3)

The maximum annual average on-shore concentrations occur in the southeast sector at a distance of 1300 meters for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3)

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42 The CCNPP Alarm Manual is controlled by CCI-302.

43 The alarm and trip setpoints ... shall be determined and adjusted in accordance with the methodology and parameters of the ODCM. (Technical Specification 3.3.3.9).

44 Equation 1G has been derived from NUREG-0133, 5.2.1.

45 NUREG-0133, 3.3

F_{dx} = the estimated main vent stack (diluted gaseous radwaste) flow rate for unit, x, (cubic meters per second)

The estimated main vent stack flow rates for Unit 1 and Unit 2 are defined below.

F_{d1} = the estimated main vent stack flow rate for Unit 1 (cubic meters per second)

Since the main vent stack flow rate will vary depending on the configuration of air dampers and the input gas streams, a conservative, nominal main vent stack flow rate is used to calculate the fixed high setpoint.

Use the nominal Unit 1 main vent stack flow rate listed on Attachment 7.

This nominal main vent stack flow rate is based on the results of an approved engineering test procedure[46].

The main vent stack flow rate shall be determined, in accordance with approved procedures, at least once per 6 months ($\pm$ 25%). The Test and Equipment Unit shall be responsible for performing this test. The results of the main vent flow rate test shall be evaluated to ensure the main vent flow rates used in the ODCM are an accurate reflection of the true main vent flow rates. The RETS Coordinator is responsible for modifying the (main vent flow rates used in the) ODCM in the event the main vent flow rate for either Unit 1 or Unit 2 has increased to a value which is greater than the maximum discharge flow rates listed on Attachment 7.

F_{d2} = the estimated main vent stack (diluted gaseous radwaste) flow rate for unit 2 (cubic meters per second)

Since the main vent stack flow rate will vary depending on the configuration of air dampers and the input gas streams, a conservative, nominal main vent stack flow rate is used to calculate the fixed high-high setpoint.

Use the nominal Unit 1 main vent stack flow rate listed on Attachment 7.

This nominal main vent stack flow rate is based on the results of an approved engineering test procedure[47].

The main vent stack flow rate shall be determined, in accordance with approved procedures, at least once per 6 months ($\pm$ 25%). The Test and Equipment Unit shall be responsible for performing this test. The results of the main vent flow rate test shall be evaluated to ensure the main vent flow rates used in the ODCM are an accurate reflection of the true main vent flow rates. The RETS Coordinator is responsible for modifying the (main vent flow rates used in the) ODCM in the event the main vent flow rate for either Unit 1 or Unit 2 has increased to a value which is greater than the maximum discharge flow rates listed on Attachment 7.

A_{TLn} = the sum of the total specific activities of all radionuclides found in TYPICAL GASEOUS RADWASTE RELEASES (microcuries/cm^3)

Calculate A_{TLn} in accordance with equation 2G.

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[46] See ETP-87-16, Revision 0, "Main Vent Stack Flow Measurement - Unit 1", completed in November 1987.

[47] See ETP-87-16, Revision 0, "Main Vent Stack Flow Measurement - Unit 2", completed in November 1987.

SPECIFIC ACTIVITY CORRESPONDING TO THE SITE BOUNDARY LIMIT

$$\sum [(f_i)(A_{TLn})] / A_{iLi} \leq L_{MPC} \qquad \text{Eq. 2G}^{48}$$

Where,

f_i = a fraction which represents the relative activity contribution of noble gas radionuclide i to the total noble gas activity for TYPICAL GASEOUS EFFLUENTS (unitless)

This value may be obtained using the guidance provided on Attachment 5.

A_{iLi} = the specific activity limit for radionuclide, i, as obtained from 10 CFR 20, Appendix B, Table II, Column 1 (microcuries/cm^3)

For all the DOMINANT RADIONUCLIDEs found in TYPICAL RADWASTE EFFLUENTS, use the value from 10 CFR 20, Appendix B, Table II, Column 1.

For each of the LESS DOMINANT RADIONUCLIDEs found in TYPICAL RADWASTE EFFLUENTS, use 2E-14 microcuries per milliliter as the value for A_{iLi} (per 10 CFR 20, Appendix B, Note 2).

L_{MPC} = the site MPC limit (MPCs) for unrestricted areas

The value chosen for L_{MPC} in this equation is 2. The basis for this limit is 10 CFR 50.72.

It has been shown[49] that, for the radionuclides present in TYPICAL GASEOUS EFFLUENTS from CCNPP, the 2 MPC limit is more restrictive than the limits of Specification 3.11.2.1(a).

It should be noted that by using "2" as the MPC limit (10 CFR 50.72), instead of using the limits of Specification 3.11.2.1(a), a safety factor has been incorporated into equation 2G.

An alarm setpoint corresponding to 2 MPCs serves to initiate a determination of whether the "4-hour NRC notification" (specified in 10 CFR 50.72) is required.

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(3) Documenting the fixed high-high alarm setpoint

(a) Whenever the fixed high-high alarm setpoint is calculated, the specific values chosen for each of the variables shall be documented in accordance with CCI-205.

(4) Changing the fixed high-high alarm setpoint for 1-RIC-5415

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[48] This equation has been derived from 10 CFR 20, Appendix B, Table II, Note 1.

[49] Addendum To Setpoint Calculations For WRGM Monitors 1-RIC-5415 and 2-RIC-5415, R.L. Conatser, December 10, 1991.

(a) If the fixed high-high alarm setpoint calculated in accordance with equation 1G exceeds the maximum range of the monitor, the fixed high-high setpoint shall be adjusted to a value which falls within the normal operating range of the monitor.

(b) The fixed high-high alarm setpoint may be established at values lower than the maximum allowable setpoint, if desired.

(c) A setpoint change should be initiated whenever any of the parameters identified in the setpoint calculation equations (identified in this section of the ODCM) have changed.

(d) The fixed high-high alarm setpoint should not be changed unless one of the following occurs:

i) the relative activity[50] of any radionuclide in TYPICAL GASEOUS EFFLUENTS has changed by greater than 10%,

ii) the historical maximum annual average atmospheric dispersion factor has changed,

iii) the MPC limit at the SITE BOUNDARY, (presently 2 MPCs) has changed,

iv) the Unit 1 or Unit 2 main vent stack flow rate has changed by greater than or equal to 10%[51],

v) the values listed in 10 CFR 20, Table II, column 1 have changed,

vi) the radiation monitor has been recently calibrated, repaired, or otherwise altered, or

vii) the monitor is not conservative in its function (see section VI.D.1.b, "Functions of 1/2-RE-5416").

(e) CCI-205 contains the administrative controls associated with changing and approving fixed alarm setpoint.

i) Fixed high setpoint for 1-RIC-5415

(1) General information

(a) The high setpoint is considered to be a fixed setpoint. The fixed high setpoint is not adjusted for each release.

(b) Whenever the fixed high setpoint is exceeded, an alarm will be generated.

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50 As determined in accordance with Attachment 5.

51 As determined by analysis of the TE-001 and ETP-87-16 test results.

(c) The CCNPP Alarm Manual refers to this setpoint as the 1-RIC-5415 Plant Ventilation Effluent Radiation Monitor high radiation alarm setpoint.

(d) The fixed high alarm setpoint is integral to the WRGM, as purchased from the supplier.

(e) The current value for the fixed high setpoint is specified in the CCNPP Alarm Manual.

(f) The fixed high setpoint is administratively controlled by CCI-205.

(g) The fixed high setpoint shall be calculated as described below[52].

(2) Calculating the fixed high alarm setpoint for 1-RIC-5415

(a) The fixed, high radiation alarm setpoint for 1-RIC-5415 shall be calculated as described below:

FIXED, HIGH RADIATION ALARM SETPOINT FOR 1-RIC-5415

$$S_{fixh} \leq K_{sf} [S_{fixhh}] \qquad \text{Eq. 3G}$$

Where,

S_{fixh} = the fixed high radiation alarm setpoint for 1-RIC-5415 (microcuries per second)

S_{fixhh} = the fixed high-high radiation alarm setpoint for 1-RIC-5415 (microcuries per second)

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP activity limit to the MPC limit, L_{MPC}, of equation 2G (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the fixed setpoint is always less than or equal to the limit MPC limit, L_{MPC}, of equation 2G.

A safety factor of 1.00 will yield a fixed high setpoint which corresponds to the MPC limit (see MPC limit, L_{MPC}, in equation 2G).

A safety factor of 0.100 will yield a fixed high setpoint which corresponds to one-tenth the MPC limit (see MPC limit, L_{MPC}, in equation 2G).

It is recommended that a safety factor of 0.1 be used for calculating the fixed high alarm setpoint, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

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52 The alarm and trip setpoints ... shall be determined and adjusted in accordance with the methodology and parameters of the ODCM. (Technical Specification 3.3.3.9).

The particular value selected for the safety factor is somewhat arbitrary, however a value less than 1.00 does provide plant personnel with adequate time to respond to changing plant conditions and to initiate corrective actions so as to minimize the possibility of violating either the 10 CFR 50.72 limit or the Technical Specification 3.3.3.9 limits.

The use of the safety factor is consistent with 10 CFR 20.1(c) which states that the licensees should, "... in addition to complying with the limits set forth in this part [10 CFR 20], make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to UNRESTRICTED AREAS, as low as is reasonably achievable."

The use of a "safety margin" is in accordance with the provisions of NUREG-0133 which states that "... the alarm and trip setpoints ... should correspond to a value(s) which represents a safe margin of assurance that the instantaneous gaseous release limit of Specification 3.11.2.1(a) will not be exceeded." (per NUREG-0133, 5.1.1).

This safety margin will prevent minor fluctuations in the nominal plant vent stack flow rates, errors in monitor efficiencies, and other statistical aberrations from adversely impacting the calculated fixed high setpoint.

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(3) Documenting the fixed high alarm setpoint

(a) Whenever the fixed high alarm setpoint is calculated, the specific values chosen for each of the variables shall be documented in accordance with CCI-205.

(4) Changing the fixed high alarm setpoint for 1-RIC-5415

(a) A setpoint change should be initiated whenever any of the parameters identified in equation 3G have changed.

(b) The fixed high alarm setpoint should be changed whenever the fixed high-high alarm setpoint is changed.

(c) The fixed high alarm setpoint should be changed if the value of the safety factor is changed.

(d) See CCI-205 for a description of activities associated with setpoint changes and setpoint approvals.

j) Adjustable alarm setpoint for 1-RIC-5415

(1) General information

(a) This setpoint is an adjustable setpoint. Whenever this radiation monitor is operable, the adjustable setpoint is calculated and adjusted[53] prior to each release of a WGDT, each containment vent, and each containment purge discharged via the main vent.

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53 The adjustable setpoint may or may not be changed for each of the releases listed here. A determination of whether to change the setpoint would only be required when conducting simultaneous releases (i.e., if a purge or

(b) The adjustable setpoint is based on the specific activities of the radionuclides present in either the WGDT or the containment building, whichever is applicable. (The radionuclide concentrations are determined by radiochemical analysis in accordance with applicable chemistry section procedures as required by Technical Specification 4.11.2.1.2).

(c) Whenever the adjustable setpoint is exceeded, the WGDT, purge, or vent discharge via the main vent will be manually suspended.

(d) Refer to the radwaste release permit for a full list of operator actions taken in response to this alarm.

(e) The adjustable setpoint corresponds to the maximum concentration of radionuclides anticipated or expected when discharging a WGDT, a containment vent, or a containment purge via the main vent.

(f) The value for the adjustable setpoint is recorded on the gaseous release permit in accordance with applicable chemistry section procedures.

(g) This alarm is not integral to the main vent radiation monitor, as purchased from the supplier.

(h) This alarm is generated by the plant computer which monitors output from 1/2-RIC-5415, and provides an alarm to plant operators when the 1/2-RIC-5415 adjustable setpoint has been exceeded.

(i) When this monitor is operable, a value for the adjustable alarm setpoint shall be calculated prior to each release of a WGDT, each containment vent, and each containment purge as shown below.

(2) Calculating the adjustable setpoint for 1/2-RIC-5415

(a) The adjustable alarm setpoint is based on the specific activity of the radionuclides in the undiluted gaseous waste (as determined by radiochemical analysis per Technical Specification 4.11.2.1.2), and the alarm setpoint is calculated as shown below.

ADJUSTABLE ALARM SETPOINT FOR 1/2-RIC-5415

$$S_{adj} \leq (1.50)(F_{dx})(c^*)\{[(F_u / F_{dx})\sum(A_{iu})(e_i)] + Bkg\} \qquad \text{Eq. 29G}^{54}$$

a vent is conducted while a WGDT is also being released). In this case, two adjustable setpoints would be calculated (i.e., one adjustable setpoint for the vent or purge and one adjustable setpoint for the WGDT). In the case of simultaneous releases, the lower (more conservative) of the two adjustable setpoints should be input into the plant computer.

54 Equation 29G has been derived from zz NUREG-0133, Addendum, page AA-1.

S_{adj} = the adjustable alarm setpoint for 1/2-RIC-5415 (microcuries per second)

1.50 = a constant, actually a safety factor, which allows for fluctuation in radiation monitor response (unitless)

This safety factor helps ensure the release is not unnecessarily terminated due to (1) electronic anomalies which cause spurious monitor responses, (2) statistical fluctuations in disintegration rates, (3) statistical fluctuations in detector efficiencies, (4) errors associated with sample analysis, and (5) errors associated with monitor calibrations.[55]

F_u = maximum undiluted radwaste flow rate (cubic meters per second)

Values of maximum undiluted radwaste flow rates for various waste streams are tabulated in Attachment 7.

F_{dx} = the estimated main vent stack (diluted gaseous radwaste) flow rate for unit x (cubic meters per second)

Since the main vent stack flow rate will vary depending on the reactor unit, the configuration of air dampers, and the input gas streams, a conservative, nominal main vent stack flow rate is used to calculate the adjustable setpoint.

Use the nominal main vent stack flow rate, for the appropriate unit, listed on Attachment 7.

This nominal main vent stack flow rate is based on the results of an approved engineering test procedure[56].

The main vent stack flow rate shall be determined, in accordance with approved procedures, at least once per 6 months ($\pm$ 25%). The Test and Equipment Unit shall be responsible for performing this test. The results of the main vent flow rate test shall be evaluated to ensure the main vent flow rates used in the ODCM are an accurate reflection of the true main vent flow rates. The Radiological Effluent Technical Specifications (RETS) Coordinator is responsible for modifying the (main vent flow rates used in the) ODCM in the event the main vent flow rate for either Unit 1 or Unit 2 has increased to a value which is greater than the maximum discharge flow rates listed on Attachment 7.

A_{iu} = specific activity of radionuclide, i, in the undiluted waste stream, either the WGDT or the containment building (microcuries per cubic centimeter)

e_i = absolute detector efficiency for nuclide, i (microcuries Xe-133 equivalent per microcuries nuclide i)

The detector efficiency for each radionuclide may be calculated from data collected during calibration of the radiation monitor.

Bkg = an approximation of the detector background (microcuries per cubic centimeter)

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55 The "analysis errors" and "calibration errors" refer to errors which are within established quality assurance and quality control limits.

56 See ETP-87-16, Revision 0, "Main Vent Stack Flow Measurement - Unit 1", or ETP-87-16, Revision 0, "Main Vent Stack Flow Measurement - Unit 2, completed in November 1987.

Bkg = an approximation of the detector background (microcuries per cubic centimeter)

c' = a conversion constant (1E6 cubic centimeters per cubic meter)

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(3) Documenting the adjustable alarm setpoint for 1/2-RIC-5415

(a) Whenever the adjustable setpoint is calculated, the specific values chosen for each of the variables shall be documented in accordance with approved chemistry section procedures (e.g., CP-604).

(4) Changing the adjustable alarm setpoint for 1/2-RIC-5415

(a) In all cases, the adjustable alarm setpoint shall be set to a value which is less than or equal to the fixed setpoint.

(b) If the adjustable alarm setpoint exceeds the maximum range of the monitor, the setpoint shall be adjusted to a value which falls within the normal operating range of the monitor.

(c) Chemistry section procedures (e.g., CP-604) contain administrative controls associated with calculating and approving an adjustable setpoint.

(d) Whenever this monitor is operable, the calculated value for the adjustable setpoint shall be entered into the plant computer prior to each release of a WGDT, a containment vent, or a containment purge via the main vent.

2. Wide Range Gas Monitor (2-RE-5416)

a) all information related to 1-RE-5416 is applicable to the Unit 2 WRGM with the following exceptions(s)

b) Monitors equivalent to 2-RE-5416

(1) 2-RE-5415 [the "Westinghouse Plant Vent Stack Monitor"] has the capability of providing the measurement and alarm functions of 2-RE-5416 during times when 2-RE-5416 is declared inoperable

(2) 2-RE-5415 provides redundant monitoring [for 2-RE-5416] at the low end of the concentration ranges (UFSAR 11.2.3.2.12)

3. Westinghouse Plant Vent Stack Monitor (1-RE-5415)

a) The Westinghouse Plant Vent Stack Monitor contains 2 radiation elements

(1) 1-RE-5414

(a) particulate detector

(b) off-line scintillation detector

(c) analog output

(d) supplies signals to radiation indicator 1/2-RI-5414

(e) values displayed by 1/2-RI-5414 are in units of counts per minute

(f) the detector manufacturer is Westinghouse

(2) 1-RE-5415

(a) noble gas detector

(b) off-line GM Tube

(c) analog output

(d) supplies signals to radiation indicator 1/2-RI-5415

(e) values displayed by 1/2-RI-5415 are in units of counts per minute

(f) the detector manufacturer is Westinghouse

b) Functions of 1-RE-5414

(1) The functions of 1-RE-5414 are mentioned here only as a basis for excluding this radiation element from the setpoint controls of Specification 3.3.3.9.

(2) This radiation element measures particulate activity contained on a moving particulate filter which is 99% efficient for particle sizes greater than 1.0 micron (UFSAR 11.2.3.2.1)

(3) The activity contained on the particulate filter is representative of the particulate activity emanating from the Unit 1 Plant Vent Stack.

(4) The ODCM will not address alarm setpoints for 1-RE-5414 [particulate monitor] since NUREG-0133, section 5.1.1 states, "It is not considered to be practicable to apply instantaneous alarm and trip setpoints to integrating radiation monitors sensitive to radioiodines, radioactive materials in particulate form and radionuclides other than noble gases."

c) Functions of 1-RE-5415[57]

(1) continuously measure the activity (CPM) of noble gases emanating from the Unit 1 main vent stack (Technical Specification 4.11.2.1.2, Table 4.11-2)

(2) continuously indicate (via 1-RI-5415) the activity (CPM) of noble gases emanating from the Unit 1 main vent stack (Technical Specification 4.11.2.1.2, Table 4.11-2)

(3) alarm (via 1-RI-5415) prior to exceeding the site-boundary, noble-gas, total-body-dose-rate limit of 500 mr/yr (per Technical Specification 3.11.2.1.a)

(4) alarm (via 1-RIC-5415) prior to exceeding the site-boundary, noble-gas, skin-dose-rate limit of 3000 mr/yr (per Technical Specification 3.11.2.1.a)

(5) maintain a LLD of 1E-6 microcuries per cubic centimeter (Technical Specification 4.11.2.1.2, Table 4.11-2)

d) OPERABILITY of 1-RE-5415

(1) This monitor shall be operable (or have OPERABILITY) when it is capable of performing its specified function(s)[58].

(2) The functions of 1-RE-5415 are listed in section (c) above.

e) Monitors equivalent to 1-RE-5415

(1) The Wide Range Gas Monitor (i.e., 1-RE-5416) has the capability of providing the measurement and alarm functions of 1-RE-5415 during times when 1-RE-5415 is declared inoperable.

(2) 1-RE-5415 provides redundant monitoring [for 1-RE-5416] at the low end of the concentration ranges (UFSAR 11.2.3.2.12).

(3) 1-RE-5415 is normally considered the PRIMARY MONITOR for measuring noble gas activity released via the Unit 1 Plant Vent Stack, and 1-RE-5416 is normally considered the BACKUP MONITOR for measuring noble gas activity released via the Unit 1 Plant Vent Stack.

(4) In the event PRIMARY MONITOR (1-RE-5415) is inoperable or otherwise unavailable, the BACKUP MONITOR (1-RE-5416) is able to fulfill the measuring, indicating, and alarming functions normally provided by the PRIMARY MONITOR.

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57 This (radiation element) monitors noble gases. Other radiation elements monitor particulates in this waste stream.

58 Technical Specification 1.6

(5) The absence of a radiation element dedicated to measuring the particulate activity in the Wide Range Gas Monitor does not preclude the use of 1-RE-5416 as a backup for 1-RE-5415. This is mentioned only as a basis for excluding 1/2-RE-5414 from the setpoint controls of Specification 3.3.3.9 (see next paragraph).

f) Radiological effluent controls for 1-RE-5415

(1) Technical Specification 3.3.3.9 states that releases via the plant vent stack may continue if any one of the following three conditions are satisfied

(a) 1-RE-5415 is operable AND the alarm and trip setpoint(s) for 1-RI-5415 are set to ensure annual dose rates due to noble gases at the SITE BOUNDARY are less than 500 mr/yr to the total body and are less than 3000 mr/yr to the skin (per Technical Specification 3.11.2.1.a), or

(b) an "equivalent monitor" (see section (e) above) is operable AND the alarm and trip setpoint(s) for the "equivalent monitor" are set to ensure annual dose rates due to noble gases at the SITE BOUNDARY are less than 500 mr/yr to the total body and are less than 3000 mr/yr to the skin (per Technical Specification 3.11.2.1.a), or

(c) grab samples are obtained and analyzed for gross activity at least once per 24 hours in accordance with Specifications 3.11.2.1.a, 4.11.2.1.1, and 4.11.2.1.2 (per Technical Specification 4.3.3.9, Table 3.3-12, ACTION 37).

(2) Technical specification 3.11.2.1.b (i.e., dose rates due to iodines and particulates at the SITE BOUNDARY) is not applicable to noble gas detector or to the setpoints related to the noble gas detector 1-RE-5415. As a result, the 1500 my/yr organ dose limit is not included as a radiological effluent control in this section of the ODCM.

g) Surveillances for 1-RE-5415

(1) Technical Specification 4.3.3.9 requires demonstrating the OPERABILITY of 1-RE-5415 by satisfying the checks, calibrations, and tests listed below:

(a) CHANNEL CHECK within the past 24 hours[59]

(b) SOURCE CHECK within the past 31 days

(c) CHANNEL CALIBRATION within the past 18 months

(d) CHANNEL FUNCTIONAL TEST within the past 6 six months

h) Setpoints for 1-RI-5415

(1) Requirements and commitments

59 Technical Specifications Table 1.2

(a) The alarm and trip setpoints ... shall be determined and adjusted in accordance with the methodology and parameters of the ODCM. (Technical Specification 3.3.3.9)

(b) The method for calculating fixed or adjustable setpoints shall be provided in the ODCM. (NUREG-0133, 5.1.1)

(2) There are three alarms associated with, or otherwise related to, 1-RE-5415.

(a) 1-RI-5415 fixed high radiation alarm setpoint

(b) 1-RI-5415 adjustable plant computer high radiation alarm setpoint

(c) 1-RI-5415 low radiation alarm setpoint

(3) In order to simplify the setpoint terminology, eliminate ambiguity, and minimize the possibility of misinterpretation, the ODCM will refer to these setpoints as follows

(a) The 1-RI-5415 fixed high radiation alarm setpoint will be referred to as the fixed setpoint.

(b) The 1-RI-5415 adjustable plant computer high radiation alarm setpoint will be referred to as the adjustable setpoint.

(c) The 1-RI-5415 low radiation alarm setpoint will be referred to as the low setpoint.

(4) Each of these alarm setpoints are described below.

i) The fixed setpoint for 1-RI-5415

(1) General information

(a) This setpoint is considered to be a fixed setpoint. The fixed setpoint is not adjusted for each release.

(b) Whenever the fixed setpoint is exceeded, an alarm will be generated.

(c) The current value for the fixed setpoint is specified in the CCNPP Alarm Manual.

(d) The CCNPP Alarm Manual refers to this setpoint as the 1-RI-5415 High Radiation Alarm Setpoint.

(e) The fixed setpoint is integral to the Main Vent (Westinghouse) RMS as purchased from the supplier.

(f) The fixed setpoint is administratively controlled by CCI-205.

(g) The fixed setpoint shall be calculated as described below[60].

(2) Calculating the fixed setpoint for 1-RI-5415

(a) The fixed high radiation alarm setpoint for 1-RI-5415 (plant vent stack monitor) shall be calculated in accordance with equation 4G.

THE FIXED HIGH ALARM SETPOINT FOR 1-RI-5415

$$S_{fix} \leq \{K_{sf} / [(x/Q)(F_{d1} + F_{d2})]\} \sum [(e_i)(A_{iLn})] \qquad \text{Eq. 4G}^{61}$$

S_{fix} = the fixed radiation alarm setpoint for 1-RI-5415 (counts per minute)

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP activity limit to the MPC limit, L_{MPC}, used in equation 2G (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the fixed setpoint is always less than or equal to the MPC limit, L_{MPC}, used in equation 2G.

A safety factor of 1.00 will yield a fixed setpoint which corresponds to the MPC limit, L_{MPC}, in equation 2G.

A safety factor of 0.500 will yield a fixed high setpoint which corresponds to one-half the MPC limit, L_{MPC}, in equation 2G.

It is recommended that a safety factor of 1.0 be used for calculating the fixed setpoint, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

The particular value selected for the safety factor is somewhat arbitrary, however a safety factor does provide plant personnel with adequate time to respond to changing plant conditions and to initiate corrective actions so as to minimize the possibility of violating either the 10 CFR 50.72 limit or the Technical Specification 3.3.3.9 limits.

The use of a safety factor is consistent with 10 CFR 20.1(c) which states that the licensees should, "... in addition to complying with the limits set forth in this part [10 CFR 20], make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to UNRESTRICTED AREAS, as low as is reasonably achievable."

The use of a "safety margin" is in accordance with the provisions of NUREG-0133, section 5.1.1, which states that "... the alarm and trip setpoints ... should correspond to a value(s) which represents a safe margin of assurance that the instantaneous gaseous release limit of Specification 3.11.2.1(a) will not be exceeded."

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60 The alarm and trip setpoints ... shall be determined and adjusted in accordance with the methodology and parameters of the ODCM. (Technical Specification 3.3.3.9).

61 Equation 4G has been derived from NUREG-0133, 5.2.1, (the 500 mr/yr equation).

This safety margin will prevent minor fluctuations in the nominal plant vent stack flow rates, errors in detector efficiencies, and other statistical aberrations from adversely impacting the calculated fixed setpoint.

x/Q = the highest calculated annual average relative concentration for any area at or beyond the UNRESTRICTED AREA boundary (2.2E-6 seconds per cubic meter)

Unit 1 and Unit 2 main vent releases are considered "long-term" releases[62], and as such, the highest historical annual average dispersion factor, (x/Q), is used in the setpoint calculations.

The highest annual average dispersion factor (x/Q) is 2.2E-6 (UFSAR, 2.3.6.3) for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

The maximum annual average on-shore concentrations occur in the southeast sector at a distance of 1300 meters for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

F_{d1} = the estimated main vent stack flow rate for Unit 1 (cubic meters per second)

Since the main vent stack flow rate will vary depending on the configuration of air dampers and the input gas streams, a conservative, nominal main vent stack flow rate is used to calculate the fixed high setpoint.

Use the nominal Unit 1 main vent stack flow rate listed on Attachment 7.

This nominal main vent stack flow rate is based on the results of an approved engineering test procedure[63].

The main vent stack flow rate shall be determined, in accordance with approved procedures, at least once per 6 months ($\pm$ 25%). The Test and Equipment Unit shall be responsible for performing this test. The results of the main vent flow rate test shall be evaluated to ensure the main vent flow rates used in the ODCM are an accurate reflection of the true main vent flow rates. The RETS Coordinator is responsible for modifying the (main vent flow rates used in the) ODCM in the event the main vent flow rate for either Unit 1 or Unit 2 has increased to a value which is greater than the maximum discharge flow rates listed on Attachment 7.

F_{d2} = the estimated main vent stack flow rate for unit 2 (cubic meters per second)

Since the main vent stack flow rate will vary depending on the configuration of air dampers and the input gas streams, a conservative, nominal main vent stack flow rate is used to calculate the fixed high setpoint.

Use the nominal Unit 1 main vent stack flow rate listed on Attachment 7.

This nominal main vent stack flow rate is based on the results of an approved engineering test procedure[64].

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62 NUREG-0133, 3.3

63 See ETP-87-16, Revision 0, "Main Vent Stack Flow Measurement - Unit 1", completed in November 1987.

64 See ETP-87-16, Revision 0, "Main Vent Stack Flow Measurement - Unit 2", completed in November 1987.

The main vent stack flow rate shall be determined, in accordance with approved procedures, at least once per 6 months (± 25%). The Test and Equipment Unit shall be responsible for performing this test. The results of the main vent flow rate test shall be evaluated to ensure the main vent flow rates used in the ODCM are an accurate reflection of the true main vent flow rates. The RETS Coordinator is responsible for modifying the (main vent flow rates used in the) ODCM in the event the main vent flow rate for either Unit 1 or Unit 2 has increased to a value which is greater than the maximum discharge flow rates listed on Attachment 7.

e_i = absolute detector efficiency for nuclide, i (cpm/microcuries per milliliter)

The detector efficiency for each radionuclide may be calculated from data collected during calibration of the radiation monitor.

A_{iLn} = the specific activities of radionuclide, i, found in TYPICAL GASEOUS RADWASTE RELEASES (calculated in accordance with 10 CFR 20, Appendix B, Table II, Note 1 as described below; microcuries per milliliter)

Calculate A_{iLn} in accordance with equation 5G.

SPECIFIC ACTIVITY LIMIT FOR NUCLIDE I IN A RADIONUCLIDE MIXTURE

$$A_{iLn} = (f_i)(A_{TLn}) \qquad \text{Eq. 5G}$$

f_i = a fraction which represents the relative activity contribution of noble gas radionuclide i to the total noble gas activity for TYPICAL GASEOUS EFFLUENTS (unitless)

This value may be obtained using the guidance provided on Attachment 5.

A_{TLn} = the sum of the total specific activities of all noble gas radionuclides found in TYPICAL GASEOUS RADWASTE RELEASES (microcuries/cm^3)

Calculate A_{TLn} in accordance with equation 2G.

SPECIFIC ACTIVITY CORRESPONDING TO THE SITE BOUNDARY LIMIT

$$\sum i [(f_i)(A_{TLn})] / A_{iLi} \leq L_{MPC} \qquad \text{Eq. 2G}^{65}$$

L_{MPC} = the MPC limit

The value chosen for L_{MPC} in this equation is 2. The basis for this limit is 10 CFR 50.72.

65 Equation 2G has been derived from 10 CFR 20, Appendix B, Table II, Note 1.

It has been shown[66] that, for the radionuclides present in TYPICAL GASEOUS EFFLUENTS from CCNPP, the 2 MPC limit is more restrictive than the limits of Specification 3.3.3.9.

It should be noted that by using "2" as the MPC limit (10 CFR 50.72), instead of using the limits of Specification 3.11.2.1(a), a safety factor has been incorporated into equation 2G.

The use of 2 MPCs as a safety margin is consistent with the provisions of NUREG-0133, section 5.1.1, which states that, "... in all cases, conservative assumptions may be necessary in establishing these setpoints to account for system variables, ... the variability in release flow, ... and the time lag between alarm and final isolation of radioactive effluents."

An alarm setpoint corresponding to 2 MPCs serves to initiate a determination of whether the "4-hour NRC notification" (specified in 10 CFR 50.72) is required.

The use of a limiting specific activity equivalent to 2 MPCs is consistent with the provisions of 10 CFR 20.106(a).

A_{iLi} = the specific activity limit for radionuclide, i, as obtained from 10 CFR 20, Appendix B, Table II, Column 1 (microcuries/cm^3)

For all the DOMINANT RADIONUCLIDEs found in TYPICAL RADWASTE EFFLUENTS, use the value from 10 CFR 20, Appendix B, Table II, Column 1.

For each of the LESS DOMINANT RADIONUCLIDEs found in TYPICAL RADWASTE EFFLUENTS, use 2E-14 microcuries per milliliter as the value for A_{iLi} (per 10 CFR 20, Appendix B, Note 2).

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(3) The low alarm setpoint for 1-RI-5415

(a) The ODCM does not address the calculations associated with the low alarm setpoint.

(b) The low alarm setpoint is specified in the CCNPP Alarm Manual.

(c) The low alarm setpoint may be used to determine OPERABILITY of this monitor (in accordance with the provisions of Technical Specification 4.3.3.9, Table 4.3-11, Note 2).

(4) Adjusting the fixed setpoint for 1-RI-5415

(a) If the fixed setpoint calculated in accordance with equation 4G exceeds the maximum range of the monitor, the fixed setpoint shall be adjusted to a value which falls within the normal operating range of the monitor.

(b) The fixed setpoint may be established at values lower than the maximum allowable setpoint, if desired.

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66 Addendum To Setpoint Calculations For WRGM Monitors 1-RIC-5415 and 2-RIC-5415, R.L. Conatser, December 10, 1991.

(c) A setpoint change should be initiated whenever any of the parameters identified in equation 4G have changed.

(d) The fixed setpoint should not be changed unless one of the following occurs:

i) the relative activity[67] of any radionuclide in TYPICAL GASEOUS EFFLUENTS has changed by greater than 10%,

ii) the historical maximum annual average atmospheric dispersion factor has changed,

iii) the MPC limit at the SITE BOUNDARY, (presently 2 MPCs) has changed,

iv) the estimated Unit 1 main vent stack flow rate or Unit 2 main vent stack flow rate has changed by greater than or equal to 10%[68],

v) the values listed in 10 CFR 20, Table II, column 1 have changed,

vi) the radiation monitor has been recently calibrated, repaired, or otherwise altered, or

vii) the monitor is not conservative in its function (see section VI.D.3.c, "Functions of 1/2-RE-5415").

(e) CCI-205 contains the administrative controls associated with changing and approving fixed alarm setpoint.

j) Adjustable alarm setpoint for 1/2-RI-5415

(1) General information

(a) This setpoint is an adjustable setpoint. Whenever this radiation monitor is operable, the adjustable setpoint is calculated and adjusted[69] prior to each release of a WGDT, each containment vent, and each containment purge discharged via the main vent.

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67 As determined in accordance with Attachment 5.

68 As determined by analysis of the TE-001 and ETP-87-16 test results.

69 The adjustable setpoint may or may not be changed for each of the releases listed here. A determination of whether to change the setpoint would only be required when conducting simultaneous releases (i.e., if a purge or a vent is conducted while a WGDT is also being released). In this case, two adjustable setpoints would be calculated (i.e., one adjustable setpoint for the vent or purge and one adjustable setpoint for the WGDT). In the case of simultaneous releases, the lower (more conservative) of the two adjustable setpoints should be input into the plant computer.

(b) The adjustable setpoint is based on the specific activities of the radionuclides present in either the WGDT or the containment building, whichever is applicable. (The radionuclide concentrations are determined by radiochemical analysis in accordance with applicable chemistry section procedures as required by Technical Specification 4.11.2.1.2).

(c) Whenever the adjustable setpoint is exceeded, the WGDT, purge, or vent discharge via the main vent will be manually suspended.

(d) Refer to the radwaste release permit for a full list of operator actions taken in response to this alarm.

(e) The adjustable setpoint corresponds to the maximum concentration of radionuclides anticipated or expected when discharging a WGDT, a containment vent, or a containment purge via the main vent.

(f) The value for the adjustable setpoint is recorded on the gaseous release permit in accordance with applicable chemistry section procedures.

(g) This alarm is not integral to the main vent radiation monitor, as purchased from the supplier.

(h) This alarm is generated by the plant computer which monitors output from 1/2-RI-5415, and provides an alarm to plant operators when the 1/2-RI-5415 adjustable setpoint has been exceeded.

(i) When this monitor is operable, a value for the adjustable alarm setpoint shall be calculated prior to each release of a WGDT, each containment vent, and each containment purge as shown below.

(2) Calculating the adjustable setpoint for 1/2-RI-5415

(a) The adjustable alarm setpoint is based on the specific activity of the radionuclides in the undiluted gaseous waste (as determined by radiochemical analysis per Technical Specification 4.11.2.1.2), and the alarm setpoint is calculated as shown below.

ADJUSTABLE ALARM SETPOINT FOR 1/2-RI-5415

$$S_{adj} \leq 1.50 (F_u / F_{dx}) [\sum (A_{iu})(e_i) + Bkg] \qquad \text{Eq. 27G}^{70}$$

S_{adj} = the adjustable alarm setpoint for 1/2-RI-5415 (cpm)

70 Equation 27G has been derived from zz NUREG-0133, Addendum, page AA-1.

1.50 = a constant, actually a safety factor, which allows for fluctuation in radiation monitor response (unitless)

This safety factor helps ensure the release is not unnecessarily terminated due to (1) electronic anomalies which cause spurious monitor responses, (2) statistical fluctuations in disintegration rates, (3) statistical fluctuations in detector efficiencies, (4) errors associated with sample analysis, and (5) errors associated with monitor calibrations.[71]

F_u = maximum undiluted radwaste flow rate (cubic meters per second)

Values of maximum undiluted radwaste flow rates for various waste streams are tabulated in Attachment 7.

F_{dx} = the estimated main vent stack (diluted gaseous radwaste) flow rate for unit x (cubic meters per second)

Since the main vent stack flow rate will vary depending on the reactor unit, the configuration of air dampers, and the input gas streams, a conservative, nominal main vent stack flow rate is used to calculate the adjustable setpoint.

Use the nominal main vent stack flow rate, for the appropriate unit, listed on Attachment 7.

This nominal main vent stack flow rate is based on the results of an approved engineering test procedure[72].

The main vent stack flow rate shall be determined, in accordance with approved procedures, at least once per 6 months (± 25%). The Test and Equipment Unit shall be responsible for performing this test. The results of the main vent flow rate test shall be evaluated to ensure the main vent flow rates used in the ODCM are an accurate reflection of the true main vent flow rates. The Radiological Effluent Technical Specifications (RETS) Coordinator is responsible for modifying the (main vent flow rates used in the) ODCM in the event the main vent flow rate for either Unit 1 or Unit 2 has increased to a value which is greater than the maximum discharge flow rates listed on Attachment 7.

A_{iu} = specific activity of radionuclide, i, in the undiluted waste stream, either the WGDT or containment building as applicable (microcuries per milliliter)

e_i = absolute detector efficiency for nuclide, i (cpm/microcuries per milliliter)

The detector efficiency for each radionuclide may be calculated from data collected during calibration of the radiation monitor.

Bkg = an approximation of the detector background (cpm)

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(3) Documenting the adjustable alarm setpoint for 1/2-RI-5415

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[71] The "analysis errors" and "calibration errors" refer to errors which are within established quality assurance and quality control limits.

[72] See ETP-87-16, Revision 0, "Main Vent Stack Flow Measurement - Unit 1", or ETP-87-16, Revision 0, "Main Vent Stack Flow Measurement - Unit 2, completed in November 1987.

(a) Whenever the adjustable setpoint is calculated, the specific values chosen for each of the variables shall be documented in accordance with approved chemistry section procedures (e.g., CP-604).

(4) Changing the adjustable alarm setpoint for 1/2-RI-5415

(a) In all cases, the adjustable alarm setpoint shall be set to a value which is less than or equal to the fixed setpoint.

(b) If the adjustable alarm setpoint exceeds the maximum range of the monitor, the setpoint shall be adjusted to a value which falls within the normal operating range of the monitor.

(c) Chemistry section procedures (e.g., CP-604) contain administrative controls associated with calculating and approving an adjustable setpoint.

(d) Whenever this monitor is operable, the calculated value for the adjustable setpoint shall be entered into the plant computer prior to each release of a WGDT, a containment vent, or a containment purge via the main vent.

k) The low alarm setpoint for 1/2-RI-5415

(1) This alarm is integral to the main vent monitor, as purchased from the supplier.

(2) The current value for the low alarm setpoint is specified in the CCNPP Alarm Manual.

(3) The low alarm setpoint may be used to determine the OPERABILITY of this monitor (per Technical Specification 4.3.3.9, CHANNEL FUNCTIONAL TEST).

(4) The alarm generated by the low alarm setpoint may be used to terminate a release in the event 1/2-RI-5415 fails (i.e., downscale failure or circuit failure) in accordance with Technical Specification 4.3.3.9.

(5) The low alarm setpoint calculations are not described in the ODCM.

(6) Changes to the low alarm setpoint are controlled by CCI-205.

4. **Westinghouse Plant Vent Stack Monitor (2-RE-5415)**

a) All information related to 1-RE-5415 is applicable to the Unit 2 plant vent stack monitor with the following exception(s):

b) Monitors equivalent to 2-RE-5415

(1) 2-RE-5416 [the "WRNGM"] has the capability of providing the measurement and alarm functions of 2-RE-5415 during times when 2-RE-5415 is declared inoperable.

(2) 2-RE-5415 provides redundant monitoring [for 2-RE-5416] at the low end of the concentration ranges (UFSAR 11.2.3.2.12).

5. **Gaseous Radwaste Treatment System Radiation Monitor (0-RE-2191)**

a) General description

(1) The GASEOUS RADWASTE TREATMENT SYSTEM Radiation Monitor (Waste Gas Decay Tank Radiation Monitor) contains 1 radiation element.

(2) It is a noble gas detector.

(3) The detector is an in-line GM tube (UFSAR, Table 11-10).

(4) The radiation element is designated 0-RE-2191.

(5) The radiation indicators designated 0-RI-2191.

(6) The units for the radiation indicator are counts per minute.

(7) The monitor was manufactured by Westinghouse.

b) Functions of 0-RE-2191

(1) continuously measure the release rate of noble gases emanating from the waste gas decay tank discharge header (Technical Specification 4.11.2.1.2, Table 4.11-2)

(2) continuously indicate (via 0-RI-2191) the activity (CPM) of noble gases emanating from the waste gas decay tank discharge header (Technical Specification 3.3.3.9 OPERABILITY requirement)

(3) alarm (via 1-RI-2191) prior to exceeding the site-boundary, noble-gas, total-body-dose-rate limit of 500 mr/yr (per Technical Specification 3.11.2.1.a)

(4) alarm (via 1-RI-2191) prior to exceeding the site-boundary, noble-gas, skin-dose-rate limit of 3000 mr/yr (per Technical Specification 3.11.2.1.a)

(5) maintain a LLD of 1E-4 microcuries per cubic centimeter (Technical Specification 4.11.2.1.2, Table 4.11-2)

c) OPERABILITY of 0-RE-2191

(1) This monitor shall be operable (or have OPERABILITY) when it is capable of performing its specified function(s)[73].

(2) For more information on the function(s) of this monitor, see "Functions of 0-RE-2191" elsewhere in this section of the ODCM.

d) Monitors equivalent to 0-RE-2191

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73 Technical Specification 1.6

(1) There are no equivalent monitors associated with 0-RE-2191 since there are no other radiation monitors permanently installed in the waste gas discharge header, however, Technical Specification 3.3.3.9 defines the plant vent stack monitor as a "BACKUP MONITOR."

(2) 0-RE-2191 is designated the PRIMARY MONITOR for measuring noble gas activity released via the GASEOUS RADWASTE TREATMENT SYSTEM.

(3) 1-RE-5415 (or 1-RE-5416) is designated the BACKUP MONITOR if the WGDT is discharged via the Unit 1 main vent.

(4) 2-RE-5415 (or 2-RE-5416) is designated the BACKUP MONITOR if the WGDT is discharged via the Unit 2 main vent.

(5) WGDTs are normally discharged through the Unit 1 main vent stack.

(6) The BACKUP MONITOR has the capability of ensuring the noble gas activity released from the GASEOUS RADWASTE TREATMENT SYSTEM--to the plant vent stack--does not exceed Technical Specification 3.11.2.1(a) at the SITE BOUNDARY (Technical Specification 3.3.3.9).

(7) In the event PRIMARY MONITOR (0-RE-2191) is inoperable or otherwise unavailable, the designated BACKUP MONITOR (either 1-RE-5415, 1-RE-5416, 2-RE-5415, or 2-RE-5416) is able to fulfill the measuring, indicating, and alarming functions normally provided by the PRIMARY MONITOR as long as plant operators record the BACKUP MONITOR readings every 15 minutes (Technical Specification 3.3.3.9, Table 3.3-12, ACTION 35a).

e) Radiological effluent controls for 0-RE-2191

(1) Technical Specification 3.3.3.9 states that releases via the GASEOUS RADWASTE TREATMENT SYSTEM may continue if ANY ONE of the following three conditions are satisfied:

(a) 0-RE-2191 is operable AND the alarm and trip setpoint(s) for 0-RI-2191 are set to ensure the annual dose rates due to noble gases at the SITE BOUNDARY are less than 500 mr/yr to the total body and are less than 3000 mr/yr to the skin (per Technical Specification 3.11.2.1.a), or

(b) One "BACKUP MONITOR" (see section (e) above) is operable; AND the "BACKUP MONITOR" readings are recorded every 15 minutes during the release; AND the alarm and .rip setpoint(s) for the "BACKUP MONITOR" are set to ensure the annual dose rates due to noble gases at the SITE BOUNDARY are less than 500 mr/yr to the total body and are less than 3000 mr/yr to the skin (per Technical Specification 3.11.2.1.a), or

(c) All three activities described below are completed prior to the release:

i) at least two independent samples of the waste gas decay tank's contents are analyzed, and

ii) at least two technically qualified members of the Facility Staff independently verify the release rate calculations, and

iii) two qualified operators verify the discharge valve lineup.

f) Surveillances for 0-RE-2191

(1) Technical Specification 4.3.3.9 requires demonstrating the OPERABILITY of 0-RE-2191 by satisfying the checks, calibrations, and tests listed below

(a) CHANNEL CHECK prior to each release[74]

(b) SOURCE CHECK prior to each release

(c) CHANNEL CALIBRATION within the past 18 months

(d) CHANNEL FUNCTIONAL TEST within the past 6 six months

g) Setpoints for 0-RI-2191

(1) Requirements and commitments

(a) The alarm and trip setpoints ... shall be determined and adjusted in accordance with the methodology and parameters of the ODCM. (Technical Specification 3.3.3.9)

(b) The method for calculating fixed or adjustable setpoints shall be provided in the ODCM. (NUREG-0133, 5.1.1)

(2) There are three radiation alarm setpoints associated with, or otherwise related to, 0-RE-2191.

(a) 0-RE-2191 fixed high radiation alarm and automatic control trip setpoint

(b) 0-RE-2191 adjustable plant computer high radiation alarm and manual control trip setpoint

(c) 0-RE-2191 low radiation alarm setpoint

(3) In order to simplify the setpoint terminology, eliminate ambiguity, and minimize the possibility of misinterpretation, the ODCM will refer to these setpoints as follows

(a) The 0-RE-2191 fixed high radiation alarm and automatic control trip setpoint will be referred to as the fixed setpoint.

(b) The 0-RE-2191 adjustable plant computer high radiation alarm and manual control trip setpoint will be referred to as the adjustable setpoint.

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74 Technical Specifications Table 1.2

(c) The 0-RE-2191 low radiation alarm setpoint will be referred to as the low setpoint.

(4) Each of these alarm setpoints are described below.

h) Fixed setpoint for 0-RI-2191

(1) General information

(a) This setpoint is considered to be a fixed setpoint. The fixed setpoint is not adjusted for each release.

(b) The fixed setpoint is an alarm and trip setpoint.

(c) Whenever the fixed setpoint is exceeded, an alarm will be generated, and the WGDT release will be automatically suspended.

(d) The fixed setpoint corresponds to the maximum concentration of radionuclides allowed (by equation 6G) in gaseous waste discharged from the gaseous radwaste processing system.

(e) The current value for the fixed setpoint is specified in the CCNPP Alarm Manual.

(f) The CCNPP Alarm Manual refers to this setpoint as the 0-RI-2191 High Radiation Alarm Setpoint.

(g) The fixed setpoint is integral to the waste gas discharge monitor, as purchased from the supplier.

(h) The fixed setpoint is administratively controlled by CCI-205.

(i) The fixed setpoint shall be calculated as described below[75].

(2) Calculating the fixed setpoint for 0-RI-2191

(a) The fixed alarm and trip setpoint for 0-RI-2191 (waste gas discharge monitor) shall be calculated as described below:

FIXED ALARM AND TRIP SETPOINT FOR 0-RI-2191

$$S_{fix} \leq \{K_{sf}/[(x/Q)(F_u)]\} \sum [(e_i)(A_{iLn})] \qquad \text{Eq. 6G}^{76}$$

Where,

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75 The alarm and trip setpoints ... shall be determined and adjusted in accordance with the methodology and parameters of the ODCM. (Technical Specification 3.3.3.9).

76 Equation 6G has been derived from NUREG-0133, 5.2.1, (the 500 mr/yr equation).

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP activity limit to the MPC limit, L_{MPC}, used in equation 2G (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the fixed setpoint is always less than or equal to the MPC limit, L_{MPC}, used in equation 2G.

A safety factor of 1.00 is used for calculating the fixed setpoint.

By setting the safety factor to 1, the safety factor is disabled.

Although it may appear that if this safety factor is set to 1.0, no safety margin exists, in actuality, another margin of safety has been incorporated into equation 2G (see definition of L_{MPC}).

A safety factor of 1.00 will yield a fixed setpoint which corresponds to the MPC limit, L_{MPC}, in equation 2G.

A safety factor of 0.500 will yield a fixed high setpoint which corresponds to one-half the MPC limit, L_{MPC}, in equation 2G.

Other values of safety factors--not to exceed 1.00--may be used for calculating the fixed setpoint as directed by the General Supervisor Chemistry.

The particular value selected for the safety factor is somewhat arbitrary, however a value less than or equal to 1.0 does provide plant personnel with adequate time to respond to changing plant conditions and to initiate corrective actions so as to minimize the possibility of violating either the 10 CFR 50.72 limit or the Technical Specification 3.3.3.9 limits.

The use of a safety factor is consistent with 10 CFR 20.1(c) which states that the licensees should, "... in addition to complying with the limits set forth in this part [10 CFR 20], make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to UNRESTRICTED AREAS, as low as is reasonably achievable."

The use of a "safety margin" is in accordance with the provisions of NUREG-0133 which states that "... the alarm and trip setpoints ... should correspond to a value(s) which represents a safe margin of assurance that the instantaneous gaseous release limit of Specification 3.11.2.1(a) will not be exceeded." (per NUREG-0133, 5.1.1).

This safety margin will prevent minor fluctuations in the nominal WGDT discharge flow rates, errors in detector efficiencies, and other statistical aberrations from adversely impacting the calculated fixed setpoint.

S_{fix} = the fixed radiation alarm setpoint for 0-RI-2191 (CPM)

x/Q = the highest calculated historical annual average relative concentration for any area at or beyond the UNRESTRICTED AREA boundary (2.2E-6 seconds per cubic meter)

A waste gas decay tank release via the Unit 1 or Unit 2 main vent is considered a "long-term" release[77], and as such, the highest historical annual average dispersion factor, (x/Q), is used in the setpoint calculations.

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77 NUREG-0133, 3.3

The highest annual average dispersion factor (x/Q) is 2.2E-6 (UFSAR, 2.3.6.3) for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

The maximum annual average on-shore concentrations occur in the southeast sector at a distance of 1300 meters for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

F_u = the estimated maximum flow rate of undiluted gases through the waste gas discharge header (cubic meters per second)

Since WGDT pressure is the motive force for discharge of a WGDT, the waste gas flow rate will continually decrease as the release progresses (i.e., as tank pressure is decreased).

Use the estimated maximum WGDT discharge flow rate, listed on Attachment 7, to calculate the fixed setpoint.

e_i = absolute detector efficiency for nuclide, i (cpm/microcuries per milliliter)

The detector efficiency for each radionuclide may be calculated from data collected during calibration of the radiation monitor.

A_{iLn} = the specific activities of radionuclide, i, found in TYPICAL GASEOUS RADWASTE RELEASES (calculated in accordance with 10 CFR 20, Appendix B, Table II, Note 1 as described below; microcuries per milliliter)

Calculate A_{iLn} in accordance with equation 5G.

SPECIFIC ACTIVITY LIMIT FOR NUCLIDE I IN A RADIONUCLIDE MIXTURE

$$A_{iLn} = (f_i)(A_{TLn}) \qquad \text{Eq. 5G}$$

f_i = a fraction which represents the relative activity contribution of noble gas radionuclide i to the total noble gas activity for TYPICAL GASEOUS EFFLUENTS (unitless)

This value may be obtained using the guidance provided on Attachment 5.

A_{TLn} = the sum of the total specific activities of all noble gas radionuclides found in TYPICAL GASEOUS RADWASTE RELEASES (microcuries/cm^3).

Calculate A_{TLn} in accordance with equation 2G.

SPECIFIC ACTIVITY OF NOBLE GASES AT THE SITE BOUNDARY

$$\sum [(f_i) (A_{TLn})] / A_{iLi} \leq L_{MPC} \qquad \text{Eq. 2G}^{78}$$

Where,

L_{MPC} = the MPC limit

The value chosen for L_{MPC} in this equation is 2. The basis for this limit is 10 CFR 50.72.

It has been shown[79] that, for the radionuclides present in TYPICAL GASEOUS EFFLUENTS from CCNPP, the 2 MPC limit is more restrictive than the limits of Specification 3.3.3.9.

It should be noted that by using "2" as the MPC limit (10 CFR 50.72), instead of using the limits of Specification 3.11.2.1(a), a safety factor has been incorporated into equation 2G.

The use of 2 MPCs as a safety margin is consistent with the provisions of NUREG-0133, section 5.1.1, which states that, "... in all cases, conservative assumptions may be necessary in establishing these setpoints to account for system variables, ... the variability in release flow, ... and the time lag between alarm and final isolation of radioactive effluents." (NUREG-0133, 5.1.1)

An alarm setpoint corresponding to 2 MPCs serves to initiate a determination of whether the "4-hour NRC notification" (specified in 10 CFR 50.72) is required.

A_{iLi} = the specific activity limit for radionuclide, i, as obtained from 10 CFR 20, Appendix B, Table II, Column 1 (microcuries/cm^3)

For all the DOMINANT RADIONUCLIDEs found in TYPICAL RADWASTE EFFLUENTS, use the value from 10 CFR 20, Appendix B, Table II, Column 1.

For each of the LESS DOMINANT RADIONUCLIDEs found in TYPICAL RADWASTE EFFLUENTS, use 2E-14 microcuries per milliliter as the value for A_{iLi} (per 10 CFR 20, Appendix B, Note 2).

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(3) Documenting the fixed setpoint for 0-RI-2191

(a) Whenever the fixed setpoint is calculated, the specific values chosen for each of the variables shall be documented in accordance with CCI-205.

(4) Changing the fixed setpoint for 0-RI-2191

(a) If the fixed setpoint calculated in accordance with equation 6G exceeds the maximum range of the monitor, the fixed setpoint shall be adjusted to a value which falls within the normal operating range of the monitor.

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78 Equation 2G has been derived from 10 CFR 20, Appendix B, Table II, Note 1.

79 Addendum To Setpoint Calculations For WRGM Monitors 1-RIC-5415 and 2-RIC-5415, R.L. Conatser, December 10, 1991.

(b) The fixed setpoint may be established at values lower than the maximum allowable setpoint, if desired.

(c) A setpoint change should be initiated whenever any of the parameters identified in equations 2G, 5G, or 6G have changed.

(d) The fixed setpoint should not be changed unless one of the following occurs:

i) the relative activity[80] of any radionuclide in TYPICAL GASEOUS EFFLUENTS has changed by greater than 10%,

ii) the historical maximum annual average atmospheric dispersion factor has changed,

iii) the MPC limit at the SITE BOUNDARY, (presently 2 MPCs) has changed,

iv) values listed in 10 CFR 20, Table II, column 1 have changed,

v) the radiation monitor has been recently calibrated, repaired, or otherwise altered, or

vi) the monitor is not conservative in its function (see section VI.D.5.b, "Functions of 0-RE-2191").

(e) CCI-205 contains the administrative controls associated with changing and approving fixed alarm setpoint.

i) Adjustable alarm setpoint for 0-RI-2191

(1) General information

(a) This setpoint is an adjustable setpoint. Whenever this radiation monitor is operable, the adjustable setpoint is calculated and adjusted[81] prior to each release of a WGDT.

(b) The adjustable setpoint is based on the specific activities of the radionuclides present in the WGDT. (The radionuclide concentrations are determined by radiochemical analysis in accordance with applicable chemistry section procedures as required by Technical Specification 4.11.2.1.2).

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80 As determined in accordance with Attachment 5.

81 The adjustable setpoint may or may not be changed for each WGDT release. A determination of whether to change the setpoint would only be required when conducting simultaneous releases (i.e., if a purge or a vent is conducted while a WGDT is also being released). In this case, two adjustable setpoints would be calculated (i.e., one adjustable setpoint for the vent or purge and one adjustable setpoint for the WGDT). In the case of simultaneous releases, the lower (more conservative) of the two adjustable setpoints should be input into the plant computer.

(c) Whenever the adjustable setpoint is exceeded, the WGDT discharge will be manually suspended.

(d) Refer to the radwaste release permit for a full list of operator actions taken in response to this alarm.

(e) The adjustable setpoint corresponds to the maximum concentration of radionuclides anticipated or expected when discharging a WGDT.

(f) The value for the adjustable setpoint is recorded on the gaseous release permit in accordance with applicable chemistry section procedures.

(g) This alarm is not integral to the gaseous radwaste treatment system radiation monitor, as purchased from the supplier.

(h) This alarm is generated by the plant computer which monitors output from 0-RI-2191, and provides an alarm to plant operators when the 0-RI-2191 adjustable setpoint has been exceeded.

(i) When this monitor is operable, a value for the adjustable alarm and trip setpoint shall be calculated prior to each release of a WGDT as shown below.

(2) Calculating the adjustable setpoint for 0-RI-2191

(a) The adjustable alarm and trip setpoint is based on the specific activity of the radionuclides in the undiluted gaseous waste (as determined by radiochemical analysis per Technical Specification 4.11.2.1.2), and the alarm and trip setpoint is calculated as shown below.

ADJUSTABLE ALARM AND TRIP SETPOINT FOR 0-RI-2191

$$S_{adj} \leq 1.50 [\sum (A_{iu}) (e_i) + Bkg] \qquad \text{Eq. 28G}^{82}$$

S_{adj} = the adjustable alarm and trip setpoint for 0-RI-2191 (cpm)

1.50 = a constant, actually a safety factor, which allows for fluctuation in radiation monitor response (unitless)

This safety factor helps ensure the release is not unnecessarily terminated due to (1) electronic anomalies which cause spurious monitor responses, (2) statistical fluctuations in disintegration

82 Equation 28G has been derived from zz NUREG-0133, Addendum, page AA-1.

rates, (3) statistical fluctuations in detector efficiencies, (4) errors associated with sample analysis, and (5) errors associated with monitor calibrations.[83]

F_u = maximum allowed undiluted radwaste flow rate (cubic meters per second)

The maximum allowed undiluted radwaste flow rate for a WGDT is tabulated in Attachment 7.

A_{iu} = specific activity of radionuclide, i, in the undiluted waste stream (microcuries per milliliter)

e_i = absolute detector efficiency for nuclide, i (cpm/microcuries per milliliter)

The detector efficiency for each radionuclide may be calculated from data collected during calibration of the radiation monitor.

Bkg = an approximation of the detector background (cpm)

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(3) Documenting the adjustable alarm setpoint for 0-RI-2191

(a) Whenever the adjustable setpoint is calculated, the specific values chosen for each of the variables shall be documented in accordance with approved chemistry section procedures (e.g., CP-604).

(4) Changing the adjustable alarm setpoint for 0-RI-2191

(a) In all cases, the adjustable setpoint shall be set to a value which is less than or equal to the fixed setpoint.

(b) If the adjustable setpoint exceeds the maximum range of the monitor, the setpoint shall be adjusted to a value which falls within the normal operating range of the monitor.

(c) Chemistry section procedures (e.g., CP-604) contain administrative controls associated with calculating and approving an adjustable setpoint.

(d) Whenever this monitor is operable, the calculated value for the adjustable setpoint shall be entered into the plant computer prior to each release of a WGDT, a containment vent, or a containment purge via the main vent.

j) The low alarm setpoint for 0-RI-2191

(1) This alarm is integral to the main vent monitor, as purchased from the supplier.

(2) The current value for the low alarm setpoint is specified in the CCNPP Alarm Manual.

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83 The "analysis errors" and "calibration errors" refer to errors which are within established quality assurance and quality control limits.

(3) The low alarm setpoint may be used to determine the OPERABILITY of this monitor (per Technical Specification 4.3.3.9, CHANNEL FUNCTIONAL TEST).

(4) The alarm generated by the low alarm setpoint may be used to terminate a release in the event 0-RI-2191 fails (i.e., downscale failure or circuit failure) in accordance with Technical Specification 4.3.3.9.

(5) The low alarm setpoint calculations are not described in the ODCM.

(6) Changes to the low alarm setpoint are controlled by CCI-205.

E. Annual Total Body Dose Rate Due To Noble Gases In Gaseous Effluents

1. Introduction

a) 10 CFR 20.105 specifies dose rate limits associated with the release of radioactive materials to UNRESTRICTED AREAS.

b) Radiological effluent controls have been established to implement the requirements of 10 CFR 20.105.

c) These radiological effluent controls are described below.

2. Radiological Effluent Controls

a) The annual total body dose rate, due to noble gases in gaseous waste discharged to UNRESTRICTED AREAS, shall be less than 500 mr/yr (per Technical Specification 3.11.2.1).

b) The routine surveillances which are performed to verify compliance with this radiological effluent control is described below.

3. Surveillance Requirement

a) The annual total body dose rate, due to noble gases in all gaseous effluents discharged from the site, shall be determined in accordance with equation 7G (per Technical Specification 4.11.2.1.1).

b) The results of the radioactive gaseous waste sampling and analysis program (required by Technical Specification 4.11.2.1.2, and implemented by various CCNPP chemistry section procedures) are used to calculate the annual total body dose rate due to noble gases in gaseous effluents.

c) The plant group(s) responsible for performing the required surveillances are identified below.

4. Responsible Plant Organization(s)

a) The Chemistry Section is responsible for calculating the annual total body dose rate due to noble gases in gaseous effluents.

b) The CCNPP Chemistry Section calculates the annual total body dose rate whenever the appropriate initiating conditions are present.

c) These initiating conditions are contained in the following section.

5. Initiating Conditions

a) The annual total body dose rate due to noble gases in gaseous effluents is calculated for each release of a WGDT.

b) The annual total body dose rate due to noble gases in gaseous effluents is calculated for each vent of a containment building.

c) The annual total body dose rate due to noble gases in gaseous effluents is calculated for each PURGE of a containment building.

d) The annual total body dose rate due to noble gases in gaseous effluents is calculated at least weekly[84] for CONTINUOUS discharges from plant vent stacks.

e) The annual total body dose rate due to noble gases in gaseous effluents is calculated for each discharge of combustion products resulting from the burning of contaminated oil.

f) The annual total body dose rate due to noble gases in gaseous effluents is calculated for each ABNORMAL AND/OR UNANTICIPATED RADIOACTIVE GAS RELEASE (as defined in CP-612).

g) Whenever the correct initiating conditions are present, the annual total body dose rates shall be calculated as described below.

6. Calculation Methodology

a) The annual total body dose rate, at the SITE BOUNDARY, due to noble gases in gaseous effluents released to UNRESTRICTED AREAS shall be calculated in accordance with equation 7G.[85]

ANNUAL TOTAL BODY DOSE RATE DUE TO NOBLE GASES IN ALL GAS RELEASES

$$D_{t0} = \sum D_{tr} \qquad \text{Eq. 7G}$$

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84 The frequency is controlled by the implementing procedure, CP-612, and is based on plant conditions. Under no conditions shall the frequency be less than once per month (Technical Specification 4.11.2.1.1 or 4.11.2.1.2, Table 4.11-2).

85 The alarm and trip setpoints ... shall be determined and adjusted in accordance with the methodology and parameters of the ODCM. (Technical Specification 3.3.3.9).

D_{10} = the site-boundary annual total body dose rate due to noble gases in all gaseous effluents discharged (simultaneously) from the site ("Unit 0")

D_{1r} = the site-boundary annual total body dose rate due to noble gases in release, r

Sum for all releases, r, which are discharged simultaneously.

An example of a SIMULTANEOUS RELEASE would include the release of noble gas radionuclides from the Unit 1 plant vent stack while also discharging noble gases from the Unit 2 plant vent stack.

An example of a SIMULTANEOUS RELEASE would include the release of noble gas radionuclides from the Unit 1 plant vent stack while also discharging a waste gas decay tank.

Calculate the values of D_{1r} for each SIMULTANEOUS RELEASE as shown below.

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b) At CCNPP, two methods exist for calculating D_{1r} (i.e., annual total body dose rate at the SITE BOUNDARY due to noble gases contained in a gaseous radwaste release, r, discharged from the site).

(1) The rigorous method shall be used IF a computer system and the appropriate software are available.

(2) The simplified method may be used IF a computer system and the appropriate software are NOT available.

(3) These methods, as well as additional supporting information, are presented in the following sections.

c) Rigorous method

(1) Solution of the following equation may prove too rigorous for routine use unless a computer system and appropriate software are available.

(2) If a computer system and the appropriate software are available, the annual total body dose rate due to noble gases in gaseous effluents discharged from the site to UNRESTRICTED AREAS shall be calculated in accordance with equation 8G.

ANNUAL TOTAL BODY DOSE RATE DUE TO NOBLE GASES IN GAS RELEASE, r (RIGOROUS METHOD)

$$D_{ir} = (x/Q)\left[\sum (K_i)(Q_{ir})\right] \qquad \text{Eq. 8G}^{86}$$

Where,

x/Q = the highest calculated annual average relative concentration for any area at or beyond the UNRESTRICTED AREA boundary (2.2E-6 seconds per cubic meter)

All releases are considered "long-term" releases[87], and as such, the highest historical annual average dispersion factor, (x/Q), is used in the dose rate calculations.

The highest annual average dispersion factor (x/Q) is 2.2E-6 (UFSAR, 2.3.6.3) for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3)

The maximum annual average on-shore concentrations occur in the southeast sector at a distance of 1300 meters for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3)

K_i = the total body dose factor due to gamma emissions for each identified noble gas radionuclide, i (mrem/yr per microcarie/cubic meter)

The total-body dose factors for gamma rays from noble gas radionuclides were obtained from Regulatory Guide 1.109, Appendix B, Table B-1.

The total-body dose factors for various noble gas radionuclides are tabulated in Attachment 10.

Q_{ir} = the release rate of noble gas radionuclide, i, in (simultaneous) gaseous release, r (microcuries/second).

Calculate the values of Q_{ir} for each SIMULTANEOUS RELEASE as shown below.

INSTANTANEOUS RELEASE RATE OF NOBLE GAS NUCLIDE i IN GASEOUS RELEASE r

$$Q_{ir} = (A_{ir})(F_r) \qquad \text{Eq. 9G}$$

Where,

A_{ir} = the specific activity of noble gas radionuclide, i, in (simultaneous) release, r (microcuries/cubic centimeter)

F_r = the discharge flow rate for (simultaneous) release, r (cubic meters per second)

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86 Equations 8G has been derived from NUREG-0133, 5.2.1, and Regulatory Guide 1.109 (Appendix B, Equation B-8 and Section C.2.e).

87 NUREG-0133, 3.3

If the discharge flow rate is unknown (e.g., the release has not been conducted), the "Maximum Discharge Flow Rate" listed on Attachments 7 or 8 may be used to calculate the annual total body dose rate.

Whenever possible, the actual discharge flow rate determined from actual release conditions (e.g., initial pressure, volume, and temperature of a WGDT along with final pressure and temperature) shall be used in equation 9G.

Additional guidance for calculating discharge flow rates may be contained in approved chemistry section procedures (e.g., CP-601 and CP-604).

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d) Simplified method

(1) If a computer system and the appropriate software are NOT available, the annual total body dose rate due to noble gases in gaseous effluents discharged from the site to UNRESTRICTED AREAS may be calculated in accordance with equation 10G.

ANNUAL TOTAL BODY DOSE RATE DUE TO NOBLE GASES IN GAS RELEASE, r (SIMPLIFIED METHOD)

$$D_{tr} = [(x/Q) (K_{avg}) / (K_{st})] \sum Q_{ir} \qquad \text{Eq. 10G}^{88}$$

Where,

x/Q = the highest calculated annual average relative concentration for any area at or beyond the UNRESTRICTED AREA boundary (2.2E-6 seconds per cubic meter)

All releases are considered "long-term" releases[89], and as such, the highest historical annual average dispersion factor, (x/Q), is used in the dose rate calculations.

The highest annual average dispersion factor (x/Q) is 2.2E-6 (UFSAR, 2.3.6.3) for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3)

The maximum annual average on-shore concentrations occur in the southeast sector at a distance of 1300 meters for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3)

K_{avg} = the empirically derived, site specific, average, total body, dose factor due to gamma emissions from TYPICAL GASEOUS EFFLUENTS (mrem/yr per microcurie/cubic meter)

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88 Equations 10G has been derived from NUREG-0133, 5.2.1, and historical, site-specific data.

89 NUREG-0133, 3.3

A site-specific, average, gamma total body dose factor for TYPICAL GASEOUS EFFLUENTS has been calculated from historical data.

The calculation of this site-specific, average, gamma air dose factor is presented on Attachment 11 (use section 3.4.5 of the old ODCM.)

Refer to the table on Attachment 11 for the current value for the empirically derived, site specific, average gamma total body dose factor.

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP annual total body dose rate limit to the annual total body dose rate limit of Specification 3.11.2.1, (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the annual total body dose rate is always less than or equal to the annual total body dose rate limit of Specification 3.11.2.1.

A safety factor of 1.00 will yield an annual total body dose rate which corresponds to the annual total body dose rate limit of Specification 3.11.2.1.

A safety factor of 0.500 will yield an annual total body dose rate which corresponds to one-half the annual total body dose rate limit of Specification 3.11.2.1.

It is recommended that a safety factor of 1.0 be used for calculating the annual total body dose rate, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

The particular value selected for the safety factor is somewhat arbitrary, however a safety factor does provide plant personnel with a degree of administrative control over the use of simplified equations for generating radioactive gaseous release permits. This administrative control is designed to minimize the possibility of violating Technical Specification 3.11.2.1 when simplifying assumptions are used.

The use of a safety factor is consistent with 10 CFR 20.1(c) which states that the licensees should, "... in addition to complying with the limits set forth in this part [10 CFR 20], make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to UNRESTRICTED AREAS, as low as is reasonably achievable."

This safety factor has been included in equation 10G to account for any potential nonconservatism associated with applying the empirically derived total body gamma dose factor, K_{avg}, to all radionuclides identified in the gaseous release. Such nonconservatism could conceivable be present whenever radionuclides having a total body gamma dose factor greater than K_{avg} are present in a gaseous release.

Q_{ir} = the release rate of noble gas radionuclide, i, in (simultaneous) gaseous release, r (microcuries/second)

Calculate the values of Q_{ir} for each SIMULTANEOUS RELEASE in accordance with equation 9G.

INSTANTANEOUS RELEASE RATE OF NOBLE GAS NUCLIDE i IN GASEOUS RELEASE r

$$Q_{ir} = (A_{ir})(F_r) \qquad \text{Eq. 9G}$$

Where,

A_{ir} = the specific activity of noble gas radionuclide, i, in (simultaneous) release, r (microcuries/cubic centimeter)

F_r = the discharge flow rate for (simultaneous) release, r (cubic meters per second)

If the discharge flow rate is unknown (e.g., the release has not been conducted), the "Maximum Discharge Flow Rate" listed on Attachments 7 or 8 may be used to calculate the annual total body dose rate.

Whenever possible, the actual discharge flow rate determined from actual release conditions (e.g., initial pressure, volume, and temperature of a WGDT along with final pressure and temperature) shall be used in equation 9G.

Additional guidance for calculating discharge flow rates may be contained in approved chemistry section procedures (e.g., CP-601 and CP-604).

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e) Radiation monitoring system algorithms

(1) The plant vent stack radiation monitoring systems display values which are proportional to the annual total body dose rates due to noble gases emanating from the plant vent stacks.

(2) The values displayed by the plant vent stack radiation monitoring systems are not used for the purpose of effluent accountability per se, but the values displayed can provide a gross approximation of annual total body dose rate (see Technical Specification 3.3.3.9).

(3) The Westinghouse Main Vent Noble Gas Monitor, 1/2-RE-5415, is an analog system and does not employ instrument algorithm to determine noble release rates.

(a) It is possible to approximate the noble gas release rates for the Unit 1 and Unit 2 main vents based on output from 1/2-RI-5415.

(b) These calculations are described elsewhere in the ODCM. (See equation 4G in the section "Calculating the Fixed Setpoint for 1/2-RI-5415.")

(4) The Sorrento WRNGM, 1/2-RE-5416, is a digital radiation monitoring system which employs an instrument algorithm to determine noble release rates (microcuries per second).

(a) It is possible to approximate the noble gas release rates for the Unit 1 and Unit 2 main vents based on output from 1/2-RIC-5415.

(b) These calculations are described elsewhere in the ODCM. (See equation 1G in the section "Calculating the Fixed High-High Alarm Setpoint for 1/2-RIC-5415.")

(c) The instrument algorithms and the (data base) values accessed by the instrument algorithms are controlled by CCI-205.

f) Once the calculations above have been completed, the calculation results are compared to the applicable limits and corrective actions are initiated as described below.

7. Corrective Actions

a) Chemistry Section surveillance procedures (e.g., CP-213) shall contain/and or reference administrative and/or Technical Specification limits for annual total body dose rates for gaseous effluents and shall specify corrective actions to be initiated when these limits are exceeded.

b) Refer to Technical Specification 3.11.2.1 for actions to be taken in the event the calculated annual total body dose rate due to noble gases in gaseous effluents exceeds 500 mr/yr.

F. Annual Skin Dose Rate Due To Noble Gases In Gaseous Effluents

1. Introduction

a) 10 CFR 20.105 specifies dose rate limits associated with the release of radioactive materials to UNRESTRICTED AREAS.

b) Radiological effluent controls have been established to implement the requirements of 10 CFR 20.105.

c) These radiological effluent controls are described below.

2. Radiological Effluent Controls

a) The annual skin dose rate, due to noble gases in gaseous waste discharged to UNRESTRICTED AREAS, shall be less than 3000 mr/yr (per Technical Specification 3.11.2.1).

b) The routine surveillances which are performed to verify compliance with this radiological effluent controls are described below.

3. Surveillance Requirement

a) The annual skin dose rate at the SITE BOUNDARY, due to noble gases in all gaseous effluents discharged from the site, shall be determined in accordance with equation 11G (per Technical Specification 4.11.2.1.1).

b) The results of the radioactive gaseous waste sampling and analysis program (required by Technical Specification 4.11.2.1.2, and implemented by various CCNPP chemistry section procedures) are used to calculate the annual skin dose rate due to noble gases in gaseous effluents.

c) The plant group(s) responsible for performing the required surveillances are identified below.

4. Responsible Plant Organization(s)

a) The Chemistry Section is responsible for calculating the annual skin dose rate due to noble gases in gaseous effluents.

b) The CCNPP Chemistry Section calculates the annual skin dose rate whenever the appropriate initiating conditions are present.

c) These initiating conditions are contained in the following section.

5. Initiating Conditions

a) The annual skin dose rate due to noble gases in all gaseous effluents discharged from the site is calculated for each release of a WGDT.

b) The annual skin dose rate due to noble gases in all gaseous effluents discharged from the site is calculated for each vent of a containment building.

c) The annual skin dose rate due to noble gases in all gaseous effluents discharged from the site is calculated for each PURGE of a containment building.

d) The annual skin dose rate due to noble gases in all gaseous effluents discharged from the site is calculated at least weekly[90] for CONTINUOUS discharges from plant vent stacks.

e) The annual skin dose rate due to noble gases in all gaseous effluents discharged from the site is calculated for each discharge of combustion products resulting from the burning of contaminated oil.

f) The annual skin dose rate due to noble gases in all gaseous effluents discharged from the site is calculated for each ABNORMAL AND/OR UNANTICIPATED RADIOACTIVE GAS RELEASE (as defined in CP-612).

g) Whenever the correct initiating conditions are present, the annual skin dose rates shall be calculated as described below.

6. Calculation Methodology

a) The annual skin dose rate, at the SITE BOUNDARY, due to noble gases in all gaseous effluents discharged simultaneously from the site to UNRESTRICTED AREAS shall be calculated in accordance with equation 11G.[91]

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90 The frequency is controlled by the implementing procedure, CP-612, and is based on plant conditions. Under no conditions shall the frequency be less than once per month (Technical Specification 4.11.2.1.1 or 4.11.2.1.2, Table 4.11-2).

91 The alarm and trip setpoints ... shall be determined and adjusted in accordance with the methodology and parameters of the ODCM. (Technical Specification 3.3.3.9).

ANNUAL SKIN DOSE RATE DUE TO NOBLE GASES IN ALL SIMULTANEOUS GAS RELEASES, r

$$D_{s0} = \sum D_{sr} \qquad \text{Eq. 11G}$$

D_{s0} = the annual skin dose rate at the SITE BOUNDARY due to noble gases in all simultaneous discharges of gaseous radwaste from the site ("Unit 0")

D_{sr} = the annual skin dose rate at the SITE BOUNDARY due to noble gases in release, r

Sum for all releases, r, which are discharged simultaneously.

An example of a SIMULTANEOUS RELEASE would include the release of noble gas radionuclides from the Unit 1 plant vent stack while also discharging noble gases from the Unit 2 plant vent stack.

An example of a SIMULTANEOUS RELEASE would include the release of noble gas radionuclides from the Unit 1 plant vent stack while also discharging a waste gas decay tank.

Calculate the values of D_{sr} for each SIMULTANEOUS RELEASE as shown below.

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b) At CCNPP, two methods exist for calculating D_{sr} (i.e., annual total skin dose rate at the SITE BOUNDARY due to noble gases contained in a gaseous radwaste release, r, discharged from the site).

(1) The rigorous method shall be used IF a computer system and the appropriate software are available.

(2) The simplified method may be used IF a computer system and the appropriate software are NOT available.

(3) These methods, as well as additional supporting information, are presented in the following sections.

c) Rigorous Method

(1) Solution of the following equation may prove too rigorous for routine use unless a computer system and appropriate software are available.

(2) If a computer system and the appropriate software are available, the annual skin dose rate due to noble gases in gaseous release, r, discharged from the site to UNRESTRICTED AREAS shall be calculated in accordance with equation 12G.

ANNUAL SKIN DOSE RATE DUE TO NOBLE GASES IN GAS RELEASE, r (RIGOROUS METHOD)

$$D_{sr} = (x/Q) \sum \{ [L_i + (1.1)(M_i)] (Q_{ir}) \} \quad \text{Eq. 12G}^{92}$$

Where,

x/Q = the highest calculated annual average relative concentration for any area at or beyond the UNRESTRICTED AREA boundary (2.2E-6 seconds per cubic meter)

All releases are considered "long-term" releases[93], and as such, the highest historical annual average dispersion factor, (x/Q), is used in the dose rate calculations.

The highest annual average dispersion factor (x/Q) is 2.2E-6 (UFSAR, 2.3.6.3) for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3)

The maximum annual average on-shore concentrations occur in the southeast sector at a distance of 1300 meters for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3)

L_i = the skin dose factor due to beta emissions for each identified noble gas radionuclide, i (mrem/yr per microcurie/cubic meter)

The beta skin dose factors have been obtained from Regulatory Guide 1.109, Appendix B, Table B-1.

The beta skin dose factors for various noble gas radionuclides are tabulated in Attachment 10.

M_i = the air dose factor due to gamma emissions for each identified noble gas radionuclide, i (mrad/yr per microcurie/cubic meter)

The gamma air dose factors have been obtained from Regulatory Guide 1.109, Appendix B, Table B-1.

The gamma air dose factors for various noble gas radionuclides are tabulated in Attachment 10.

1.1 = The conversion constant, 1.1 mrem/mrad, represents the skin dose (1.1 mrem) equivalent to air dose (1.0 mrad), and is used to convert air dose to skin dose.

Q_{ir} = the release rate of noble gas radionuclide, i, in (simultaneous) release, r (microcuries/second).

This value shall be calculated in accordance with equation 9G.

INSTANTANEOUS RELEASE RATE OF NOBLE GAS NUCLIDE i IN GASEOUS RELEASE r

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92 Equation 12G has been derived from NUREG-0133, 5.2.1, and Regulatory Guide 1.109 (Appendix B, Equation B-9 and Section C.2.f).

93 NUREG-0133, 3.3

$$Q_{ir} = (A_{ir})(F_r) \qquad \text{Eq. 9G}$$

A_{ir} = the specific activity of noble gas radionuclide, i, in (simultaneous) release, r (microcuries/cubic centimeter)

F_r = the discharge flow rate for (simultaneous) release, r (cubic meters per second)

If the discharge flow rate is unknown (e.g., the release has not been conducted), the "Maximum Discharge Flow Rate" listed on Attachments 7 or 8 may be used to calculate the annual skin dose rate.

Whenever possible, the actual discharge flow rate determined from actual release conditions (e.g., initial pressure, volume, and temperature of a WGDT along with final pressure and temperature) shall be used in equation 9G.

Additional guidance for calculating discharge flow rates may be contained in approved chemistry section procedures (e.g., CP-601 and CP-604).

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d) Simplified method

(1) If a computer system and the appropriate software are NOT available, the annual skin dose rate due to noble gases in gaseous effluents discharged from the site to UNRESTRICTED AREAS may be calculated in accordance with equation 13G.

ANNUAL SKIN DOSE RATE DUE TO NOBLE GASES IN GAS RELEASE, r (SIMPLIFIED METHOD)

$$D_{sr} = [(x/Q)/(K_{sf})][L_{avg} + (1.1)(M_{avg})]\sum Q_{ir} \qquad \text{Eq. 13G}^{94}$$

Where,

x/Q = the highest calculated annual average relative concentration for any area at or beyond the UNRESTRICTED AREA boundary (2.2E-6 seconds per cubic meter)

All releases are considered "long-term" releases[95], and as such, the highest historical annual average dispersion factor, (x/Q), is used in the dose rate calculations.

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94 Equation 12G has been derived from NUREG-0133, 5.2.1, and Regulatory Guide 1.109 (Appendix B, Equation B-9 and Section C.2.f).

95 NUREG-0133, 3.3

The highest annual average dispersion factor (x/Q) is 2.2E-6 (UFSAR, 2.3.6.3) for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3)

The maximum annual average on-shore concentrations occur in the southeast sector at a distance of 1300 meters for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3)

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP annual skin dose rate limit to the annual skin dose rate limit of Specification 3.11.2.1, (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the annual skin dose rate is always less than or equal to the annual skin dose rate limit of Specification 3.11.2.1.

A safety factor of 1.00 will yield an annual skin dose rate which corresponds to the annual skin dose rate limit of Specification 3.11.2.1.

A safety factor of 0.500 will yield an annual skin dose rate which corresponds to one-half the annual skin dose rate limit of Specification 3.11.2.1.

It is recommended that a safety factor of 1.0 be used for calculating the annual skin dose rate, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

The particular value selected for the safety factor is somewhat arbitrary, however a safety factor does provide plant personnel with a degree of administrative control over the use of simplified equations for generating radioactive gaseous release permits. This administrative control is designed to minimize the possibility of violating Technical Specification 3.11.2.1 when simplifying assumptions are used.

The use of a safety factor is consistent with 10 CFR 20.1(c) which states that the licensees should, "... in addition to complying with the limits set forth in this part [10 CFR 20], make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to UNRESTRICTED AREAS, as low as is reasonably achievable."

This safety factor has been included in equation 13G to account for any potential nonconservatism associated with applying the empirically derived skin beta dose factor, L_{avg}, to all radionuclides identified in the gaseous release. Such nonconservatism could conceivable be present whenever radionuclides having a skin beta dose factor greater than L_{avg} are present in a gaseous release.

L_{avg} = the empirically derived, site specific, average, skin dose factor due to beta emissions from TYPICAL GASEOUS EFFLUENTS (mrem/yr per microcurie/cubic meter)

A site-specific, average, beta skin dose factor for TYPICAL GASEOUS EFFLUENTS has been calculated from historical data.

The calculation of this site-specific, average, beta skin dose factor is presented on Attachment 11.

Refer to the table on Attachment 11 for the current value for the empirically derived, site specific, average beta skin dose factor.

M_{avg} = the empirically derived, site specific, average, air dose factor due to gamma emissions from TYPICAL GASEOUS EFFLUENTS (mrad/yr per microcurie/cubic meter)

A site-specific, average, gamma air dose factor for TYPICAL GASEOUS EFFLUENTS has been calculated from historical data.

The calculation of this site-specific, average, gamma air dose factor is presented on Attachment 11.

Refer to the table on Attachment 11 for the current value for the empirically derived, site specific, average gamma air dose factor.

1.1 = The conversion constant, 1.1 mrem/mrad, represents the skin dose (1.1 mrem) equivalent to air dose (1.0 mrad), and is used to convert air dose to skin dose.

Q_{ir} = the release rate of noble gas radionuclide, i, in (simultaneous) release, r (microcuries/second)

This value shall be calculated in accordance with equation 9G.

INSTANTANEOUS RELEASE RATE OF NOBLE GAS NUCLIDE i IN GASEOUS RELEASE r

$$Q_{ir} = (A_{ir})(F_r) \qquad \text{Eq. 9G}$$

A_{ir} = the specific activity of noble gas radionuclide, i, in (simultaneous) release, r (microcuries/cubic centimeter)

F_r = the discharge flow rate for (simultaneous) release, r (cubic meters per second)

If the discharge flow rate is unknown (e.g., the release has not been conducted), the "Maximum Discharge Flow Rate" listed on Attachments 7 or 8 may be used to calculate the annual skin dose rate.

Whenever possible, the actual discharge flow rate determined from actual release conditions (e.g., initial pressure, volume, and temperature of a WGDT along with final pressure and temperature) shall be used in equation 9G.

Additional guidance for calculating discharge flow rates may be contained in approved chemistry section procedures (e.g., CP-601 and CP-604).

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e) Radiation monitoring system algorithms

(1) The plant vent stack radiation monitoring systems display values which are proportional to the annual skin dose rate due to noble gases emanating from the plant vent stacks.

(2) The values displayed by the plant vent stack radiation monitoring systems are not used for the purpose of effluent accountability per se, but the values displayed can provide a gross approximation of annual skin dose rate (see Technical Specification 3.3.3.9).

(3) The Westinghouse Main Vent Stack Noble Gas Monitor, 1/2-RE-5415, is an analog system and does not employ instrument algorithm to determine noble release rates.

(a) It is possible to approximate the noble gas release rates for the Unit 1 and Unit 2 main vents based on output from 1/2-RI-5415.

(b) These calculations are described elsewhere in the ODCM. (See equation 4G in the section "Calculating the Fixed Setpoint for 1/2-RI-5415.")

(4) The Sorrento WRNGM, 1/2-RE-5416, is a digital radiation monitoring system which employs an instrument algorithm to determine noble release rates (microcuries per second).

(a) It is possible to approximate the noble gas release rates for the Unit 1 and Unit 2 main vents based on output from 1/2-RIC-5415.

(b) These calculations are described elsewhere in the ODCM. (See equation 1G in the section "Calculating the Fixed High-High Alarm Setpoint for 1/2-RIC-5415.")

(5) The instrument algorithms and the (data base) values accessed by the instrument algorithms are controlled by CCI-205.

f) Once the calculations above have been completed, the calculation results are compared to the applicable limits and corrective actions are initiated as described below.

7. Corrective Actions

a) Chemistry Section surveillance procedures (e.g., CP-213) shall contain/and or reference administrative and/or Technical Specification limits for annual skin dose rate for gaseous effluents and shall specify corrective actions to be initiated when these limits are exceeded.

b) Refer to Technical Specification 3.11.2.1 for actions to be taken in the event the calculated annual skin dose rate exceeds 3000 mr/yr.

G. Annual Organ Dose Rates Due To Iodines And Particulates In Gaseous Effluents

1. Introduction

a) 10 CFR 20.105 specifies dose rate limits associated with the release of radioactive materials to UNRESTRICTED AREAS.

b) Radiological effluent controls have been established to implement the requirements of 10 CFR 20.105.

c) These radiological effluent controls are described below.

2. Radiological Effluent Controls

   a) The annual organ dose rates, due to iodines and particulates in gaseous waste discharged to UNRESTRICTED AREAS, shall be less than 1500 mr/yr (per Technical Specification 3.11.2.1).

   b) The routine surveillances which are performed to verify compliance with this radiological effluent controls are described below.

3. Surveillance Requirements

   a) The chemistry section's sampling and analysis procedure(s) (e.g., CP-504, CP-604) shall describe the CCNPP radioactive gaseous waste sampling and analysis program (required by Technical Specification 4.11.2.1.2).

   b) The results of the radioactive gaseous waste sampling and analysis program are used to calculate the annual organ dose rates due to iodines and particulates in gaseous effluents.

   c) The plant group(s) responsible for performing the required surveillances are identified below.

4. Responsible Plant Organization(s)

   a) The Chemistry Section is responsible for calculating the annual organ dose rates due to iodines and particulates in gaseous effluents.

   b) The CCNPP Chemistry Section calculates the annual organ dose rates whenever the appropriate initiating conditions are present.

   c) These initiating conditions are contained in the following section.

5. Initiating Conditions

   a) The annual organ dose rate--for each organ and at the SITE BOUNDARY--due to iodines and particulates in gaseous effluents is calculated at least weekly[96] for CONTINUOUS discharges from plant vent stacks.

   b) The annual organ dose rate--for each organ and at the SITE BOUNDARY--due to iodines and particulates in gaseous effluents is calculated for each discharge of combustion products resulting from the burning of contaminated oil.

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96 The frequency is controlled by the implementing procedure, CP-612, and is based on plant conditions. Under no conditions shall the frequency be less than once per month (Technical Specification 4.11.2.1.1 or 4.11.2.1.2, Table 4.11-2).

c) The annual organ dose rate--for each organ and at the SITE BOUNDARY--due to iodines and particulates in gaseous effluents is calculated for each ABNORMAL AND/OR UNANTICIPATED RADIOACTIVE GAS RELEASE[97].

d) Whenever the correct initiating conditions are present, the annual organ dose rates shall be calculated as described below.

6. Calculation Methodology

a) The annual organ dose rate, at the SITE BOUNDARY, due to iodine and particulate radionuclides in gaseous effluents released to UNRESTRICTED AREAS shall be calculated in accordance with equation 14G.[98]

ANNUAL ORGAN, o , DOSE RATE DUE TO IODINES AND PARTICULATES IN ALL SIMULTANEOUS GASEOUS RELEASES, r FROM THE SITE, 0

$$D_{o0} = \sum D_{or} \qquad \text{Eq. 14G}$$

D_{o0} = the site-boundary annual organ dose rate due to iodine and particulate radionuclides in all gaseous effluents discharged simultaneously from the site ("Unit 0")

D_{or} = the site-boundary annual organ dose rate due to iodine and particulate radionuclides in release, r

Sum for all releases, r, which are discharged simultaneously.

An example of a SIMULTANEOUS RELEASE would include the release of iodines and particulate radionuclides from the Unit 1 plant vent stack while also discharging iodines and particulate radionuclides from the Unit 2 plant vent stack.

An example of a SIMULTANEOUS RELEASE would include the release of iodine and particulate radionuclides from the Unit 1 plant vent stack while also discharging a waste gas decay tank.

Calculate the values of D_{or} for each SIMULTANEOUS RELEASE as shown below.

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b) At CCNPP, two methods exist for calculating D_{or} (i.e., the annual organ dose rates due to iodine and particulate radionuclides in gaseous effluents released to UNRESTRICTED AREAS).

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97 See the definition of ABNORMAL/UNANTICIPATED GAS RELEASE in the DEFINITIONS section of the ODCM.

98 The alarm and trip setpoints ... shall be determined and adjusted in accordance with the methodology and parameters of the ODCM. (Technical Specification 3.3.3.9).

(1) The rigorous method shall be used IF a computer system and the appropriate software are available.

(2) The simplified method may be used IF a computer system and the appropriate software are NOT available.

(3) These methods, as well as additional supporting information, are presented in the following sections.

c) Rigorous Method

(1) Solution of the following equation may prove too rigorous for routine use unless a computer system and appropriate software are available.

(2) If a computer system and the appropriate software are available, the annual organ dose rates due to iodines and particulates in gaseous effluents released to an UNRESTRICTED AREA shall be calculated in accordance with equation 15G.

ANNUAL ORGAN, o, DOSE RATE DUE TO IODINES AND PARTICULATES IN GASEOUS RELEASE, r (RIGOROUS METHOD)

$$D_{or} = (x/Q) \sum (P_i)(Q_{ir}) \qquad \text{Eq. 15G}^{99}$$

Where,

x/Q = the highest calculated annual average relative concentration for any area at or beyond the UNRESTRICTED AREA boundary (2.2E-6 seconds per cubic meter)

All releases are considered "long-term" releases[100], and as such, the highest historical annual average dispersion factor, (x/Q), is used in the dose rate calculations.

The highest annual average dispersion factor (x/Q) is 2.2E-6 (UFSAR, 2.3.6.3) for purposes of routine, long-term concentrations (UFSAR, 2.3.6.3).

The maximum annual average on-shore concentrations occur in the southeast sector at a distance of 1300 meters for purposes of routine, long-term concentrations (UFSAR, 2.3.6.3).

P_i = the maximum organ inhalation pathway dose parameter for iodine and particulate radionuclides, i, for the most restrictive (i.e., child) age group (mrem/year per microcurie/cubic meter)

The inhalation pathway dose parameters have been obtained in accordance with NUREG-0133, 5.2.1.1.

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99 Equation 15G has been derived from NUREG-0133, 5.2.1.

100 NUREG-0133, 3.3

The pathway dose factor specified in NUREG-0133, 5.2.1.b, specifies calculating the exposure to the "INFANT" age group, where the exposure is due to a combination of three separate pathways.

1) inhalation,

2) ground plane, and

3) food.

The latest NRC guidance has deleted the requirement to include the ground plane and food dose contributions when calculating maximum organ doses, therefor no pathway dose factors are calculated for the ground plane or food pathways.

The latest NRC guidance has changed the critical receptor age group from "infant" to "child."

The child, inhalation pathway dose parameters for various radionuclides, sorted by critical organ, are tabulated in Attachment 12.

It should be noted that the dose parameters, P_i, (listed in Attachment 12) calculated in accordance with NUREG-0133, section 5.2.1.1 and the latest NRC guidance are numerically equal to the "Inhalation Pathway Factors," K_i, calculated in accordance with NUREG-0133, section 5.3.1.1. As a result the ODCM does not contain two separate tables for values of P_i and K_i.

Q_{ir} = the release rate of iodine or particulate radionuclide, i, in (simultaneous) gaseous release, r (microcuries/second).

Calculate the values of Q_{ir} for each SIMULTANEOUS RELEASE in accordance with equation 9G.

INSTANTANEOUS RELEASE RATE OF IODINE OR PARTICULATE NUCLIDE i IN GASEOUS RELEASE r

$$Q_{ir} = (A_{ir})(F_r) \qquad \text{Eq. 9G}$$

A_{ir} = the specific activity of iodine or particulate radionuclide, i, in (simultaneous) release, r (microcuries/cubic centimeter)

F_r = the discharge flow rate for (simultaneous) release, r (cubic meters per second)

If the discharge flow rate is unknown (e.g., the release has not been conducted), the "Maximum Discharge Flow Rate" listed on Attachments 7 or 8 may be used to calculate the annual organ dose rate.

Additional guidance for calculating discharge flow rates may be contained in approved chemistry section procedures (e.g., CP-601 and CP-604).

d) simplified method

(1) If a computer system and the appropriate software are NOT available, the annual organ dose rate due to iodines and particulates in gaseous effluents discharged from the site to UNRESTRICTED AREAS may be calculated in accordance with equation 16G.

ANNUAL ORGAN, o, DOSE RATE DUE TO IODINES AND PARTICULATES IN GASEOUS RELEASE, r (SIMPLIFIED METHOD)

$$D_{or} = (1/K_{sf})(x/Q)(P_{max}) \sum Q_{ir} \qquad \text{Eq. 16G}^{101}$$

Where,

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP organ dose rate limit to the organ dose rate limit of Specification 3.11.2.1, (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the organ dose rate is always less than or equal to the organ dose rate limit of Specification 3.11.2.1.

A safety factor of 1.00 will yield an organ dose rate which corresponds to the organ dose rate limit of Specification 3.11.2.1.

A safety factor of 0.500 will yield an organ dose which corresponds to one-half the organ dose rate limit of Specification 3.11.2.1.

It is recommended that a safety factor of 1.0 be used for calculating the organ dose rate, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

The particular value selected for the safety factor is somewhat arbitrary, however a safety factor does provide plant personnel with a degree of administrative control over the use of simplified equations for generating radioactive gaseous release permits. This administrative control is designed to minimize the possibility of violating Technical Specification 3.11.2.1 when simplifying assumptions are used.

The use of a safety factor is consistent with 10 CFR 20.1(c) which states that the licensees should, "... in addition to complying with the limits set forth in this part [10 CFR 20], make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to UNRESTRICTED AREAS, as low as is reasonably achievable."

This safety factor has been included in equation 16G to account for any potential nonconservatism associated with applying the dose parameter, P_{max}, to all radionuclides identified in the gaseous release. Such nonconservatism could conceivable be present whenever radionuclides having a dose parameter greater than P_{max} are present in a gaseous release.

x/Q = the highest calculated annual average relative concentration for any area at or beyond the UNRESTRICTED AREA boundary (2.2E-6 seconds per cubic meter)

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101 Equation 16G has been derived from NUREG-0133, 5.2.1.

All releases are considered "long-term" releases[102], and as such, the highest historical annual average dispersion factor, (x/Q), is used in the dose rate calculations.

The highest annual average dispersion factor (x/Q) is 2.2E-6 (UFSAR, 2.3.6.3) for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

The maximum annual average on-shore concentrations occur in the southeast sector at a distance of 1300 meters for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

P_{max} = the most restrictive dose parameter which would be reasonably anticipated for the inhalation pathway, child age group, thyroid organ, and I-131 radionuclide (mrem/year per microcurie/cubic meter)

The inhalation pathway dose parameters have been obtained in accordance with NUREG-0133, 5.2.1.1.

The pathway dose factor specified in NUREG-0133, 5.2.1.b, specifies calculating the exposure to the "INFANT" age group, where the exposure is due to a combination of three separate pathways.

1) inhalation,

2) ground plane, and

3) food.

The latest NRC guidance has deleted the requirement to include the ground plane and food dose contributions when calculating maximum organ doses, therefor no pathway dose factors are calculated for the ground plane or food pathways.

The latest NRC guidance has changed the critical receptor age group from "infant" to "child."

The child, inhalation pathway dose parameters for various radionuclides, sorted by critical organ, are tabulated in Attachment 12.

It should be noted that the dose parameters, P_i, (listed in Attachment 12) calculated in accordance with NUREG-0133, section 5.2.1.1 and the latest NRC guidance are numerically equal to the "Inhalation Pathway Factors," K_i, calculated in accordance with NUREG-0133, section 5.3.1.1. As a result the ODCM does not contain two separate tables for values of P_i and K_i.

Q_{ir} = the release rate of iodine or particulate radionuclide, i, in (simultaneous) gaseous release, r (microcuries/second).

Calculate the values of Q_{ir} for each SIMULTANEOUS RELEASE in accordance with equation 9G.

INSTANTANEOUS RELEASE RATE OF IODINE OR PARTICULATE NUCLIDE i IN GASEOUS RELEASE r

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102 NUREG-0133, 3.3

$$Q_{ir} = (A_{ir})(F_r) \qquad \text{Eq. 9G}$$

A_{ir} = the specific activity of iodine or particulate radionuclide, i, in (simultaneous) release, r (microcuries/cubic centimeter)

F_r = the discharge flow rate for (simultaneous) release, r (cubic meters per second)

If the discharge flow rate is unknown (e.g., the release has not been conducted), the "Maximum Discharge Flow Rate" listed on Attachments 7 or 6 may be used to calculate the annual organ dose rate.

Additional guidance for calculating discharge flow rates may be contained in approved chemistry section procedures (e.g., CP-601 and CP-604).

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e) Once the calculations above have been completed, the calculation results are compared to the applicable limits and corrective actions are initiated as described below.

7. Corrective Actions

a) Chemistry Section surveillance procedures (e.g., CP-213) shall contain/and or reference administrative and/or Technical Specification limits for annual organ dose rates for gaseous effluents and shall specify corrective actions to be initiated when these limits are exceeded.

b) Refer to Technical Specification 3.11.2.1 for actions to be taken in the event the calculated annual organ dose rate to any organ exceeds 1500 mr/yr.

H. Cumulative Gamma Air Doses Due To Noble Gases In Gaseous Effluents

1. Introduction

a) Appendix I to 10 CFR 50 specifies cumulative gamma air dose limits associated with the release of radioactive materials to UNRESTRICTED AREAS.

b) Radiological effluent controls have been established to implement the requirements of 10 CFR 50, Appendix I.

c) These radiological effluent controls are described below.

2. Radiological Effluent Controls

a) The cumulative gamma air dose, due to noble gases in gaseous effluents released to UNRESTRICTED AREAS, shall be less than 10 mrads in any calendar quarter, and shall be less than 20 mrads in any calendar year (per Technical Specification 3.11.2.2)

b) The routine surveillances which are performed to verify compliance with these radiological effluent controls are described below.

3. Surveillance Requirement(s)

a) The cumulative gamma air doses, for the current calendar month, the calendar quarter, and the current calendar year, due to noble gases in gaseous effluents, shall be determined at least once every 60 days (Technical Specification 4.11.2.2).

b) The plant group(s) responsible for performing the required surveillance(s) are identified below.

4. Responsible Plant Organizations

a) The Chemistry Section is responsible for calculating the cumulative gamma air doses for the current calendar quarter and the current calendar year.

b) The CCNPP Chemistry Section calculates the cumulative gamma air doses whenever the appropriate initiating conditions are present

c) These initiating conditions are contained in the following section.

5. Initiating Conditions

a) The cumulative gamma air doses due to noble gases in gaseous effluents shall be determined at least once per 60 days (Technical Specification 4.11.2.2).

b) The cumulative gamma air doses due to noble gases in gaseous effluents shall be calculated for each release of a WGDT (CP-604).

c) The cumulative gamma air doses due to noble gases in gaseous effluents shall be calculated for each vent of a containment building (CP-604).

d) The cumulative gamma air doses due to noble gases in gaseous effluents shall be calculated for each PURGE of a containment building (CP-604).

e) The cumulative gamma air doses due to noble gases in gaseous effluents shall be calculated at least weekly[103] for CONTINUOUS discharges from plant vent stacks (CP-612).

f) The cumulative gamma air doses due to noble gases in gaseous effluents shall be calculated for each discharge of combustion products resulting from the burning of contaminated oil.

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[103] The frequency is controlled by the implementing procedure, CP-612, and is based on plant conditions. Under no conditions shall the frequency be less than once per month (Technical Specification 4.11.2.1.1 or 4.11.2.1.2, Table 4.11-2).

g) The cumulative gamma air doses due to noble gases in gaseous effluents shall be calculated for each ABNORMAL AND/OR UNANTICIPATED RADIOACTIVE GAS RELEASE[104] (CP-612).

h) Whenever the correct initiating conditions are present, the cumulative gamma air doses shall be calculated as described below.

6. Calculation Methodology

a) The cumulative gamma air dose at the SITE BOUNDARY (e.g., for the current calendar month, current calendar quarter, current calendar year, or previous 92 days) due to noble gases in gaseous effluents shall be calculated using the following equation[105]:

CUMULATIVE GAMMA, g, AIR DOSE FOR ALL GASEOUS RELEASES, r, DISCHARGED DURING TIME INTERVAL, t

$$D_{gt} = \sum D_{gr} \qquad \text{Eq. 17G}$$

Where,

D_{gt} = the cumulative gamma air dose (mrad) at the SITE BOUNDARY due to noble gas radionuclides contained in all gaseous radwaste discharged from the site during the time interval, t

D_{gr} = the cumulative gamma air dose (mrad) at the SITE BOUNDARY due to noble gas radionuclides contained in gaseous radwaste release, r, discharged from the site during the time interval of interest

Calculate the values of D_{gr} for each gaseous release as described below.

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b) At CCNPP, two methods exist for calculating D_{gr} (i.e., the gamma air dose at the SITE BOUNDARY due to noble gas radionuclides contained in a gaseous radwaste release, r, discharged from the site during a specified time interval).

(1) The rigorous method shall be used IF a computer system and the appropriate software are available.

(2) The simplified method may be used IF a computer system and the appropriate software are NOT available.

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[104] The criteria used to define ABNORMAL AND UNANTICIPATED GAS RELEASES may be found in CP-612 or CP-604.

[105] The alarm and trip setpoints ... shall be determined and adjusted in accordance with the methodology and parameters of the ODCM. (Technical Specification 3.3.3.9).

(3) These methods, as well as additional supporting information, are presented in the following sections.

c) rigorous method

(1) Solution of the following equation may prove too rigorous for routine use unless a computer system and appropriate software are available.

(2) If a computer system and the appropriate software are available, the gamma air dose due to noble gases in gaseous effluents released to UNRESTRICTED AREAS shall be calculated in accordance with equation 18G.

GAMMA AIR DOSE DUE TO NOBLE GASES IN GAS RELEASE, r (RIGOROUS EQUATION)

$$D_{gr} = (3.17E\text{-}8)(x/Q)\sum[(M_i)(Q'_{ir})] \qquad \text{Eq. 18G}^{106}$$

Where,

3.17E-8 = The conversion constant, 3.17E-8, represents the inverse of the number of seconds in a year.

x/Q = the highest calculated annual average relative concentration for any area at or beyond the UNRESTRICTED AREA boundary (2.2E-6 seconds per cubic meter)

All releases are considered "long-term" releases[107], and as such, the highest historical annual average dispersion factor, (x/Q), is used in the dose calculations.

The highest annual average dispersion factor (x/Q) is 2.2E-6 (UFSAR, 2.3.6.3) for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

The maximum annual average on-shore concentrations occur in the southeast sector at a distance of 1300 meters for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

M_i = the air dose factor due to gamma emissions for each identified noble gas radionuclide, i (mrad/yr per microcurie/cubic meter)

The gamma air dose factors have been obtained from Regulatory Guide 1.109, Appendix B, Table B-1.

The gamma air dose factors for various noble gas radionuclides are tabulated in Attachment 10.

Q'_{ir} = the total (time averaged) activity of noble gas radionuclide, i, in gaseous release, r (microcuries).

At CCNPP, all releases are considered long term releases.

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106 Equation 18G has been derived from NUREG-0133, 5.3.1..

107 NUREG-0133, 3.3

Calculate the values of Q_{ir} for each release in accordance with equation 19G.

TOTAL (TIME AVERAGED) ACTIVITY OF NOBLE GAS NUCLIDE i IN GASEOUS RELEASE r

$$Q'_{ir} = (A_{ir})(F_r)(t_{ir})(c') \qquad \text{Eq. 19G}$$

A_{ir} = the specific activity of noble gas radionuclide, i, in release, r, discharged during the time interval of interest (microcuries/cubic centimeter)

F_r = the discharge flow rate for release, r, discharged during the time interval of interest (cubic meters per second)

If the discharge flow rate is unknown (e.g., the gaseous radwaste has not been released), the "Maximum Discharge Flow Rate" listed on Attachments 7 or 8 may be used to calculate the average activity for nuclide i.

Whenever possible, the actual discharge flow rate determined from actual release conditions (e.g., initial pressure, volume, and temperature of a WGDT along with final pressure and temperature) shall be used in equation 9G.

Additional guidance for calculating discharge flow rates may be contained in approved chemistry section procedures (e.g., CP-601 and CP-604).

t_{ir} = the duration of the gaseous radwaste release (seconds)

c' = a conversion constant, 1E6 cubic centimeters per cubic meter, which represents the number of cubic centimeters per cubic meter.

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(3) In the event a computer system is unavailable, a simplified equation may be used to calculate the gamma air dose due to noble gases in gaseous effluents released to UNRESTRICTED AREAS.

(4) The simplified method is presented below.

d) simplified method

(1) If a computer system and appropriate software are NOT available to perform the rigorous gamma air dose calculation described in the previous section, the gamma air dose, due to noble gas radionuclides, in any single release of waste gases discharged to UNRESTRICTED AREAS may be calculated in accordance with equation 20G.

GAMMA AIR DOSE DUE TO NOBLE GASES IN GAS RELEASE, r (SIMPLIFIED EQUATION)

$$D_{gT} = [(3.17E\text{-}8)(x/Q)(M_{avg})/K_{sf}] \sum Q'_{ir} \qquad \text{Eq. 20G}^{108}$$

3.17E-8 = The conversion constant, 3.17E-8, represents the inverse of the number of seconds in a year.

x/Q = the highest calculated annual average relative concentration for any area at or beyond the UNRESTRICTED AREA boundary (2.2E-6 seconds per cubic meter)

All releases are considered "long-term" releases[109], and as such, the highest historical annual average dispersion factor, (x/Q), is used in the dose calculations.

The highest annual average dispersion factor (x/Q) is 2.2E-6 (UFSAR, 2.3.6.3) for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

The maximum annual average on-shore concentrations occur in the southeast sector at a distance of 1300 meters for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

M_{avg} = the empirically derived, site specific, average gamma air dose factor for each identified noble gas radionuclide, i (mrad/yr per microcurie/cubic meter)

A site-specific, average, gamma air dose factor has been calculated from historical data.

The calculation of this site-specific, average, gamma air dose factor is presented on Attachment 11 (use section 3.4.5 of the old ODCM.)

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP gamma air dose limit to the gamma air dose limit of Specification 3.11.2.2, (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the gamma air dose is always less than or equal to the gamma air dose limit of Specification 3.11.2.2.

A safety factor of 1.00 will yield an gamma air dose which corresponds to the gamma air dose limit of Specification 3.11.2.2.

A safety factor of 0.500 will yield an gamma air dose which corresponds to one-half the gamma air dose limit of Specification 3.11.2.2.

It is recommended that a safety factor of 1.0 be used for calculating the gamma air dose, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

The particular value selected for the safety factor is somewhat arbitrary, however a safety factor does provide plant personnel with a degree of administrative control over the use of simplified equations for generating radioactive gaseous release permits. This administrative control is designed to minimize the possibility of violating Technical Specification 3.11.2.2 when simplifying assumptions are used.

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108 Equation 20G has been derived from NUREG-0133, 5.3.1.

109 NUREG-0133, 3.3

The use of a safety factor is consistent with 10 CFR 20.1(c) which states that the licensees should, "... in addition to complying with the limits set forth in this part [10 CFR 20], make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to UNRESTRICTED AREAS, as low as is reasonably achievable."

This safety factor has been included in equation 20G to account for any potential nonconservatism associated with applying the empirically derived gamma air dose factor, M_{avg}, to all radionuclides identified in the gaseous release. Such nonconservatism could conceivable be present whenever radionuclides having a gamma air dose factor greater than M_{avg} are present in a gaseous release.

Q'_{ir} = the total (time averaged) activity of noble gas radionuclide, i, in gaseous release, r (microcuries)

At CCNPP, all releases are considered long term releases.

Calculate the values of Q_{ir} for each release in accordance with equation 19G.

TOTAL (TIME AVERAGED) ACTIVITY OF NOBLE GAS NUCLIDE i IN GASEOUS RELEASE r

$$Q'_{ir} = (A_{ir})(F_r)(t_{lr})(c') \qquad \text{Eq. 19G}$$

A_{ir} = the specific activity of noble gas radionuclide, i, in release, r, discharged during the time interval of interest (microcuries/cubic centimeter).

F_r = the discharge flow rate for release, r, discharged during the time interval of interest (cubic meters per second).

If the discharge flow rate is unknown (e.g., the gaseous radwaste has not been released), the "Maximum Discharge Flow Rate" listed on Attachments 7 or 8 may be used to calculate the average activity for nuclide i.

Additional guidance for calculating discharge flow rates may be contained in approved chemistry section procedures (e.g., CP-601 and CP-604).

t_{lr} = the duration of the gaseous radwaste release (seconds).

c' = a conversion constant, 1E6 cubic centimeters per cubic meter, which represents the number of cubic centimeters per cubic meter.

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e) Once the calculations above have been completed, the calculation results are compared to the applicable limits and corrective actions are initiated as described below.

7. Corrective Actions

a) Chemistry Section surveillance procedures (e.g., CP-213) shall contain/and or reference administrative and/or Technical Specification limits for quarterly and yearly gamma air doses for gaseous effluents and shall specify corrective actions to be initiated when these limits are exceeded.

b) Refer to Technical Specification 3.11.2.2 for actions to be taken in the event the calculated cumulative gamma air doses exceed 10 mrads per calendar quarter or 20 mrads per calendar year.

I. Cumulative Beta Air Doses Due To Noble Gases In Gaseous Effluents

1. Introduction

a) Appendix I to 10 CFR 50 specifies cumulative beta air dose limits associated with the release of radioactive materials to UNRESTRICTED AREAS.

b) Radiological effluent controls have been established to implement the requirements of 10 CFR 50, Appendix I.

c) These radiological effluent controls are described below.

2. Radiological Effluent Controls

a) The cumulative beta air dose, due to noble gases in gaseous effluents released to UNRESTRICTED AREAS, shall be less than 20 mrads in any calendar quarter, and shall be less than 40 mrads in any calendar year (per Technical Specification 3.11.2.2)

b) The routine surveillances which are performed to verify compliance with these radiological effluent controls are described below.

3. Surveillance Requirement(s)

a) The cumulative beta air doses, for the current calendar quarter and the current calendar year, due to noble gases in gaseous effluents, shall be determined at least once every 60 days (Technical Specification 4.11.2.2).

b) The plant group(s) responsible for performing the required surveillance(s) are identified below.

4. Responsible Plant Organizations

a) The Chemistry Section is responsible for calculating the cumulative beta air doses for the current calendar quarter and the current calendar year.

b) The CCNPP Chemistry Section calculates the cumulative beta air doses whenever the appropriate initiating conditions are present

c) These initiating conditions are contained in the following section.

5. Initiating Conditions

a) The cumulative beta air doses due to noble gases in gaseous effluents shall be determined at least once per 60 days (Technical Specification 4.11.2.2).

b) The cumulative beta air doses due to noble gases in gaseous effluents are calculated for each release of a WGDT (CP-604).

c) The cumulative beta air doses due to noble gases in gaseous effluents are calculated for each vent of a containment building (CP-604).

d) The cumulative beta air doses due to noble gases in gaseous effluents are calculated for each PURGE of a containment building (CP-604).

e) The cumulative beta air doses due to noble gases in gaseous effluents are calculated at least weekly[110] for CONTINUOUS discharges from plant vent stacks (CP-612).

f) The cumulative beta air doses due to noble gases in gaseous effluents are calculated for each discharge of combustion products resulting from the burning of contaminated oil.

g) The cumulative beta air doses due to noble gases in gaseous effluents are calculated for each ABNORMAL AND/OR UNANTICIPATED RADIOACTIVE GAS RELEASE[111] (CP-612).

h) Whenever the correct initiating conditions are present, the cumulative beta air doses shall be calculated as described below.

6. Calculation Methodology

a) The cumulative beta air doses (e.g., for the current calendar month, current calendar quarter, current calendar year, or previous 92 days) due to noble gases in gaseous effluents shall be calculated in accordance with equation 21G.

CUMULATIVE BETA AIR DOSE FOR ALL GASEOUS RELEASES, r, DISCHARGED DURING TIME INTERVAL, t

$$D_{\beta t} = \sum D_{\beta r} \qquad \text{Eq. 21G}$$

Where,

$D_{\beta t}$ = the cumulative beta air dose (mrad) at the SITE BOUNDARY due to noble gas radionuclides contained in all gaseous radwaste discharged from the site during the time interval, t

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110 The frequency is controlled by the implementing procedure, CP-612, and is based on plant conditions. Under no conditions shall the frequency be less than once per month (Technical Specification 4.11.2.1.1 or 4.11.2.1.2, Table 4.11-2).

111 The criteria used to define ABNORMAL AND UNANTICIPATED GAS RELEASES may be found in CP-612 or CP-604.

$D_{\beta r}$ = the beta air dose (mrad) due to noble gas radionuclides contained in gaseous radwaste release, r, discharged from the site during the time interval of interest

Calculate the values of $D_{\beta r}$ for each gaseous release as described below.

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b) At CCNPP, two methods exist for calculating $D_{\beta r}$ (the beta air dose at the SITE BOUNDARY due to noble gas radionuclides contained in a gaseous radwaste release, r, discharged from the site).

(1) The rigorous method shall be used IF a computer system and the appropriate software are available.

(2) The simplified method may be used IF a computer system and the appropriate software are NOT available.

(3) These methods, as well as additional supporting information, are presented in the following sections.

c) Rigorous method

(1) Solution of the following equation may prove too rigorous for routine use unless a computer system and appropriate software are available.

(2) If a computer system and the appropriate software are available, the cumulative beta air dose due to noble gases in gaseous effluents released to UNRESTRICTED AREAS shall be calculated in accordance with equation 22G.

BETA AIR DOSE DUE TO NOBLE GASES IN GAS RELEASE, r (RIGOROUS EQUATION)

$$D_{\beta r} = (3.17E\text{-}8)(x/Q)\sum[(N_i)(Q_{ir})] \qquad \text{Eq. 22G}^{112}$$

Where,

$D_{\beta r}$ = the beta air dose due to noble gas radionuclides contained in gaseous radwaste release, r, discharged from the site during the time interval of interest

3.17E-8 = The conversion constant, 3.17E-8, represents the inverse of the number of seconds in a year.

x/Q = the highest calculated annual average relative concentration for any area at or beyond the UNRESTRICTED AREA boundary (2.2E-6 seconds per cubic meter)

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112 Equation 22G has been derived from NUREG-0133, 5.3.1.

All releases are considered "long-term" releases[113], and as such, the highest historical annual average dispersion factor, (x/Q), is used in the dose calculations.

The highest annual average dispersion factor (x/Q) is 2.2E-6 (UFSAR, 2.3.6.3) for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

The maximum annual average on-shore concentrations occur in the southeast sector at a distance of 1300 meters for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

N_i = the air dose factor due to beta emissions for each identified noble gas radionuclide, i (mrad/yr per microcurie/cubic meter)

The beta air dose factors have been obtained from Regulatory Guide 1.109, Appendix B, Table B-1.

The beta air dose factors for various noble gas radionuclides are tabulated in Attachment 10 (Attachment 1 of old ODCM).

Q'_{ir} = the total (time averaged) activity of noble gas radionuclide, i, in gaseous release, r (microcuries).

At CCNPP, all releases are considered long term releases.

Calculate the values of Q_{ir} for each release in accordance with equation 19G.

TOTAL (TIME AVERAGED) ACTIVITY OF NOBLE GAS NUCLIDE i IN GASEOUS RELEASE r

$$Q'_{ir} = (A_{ir})(F_r)(t_{ir})(c') \qquad \text{Eq. 19G}$$

A_{ir} = the specific activity of noble gas radionuclide, i, in release, r, discharged during the time interval of interest (microcuries/cubic centimeter).

F_r = the discharge flow rate for release, r, discharged during the time interval of interest (cubic meters per second).

If the discharge flow rate is unknown (e.g., the gaseous radwaste has not been released), the "Maximum Discharge Flow Rate" listed on Attachments 7 or 8 may be used to calculate the average activity for nuclide i.

Additional guidance for calculating discharge flow rates may be contained in approved chemistry section procedures (e.g., CP-601 and CP-604).

t_{ir} = the duration of the gaseous radwaste release (seconds).

c' = a conversion constant, 1E6 cubic centimeters per cubic meter.

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[113] NUREG-0133, 3.3

(3) In the event a computer system is unavailable, a simplified equation may be used to calculate the gamma air dose due to noble gases in gaseous effluents released to UNRESTRICTED AREAS

(4) The simplified method is presented below.

d) Simplified method

(1) If a computer system and the appropriate software are NOT available to perform the rigorous beta air dose calculation described in the previous section, the beta air dose resulting from a single release of waste gases discharged to UNRESTRICTED AREAS may be calculated in accordance with equation 23G.

BETA AIR DOSE DUE TO NOBLE GASES IN GAS RELEASE, r (SIMPLIFIED EQUATION)

$$D_{\beta r} = [\,(3.17E\text{-}8)\,(x/Q)\,(N_{avg})\,/\,K_{sf}\,]\sum Q_{ir} \qquad \text{Eq. 23G}^{114}$$

3.17E-8 = The conversion constant, 3.17E-8, represents the inverse of the number of seconds in a year.

x/Q = the highest calculated annual average relative concentration for any area at or beyond the UNRESTRICTED AREA boundary (2.2E-6 seconds per cubic meter)

All releases are considered "long-term" releases[115], and as such, the highest historical annual average dispersion factor, (x/Q), is used in the dose calculations.

The highest annual average dispersion factor (x/Q) is 2.2E-6 (UFSAR, 2.3.6.3) for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

The maximum annual average on-shore concentrations occur in the southeast sector at a distance of 1300 meters for purposes of routine, long-term concentrations (e.g., routine noble gas releases) (UFSAR, 2.3.6.3).

N_{avg} = the empirically derived, site specific, average beta air dose factor for each identified noble gas radionuclide, i (mrad/yr per microcurie/cubic meter)

A site-specific, average, beta air dose factor has been calculated from historical data.

The calculation of this site-specific, average, beta air dose factor is presented on Attachment 11.

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114 Equation 23G has been derived from NUREG-0133, 5.3.1.

115 NUREG-0133, 3.3

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP beta air dose limit to the beta air dose limit of Specification 3.11.2.2, (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the beta air dose is always less than or equal to the beta air dose limit of Specification 3.11.2.2.

A safety factor of 1.00 will yield an organ dose which corresponds to the beta air dose limit of Specification 3.11.2.2.

A safety factor of 0.500 will yield an beta air dose which corresponds to one-half the beta air dose limit of Specification 3.11.2.2.

It is recommended that a safety factor of 1.0 be used for calculating the beta air dose, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

The particular value selected for the safety factor is somewhat arbitrary, however a safety factor does provide plant personnel with a degree of administrative control over the use of simplified equations for generating radioactive gaseous release permits. This administrative control is designed to minimize the possibility of violating Technical Specification 3.11.2.2 when simplifying assumptions are used.

The use of a safety factor is consistent with 10 CFR 20.1(c) which states that the licensees should, "... in addition to complying with the limits set forth in this part [10 CFR 20], make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to UNRESTRICTED AREAS, as low as is reasonably achievable."

This safety factor has been included in equation 23G to account for any potential nonconservatism associated with applying the empirically derived beta air dose factor, N_{avg}, to all radionuclides identified in the gaseous release. Such nonconservatism could conceivable be present whenever radionuclides having a beta air dose factor greater than N_{avg} are present in a gaseous release.

Q'_{ir} = the total (time averaged) activity of noble gas radionuclide, i, in gaseous release, r (microcuries)

At CCNPP, all releases are considered long term releases.

Calculate the values of Q_{ir} for each release in accordance with equation 19G.

TOTAL (TIME AVERAGED) ACTIVITY OF NOBLE GAS NUCLIDE i IN GASEOUS RELEASE r

$$Q'_{ir} = (A_{ir})(F_r)(t_{lr})(c') \qquad \text{Eq. 19G}$$

A_{ir} = the specific activity of noble gas radionuclide, i, in release, r, discharged during the time interval of interest (microcuries/cubic centimeter)

F_r = the discharge flow rate for release, r, discharged during the time interval of interest (cubic meters per second)

If the discharge flow rate is unknown (e.g., the gaseous radwaste has not been released), the "Maximum Discharge Flow Rate" listed on Attachments 7 or 8 may be used to calculate the average activity for nuclide i.

Additional guidance for calculating discharge flow rates may be contained in approved chemistry section procedures (e.g., CP-601 and CP-604).

t_{lr} = the duration of the gaseous radwaste release (seconds).

c' = a conversion constant, 1E6 cubic centimeters per cubic meter.

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e) Once the calculations above have been completed, the calculation results are compared to the applicable limits and corrective actions are initiated as described below.

7. Corrective Actions

a) Chemistry Section surveillance procedures (e.g., CP-213) shall contain/and or reference administrative and/or Technical Specification limits for quarterly and yearly beta air doses for gaseous effluents and shall specify corrective actions to be initiated when these limits are exceeded.

b) Refer to Technical Specification 3.11.2.2 for actions to be taken in the event the calculated cumulative beta air doses exceed 20 mrads per calendar quarter or 40 mrads per calendar year.

J. Cumulative Organ Doses Due To Iodines And Particulates In Gaseous Effluents

1. Introduction

a) Appendix I to 10 CFR 50 specifies cumulative organ dose limits associated with the release of radioactive materials to UNRESTRICTED AREAS.

b) Radiological effluent controls have been established to implement the requirements of 10 CFR 50, Appendix I.

c) These radiological effluent controls are described below.

2. Radiological Effluent Controls

a) The cumulative organ dose due to iodines and particulates in gaseous effluents released to UNRESTRICTED AREAS shall be less than 15 mrems per calendar quarter, and shall be less than 30 mrems per calendar year (per Technical Specification 3.11.2.3).

b) The cumulative organ dose due to iodines and particulates in gaseous, contaminated oil combustion products released to UNRESTRICTED AREAS shall be less than 0.015 mrems per quarter, and shall be less than 0.030 mrems per year (per Technical Specification 3.11.2.3).

c) The routine surveillances which are performed to verify compliance with this radiological effluent controls are described below.

3. Surveillance Requirements

a) The cumulative organ doses (due to iodines and particulates in gaseous waste discharged to UNRESTRICTED AREAS), for the current calendar month, the current calendar quarter, and the current calendar year, shall be determined at least once every 60 days in accordance with the ODCM (per Technical Specification 4.11.2.3).

b) The plant group(s) responsible for performing the required surveillances are identified below.

4. Responsible Plant Organizations

a) The Chemistry Section is responsible for implementing the surveillances required by Technical Specification 4.11.2.3.

b) The CCNPP Chemistry Section calculates the cumulative organ doses whenever the appropriate initiating conditions are present

c) These initiating conditions are contained in the following section.

5. Initiating Conditions

a) The cumulative organ dose--for each organ--shall be determined at least once per 60 days (Technical Specification 4.11.2.2).

b) The cumulative organ dose--for each organ--due to iodines and particulates in gaseous effluents shall be calculated at least weekly[116] for CONTINUOUS discharges from plant vent stacks (CP-612).

c) The cumulative organ dose--for each organ--due to iodines and particulates in gaseous effluents shall be calculated for each discharge of combustion products resulting from the burning of contaminated oil.

d) The cumulative organ dose--for each organ--due to iodines and particulates in gaseous effluents shall be calculated for each ABNORMAL AND/OR UNANTICIPATED RADIOACTIVE GAS RELEASE (CP-612).

e) Whenever the correct initiating conditions are present, the annual cumulative organ doses shall be calculated as described below.

6. Calculation Methodology

a) The cumulative organ doses (for the calendar month, calendar quarter, previous 92 days, and calendar year) due to iodines and particulates in gaseous waste discharged to UNRESTRICTED AREAS shall be calculated in accordance with equation 24G.

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116 The frequency is controlled by the implementing procedure, CP-612, and is based on plant conditions. Under no conditions shall the frequency be less than once per month (Technical Specification 4.11.2.1.1 or 4.11.2.1.2, Table 4.11-2).

CUMULATIVE DOSE TO ORGAN, o, FROM ALL GASEOUS RELEASES, r, DISCHARGED DURING TIME INTERVAL, t

$$D_{ot} = \sum D_{or} \qquad \text{Eq. 24G}$$

Where,

D_{ot} = the cumulative dose (mrad) to organ, o, at the SITE BOUNDARY, due to iodine and particulate radionuclides contained in gaseous waste discharged from the site during the time interval, t

D_{or} = the dose (mrad) to organ, o, at the SITE BOUNDARY due to iodine and particulate radionuclides in gaseous release, r, discharged from the site during the time interval of interest

Calculate the values of D_{or} for each gaseous release as described below.

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b) At CCNPP, two methods exist for calculating D_{or} (the organ doses due to iodines and particulates resulting from any single release of radioactive gases to an UNRESTRICTED AREA).

(1) The rigorous method shall be used IF a computer system and the appropriate software are available.

(2) The simplified method may be used IF a computer system and the appropriate software are NOT available.

(3) These methods, as well as additional supporting information, are presented in the following sections.

c) Rigorous method

(1) Solution of the following equation may prove too rigorous for routine use unless a computer system and the appropriate software are available.

(2) If a computer system and the appropriate software are available, the organ doses due to iodines and particulates contained in any single release of radioactive gases to UNRESTRICTED AREAS shall be calculated in accordance with equation 25G.

DOSE TO ORGAN, o, DUE TO IODINES AND PARTICULATES IN GAS RELEASE, r (RIGOROUS EQUATION)

$$D_{or} = (3.17E\text{-}8)(W_v)\sum(R_{ipao})(Q'_{ir}) \qquad \text{Eq. 25G}^{117}$$

Where,

D_{or} = the dose to organ, o, at the SITE BOUNDARY due to iodine and particulate radionuclides in gaseous release, r, discharged from the site during the time interval of interest

3.17E-8 = The conversion constant, 3.17E-8, represents the inverse of the number of seconds in a year.

W_v = the dispersion parameter for estimating the dose to an individual at the controlling location for long term releases, and may assume one of two values as described below

W_v is x/Q for the inhalation pathway (sec/cubic meter)

W_v is D/Q for the food and ground plane pathways ($meters^{-2}$)

R_{ipao} = the dose factor for each identified iodine or particulate radionuclide, i, exposure pathway, p, receptor age group, a, and organ, o (m^2 mrem/year per microcuries/second or mrem/year per microcuries/cubic meter)

dose factors have been derived for the following pathways

1) inhalation - see Attachment 12

2) ground plane - see Attachment 12

3) grass-cow-milk - see Attachment 12

4) grass-cow-meat - see Attachment 12

5) vegetation - see Attachment 12

The inhalation pathway dose factors were obtained using the formula from NUREG-0133, 5.3.1.1.

The ground plane dose factors were obtained using the formula from NUREG-0133, 5.3.1.2.

The grass-cow-milk pathway dose factors were obtained using the formula from NUREG-0133, 5.3.1.3.

The grass-cow-meat pathway dose factors were obtained using the formula from NUREG-0133, 5.3.1.4.

The vegetation pathway dose factors were obtained using the formula from NUREG-0133, 5.3.1.5.

Q'_{ir} = the total (time averaged) activity of iodine or particulate radionuclide, i, in gaseous release, r, discharged during the specified time interval (microcuries)

At CCNPP, all releases are considered long term releases.

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117 Equation 25G has been derived from NUREG-0133, 5.3.1.

Calculate the values of Q_{ir} for each release in accordance with equation 19G.

TOTAL (TIME AVERAGED) ACTIVITY OF IODINE OR PARTICULATE NUCLIDE i IN GASEOUS RELEASE r

$$Q'_{ir} = (A_{ir})(F_r)(t_{lr})(c') \qquad \text{Eq. 19G}$$

A_{ir} = the specific activity of iodine and particulate radionuclide, i, in release, r, discharged during the time interval of interest (microcuries/cubic centimeter)

F_r = the discharge flow rate for release, r, discharged during the time interval of interest (cubic meters per second)

If the discharge flow rate is unknown (e.g., the gaseous radwaste has not been released), the "Maximum Discharge Flow Rate" listed on Attachments 7 or 8 may be used to calculate the average activity for nuclide i.

Additional guidance for calculating discharge flow rates may be contained in approved chemistry section procedures (e.g., CP-601 and CP-604).

t_{lr} = the duration of the gaseous radwaste release (seconds)

c' = a conversion constant, 1E6 cubic centimeters per cubic meter

(3) In the event a computer system and the appropriate software are unavailable, a simplified equation may be used to calculate the organ doses due to individual gaseous releases.

(4) The simplified method is presented below.

d) simplified method

(1) If a computer system and appropriate software are NOT available to perform the rigorous organ dose calculations described in the previous section, the organ doses due to iodines and particulates in a single release of radioactive gases discharged to an UNRESTRICTED AREA may be calculated in accordance with equation 26G.

DOSE TO ORGAN, o, FROM IODINES AND PARTICULATES IN GAS RELEASE, r (SIMPLIFIED EQUATION)

$$D_{maxor} = [(3.17E\text{-}8)(W_v)(R_{I\text{-}131})/K_{sf}] \sum_{annual} (Q^{\cdot}_{ir}) \qquad \text{Eq. 26G}^{118}$$

D_{maxor} = the maximum dose to any organ, o, due to iodines and particulates contained in any single release, r, of radioactive gases to an UNRESTRICTED AREA

3.17E-8 = The conversion constant, 3.17E-8, represents the inverse of the number of seconds in a year.

D/Q = the dispersion parameter at the controlling location for long term releases (meters^{-2})

The value for D/Q has been determined to be 8.63E-10 m^2.[119]

The grass-cow-milk pathway is the controlling pathway.[120]

The controlling sector is the south-southwest sector.[121]

The controlling location is at a distance of 4800 meters.[122]

$R_{I\text{-}131}$ = the infant, thyroid, dose factor for I-131 via the grass-cow-milk pathway (m^2 mrem/year per microcuries/second)

This value is 1.05E12 and it is listed on Attachment 12.

K_{sf} = a constant, actually a safety factor, which is the ratio of the CCNPP organ dose limit to the organ dose limit of Specification 3.11.2.3, (unitless)

The safety factor chosen shall be less than or equal to 1.00. This ensures the organ dose is always less than or equal to the organ dose limit of Specification 3.11.2.3.

A safety factor of 1.00 will yield an organ dose which corresponds to the organ dose limit of Specification 3.11.2.3.

A safety factor of 0.500 will yield an organ dose which corresponds to one-half the organ dose limit of Specification 3.11.2.3.

It is recommended that a safety factor of 1.0 be used for calculating the organ dose, however, other values--not to exceed 1.00--may be used as directed by the General Supervisor Chemistry.

The particular value selected for the safety factor is somewhat arbitrary, however a safety factor does provide plant personnel with a degree of administrative control over the use of simplified equations for generating radioactive gaseous release permits. This administrative control is

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118 Equation 26G has been derived from NUREG-0133, 5.3.1

119 See CP-607, Revision 1, section 3.4.3.

120 See the "Land Use Survey", 1990.

121 It should be noted that the controlling sector mentioned in the UFSAR, section 2.3.6.4, is inaccurate because the UFSAR has not been updated to include the results of the 1990 "Land Use Survey."

122 See the "Land Use Survey", 1990.

designed to minimize the possibility of violating Technical Specification 3.11.2.3 when simplifying assumptions are used.

The use of a safety factor is consistent with 10 CFR 20.1(c) which states that the licensees should, "... in addition to complying with the limits set forth in this part [10 CFR 20], make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to UNRESTRICTED AREAS, as low as is reasonably achievable."

This safety factor has been included in equation 26G to account for any potential nonconservatism associated with applying the infant, thyroid, grass-cow-milk dose factor, R_{I-131}, to all radionuclides identified in the gaseous release. Such nonconservatism could conceivable be present whenever radionuclides having a pathway dose factor greater than R_{I-131} are present in a gaseous release.

Q'_{ir} = the total (time averaged) activity of iodine or particulate radionuclide, i, in gaseous release, r (microcuries)

At CCNPP, all releases are considered long term releases.

This value shall be calculated in accordance with equation 19G.

TOTAL (TIME AVERAGED) ACTIVITY OF IODINE OR PARTICULATE NUCLIDE i IN GASEOUS RELEASE r

$$Q'_{ir} = (A_{ir})(F_r)(t_{lr})(c') \qquad \text{Eq. 19G}$$

A_{ir} = the specific activity of iodine and particulate radionuclide, i, in release, r, discharged during the time interval of interest (microcuries/cubic centimeter)

F_r = the discharge flow rate for release, r, discharged during the time interval of interest (cubic meters per second)

If the discharge flow rate is unknown (e.g., the gaseous radwaste has not been released), the "Maximum Discharge Flow Rate" listed on Attachments 7 or 8 may be used to calculate the average activity for nuclide i.

Additional guidance for calculating discharge flow rates may be contained in approved chemistry section procedures (e.g., CP-601 and CP-604).

t_{lr} = the duration of the gaseous radwaste release (seconds)

c' = a conversion constant, 1E6 cubic centimeters per cubic meter

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e) Once the calculations above have been completed, the calculation results are compared to the applicable limits and corrective actions are initiated as described below.

7. Corrective Actions

a) Chemistry Section surveillance procedures (e.g., CP-213) shall contain/and or reference administrative and/or Technical Specification limits for cumulative organ dose for gaseous effluents and shall specify corrective actions to be initiated when these limits are exceeded.

b) Refer to Technical Specification 3.11.2.3 for actions to be taken in the event the calculated cumulative gamma air doses exceed any of the radiological effluent controls listed above.

K. Limits For The Gaseous Waste Processing System

1. Introduction

a) 10 CFR 50.36a requires licensees to maintain and use the equipment installed in the gaseous waste processing system for the purpose of controlling effluents to the environment.

b) Radiological effluent controls have been established to implement the requirements of 10 CFR 50.36a.

c) These radiological effluent controls are described below.

2. Radiological effluent controls

a) The GASEOUS RADWASTE TREATMENT SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM shall be used to reduce radioactive materials in gaseous waste prior to their discharge when the gaseous effluent air dose, to areas at and beyond the SITE BOUNDARY, exceeds 1.20 mrads gamma radiation in a 92 day period (per Technical Specification 3.11.2.4).

b) The GASEOUS RADWASTE TREATMENT SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM shall be used to reduce radioactive materials in gaseous waste prior to their discharge when the gaseous effluent air dose, to areas at and beyond the SITE BOUNDARY, exceeds 2.4 mrads beta radiation in a 92 day period (per Technical Specification 3.11.2.4).

c) The VENTILATION EXHAUST TREATMENT SYSTEM shall be used to reduce the quantity of radioactive materials in gaseous waste prior to their discharge when the calculated doses due to gaseous effluent releases, to areas at and beyond the SITE BOUNDARY exceeds 1.80 mrem to any organ in a 92 day period (per Technical Specification 3.11.2.4).

d) The routine surveillances which are performed to verify compliance with this radiological effluent controls are described below.

3. Surveillance Requirement(s)

a) The cumulative gamma air dose, for the previous 92 days, due to noble gases in gaseous effluents, shall be determined at least once every 60 days (Technical Specification 4.11.2.2).

b) The plant group(s) responsible for performing the required surveillance(s) are identified below.

4. Responsible Plant Organizations

a) The Chemistry Section is responsible for calculating the cumulative gamma air doses for the current calendar month, the previous 92 days, the current calendar quarter, and the current calendar year.

b) The cumulative gamma air dose for the previous 92 days is calculated whenever the appropriate initiating conditions are present

c) These initiating conditions are contained in the following section.

5. Initiating conditions

a) For a listing of initiating conditions associated with calculating gamma air doses, see "Initiating Conditions" in the section of the ODCM titled, "Cumulative Gamma Air Doses Due To Noble Gases In Gaseous Effluents."

b) For a listing of initiating conditions associated with calculating beta air doses, see "Initiating Conditions" in the section of the ODCM titled, "Cumulative Beta Air Doses Due To Noble Gases In Gaseous Effluents."

c) For a listing of initiating conditions associated with calculating cumulative organ doses, see "Initiating Conditions" in the section of the ODCM titled, "Cumulative Organ Doses Due To Iodines And Particulates In Gaseous Effluents."

6. Calculation methodology

a) Calculate the previous 92-day cumulative gamma air dose as described in the section "Cumulative Gamma Air Doses Due To Noble Gases In Gaseous Effluents."

b) Calculate the previous 92-day cumulative beta air dose as described in the section "Cumulative Beta Air Doses Due To Noble Gases In Gaseous Effluents."

c) Calculate the previous 92-day cumulative organ dose as described in the section "Cumulative Organ Doses Due To Iodines And Particulates In Gaseous Effluents."

7. Corrective Actions

a) Chemistry Section surveillance procedures (e.g., CP-212) shall contain/and or reference administrative and/or Technical Specification limits for 92-day cumulative gamma, beta, or organ doses for gaseous effluents and shall specify corrective actions to be initiated when these limits are exceeded.

b) Refer to Technical Specification 3.11.2.4 for actions to be taken in the event the calculated 92-day cumulative gamma air, beta air, or organ doses exceed any of the radiological effluent controls listed above.

L. Limits On Total Annual Dose -- Gases, Liquids, and Uranium Fuel Cycle Sources

1. Introduction

a) 40 CFR 190 specifies annual dose limits for radionuclides released to the environment.

b) Radiological effluent controls have been established to implement the requirements of 40 CFR 190.

c) These radiological effluent controls are described below.

2. Radiological effluent controls

a) The total body dose from exposure to the combination of liquid releases, gas releases, and uranium fuel cycle sources shall be less than 25 mrem for the current calendar year (per Technical Specification 3.11.4).

b) The organ dose (for the maximum exposed organ, not including the thyroid) from exposure to the combination of liquid releases, gas releases, and uranium fuel cycle sources shall be less than 25 mrem for the current calendar year (per Technical Specification 3.11.4).

c) The thyroid dose from exposure to the combination of liquid releases, gas releases, and uranium fuel cycle sources shall be less than 75 mrem for the current calendar year (per Technical Specification 3.11.4).

d) The routine surveillances which are performed to verify compliance with these radiological effluent controls are described below.

3. Surveillance Requirements

a) The cumulative gamma air doses, for current calendar month, the current calendar quarter, and the current calendar year, due to noble gases in gaseous effluents, shall be determined at least once every 60 days (Technical Specification 4.11.2.2,).

b) The cumulative organ doses (due to iodines and particulates in gaseous waste discharged to UNRESTRICTED AREAS), for the current calendar month, the current calendar quarter, and the current calendar year, shall be determined at least once every 60 days in accordance with the ODCM (per Technical Specification 4.11.2.3).

c) Cumulative total body dose to MEMBERS OF THE PUBLIC in UNRESTRICTED AREAS--for the current calendar month, the calendar quarter, and the current calendar year--shall be calculated at least once per 60 days (per Technical Specification 4.11.1.2).

d) Cumulative organ doses to MEMBERS OF THE PUBLIC in UNRESTRICTED AREAS--for the current calendar month, the current calendar quarter, and the current calendar year--shall be calculated at least once per 60 days (per Technical Specification 4.11.1.2).

e) The direct radiation dose to members of the public exposed to uranium fuel cycle sources (i.e., reactor units and outside storage tanks) shall be determined IF THE APPROPRIATE INITIATING CONDITIONS ARE PRESENT.

4. Responsible Plant Organization(s)

a) The Chemistry Section is responsible for implementing the effluent surveillances required by Technical Specification 4.11.4.1.

b) The Chemistry Unit, Technical Services Section, BG&E Fossil Energy Division, is responsible for implementing the surveillances for direct radiation required by Technical Specification 4.11.4.2.

c) IT SHOULD BE NOTED THAT NO SURVEILLANCES NEED BE PERFORMED UNLESS THE APPROPRIATE INITIATING CONDITIONS ARE PRESENT.

d) These initiating conditions are contained in the following section.

5. Initiating conditions

a) The total dose from liquid releases, gas releases, and uranium fuel cycle sources shall be determined whenever the calculated doses from **liquid effluents** exceed any of the following (per Technical Specification 4.11.4.2):

(1) Six (6) mrem per quarter to the total body

(2) Twelve (12) mrem per calendar year to the total body

(3) Twenty (20) mrem per quarter to any organ

(4) Forty (40) mrem per calendar year to any organ

b) The total dose from liquid releases, gas releases, and uranium fuel cycle sources shall be determined whenever the calculated air doses from noble gasses in **gaseous effluents** exceed any of the following (per Technical Specification 4.11.4.2):

(1) Twenty (20) mrad gamma per quarter

(2) Forty (40) mrad gamma per calendar year

(3) Forty (40) mrad beta per quarter

(4) Eighty (80) mrad beta per calendar year

c) The total dose from liquid releases, gas releases, and uranium fuel cycle sources shall be determined whenever the calculated organ doses from iodines and particulates in **gaseous effluents** exceed any of the following (per Technical Specification 4.11.4.2):

(1) Thirty (30) mrem per quarter to any organ

(2) Sixty (60) mrem per calendar year to any organ

d) Whenever the correct initiating conditions are present, the total doses from liquid releases, gas releases, and uranium fuel cycle sources (for the calendar year) shall be calculated as shown below.

6. Calculation methodology

a) The total body dose and the organ doses from liquid releases, gas releases, and uranium fuel cycle sources (for the calendar year) shall be calculated in accordance with equation 1T and 2T respectively.

TOTAL, TOTAL BODY DOSE FROM LIQUID RELEASES, GAS RELEASES, AND URANIUM FUEL CYCLE SOURCES

$$D_{tball} = D_{ToL} + D_{gi} + D_{tank} \quad \text{Eq. 1T}$$

TOTAL ORGAN DOSES FROM LIQUID RELEASES, GAS RELEASES, AND URANIUM FUEL CYCLE SOURCES

$$D_{oall} = D_{ToL} + D_{oi} + D_{tank} \quad \text{Eq. 2T}$$

D_{tball} = the dose (mrem) to total body resulting from the combination of all gas releases, all liquid releases, and all uranium fuel cycle sources.

D_{oall} = the dose (mrem) to organ, o, resulting from the combination of all gas releases, all liquid releases, and all uranium fuel cycle sources.

Separate values shall be calculated for each of the organs listed below:

1. bone
2. liver
3. thyroid
4. kidney
5. lung
6. GI tract

D_{ToL} = the cumulative dose (mrem) to organ, o, for all liquid releases discharged in a given time interval

Calculate this value as specified by equation 8L.

D_{gt} = the site-boundary cumulative gamma air dose (mrad) due to noble gas radionuclides contained in all gaseous radwaste discharged from the site during the time interval, t

Calculate this value as specified by equation 17G, except substitute K_i for M_i (see Attachment 10).

D_{ot} = the site-boundary cumulative organ dose (mrem) resulting from the release of iodine and particulate radionuclides in gaseous releases from the site

Calculate this value as specified by equation 24G.

D_{tank} = the calendar-year cumulative dose (mrem) to the maximum exposed MEMBER OF THE PUBLIC due to direct radiation from the reactor units and outside storage tanks

This value shall be based on the results of direct radiation measurements from TLDs or continuous dose rate instruments placed near the SITE BOUNDARY (e.g., from radiological environmental monitoring sites DR1-DR9 described on Attachment 13 and shown on Attachment 18).

The Environmental Programs Section, BG&E Corporate Affairs Group, is responsible for determining this value. |

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b) Compare the calculated values to the radiological effluent controls (listed in this section), and if any of the radiological effluent controls have been exceeded, perform the appropriate corrective actions listed below.

7. Corrective Actions

a) Chemistry Section surveillance procedures (e.g., CP-212) shall contain/and or reference administrative and/or Technical Specification limits for total dose for liquid releases, gaseous releases, and uranium fuel cycle sources and shall specify corrective actions to be initiated when these limits are exceeded.

b) Refer to Technical Specification 3.11.4 for actions to be taken in the event the total dose exceeds any of the radiological effluent controls listed above.

c) If any of the radiological effluent controls have been exceeded, refer to 40 CFR 302, Appendix B, and verify the quantities of radioactive materials released are less than the values specified. [375B]

M. Special Exceptions and Assumptions For Calculation of Doses and Dose Rates

1. Camp Conoy

a) Location

(1) Camp Conoy is located within the site boundary.

(2) Camp Conoy is located in the SE sector.

(3) Camp Conoy is approximately 3000 feet from the plant.

b) Occupancy

(1) Camp Conoy is frequently visited by MEMBERS OF THE PUBLIC.

(2) Maximum occupancy for MEMBERS OF THE PUBLIC at Camp Conoy is restricted to approximately 3380 hours per year.

c) Meteorology

(1) The highest historical annual average x/Q for Camp Conoy is 2.40E-6 seconds per cubic meter.[123]

d) Dose calculation assumptions

(1) Based on sections (b) and (c) above, any actual exposure to a MEMBER OF THE PUBLIC at Camp Conoy will be less than the calculated exposure for a MEMBER OF THE PUBLIC at the site boundary.[124]

(2) No special considerations are required for addressing potential exposure at Camp Conoy.

2. Visitor's Center

a) Location

(1) The Visitor's Center is located within the site boundary.

(2) The Visitor's Center is located in the WNW sector.

(3) The Visitor's Center is approximately 1000 feet from the plant.

b) Occupancy

(1) The Visitor's Center is frequently visited by MEMBERS OF THE PUBLIC.

(2) Maximum occupancy for MEMBERS OF THE PUBLIC at The Visitor's Center is restricted to daylight hours.

c) Meteorology

(1) The highest historical annual average x/Q for the Visitor's Center is 8.68E-6 seconds per cubic meter.[125]

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[123] See CP-607, Revision 1, page 24.

[124] See CP-607, Revision 1, page 24.

[125] See CP-607, Revision 1, page 24.

(2) The wind frequency for the WNW sector, based on 1983 meteorological data, is four percent (4%).[126]

d) Dose calculation assumptions

(1) "Using a conservative basis of 10% wind frequency, and individual visiting the center for 330 hours/year during the periods of worst case meteorological conditions would be most highly exposed."[127]

(2) The dose calculated for the controlling site boundary is more conservative by a factor of 7.[128]

(3) Based on sections (b) and (c) above, any actual exposure to a MEMBER OF THE PUBLIC at The Visitor's Center will be less than the calculated exposure for a MEMBER OF THE PUBLIC at the site boundary.

(4) No special considerations are required for addressing potential exposure at The Visitor's Center.

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126 See CP-607, Revision 1, page 24.

127 See CP-607, Revision 1, page 24.

128 See CP-607, Revision 1, page 24.

VII. RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

A. Monitoring Program

1. Introduction

   a) 10 CFR 50, Appendix I, Section IV.B.2 requires licensees to establish an environmental surveillance and monitoring program for the purpose of evaluating the relationship between quantities of radioactive material released in effluents and resultant radiation doses to individuals.

   b) Radiological environmental controls have been established to implement the requirements of 10 CFR 50, Appendix I, Section IV.B.2.

   c) These radiological environmental controls are described below.

2. Controls on the Radiological Environmental Monitoring Program (REMP)

   a) The REMP shall consist of environmental sample locations, analysis parameters, analysis frequencies, detection limits, and action levels all of which conform to the requirements of Technical Specification 3.12.1. (See Attachment 13, 14, 15, 16, and 17).

   b) The REMP shall maintain a map showing sample locations near the site boundary in accordance with Technical Specification 3.12.1. (See Attachment 18).

   c) The REMP shall maintain a map showing sample locations within a 8 km. radius of the plant in accordance with Technical Specification 6.9.1.7. (See Attachment 19).

3. Surveillance Requirements

   a) Surveillances for direct radiation

      (1) Direct radiation dosimetry shall be collected from locations DR1-DR23 listed on Attachment 13.

      (2) In the event any of the monitoring stations, DR1-DR23, described on Attachment 13 become unavailable, establish new monitoring stations (with new dosimetry) as described below:

         (a) In lieu of any location DR1-DR9 described on Attachment 13, establish a new monitoring station in the same metrological sector in the general area of the SITE BOUNDARY.

         (b) In lieu of any location DR10-DR18 described on Attachment 13, establish a new monitoring station in the same metrological sector in the 6-8 km range from the site.

         (c) In lieu of any location DR19-DR23 described on Attachment 13, establish a new monitoring station in either a special interest area (e.g., population center, nearby residence, school) or a control station whichever is applicable.

(3) In the event any dosimetry at an existing monitoring location DR1-DR23 becomes unavailable, place new dosimetry at the monitoring station.

(4) Analyze the dosimeters at the frequencies and for the parameters identified on Attachment 14.

(5) The sampling locations(s), excluding the control station location, having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from the RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM after October 31 of the year in which the land use census was conducted in accordance with Technical Specification 3.12.2.b.

b) Surveillances for airborne activity

(1) Radioiodine and particulate samples shall be collected from locations A1-A5 listed on Attachment 13.

(2) In the event any of the monitoring stations, A1-A5, described on Attachment 13 become unavailable, establish new monitoring station(s) (fitted with new radioiodine and particulate samplers) as described below:

(a) In lieu of any location A1-A3 described on Attachment 13, establish a new monitoring station in the general area of the SITE BOUNDARY, such that the three monitoring stations are located in the metrological sectors with the three highest calculated annual average ground level D/Q.

(b) In lieu location A4 described on Attachment 13, establish a new monitoring station near a community having the highest calculated annual average ground level D/Q.

(c) In lieu of location A5 described on Attachment 13 establish a new "control" location 15 to 30 kilometers from the plant in the least prevalent wind direction.

(3) In the event any radioiodine cartridge or particulate filter becomes unavailable from an existing monitoring location A1-A5 described on Attachment 13, place new radioiodine cartridge or particulate filter in the air sampler at the monitoring station.

(4) Analyze the samples at the frequencies and for the parameters identified on Attachment 15.

(5) The sampling locations(s), excluding the control station location, having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from the RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM after October 31 of the year in which the land use census was conducted in accordance with Technical Specification 3.12.2.b.

c) Surveillances of waterborne activity

(1) Water samples shall be collected from the locations Wa1, Wa2, and Wb1 listed on Attachment 13.

(2) In the event any of the samples at Wa1, Wa2, or Wb1 are unavailable, collect substitute samples as described below:

(a) In lieu of a liquid sample at Wa1, collect a substitute sample of surface water from the intake area.

(b) In lieu of a liquid sample at Wa2, collect a substitute sample of surface water from the discharge area.

(c) In lieu of sample at Wb1, collect a substitute sample of sediment from a downstream shoreline with existing or potential recreational value.

(3) Analyze the samples at the frequencies and for the parameters identified on Attachment 16.

(4) The sampling locations(s), excluding the control station location, having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from the RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM after October 31 of the year in which the land use census was conducted in accordance with Technical Specification 3.12.2.b.

d) Surveillances for ingestible activity

(1) Fish/inverterbrate, milk, and food product samples shall be collected from the locations Ia1 thru Ia6 and Ib1 thru Ib9 listed on Attachment 13.

(2) In the event any of the samples at Ia1 thru Ia6 or Ib1 thru Ib9 are unavailable, collect substitute samples as described below:

(a) In lieu of samples at Ia1 thru Ia3, collect substitute three commercially and/or recreationally important species (two fish species and one invertebrate species) from the vicinity of the plant discharge area.

(b) In lieu of samples at Ia4 thru Ia6, collect three commercially and/or recreationally important species (two fish species and one invertebrate species) from an area not influenced by plant discharges.

(c) In lieu of samples at Ib1 thru Ib6, collect three kinds of broad leaf vegetation grown near the SITE BOUNDARY at two different locations of highest average ground level D/Q[129].

(d) In lieu of samples at Ib7 thru Ib9, collect one sample each of the similar broad leaf vegetation grown 15-30 km distant in the least prevalent wind direction.

(3) Analyze the samples at the frequencies and for the parameters identified on Attachment 17.

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[129] With fresh leafy vegetable samples unavailable from one or more of the sample locations listed on Attachment 13, perform corrective actions specified by Technical Specification 3.12.1.c.

(4) The sampling locations(s), excluding the control station location, having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from the Radiological Environmental Monitoring Program after October 31 of the year in which the land use census was conducted in accordance with Technical Specification 3.12.2.b.

4. Responsible Company Organizations

a) The Technical Services Section, BG&E Fossil Energy Division is responsible for performing the surveillances listed above.

5. Initiating conditions

a) Collect samples in accordance with the frequencies specified on Attachments 14, 15, 16, and 17.

b) Analyze samples in accordance with the frequencies specified on Attachments 15, 16, and 17.

c) Calculate the potential annual doses in accordance with the methodology outlined below if any of the following conditions are true:

(1) any of the above surveillance results reveal levels of environmental activity greater than the Action Levels specified on Attachments 15, 16 17 (per Technical Specification Table 3.12-2)

(2) any radionuclides other than those in Attachments 15, 16, and 17 are detected, and the radionuclides are the result of plant effluents.

d) The Environmental Programs Section, BG&E Corporate Affairs Group, is responsible for notifying the General Supervisor--Chemistry, CCNPP, if any of the following conditions are true: | 1

(1) any of the above surveillance results reveal levels of environmental activity greater than the Action Levels specified on Attachments 15, 16 17 (per Technical Specification Table 3.12-2)

(2) any radionuclides other than those in Attachments 15, 16, and 17 are detected, and the radionuclides are the result of plant effluents, and the potential annual doses due to the radionuclides are greater than the calendar year limits of Specifications 3.11.1.2, 3.11.2.2, and 3.11.2.3.

6. Calculation methodology

a) If the correct initiating conditions, as described above, are present, calculate potential annual doses for the pathway of interest in accordance with the methodologies contained in ODCM, or

b) if methodologies other than those listed in the ODCM are used to calculate potential annual doses, such methodologies shall be documented in the AREOR in accordance with Technical Specification 3.12.1.b.

7. Corrective Actions

a) If a sample is unobtainable due to sampling equipment malfunction, then attempt to restore equipment to operable status before the end of the next sampling period, and document in the AREOR (per Technical Specification 4.12.1, Table 3.12-1, notation "a").

b) If the RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM is not being conducted in accordance with Attachments 13, 14, 15, or 16, document deviations in the AREOR (per Technical Specification 3.12.1.a).

c) With fresh leafy vegetable samples unavailable from one or more of the sample locations listed on Attachment 13, establish a new monitoring location and document applicable information in the AREOR (per Technical Specification 3.12.1.c).

d) When the analysis result for any parameter exceeds the Action Level listed on Attachments 15, 16, or 17, submit a Special Report to the NRC (per Technical Specification 3.12.1.b).

e) When radionuclides other than those listed on Attachments 15, 16, and 17 are detected; and if those radionuclides are the result of plant effluents; and if the potential annual doses due to the radionuclides are greater than the calendar year limits of Specifications 3.11.1.2, 3.11.2.2, and 3.11.2.3; submit a Special Report in accordance with Technical Specification 3.12.1.b.

B. Land Use Census

1. Introduction

a) 10 CFR 50, Appendix I, Section IV.B.3 requires licensees to identify changes in the use of UNRESTRICTED AREAS in order to permit modifications in monitoring programs.

b) Radiological environmental controls have been established to implement the requirements of 10 CFR 50, Appendix I, Section IV.B.3.

c) These radiological environmental controls are described below.

2. Controls on the Land Use Census

a) Identify the location of the nearest milk animal, within a distance of 8 km of the plant site, in each of the 9 metrological sectors (per Technical Specification 3.12.2).

b) Identify the location of the nearest residence, within a distance of 8 km of the plant site, in each of the 9 metrological sectors (per Technical Specification 3.12.2).

c) Identify the location of the nearest garden, within a distance of 8 km of the plant site, in each of the 9 metrological sectors; or if the garden census was not conducted, obtain samples of three different kinds of broad leaf vegetation from the SITE BOUNDARY in two different metrological sectors which have the highest predicted SITE BOUNDARY D/Q (per Technical Specification 3.12.2).

3. Surveillance Requirement(s)

a) Perform a land use census that will provide the best results. Example methods may include, but are not limited to, the following:

(1) door-to-door surveys

(2) aerial views

(3) consult local agricultural authorities

b) Document the results of the land use census in the Annual Radiological Environmental Operating Report in accordance with Specification 6.9.1.7.

4. Responsible Company Organizations

a) The Environmental Programs Section, BG&E Corporate Affairs Group, is responsible for performing the surveillances listed above. | 1

5. Initiating conditions

a) Conduct the land use census during the growing season, and conduct the land use census at least once per 12 months.

6. Calculation methodology

a) Calculate doses for the pathways of interest in accordance with the methodologies contained in Regulatory Guide 1.109, or

b) if methodologies other than those listed in Regulatory Guide 1.109 are used to calculate doses, such methodologies should be documented in the Annual Radiological Environmental Operating Report.

7. Corrective Actions

a) The results of the land use census shall be used to determine the RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM's sample locations identified on Attachment 13.

b) If the land use census has identified a location(s) that yields a calculated dose or dose commitment greater than the values currently being calculated in Specification 4.11.2.3, perform the following activities.

(1) Document the new location(s) in the next Annual Radiological Environmental Operating Report in accordance with Specification 6.9.1.7, and

(2) revise the figures and tables in the ODCM to reflect the new location(s).

c) If the land use census has identified a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) which is 20% greater than the equivalent location identified on Attachment 13, perform the following activities.

(1) Add the new location(s) to the RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM within 30 days,

(2) document the new location(s) in the next Annual Radiological Environmental Operating Report in accordance with Specification 6.9.1.7, and

(3) revise the figures and tables in the ODCM to reflect the new location(s).

C. Interlaboratory Comparison Program

1. Introduction

a) 10 CFR 50, Appendix I, Section IV.B.2 requires licensees to establish an environmental surveillance and monitoring program for the purpose of evaluating the relationship between quantities of radioactive material released in effluents and resultant radiation doses to individuals.

b) Radiological environmental controls have been established to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring.

c) These radiological environmental controls are described below.

2. Controls on the Interlaboratory Comparison Program

a) Analyze INTERLABORATORY COMPARISON PROGRAM samples supplied by either the Commission or a Commission approved laboratory for all parameters listed on Attachments 15, 16, and/or 17, as applicable[130] (per Technical Specification 3.12.3).

3. Surveillance Requirement(s)

a) A summary of the results obtained as part of the Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report pursuant to Specification 6.9.1.7.

b) This section of the ODCM shall describe the Interlaboratory Comparison Program.

4. Responsible Company Organizations

a) The Chemistry Unit, Technical Services Section, BG&E Fossil Energy Division, is responsible for performing the surveillances listed above.

5. Initiating conditions

a) Analyze INTERLABORATORY COMPARISON PROGRAM samples whenever they are supplied by either the Commission or a Commission approved laboratory.

6. Calculation methodology

a) Analysis methods and calculational methodologies used to satisfy the above surveillances shall be documented in approved procedures.

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130 The EPA may supply the INTERLABORATORY COMPARISON PROGRAM samples. Since no Commission approved laboratory supplies TLDs as part of a comparison program, no TLDs are analyzed as part of the INTERLABORATORY COMPARISON PROGRAM.

7. Corrective Actions

a) If analyses are not performed as required, document actions taken to prevent reoccurrence in the Annual Radiological Environmental Operating Report (AREOR) pursuant to Specification 6.9.1.7.

D. Annual Radiological Environmental Operating Report

1. Introduction

a) 10 CFR 50, Appendix I, Section IV.B.2 requires licensees to provide data on measurable levels of radiation and radioactive materials in the environment.

b) Radiological environmental controls have been established to implement the requirements of 10 CFR 50, Appendix I, Section IV.B.2.

c) These radiological environmental controls are described below.

2. Controls on the Annual Radiological Environmental Operating Report (AREOR)

a) The AREOR shall include a summary description of the radiological environmental monitoring program.

b) The AREOR shall include a table stating the distance and direction from the central point between the two containment buildings to each of the sample points.

c) The AREOR shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period.

d) The AREOR shall include a comparison with Radiological Environmental Operating Report preoperational studies.

e) The AREOR shall include a comparison with operational controls as appropriate.

f) The AREOR shall include a comparison with the previous environmental surveillance reports.

g) The AREOR shall include an assessment of the observed impacts of the plant operation on the environment.

h) The AREOR shall include the results of the land use censuses required by Specification 3.12.2.

i) The AREOR shall include the results of analysis of all radiological environmental samples taken during the period pursuant to the locations specified on Attachment 13.

j) The AREOR shall include the results of all environmental radiation measurements taken during the period pursuant to the locations specified on Attachment 13.

k) The AREOR shall include summarized and tabulated results--in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979--of analysis of all radiological environmental samples taken during the period pursuant to the locations specified on Attachment 13.

l) The AREOR shall include summarized and tabulated results--in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979--of all environmental radiation measurements taken during the period pursuant to the locations specified on Attachment 13.

m) The AREOR shall include an explanation for missing results, if some individual results (as described in the above paragraph) are not available for inclusion with the report.

n) The AREOR shall include any data which was missing from previous reports.

o) The AREOR shall include a summary description of the Radiological Environmental Monitoring Program.

p) The AREOR shall include at least two legible maps[131] covering all sampling locations keyed to a table giving distances and directions from the central point between the two containment buildings.

q) The AREOR shall include results of the licensee participation in the INTERLABORATORY COMPARISON PROGRAM required by Specification 3.12.3.

r) The AREOR shall include a discussion of all deviations from the sampling schedules listed on Attachments 14, 15, 16, and 17, and specify the reason(s) for the deviations, and the plan for preventing recurrence.

s) The AREOR shall include a discussion of all analyses in which the LLD listed on Attachments 15, 16, and 17 (and required by Technical Specification Table 4.12-1) was not achievable.

t) The AREOR shall include the identification of the cause of unavailability of samples (if any), and describe the locations used for replacement samples.

u) The AREOR shall include any permanent changes in the sample locations which could appear in the monitoring program.

v) The AREOR shall include revised figure(s) (e.g., like Attachments 18 and 19) and tables (e.g., like Attachment 13) for the ODCM which reflect any new RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM sample location(s).

3. Surveillance Requirement(s)

a) Write the Annual Radiological Environmental Operating Report covering the previous calendar year's operation of the reactor units.

4. Responsible Company Organizations

a) The Environmental Programs Section, BG&E Corporate Affairs Group, is responsible for performing the surveillances listed above[132]. |

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131 One map shall cover stations near the SITE BOUNDARY; a second shall include the more distant stations.

132 A separate company may be contracted to complete the Routine AREOR.

5. Initiating conditions

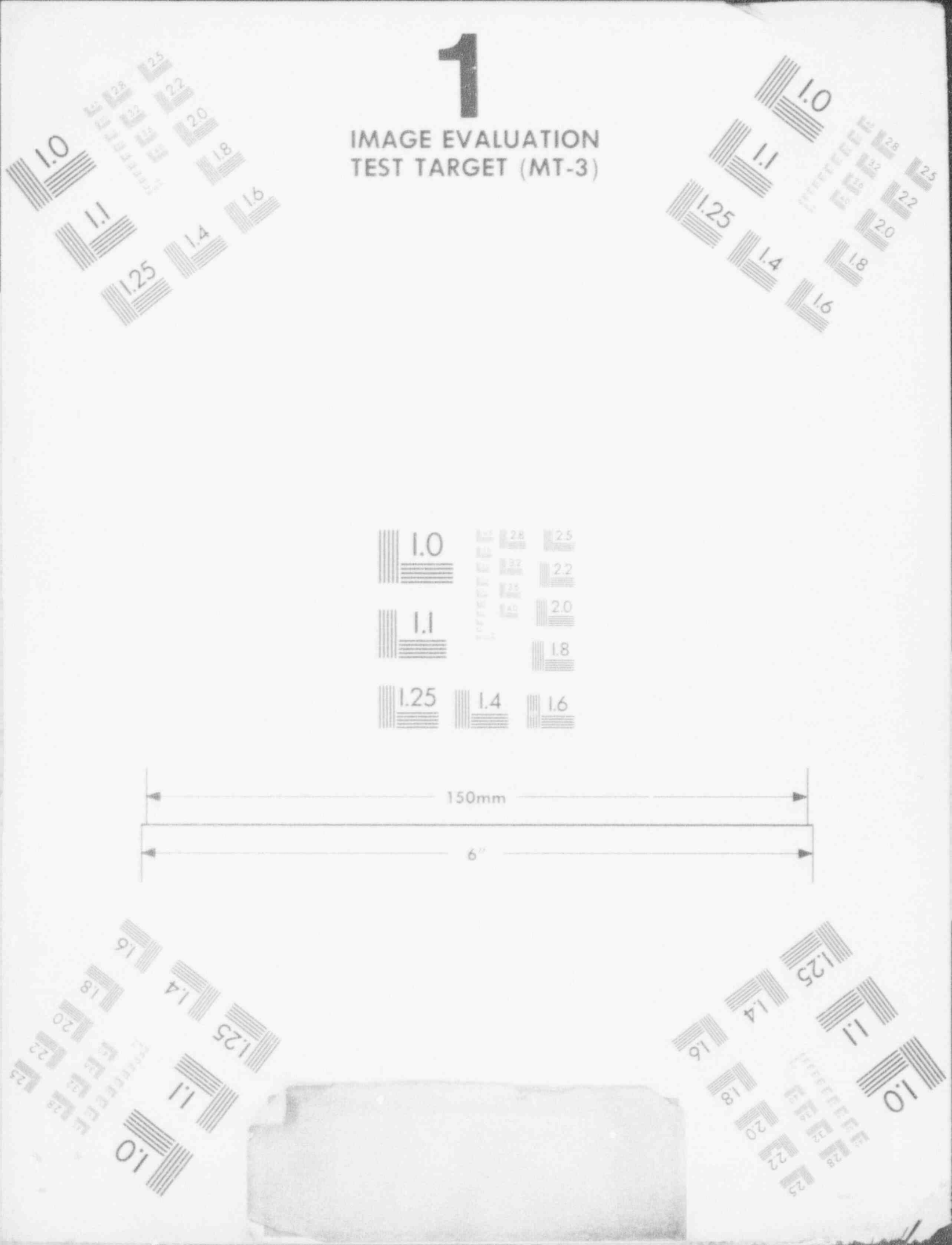
   a) Submit the Routine AREOR (covering operation of the reactor units for the previous calendar year) by May 1 of each year.

6. Calculation methodology

   a) Calculational methodologies used to satisfy the above surveillances should be documented in approved procedures, or should be included in the AREOR.

7. Corrective Actions

   a) If analyses are not performed as required, document actions taken to prevent reoccurrence in the AREOR pursuant to Specification 6.9.1.7.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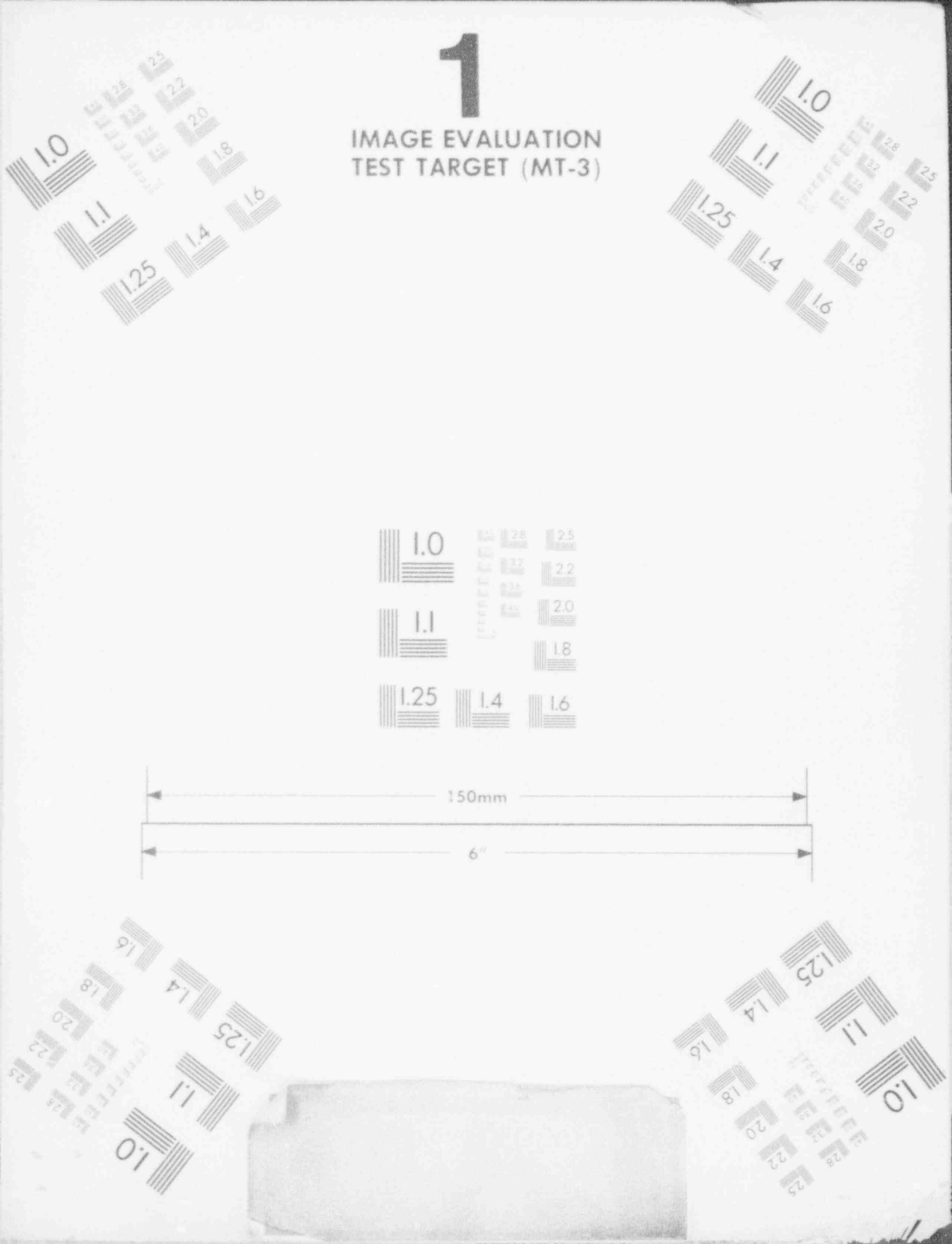
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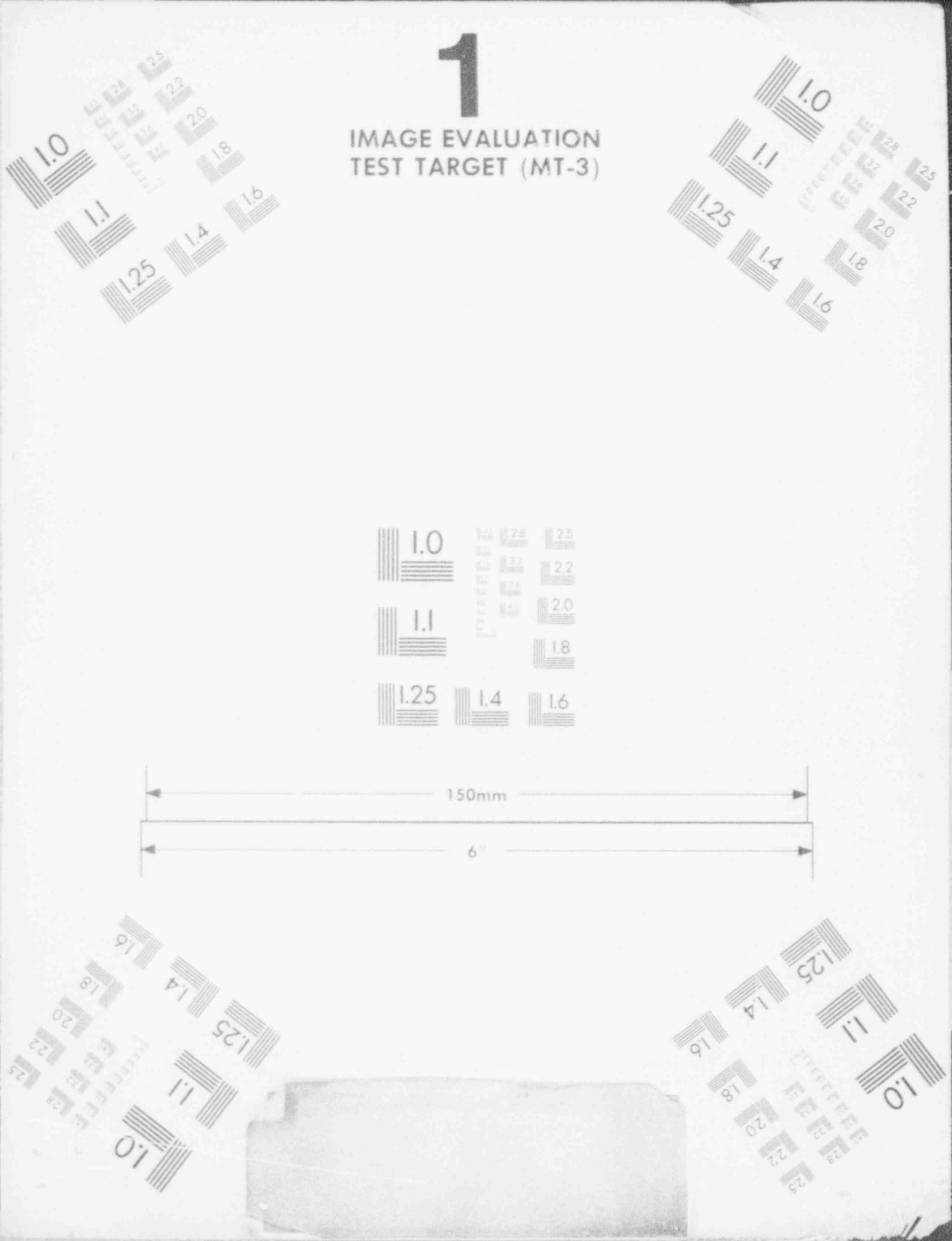
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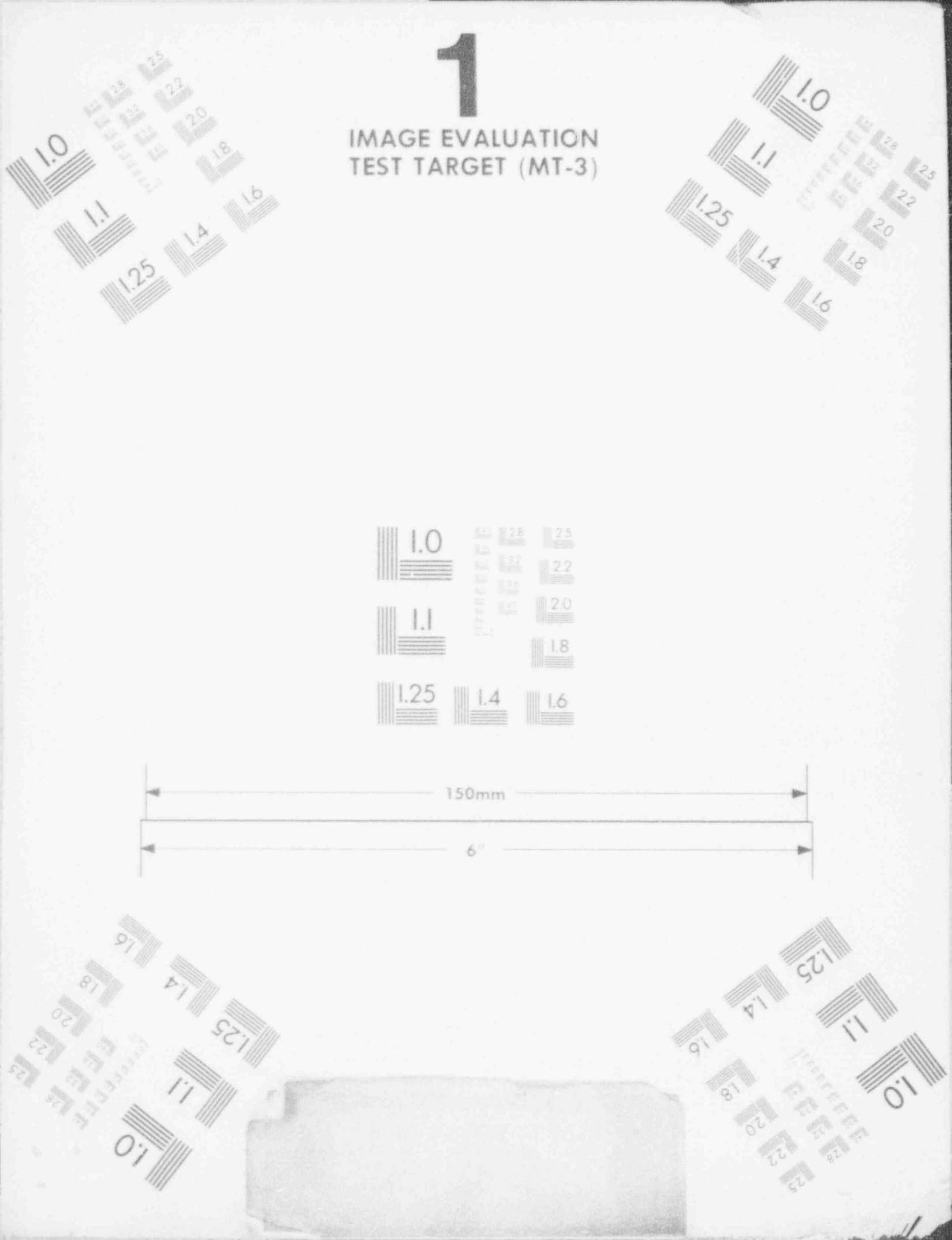
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VIII. ADMINISTRATION OF THE ODCM

A. Introduction

1. Technical Specification 6.8.1 requires written procedures covering the ODCM and the implementation of the ODCM.

2. Administrative controls have been established to implement the requirements of Technical Specification 6.8.1.

3. These administrative controls are described below.

B. Controls On The ODCM

1. The format, organization, content, and administration of the ODCM are controlled by CCI-413.

2. Methodologies identified in the ODCM are implemented by various BG&E organizations in accordance with approved procedures. (See the "RESPONSIBILITIES" section of CCI-413 for a list of those Sections of BG&E responsible for approving and maintaining procedures which implement the requirements of the ODCM.)

3. The main vent stack flow rates shall be verified in accordance with the surveillances described in the following section.

C. Surveillance Requirements

1. Complete audits and PERIODIC REVIEWS of the ODCM in accordance with CCI-413.

2. Determine main vent stack flow rates for both units as described below.

   a) The main vent stack flow rate shall be determined, in accordance with approved procedures, at least once per 6 months ($\pm$ 25%).

   b) The Test and Equipment Unit shall be responsible for performing this test.

   c) The results of the main vent flow rate test shall be evaluated to ensure the main vent flow rates used in the ODCM are an accurate reflection of the true main vent flow rates.

   d) IF the main vent stack flow rate for either unit, as determined in accordance with approved Test and Equipment procedure(s), changes $\pm$ 10% from the values referenced in Attachment 7 of the ODCM, a technical evaluation shall be initiated to determine if the ODCM should be revised.

D. Responsible Company Organizations

1. CCI-413 identifies the responsibilities of various personnel and company organizations which administer and implement the ODCM. This section of the ODCM identifies company organizations which are assigned responsibility for implementing the surveillances described above.

2. The Test Equipment Unit is responsible for ensuring the main vent stack flow rate test procedure (e.g., TE-001 or equivalent) is completed in accordance with the surveillances listed above.

3. The Test Equipment Unit is responsible for forwarding main vent stack flow rate test results to the General Supervisor - Chemistry.

4. The RETS Coordinator, CCNPPD Chemistry Section, is responsible for evaluating main vent flow rate test results (e.g., TE-001 or equivalent results) and for performing the technical evaluation described in the above surveillances.

E. Initiating Conditions

1. Main vent stack flow rates shall be determined at least once per 6 months (± 25%), or more often if required by Technical Specifications.

2. Complete PERIODIC REVIEWS of the ODCM as specified in CCI-413.

F. Calculation Methodologies

1. Calculational methodologies used to satisfy the above surveillances should be documented in approved procedures.

2. Documents which serve as a basis for calculation methodologies used in the ODCM should be maintained in an accessible location.

   (1) Supporting documents may be incorporated into the ODCM (e.g., as Attachments).

   (2) Supporting documents may be maintained in a "procedure history file".

   (3) Supporting documents may be identified in the "references" section of the ODCM.

G. Corrective Actions

1. IF main vent stack flow rates, as determined in accordance with appropriate Test Equipment procedure(s), change ± 10% from the values referenced in Attachment 7 of the ODCM, a technical evaluation shall be initiated to determine if the ODCM should be revised.

H. Bases | 1

1. [B527], NRC Inspection Report INSR 91-30/30 | 1

I. Executive Summary Of Changes | 1

1. Revision 0, Change 0: Initital Issue of ODCM under control of CCI-413. | 1

2. Revision 0, Change 1: Added the words "Revision 0, Change 1" to title page. Added committment/bases tracking number [B527] to margins of pages 10, 11, 12, and 60. Added a "Bases" section to page 160. Added "Executive Summary of Changes" section to page 160. Modified "List Of Effective Pages." Changed "Fossil Energy Division" to "Corporate Affairs Group." | 1

ATTACHMENT 1

Final Grading And Drainage Plan

A reference diagram which depicts the grading for and the drainage from the Calvert Cliffs Nuclear Power Plant can be found in the following reference:

Plant Data Book, Calvert Cliffs Nuclear Power Plant Units 1 and 2, Bechtel Power Corporation, Job 6750, March 1975, Volume 1, Section 27, Drawing C-17

The above referenced grading and drainage plan is intended for reference only. This drawing may not reflect the changes and modifications since March 1975.

ATTACHMENT 2 (Page 1 of 3)

OUTFALL 001 - SOURCES OF LIQUID RADIOACTIVE WASTE

Waste Stream	Radiation Monitor	Type of release	Max. Discharge Flow Rate		Maximum Volume		Notes
			gal/min	liters/min.	gal	liters	
Rx. Coolant Wst. Mon. Tk.	0-RE-2201	Batch	120	454	90000[16]	3.407E5[16]	
Rx. Coolant Wst. Rec. Tk.	0-RE-2201	Batch	120	454	90000[16]	3.407E5[16]	
Misc. Wst. Mon. Tk.	0-RE-2201	Batch	120	454	4000[16]	15140[16]	
Misc. Wst. Rec. Tk.	0-RE-2201	Batch	120	454	4000[16]	15140[16]	
Aux. Boiler Steam Drum	All releases are via Auxiliary Blowdown Tank						
Aux. Blowdown Tk.	Unmonitored	Continuous	200[15]	757	N/A	N/A	
Waste Neut. Tk. 11	Unmonitored	Batch	1000[1]	3790[1]	45988	1.74E5	
Waste Neut. Tk. 12	Unmonitored	Batch	1000[1]	3790[1]	47749	1.80E5	
Stm. Gen. Blowdown Tk.	1/2-RE-4014[17]	Batch[14]	225[2]	852[2]	2350[3]	8895[3]	
Component Cooling Water[4]	Unmonitored	Continuous	variable[5]	variable[5]	44090[6]	1.669E5	
Condenser Hotwells	Unmonitored	Batch[13]	4500[7]	17000[7]	1.05E5	3.97E5	
Salt Water System	Unmonitored	Continuous	15500	58670	N/A	N/A	
Condensate Storage Tank[8]	Unmonitored	Batch	variable[9]	variable[9]	3.5E5[10]	1.3E6[10]	
Demin. Water Storage Tank[11]	Unmonitored	Batch	variable[9]	variable[9]	3.5E5[10]	1.3E6[10]	
Precoat Sump[12]	Unmonitored	Continuous	50	94.6	10305	39004	

ATTACHMENT 2 (Page 2 of 3)

OUTFALL 001 - SOURCES OF LIQUID RADIOACTIVE WASTE

1. This flow rate is only an approximation. The motive force is gravity

2. This is the maximum flow rate. The actual flow rate will be considerably less.

3. This is the maximum volume of the tank, however, since this is a continuous release, the volume discharged would be calculated from the discharge flow rate and duration of the release.

4. There is no direct path by which radioactive liquid from the CCW System could enter outfall 001. Liquid from the CCW System may leak into either the Salt Water System (which drains to outfall 001) or the Liquid Waste Processing System (via Aux. Bldg. Drains).

5. Radioactive liquid is not normally released from the CCW system. Flow rate to outfall 001 may occur via Salt Water System. For this pathway, the flow rate will vary (e.g., depending on size of leak). See Safety Analysis No. 2, FCR 82-1053, Supplement 1.

6. System volume is 5894 cubic feet. Conversion coustant is 0.13368 cubic feet per gallon.

7. The flow rate shown here is the flow rate for one condensate pump. Verify the number on condensate pumps in service, and modify this flow rate accordingly.

8. Radioactive liquid is not normally released from the CST. The CST would drain to outfall 001 only if catastrophic tank failure occurred. Small leaks would be collected by storm drains which would be released to outfall 002.

9. Flow rate should be calculated on a case-by-case basis.

10. Volume obtained from "Plant Data Book", BG&E CCNPP Units 1 and 2, Bechtel Power Corporation, Volume 1, Job 6750.

11. Radioactive liquid is not normally released from the demineralized water storage tank (DWST). The DWST would drain to outfall 001 only if catastrophic tank failure occurred. Small leaks would be collected by the storm drains which would be released to outfall 002.

12. If the precoat sump contents were contaminated, releases would probably be directed to outfall 001, however depending on the valve line-ups, the sump may be discharged to outfall 002.

13. May be a continuous release if contaminated sealing steam is operated during the release.

ATTACHMENT 2 (Page 3 of 3)

OUTFALL 001 - SOURCES OF LIQUID RADIOACTIVE WASTE

14. Although steam generator releases are normally batch releases, discharges may at times be continuous. Verify type of release to by conducted prior to discharge.

15. This is the maximum rated discharge for two pumps in operation. If less than two pumps will be operable for the release, a flow setpoint should be specified for the release.

16. The volume specified is the design basis volume from Table 11-1 of the UFSAR.

17. The steam generator blowdown effluent radiation monitor, 1/2-RE-4095, may be equivalent to the 1/2-RE-4014 (see section V.D.2).

ATTACHMENT 3 (Page 1 of 2)

OUTFALLS 002, 003, 004 - POTENTIAL SOURCES OF LIQUID RADIOACTIVE WASTE

Waste Stream	Radiation Monitor	Type of Release	Max. Discharge Flow Rate		Maximum Volume		Outfall
			gal/min	liters/min	gal	liters	
Turbine Bldg. Sump No. 11	Unmonitored	Continuous	470	889	1950	7381	002
Turbine Bldg. Sump No. 12	Unmonitored	Continuous	470	889	2415	9141	002
Turbine Bldg. Sump No. 21	Unmonitored	Continuous	470	889	2490	9425	002
Turbine Bldg. Sump No. 22	Unmonitored	Continuous	470	889	2182	8259	002
Precoat Sump	Unmonitored	Continuous	50	94.6	10305	39004	002
Diesel Oil Interceptor Sump	Unmonitored	Continuous	100	378.5	5790	21920	004
Yard Oil Interceptor	Unmonitored	Continuous	variable[3]	variable[3]	N/A	N/A	002
Refueling Water Tank	Unmonitored	Batch/Cont.[7]	variable[3]	variable[3]	4.2E5	1.6E6	any[9]
Condensate Storage Tank	Unmonitored	Batch/Cont.[7]	variable[3]	variable[3]	3.5E5[6]	1.3E6[6]	002[2,4]
Service Water System	1/2-RE-1595	Continuous	variable[3]	variable[3]	31418	1.189E5	002
Demin. Water Storage Tank	Unmonitored	Batch/Cont.[7]	variable[3]	variable[3]	3.5E5[6]	1.3E6[6]	002[2]
Plant Heating System	Unmonitored	Continuous	variable[3]	variable[3]	N/A	N/A	002[8]

ATTACHMENT 3 (Page 2 of 2)

OUTFALLS 002, 003, 004 - POTENTIAL SOURCES OF LIQUID RADIOACTIVE WASTE

1. The maximum discharge flow rate is dependent on the influent flow rate (e.g., turbine building sump discharges).

2. The contents of these tanks are not normally discharged to the environment, however in the event of a small leak or catastrophic tank failure, the tank contents could be released to the designated outfall(s).

3. Maximum discharge flow rate shall be determined on a case-by-case basis.

4. It is also possible for the CST to be discharged via the condenser hotwells.

5. Flow rate should be calculated on a case-by-case basis.

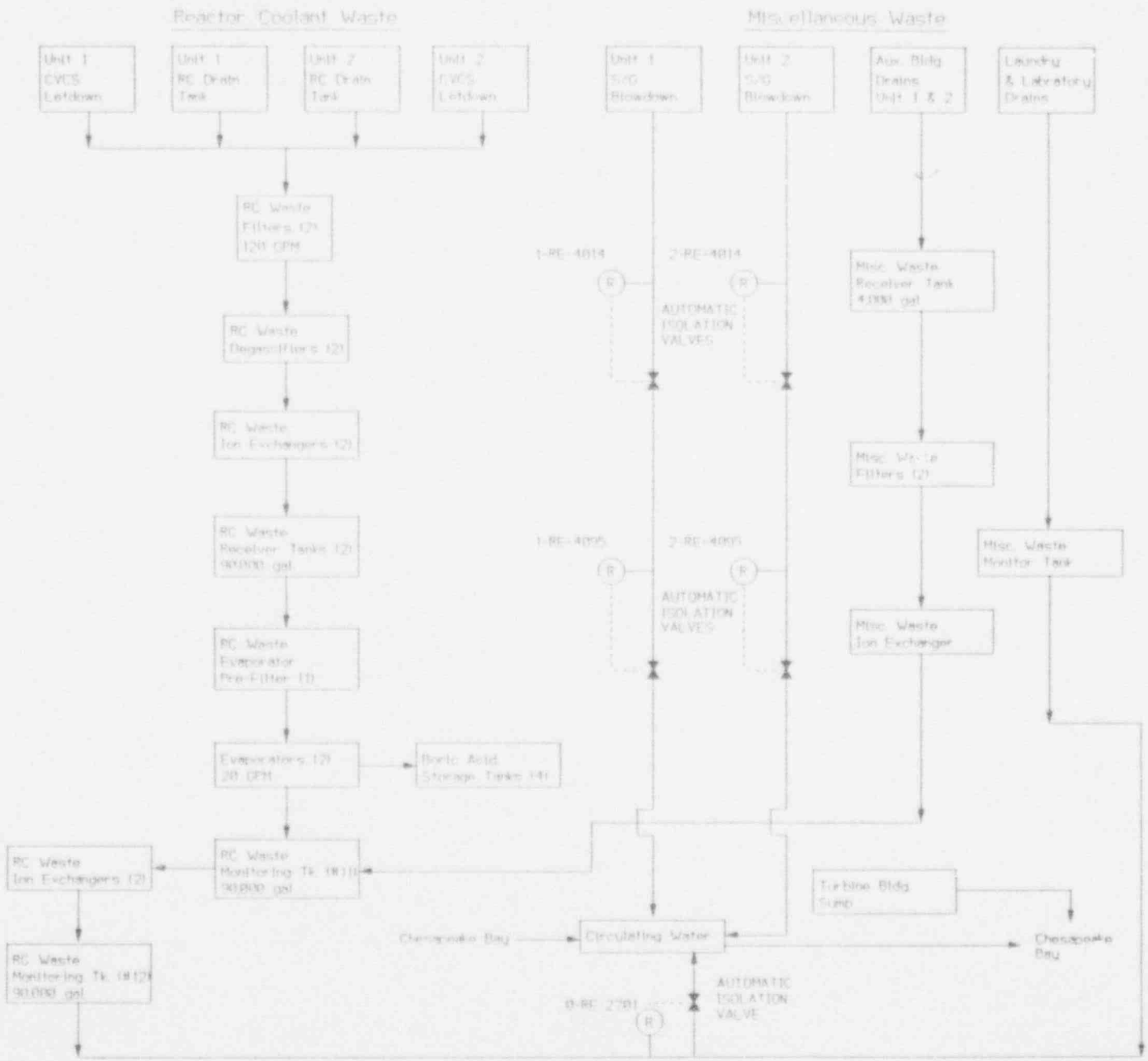
6. Volume obtained from "Plant Data Book", BG&E CCNPP Units 1 and 2, Bechtel Power Corporation, Volume 1, Job 6750.

7. Releases via this pathway would be considered a batch release if a catastrophic tank failure occurred. In the event of a small leak, the release may be considered a continuous release. The release mode should be determination on a case-by-case basis.

8. The plant heating system is a closed system and is not normally released to the environment. In the event of a leak, the effluent may be released to the environment via the turbine building sumps (outfall 002). In some cases, depending on the location of the leak, the effluent would be collected in the auxiliary building sump and subsequently released through the liquid radioactive waste processing system. The effluent pathway should be determined on a case-by-case basis.

9. The contents of these tanks are not normally discharged to the environment, however in the event of a small leak or catastrophic tank failure, the tank contents could be released to outfall 002, 003, or 004..

ATTACHMENT 4
BLOCK DIAGRAM OF LIQUID RADIOACTIVE WASTE SYSTEMS



ATTACHMENT 5

DOMINANT AND LESS DOMINANT RADIONUCLIDES IN TYPICAL RADWASTE DISCHARGES

1. Select the calendar quarters which contain at least one "typical" liquid (or gas) release.

2. Obtain the Semi-Annual Radioactive Effluent Release Report(s) which contain information related to the calendar quarters selected in step 1 above.

3. Create a matrix in which the "columns" represent calendar quarters, and the "rows" represent the radionuclides.

4. Record the quarterly activity (curies) of the radionuclide in the appropriate cells of the matrix created in step 3. (Do not include data from quarters which are not "typical" in terms of liquid [or gas] releases.)

5. Sum the quarterly activities (curies) for each individual radionuclide.

$$A_{iT} = \sum A_{iQ} \qquad \text{Eq. 1R}$$

6. Sum the quarterly activities for all radionuclides, i.

$$A_T = \sum A_{iT} \qquad \text{Eq. 2R}$$

7. Calculate the fraction of the total activity attributable to each radionuclide (i.e., the relative activity of nuclide i).

$$f_i = A_{iT} / A_T \qquad \text{Eq. 3R}$$

8. Characterize each radionuclide as either "dominant" or "less dominant" as shown below:

   * The radionuclide is defined as a DOMINANT RADIONUCLIDE if the following inequality is true.

$$f_i \geq 0.010 \qquad \text{Eq. 4R}$$

   * The radionuclide is defined as a LESS DOMINANT RADIONUCLIDE if the following inequality is true.

$$f_i < 0.010 \qquad \text{Eq. 5R}$$

ATTACHMENT 6

LIQUID EFFLUENT DOSE FACTORS

(mrem/hr per uCi/ml)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	2.820E-01	2.820E-01	2.820E-01	2.820E-01	2.820E-01	2.820E-01
BE-7	2.700E+01	1.100E+01	6.500E+01	1.300E+00	1.600E+01	3.100E+00	2.700E+02
C-14	1.450E+04	2.900E+03	2.900E+03	2.900E+03	2.900E+03	2.900E+03	2.900E+03
NA-24	4.570E-01	4.570E-01	4.570E-01	4.570E-01	4.570E-01	4.570E-01	4.570E-01
P-32	4.690E+06	2.910E+05	1.810E+05	0.000E+00	0.000E+00	0.000E+00	5.270E+05
CR-51	0.000E+00	0.000E+00	5.580E+00	3.340E+00	1.230E+00	7.400E+00	1.400E+03
MN-54	0.000E+00	7.060E+03	1.350E+03	0.000E+00	2.100E+03	0.000E+00	2.160E+04
MN-56	0.000E+00	1.780E+02	3.150E+01	0.000E+00	2.260E+02	0.000E+00	5.670E+03
FE-55	5.110E+04	3.530E+04	8.230E+03	0.000E+00	0.000E+00	1.970E+04	2.030E+04
FE-59	8.060E+04	1.900E+05	7.270E+04	0.000E+00	0.000E+00	5.300E+04	6.320E+05
CO-57	0.000E+00	1.420E+02	2.360E+02	0.000E+00	0.000E+00	0.000E+00	3.590E+03
CO-58	0.000E+00	6.030E+02	1.350E+03	0.000E+00	0.000E+00	0.000E+00	1.220E+04
CO-60	0.000E+00	1.730E+03	3.820E+03	0.000E+00	0.000E+00	0.000E+00	3.250E+04
NI-63	4.960E+04	3.440E+03	1.670E+03	0.000E+00	0.000E+00	0.000E+00	7.180E+02
NI-65	2.020E+02	2.620E+01	1.200E+01	0.000E+00	0.000E+00	0.000E+00	6.650E+02
CU-64	0.000E+00	2.140E+02	1.010E+02	0.000E+00	5.400E+02	0.000E+00	1.830E+04
ZN-65	1.610E+05	5.130E+05	2.320E+05	0.000E+00	3.430E+05	0.000E+00	3.230E+05
ZN-69	3.430E+02	6.560E+02	4.560E+01	0.000E+00	4.260E+02	0.000E+00	9.850E+01
BR-82	0.000E+00	0.000E+00	4.070E+00	0.000E+00	0.000E+00	0.000E+00	4.670E+00
BR-83	0.000E+00	0.000E+00	7.250E-02	0.000E+00	0.000E+00	0.000E+00	1.040E-01
BR-84	0.000E+00	0.000E+00	9.390E-02	0.000E+00	0.000E+00	0.000E+00	7.370E-07
BR-85	0.000E+00	0.000E+00	3.860E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	6.240E+02	2.910E+02	0.000E+00	0.000E+00	0.000E+00	1.230E+02
RB-88	0.000E+00	1.790E+00	9.490E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	1.190E+00	8.340E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	4.990E+03	0.000E+00	1.430E+02	0.000E+00	0.000E+00	0.000E+00	8.000E+02
SR-90	1.230E+05	0.000E+00	3.010E+04	0.000E+00	0.000E+00	0.000E+00	3.550E+03
SR-91	9.180E+01	0.000E+00	3.710E+00	0.000E+00	0.000E+00	0.000E+00	4.370E+02
SR-92	3.480E+01	0.000E+00	1.510E+00	0.000E+00	0.000E+00	0.000E+00	6.900E+02

ATTACHMENT 6

LIQUID EFFLUENT DOSE FACTORS

(mrem/hr per uCi/ml)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
Y-90	6.060E+00	0.000E+00	1.630E-01	0.000E+00	0.000E+00	0.000E+00	6.420E+04
Y-91M	5.730E-02	0.000E+00	2.220E-03	0.000E+00	0.000E+00	0.000E+00	1.680E-01
Y-91	8.880E+01	0.000E+00	2.370E+00	0.000E+00	0.000E+00	0.000E+00	4.890E+04
Y-92	5.320E-01	0.000E+00	1.560E-02	0.000E+00	0.000E+00	0.000E+00	9.320E+03
Y-93	1.690E+00	0.000E+00	4.660E-02	0.000E+00	0.000E+00	0.000E+00	5.350E+04
ZR-95	1.590E+01	5.110E+00	3.460E+00	0.000E+00	8.020E+00	0.000E+00	1.620E+04
ZR-97	8.810E-01	1.780E-01	8.130E-02	0.000E+00	2.680E-01	0.000E+00	5.510E+04
NB-95	4.470E+02	2.490E+02	1.340E+02	0.000E+00	2.460E+02	0.000E+00	1.510E+06
NB-97	3.750E+00	9.490E-01	3.460E-01	0.000E+00	1.110E+00	0.000E+00	3.500E+03
MO-99	0.000E+00	1.280E+02	2.430E+01	0.000E+00	2.890E+02	0.000E+00	2.960E+02
TC-99M	1.300E-02	3.660E-02	4.660E-01	0.000E+00	5.560E-01	1.790E-02	2.170E+01
TC-101	1.330E-02	1.920E-02	1.880E-01	0.000E+00	3.460E-01	9.810E-03	0.000E+00
RU-103	1.070E+02	0.000E+00	4.600E+01	0.000E+00	4.070E+02	0.000E+00	1.250E+04
RU-105	8.890E+00	0.000E+00	3.510E+00	0.000E+00	1.150E+02	0.000E+00	5.440E+03
RU-106	1.590E+03	0.000E+00	2.010E+02	0.000E+00	3.060E+03	0.000E+00	1.030E+05
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD-109	2.100E+05	4.000E+06	1.600E+06	1.500E+05	2.200E+07	1.800E+05	2.500E+06
AG-110M	1.560E+03	1.450E+03	8.600E+02	0.000E+00	2.850E+03	0.000E+00	5.910E+05
SN-113	6.700E+03	1.200E+03	2.100E+04	6.200E+02	1.600E+03	7.300E+02	2.200E+05
SB-124	2.770E+02	5.230E+00	1.100E+02	6.710E-01	0.000E+00	2.150E+02	7.860E+03
SB-125	1.770E+02	1.980E+00	4.210E+01	1.800E-01	0.000E+00	1.360E+02	1.950E+03
TE-125M	2.170E+02	7.860E+01	2.910E+01	6.520E+01	8.820E+02	0.000E+00	8.660E+02
TE-127M	5.480E+02	1.960E+02	6.680E+01	1.400E+02	2.230E+03	0.000E+00	1.840E+03
TE-127	8.900E+00	3.200E+00	1.930E+00	6.600E+00	3.630E+01	0.000E+00	7.030E+02
TE-129M	9.310E+02	3.470E+02	1.470E+02	3.200E+02	3.890E+03	0.000E+00	4.690E+03
TE-129	2.540E+00	9.550E-01	6.190E-01	1.950E+00	1.070E+01	0.000E+00	1.920E+00
TE-131M	1.400E+02	6.850E+01	5.710E+01	1.080E+02	6.940E+02	0.000E+00	6.800E+03
TE-131	1.590E+00	6.660E-01	5.030E-01	1.310E+00	6.990E+00	0.000E+00	2.260E-01

ATTACHMENT 6

LIQUID EFFLUENT DOSE FACTORS

(mrem/hr per uCi/ml)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
TE-132	2.040E+02	1.320E+02	1.240E+02	1.460E+02	1.270E+03	0.000E+00	6.240E+03
I-130	3.960E+01	1.170E+02	4.610E+01	9.910E+03	1.820E+02	0.000E+00	1.010E+02
I-131	2.180E+02	3.120E+02	1.790E+02	1.020E+05	5.350E+02	0.000E+00	8.230E+01
I-132	1.060E+01	2.850E+01	9.960E+00	9.960E+02	4.540E+01	0.000E+00	5.350E+00
I-133	7.450E+01	1.300E+02	3.950E+01	1.900E+04	2.260E+02	0.000E+00	1.160E+02
I-134	5.560E+00	1.510E+01	5.400E+00	2.620E+02	2.400E+01	0.000E+00	1.320E-02
I-135	2.320E+01	6.080E+01	2.240E+01	4.010E+03	9.750E+01	0.000E+00	6.870E+01
CS-134	6.840E+03	1.630E+04	1.330E+04	0.000E+00	5.270E+03	1.750E+03	2.850E+02
CS-136	7.160E+02	2.830E+03	2.040E+03	0.000E+00	1.570E+03	2.160E+02	3.210E+02
CS-137	8.770E+03	1.200E+04	7.850E+03	0.000E+00	4.070E+03	1.350E+03	2.320E+02
CS-138	6.070E+00	1.200E+01	5.940E+00	0.000E+00	8.810E+00	8.700E-01	5.120E-05
BA-139	7.850E+00	5.590E-03	2.300E-01	0.000E+00	5.230E-03	3.170E-03	1.390E+01
BA-140	1.640E+03	2.060E+00	1.080E+02	0.000E+00	7.020E-01	1.180E+00	3.380E+03
BA-141	3.810E+00	2.880E-03	1.290E-01	0.000E+00	2.680E-03	1.630E-03	1.800E-09
BA-142	1.720E+00	1.770E-03	1.080E-01	0.000E+00	1.500E-03	1.000E-03	0.000E+00
LA-140	1.570E+00	7.940E-01	2.100E-01	0.000E+00	0.000E+00	0.000E+00	5.830E+04
CE-139	1.000E+02	4.800E+01	3.700E+02	6.200E-01	3.400E+01	4.800E+00	3.200E+03
LA-142	8.060E-02	3.670E-02	9.130E-03	0.000E+00	0.000E+00	0.000E+00	2.680E+02
CE-141	3.430E+00	2.320E+00	2.630E-01	0.000E+00	1.080E+00	0.000E+00	8.860E+03
CE-143	6.040E-01	4.460E+02	4.940E-02	0.000E+00	1.970E-01	0.000E+00	1.670E+04
CE-144	1.790E+02	7.470E+01	9.590E+00	0.000E+00	4.430E+01	0.000E+00	6.040E+04
PR-143	5.790E+00	2.320E+00	2.870E-01	0.000E+00	1.340E+00	0.000E+00	2.540E+04
PR-144	1.900E-02	7.870E-03	9.640E-04	0.000E+00	4.440E-03	0.000E+00	2.730E-09
ND-147	3.960E+00	4.580E+00	2.740E-01	0.000E+00	2.680E+00	0.000E+00	2.200E+04
W-187	9.160E+00	7.660E+00	2.680E+00	0.000E+00	0.000E+00	0.000E+00	2.510E+03
NP-239	3.530E-02	3.470E-03	1.910E-03	0.000E+00	1.080E-02	0.000E+00	7.110E+02
HG-203	1.400E+05	0.000E+00	1.600E+05	0.000E+00	1.600E+06	1.000E+05	3.200E+05

ATTACHMENT 7

GENERAL INFORMATION RELATED TO GASEOUS RELEASES VIA THE MAIN VENTS

Waste Stream[1]	Radiation Monitor	Type of release	Nominal Discharge Flow Rate		Maximum Discharge Flow Rate		Notes
			m^3/sec	SCFM	m^3/sec	SCFM	
Waste Gas System (WGDT)	0-RE-2191[2]	Batch	N/A	N/A	2.36E-2	50	
Cntmt. Vent (via H2 Purge)	1/2-RE-5415[3]	Batch[4]	N/A	N/A	2.36E-2	50	
Cntmt. Purge (5% Modified)	1/2-RE-5415[3]	Continuous	N/A	N/A	1.928	4085	
Cntmt. Purge (10% Modified)	1/2-RE-5415[3]	Continuous	N/A	N/A	7.996	16940	
Cntmt. Purge (100% Modified)	1/2-RE-5415[3]	Continuous	N/A	N/A	17.70	37500	
Unit 1 Main Vent Release	1-RE-5415[5]	Continuous	59.4[6]	125858[6]	65.34[7]	138444[7]	
Unit 2 Main Vent Release	2-RE-5415[8]	Continuous	47.1[6]	99749[6]	51.78[7]	109724[7]	

1 information for waste streams not listed in this table should be evaluated on a case-by-case basis.

2 Since the WGDT is released to the plant vent stack, 1/2-RE-5415 and 1/2-RE-5416 may also be used to monitor releases from a WGDT.

3 The WRGM, 1/2-RE-5416, may also monitor main vent releases.

4 A containment vent is considered a "batch" release (even though inleakage of radioactive gases into the containment atmosphere may occur during the time the vent is in progress).

5 The WRGM, 1-RE-5416, may also monitor main vent releases.

6 This is the mean main vent stack flow rate as determined by approved Engineering Test Procedure (i.e., ETP-87-16).

7 This is the maximum vent stack flow rate as determined by approved Engineering Test Procedure (i.e., ETP-87-16).

8 The WRGM, 2-RE-5416, may also monitor main vent releases.

ATTACHMENT 8

GENERAL INFORMATION RELATED TO GASEOUS RELEASES VIA PATHWAYS OTHER THAN THE MAIN VENTS

Waste Stream[1]	Radiation Monitor	Type of Release	Nominal Discharge Flow Rate	Notes
Aux. Boiler Deaerator	Unmonitored	See Footnote[2]	See Footnote[3]	
Stm. Gen. Atm. Stm. Dumps	Unmonitored	See Footnote[2]	See Footnote[3]	
Plant Nitrogen System	Unmonitored	See Footnote[2]	See Footnote[3]	
Turbine Bldg. Vent. Exh.	Unmonitored	See Footnote[2]	See Footnote[3]	
Emergency Air Lock	Unmonitored	See Footnote[2]	See Footnote[3]	
Plant Compressed Air	Unmonitored	See Footnote[2]	See Footnote[3]	
Main Steam Line Penetrations	Unmonitored	See Footnote[2]	See Footnote[3]	

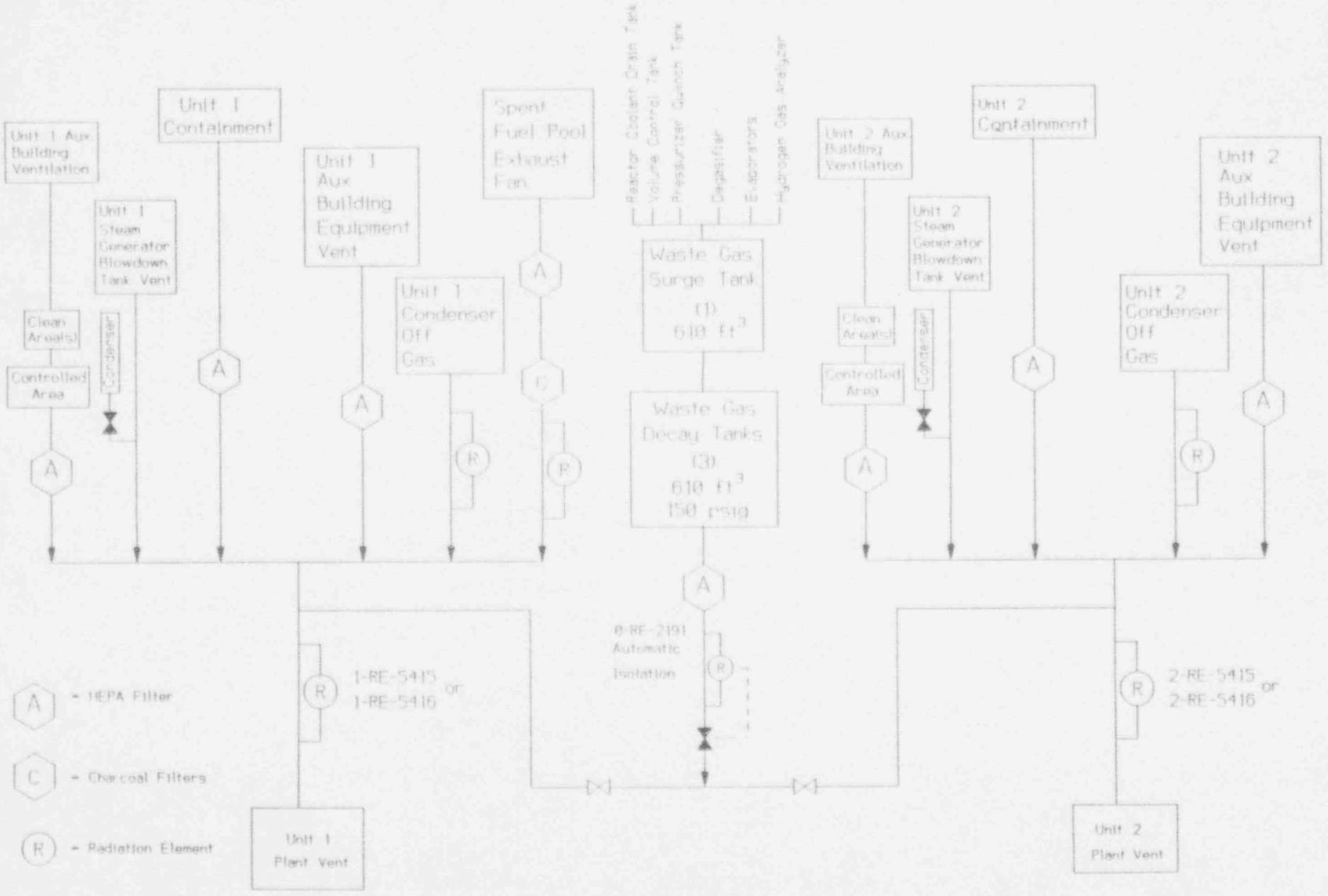
1 Information for waste streams not listed in this table should be evaluated on a case-by-case basis.

2 Since radioactive gaseous waste is not normally vented via this pathway, the determination of release type (i.e., continuous or batch) will be evaluated on a case-by-case basis.

3 Since radioactive gaseous waste is not normally vented via this pathway, the determination of discharge flow rate will be evaluated on a case-by-case basis.

Attachment 9

Radioactive Gaseous Waste Treatment System (CCNPP)



ATTACHMENT 10

NOBLE GAS DOSE FACTORS

NUCLIDE	GAMMA BODY DOSE K_i (mrem/yr)/(μCi/m^3)	BETA SKIN DOSE L_i (mrem/yr)/(μCi/m^3)	GAMMA AIR DOSE M_i (mrad/yr)/(μCi/m^3)	BETA AIR DOSE N_i (mrad/yr)/(μCi/m^3)
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-85m	1.17E+03	1.46E+03	1.23E+03	1.97E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03

ATTACHMENT 11

EMPIRICAL DERIVATION OF SITE-SPECIFIC DOSE FACTORS

The total body dose, the skin dose, and the air doses--resulting from gamma and beta emitting radionuclides in discharges of gaseous radwaste--are normally calculated using nuclide specific dose factors. However, these same doses may be estimated using empirically derived, site specific, dose factors as shown below.

TOTAL-BODY, GAMMA-DOSE FACTOR

A site-specific, total-body, gamma-dose factor has been derived from histor data in accordance with the following equation.

$$K_{avg} = \sum (K_i)(f_i) \qquad \text{Eq. 1F}$$

K_{avg} = the empirically derived, site-specific, total-body, gamma-dose factor due to all noble gases released during a specified time period

Values of K_{avg} have been calculated using gaseous radwaste discharge data collected over several years.

The results of the calculations appear in the Table on page 5 of this attachment.

K_i = the total body dose factor due to gamma emissions for each identified noble gas radionuclide, i (mrem/yr per microcurie/cubic meter)

The total-body dose factors for gamma rays from noble gas radionuclides were obtained from Regulatory Guide 1.109, Appendix B, Table B-1.

The total-body dose factors for various noble gas radionuclides are tabulated in Attachment 10.

f_i = a fraction which represents the relative activity contribution of noble gas radionuclide i to the total noble gas activity for TYPICAL GASEOUS EFFLUENTS (unitless)

This value has been calculated for all gaseous radwaste discharges for the years 1986, 1987, and 1988 in accordance with equation 3R on Attachment 5.

ATTACHMENT 11

EMPIRICAL DERIVATION OF SITE-SPECIFIC DOSE FACTORS

SKIN, BETA-DOSE FACTOR

A site-specific, skin, beta-dose factor has been derived from historical data in accordance with the following equation.

$$L_{avg} = \sum (L_i)(f_i) \qquad \text{Eq. 2F}$$

L_{avg} = the empirically derived, site-specific, skin, beta-dose factor due to all noble gases released during a specified time period

Values of L_{avg} have been calculated using gaseous radwaste discharge data collected over several years.

The results of the calculations appear in the Table on page 5 of this attachment.

L_i = the skin dose factor due to beta emissions for each identified noble gas radionuclide, i (mrem/yr per microcurie/cubic meter)

The beta skin dose factors have been obtained from Regulatory Guide 1.109, Appendix B, Table B-1.

The beta skin dose factors for various noble gas radionuclides are tabulated in Attachment 10.

f_i = a fraction which represents the relative activity contribution of noble gas radionuclide i to the total noble gas activity for TYPICAL GASEOUS EFFLUENTS (unitless)

This value has been calculated for all gaseous radwaste discharges for the years 1986, 1987, and 1988 in accordance with equation 3R on Attachment 5.

ATTACHMENT 11

EMPIRICAL DERIVATION OF SITE-SPECIFIC DOSE FACTORS

GAMMA-AIR-DOSE FACTOR

A site-specific, gamma-air-dose factor has been derived from historical data in accordance with the following equation.

$$M_{avg} = \sum (M_i)(f_i) \qquad \text{Eq. 3F}$$

M_{avg} = the empirically derived, site-specific, gamma-air-dose factor due to all noble gases released during a specified time period

Values of M_{avg} have been calculated using gaseous radwaste discharge data collected over several years.

The results of the calculations appear in the Table on page 5 of this attachment.

M_i = the air dose factor due to gamma emissions for each identified noble gas radionuclide, i (mrad/yr per microcurie/cubic meter)

The gamma air dose factors have been obtained from Regulatory Guide 1.109, Appendix B, Table B-1.

The gamma air dose factors for various noble gas radionuclides are tabulated in Attachment 10.

f_i = a fraction which represents the relative activity contribution of noble gas radionuclide i to the total noble gas activity for TYPICAL GASEOUS EFFLUENTS (unitless)

This value has been calculated for all gaseous radwaste discharges for the years 1986, 1987, and 1988 in accordance with equation 3R on Attachment 5.

ATTACHMENT 11

EMPIRICAL DERIVATION OF SITE-SPECIFIC DOSE FACTORS

BETA-AIR-DOSE FACTOR

A site-specific, beta-air-dose factor has been derived from historical data in accordance with the following equation.

$$N_{avg} = \sum (N_i)(f_i) \qquad \text{Eq. 4F}$$

N_{avg} = the empirically derived, site-specific, beta-air-dose factor due to all noble gases released during a specified time period

Values of N_{avg} have been calculated using gaseous radwaste discharge data collected over several years.

The results of the calculations appear in the Table on page 5 of this attachment.

N_i = the air dose factor due to beta emissions for each identified noble gas radionuclide, i (mrad/yr per microcurie/cubic meter)

The beta air dose factors have been obtained from Regulatory Guide 1.109, Appendix B, Table B-1.

The beta air dose factors for various noble gas radionuclides are tabulated in Attachment 10 (Attachment 1 of old ODCM).

f_i = a fraction which represents the relative activity contribution of noble gas radionuclide i to the total noble gas activity for TYPICAL GASEOUS EFFLUENTS (unitless)

This value has been calculated for all gaseous radwaste discharges for the years 1986, 1987, and 1988 in accordance with equation 3R on Attachment 5.

ATTACHMENT 11

EMPIRICAL DERIVATION OF SITE-SPECIFIC DOSE FACTORS

Page 5 of 5

SITE-SPECIFIC, AVERAGE DOSE FACTORS

Year	K_{avg}	L_{avg}	M_{avg}	N_{avg}
1986	330	790	390	1100
1987	340	810	400	1100
1988	390	960	450	1200
Average	350	850	410	1100
Maximum % difference	11%	13%	10%	9%

As can be seen from the above table, the percent difference between the yearly dose factors and the 3-year average dose factors range from 9% to 13%. This variability is minor considering other areas of uncertainty inherent in the environmental dose calculation models.

It should be noted that the emperically-derived, site-specific, average dose factors listed in the above table shall only rarely be used. In those rare instances where emperically-derived, site-specific, average dose factors are used, the results shall be carefully evaluated by qualified members of the facility staff to ensure the estimated doses are only a small fraction of the Technical Specification limits. Additionally, the doses shall be recalculated using the RIGOROUS METHODS prior to submitting the Semi-Annual Radioactive Effluent Release Report.

ATTACHMENT 12

GRASS-COW-MEAT DOSE FACTORS

ADULT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	3.250E+02	3.250E+02	3.250E+02	3.250E+02	3.250E+02	3.250E+02
C-14	3.330E+05	6.660E+04	6.660E+04	6.660E+04	6.660E+04	6.660E+04	6.660E+04
NA 24	1.840E-03	1.840E-03	1.840E-03	1.840E-03	1.840E-03	1.840E-03	1.840E-03
P-32	4.650E+09	2.890E+08	1.800E+08	0.000E+00	0.000E+00	0.000E+00	5.230E+08
CR-51	0.000E+00	0.000E+00	7.070E+03	4.220E+03	1.560E+03	9.380E+03	1.780E+06
MN-54	0.000E+00	9.150E+06	1.750E+06	0.000E+00	2.720E+06	0.000E+00	2.800E+07
MN-56	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-55	2.930E+08	2.020E+08	4.720E+07	0.000E+00	0.000E+00	1.130E+08	1.160E+08
FE-59	2.670E+08	6.270E+08	2.400E+08	0.000E+00	0.000E+00	1.750E+08	2.090E+09
CO-57	0.000E+00	5.640E+06	9.370E+06	0.000E+00	0.000E+00	0.000E+00	1.430E+08
CO-58	0.000E+00	1.830E+07	4.100E+07	0.000E+00	0.000E+00	0.000E+00	3.700E+08
CO-60	0.000E+00	7.520E+07	1.660E+08	0.000E+00	0.000E+00	0.000E+00	1.410E+09
NI-63	1.890E+10	1.310E+09	6.330E+08	0.000E+00	0.000E+00	0.000E+00	2.730E+08
NI-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU-64	0.000E+00	2.950E-07	1.390E-07	0.000E+00	7.450E-07	0.000E+00	2.520E-05
ZN-65	3.560E+08	1.130E+09	5.120E+08	0.000E+00	7.570E+08	0.000E+00	7.130E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.870E+08	2.270E+08	0.000E+00	0.000E+00	0.000E+00	9.600E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.010E+08	0.000E+00	8.650E+06	0.000E+00	0.000E+00	0.000E+00	4.840E+07
SR-90	1.240E+10	0.000E+00	3.050E+09	0.000E+00	0.000E+00	0.000E+00	3.590E+08
SR-91	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.380E-09
SR-92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-90	1.070E+02	0.000E+00	2.860E+00	0.000E+00	0.000E+00	0.000E+00	1.130E+06
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	1.130E+06	0.000E+00	3.030E+04	0.000E+00	0.000E+00	0.000E+00	6.240E+08
Y-92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-93	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.080E-07
ZR-95	1.880E+06	6.040E+05	4.090E+05	0.000E+00	9.480E+05	0.000E+00	1.910E+09
ZR-97	1.830E-05	3.690E-06	1.690E-06	0.000E+00	5.580E-06	0.000E+00	1.140E+00
NB-95	2.290E+06	1.280E+06	6.860E+05	0.000E+00	1.260E+06	0.000E+00	7.750E+09
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO-99	0.000E+00	1.090E+05	2.070E+04	0.000E+00	2.460E+05	0.000E+00	2.520E+05
TC-99M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.060E+08	0.000E+00	4.550E+07	0.000E+00	4.030E+08	0.000E+00	1.230E+10
RU-105	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-106	2.800E+09	0.000E+00	3.540E+08	0.000E+00	5.400E+09	0.000E+00	1.810E+11

ATTACHMENT 12

GRASS-COW-MEAT DOSE FACTORS

ADULT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	6.690E+06	6.190E+06	3.670E+06	0.000E+00	1.220E+07	0.000E+00	2.520E+09
SB-124	1.980E+09	3.740E+07	7.850E+08	4.800E+06	0.000E+00	1.540E+09	5.620E+10
SB-125	1.910E+09	2.130E+07	4.540E+08	1.940E+06	0.000E+00	1.470E+09	2.100E+10
TE-125M	3.590E+08	1.300E+08	4.810E+07	1.080E+08	1.460E+09	0.000E+00	1.430E+09
TE-127M	1.120E+09	3.990E+08	1.360E+08	2.850E+08	4.530E+09	0.000E+00	3.740E+09
TE-127	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.090E-09	0.000E+00	2.100E-08
TE-129M	1.140E+09	4.270E+08	1.810E+08	3.930E+08	4.770E+09	0.000E+00	5.760E+09
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	4.510E+02	2.210E+02	1.840E+02	3.500E+02	2.240E+03	0.000E+00	2.190E+04
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	1.400E+06	9.070E+05	8.510E+05	1.000E+06	8.730E+06	0.000E+00	4.290E+07
I-130	2.350E-06	6.940E-06	2.740E-06	5.880E-04	1.080E-05	0.000E+00	5.980E-06
I-131	1.080E+07	1.540E+07	8.830E+06	5.050E+09	2.640E+07	0.000E+00	4.070E+06
I-132	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-133	4.300E-01	7.470E-01	2.280E-01	1.100E+02	1.300E+00	0.000E+00	6.720E-01
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS-134	6.570E+08	1.560E+09	1.280E+09	0.000E+00	5.060E+08	1.680E+08	2.740E+07
CS-136	1.180E+07	4.670E+07	3.360E+07	0.000E+00	2.600E+07	3.560E+06	5.300E+06
CS-137	8.720E+08	1.190E+09	7.810E+08	0.000E+00	4.050E+08	1.350E+08	2.310E+07
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	2.880E+07	3.610E+04	1.890E+06	0.000E+00	1.230E+04	2.070E+04	5.920E+07
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	3.600E-02	1.810E-02	4.790E-03	0.000E+00	0.000E+00	0.000E+00	1.330E+03
LA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-141	1.400E+04	9.480E+03	1.080E+03	0.000E+00	4.400E+03	0.000E+00	3.620E+07
CE-143	2.090E-02	1.550E+01	1.710E-03	0.000E+00	6.800E-03	0.000E+00	5.780E+02
CE-144	1.460E+06	6.090E+05	7.830E+04	0.000E+00	3.610E+05	0.000E+00	4.930E+08
PR-143	2.130E+04	8.540E+03	1.060E+03	0.000E+00	4.930E+03	0.000E+00	9.330E+07
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	7.080E+03	8.180E+03	4.900E+02	0.000E+00	4.780E+03	0.000E+00	3.930E+07
W-187	2.160E-02	1.810E-02	6.320E-03	0.000E+00	0.000E+00	0.000E+00	5.920E+00
NP-239	2.560E-01	2.510E-02	1.390E-02	0.000E+00	7.840E-02	0.000E+00	5.150E+03

ATTACHMENT 12

GRASS-COW-MEAT DOSE FACTORS

TEEN

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	1.940E+02	1.940E+02	1.940E+02	1.940E+02	1.940E+02	1.940E+02
C-14	2.810E+05	5.620E+04	5.620E+04	5.620E+04	5.620E+04	5.620E+04	5.620E+04
NA-24	1.470E-03	1.470E-03	1.470E-03	1.470E-03	1.470E-03	1.470E-03	1.470E-03
P-32	3.930E+09	2.440E+08	1.520E+08	0.000E+00	0.000E+00	0.000E+00	3.300E+08
CR-51	0.000E+00	0.000E+00	5.650E+03	3.140E+03	1.240E+03	8.070E+03	9.500E+05
MN-54	0.000E+00	6.980E+06	1.380E+06	0.000E+00	2.080E+06	0.000E+00	1.430E+07
MN-56	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-55	2.380E+08	1.690E+08	3.930E+07	0.000E+00	0.000E+00	1.070E+08	7.300E+07
FE-59	2.130E+08	4.980E+08	1.920E+08	0.000E+00	0.000E+00	1.570E+08	1.180E+09
CO-57	0.000E+00	4.530E+06	7.590E+06	0.000E+00	0.000E+00	0.000E+00	8.450E+07
CO-58	0.000E+00	1.410E+07	3.250E+07	0.000E+00	0.000E+00	0.000E+00	1.940E+08
CO-60	0.000E+00	5.830E+07	1.310E+08	0.000E+00	0.000E+00	0.000E+00	7.600E+08
NI-63	1.520E+10	1.070E+09	5.150E+08	0.000E+00	0.000E+00	0.000E+00	1.710E+08
NI-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU-64	0.000E+00	2.410E-07	1.130E-07	0.000E+00	6.100E-07	0.000E+00	1.870E-05
ZN-65	2.500E+08	8.690E+08	4.050E+08	0.000E+00	5.560E+08	0.000E+00	3.680E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.060E+08	1.910E+08	0.000E+00	0.000E+00	0.000E+00	6.010E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	2.540E+08	0.000E+00	7.290E+06	0.000E+00	0.000E+00	0.000E+00	3.030E+07
SR-90	8.050E+09	0.000E+00	1.990E+09	0.000E+00	0.000E+00	0.000E+00	2.260E+08
SR-91	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.100E-09
SR-92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-90	8.980E+01	0.000E+00	2.420E+00	0.000E+00	0.000E+00	0.000E+00	7.400E+05
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	9.560E+05	0.000E+00	2.560E+04	0.000E+00	0.000E+00	0.000E+00	3.920E+08
Y-92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-93	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.690E-07
ZR-95	1.510E+06	4.760E+05	3.270E+05	0.000E+00	6.990E+05	0.000E+00	1.100E+09
ZR-97	1.530E-05	3.020E-06	1.390E-06	0.000E+00	4.580E-06	0.000E+00	8.180E-01
NB-95	1.790E+06	9.940E+05	5.470E+05	0.000E+00	9.640E+05	0.000E+00	4.250E+09
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO-99	0.000E+00	8.980E+04	1.710E+04	0.000E+00	2.060E+05	0.000E+00	1.610E+05
TC-99M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	8.600E+07	0.000E+00	3.680E+07	0.000E+00	3.030E+08	0.000E+00	7.180E+09
RU-105	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-106	2.360E+09	0.000E+00	2.970E+08	0.000E+00	4.550E+09	0.000E+00	1.130E+11

ATTACHMENT 12

GRASS-COW-MEAT DOSE FACTORS

TEEN

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	5.060E+06	4.790E+06	2.910E+06	0.000E+00	9.140E+06	0.000E+00	1.350E+09
SB-124	1.620E+09	2.980E+07	6.310E+08	3.670E+06	0.000E+00	1.410E+09	3.260E+10
SB-125	1.560E+09	1.710E+07	3.660E+08	1.490E+06	0.000E+00	1.370E+09	1.220E+10
TE-125M	3.030E+08	1.090E+08	4.050E+07	8.470E+07	0.000E+00	0.000E+00	8.940E+08
TE-127M	9.410E+08	3.340E+08	1.120E+08	2.240E+08	3.820E+09	0.000E+00	2.350E+09
TE-127	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.750E-08
TE-129M	9.580E+08	3.560E+08	1.520E+08	3.090E+08	4.010E+09	0.000E+00	3.600E+09
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	3.760E+02	1.800E+02	1.500E+02	2.710E+02	1.880E+03	0.000E+00	1.450E+04
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	1.150E+06	7.260E+05	6.840E+05	7.660E+05	6.970E+06	0.000E+00	2.300E+07
I-130	1.890E-06	5.480E-06	2.190E-06	4.470E-04	8.440E-06	0.000E+00	4.210E-06
I-131	8.950E+06	1.250E+07	6.730E+06	3.660E+09	2.160E+07	0.000E+00	2.480E+06
I-132	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-133	3.590E-01	6.100E-01	1.860E-01	8.510E+01	1.070E+00	0.000E+00	4.610E-01
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS-134	5.230E+08	1.230E+09	5.710E+08	0.000E+00	3.910E+08	1.490E+08	1.530E+07
CS-136	9.220E+06	3.630E+07	2.440E+07	0.000E+00	1.970E+07	3.110E+06	2.920E+06
CS-137	7.240E+08	9.630E+08	3.360E+08	0.000E+00	3.280E+08	1.270E+08	1.370E+07
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	2.380E+07	2.910E+04	1.530E+06	0.000E+00	9.880E+03	1.960E+04	3.670E+07
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	2.960E-02	1.450E-02	3.870E-03	0.000E+00	0.000E+00	0.000E+00	8.350E+02
LA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-141	1.180E+04	7.860E+03	9.030E+02	0.000E+00	3.700E+03	0.000E+00	2.250E+07
CE-143	1.760E-02	1.280E+01	1.430E-03	0.000E+00	5.740E-03	0.000E+00	3.850E+02
CE-144	1.230E+06	5.080E+05	6.600E+04	0.000E+00	3.040E+05	0.000E+00	3.090E+08
PR-143	1.790E+04	7.150E+03	8.920E+02	0.000E+00	4.160E+03	0.000E+00	5.900E+07
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	6.240E+03	6.790E+03	4.060E+02	0.000E+00	3.980E+03	0.000E+00	2.450E+07
W-187	1.810E-02	1.480E-02	5.170E-03	0.000E+00	0.000E+00	0.000E+00	3.990E+00
NP-239	2.230E-01	2.110E-02	1.170E-02	0.000E+00	6.610E-02	0.000E+00	3.390E+03

ATTACHMENT 12

GRASS-COW-MEAT DOSE FACTORS

CHILD

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	2.340E+02	2.340E+02	2.340E+02	2.340E+02	2.340E+02	2.340E+02
C-14	5.290E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05
NA-24	2.340E-03	2.340E-03	2.340E-03	2.340E-03	2.340E-03	2.340E-03	2.340E-03
P-32	7.410E+09	3.470E+08	2.860E+08	0.000E+00	0.000E+00	0.000E+00	2.050E+08
CR-51	0.000E+00	0.000E+00	8.810E+03	4.890E+03	1.340E+03	8.930E+02	4.670E+05
MN-54	0.000E+00	7.990E+06	2.130E+06	0.000E+00	2.240E+06	0.000E+00	6.700E+06
MN-56	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-55	4.570E+08	2.420E+08	7.510E+07	0.000E+00	0.000E+00	1.370E+08	4.490E+07
FE-59	3.780E+08	6.120E+08	3.050E+08	0.000E+00	0.000E+00	1.770E+08	6.370E+08
CO-57	0.000E+00	5.920E+06	1.200E+07	0.000E+00	0.000E+00	0.000E+00	4.850E+07
CO-58	0.000E+00	1.650E+07	5.040E+07	0.000E+00	0.000E+00	0.000E+00	9.600E+07
CO-60	0.000E+00	6.930E+07	2.040E+08	0.000E+00	0.000E+00	0.000E+00	3.840E+08
NI-63	2.910E+10	1.560E+09	9.910E+08	0.000E+00	0.000E+00	0.000E+00	1.050E+08
NI-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU-64	0.000E+00	3.240E-07	1.960E-07	0.000E+00	7.820E-07	0.000E+00	1.520E-05
ZN-65	3.750E+08	1.000E+09	6.220E+08	0.000E+00	6.300E+08	0.000E+00	1.760E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	5.760E+08	3.540E+08	0.000E+00	0.000E+00	0.000E+00	3.710E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	4.820E+08	0.000E+00	1.380E+07	0.000E+00	0.000E+00	0.000E+00	1.860E+07
SR-90	1.040E+10	0.000E+00	2.640E+09	0.000E+00	0.000E+00	0.000E+00	1.400E+08
SR-91	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.010E-09
SR-92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-90	1.700E+02	0.000E+00	4.550E+00	0.000E+00	0.000E+00	0.000E+00	4.840E+05
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	1.810E+06	0.000E+00	4.830E+04	0.000E+00	0.000E+00	0.000E+00	2.410E+08
Y-92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-93	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.550E-07
ZR-95	2.680E+06	5.890E+05	5.240E+05	0.000E+00	8.430E+05	0.000E+00	6.140E+08
ZR-97	2.840E-05	4.100E-06	2.420E-06	0.000E+00	5.890E-06	0.000E+00	6.210E-01
NB-95	3.090E+06	1.200E+06	8.610E+05	0.000E+00	1.130E+06	0.000E+00	2.230E+09
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO-99	0.000E+00	1.250E+05	3.090E+04	0.000E+00	2.670E+05	0.000E+00	1.030E+05
TC-99M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.560E+08	0.000E+00	5.980E+07	0.000E+00	3.920E+08	0.000E+00	4.020E+09
RU-105	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-106	4.440E+09	0.000E+00	5.540E+08	0.000E+00	5.990E+09	0.000E+00	6.900E+10

ATTACHMENT 12

GRASS-COW-MEAT DOSE FACTORS

CHILD

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	8.400E+06	5.670E+06	4.530E+06	0.000E+00	1.060E+07	0.000E+00	6.750E+08
SB-124	2.930E+09	3.800E+07	1.030E+09	6.460E+06	0.000E+00	1.620E+09	1.830E+10
SB-125	2.850E+09	2.190E+07	5.960E+08	2.640E+06	0.000E+00	1.590E+09	6.800E+09
TE-125M	5.690E+08	1.540E+08	7.590E+07	1.600E+08	0.000E+00	0.000E+00	5.490E+08
TE-127M	1.770E+09	4.780E+08	2.110E+08	4.240E+08	5.060E+09	0.000E+00	1.440E+09
TE-127	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.210E-09	0.000E+00	1.660E-08
TE-129M	1.810E+09	5.040E+08	2.800E+08	5.820E+08	5.300E+09	0.000E+00	2.200E+09
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	7.000E+02	2.420E+02	2.580E+02	4.980E+02	2.340E+03	0.000E+00	5.820E+03
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	2.090E+06	9.270E+05	1.120E+06	1.350E+06	8.600E+06	0.000E+00	9.330E+06
I-130	3.390E-06	6.850E-06	3.530E-06	7.540E-04	1.020E-05	0.000E+00	3.200E-06
I-131	1.660E+07	1.670E+07	9.490E+06	5.520E+09	2.740E+07	0.000E+00	1.490E+06
I-132	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-133	6.680E-01	8.260E-01	3.120E-01	1.530E+02	1.380E+00	0.000E+00	3.330E-01
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS-134	9.220E+08	1.510E+09	3.190E+08	0.000E+00	4.690E+08	1.680E+08	8.150E+06
CS-136	1.590E+07	4.370E+07	2.830E+07	0.000E+00	2.330E+07	3.470E+06	1.540E+06
CS-137	1.330E+09	1.280E+09	1.880E+08	0.000E+00	4.160E+08	1.500E+08	7.990E+06
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	4.390E+07	3.850E+04	2.560E+06	0.000E+00	1.250E+04	2.290E+04	2.220E+07
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	5.410E-02	1.890E-02	6.380E-03	0.000E+00	0.000E+00	0.000E+00	5.270E+02
LA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-141	2.220E+04	1.110E+04	1.640E+03	0.000E+00	4.840E+03	0.000E+00	1.380E+07
CE-143	3.300E-02	1.790E+01	2.590E-03	0.000E+00	7.510E-03	0.000E+00	2.620E+02
CE-144	2.320E+06	7.260E+05	1.240E+05	0.000E+00	4.020E+05	0.000E+00	1.890E+08
PR-143	3.390E+04	1.020E+04	1.680E+03	0.000E+00	5.510E+03	0.000E+00	3.660E+07
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	1.170E+04	9.480E+03	7.340E+02	0.000E+00	5.200E+03	0.000E+00	1.500E+07
W-187	3.360E-02	1.990E-02	8.920E-03	0.000E+00	0.000E+00	0.000E+00	2.790E+00
NP-239	4.200E-01	3.020E-02	2.120E-02	0.000E+00	8.730E-02	0.000E+00	2.230E+03

ATTACHMENT 12

GRASS-COW-MEAT DOSE FACTORS

INFANT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract

ATTACHMENT 12

GRASS-COW-MEAT DOSE FACTORS

INFANT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract

ATTACHMENT 12

VEGETATION DOSE FACTORS

ADULT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	2.260E+03	2.260E+03	2.260E+03	2.260E+03	2.260E+03	2.260E+03
C-14	8.970E+05	1.790E+05	1.790E+05	1.790E+05	1.790E+05	1.790E+05	1.790E+05
NA-24	2.760E+05	2.760E+05	2.760E+05	2.760E+05	2.760E+05	2.760E+05	2.760E+05
P-32	1.400E+09	8.730E+07	5.420E+07	0.000E+00	0.000E+00	0.000E+00	1.580E+08
CR-51	0.000E+00	0.000E+00	4.660E+04	2.790E+04	1.030E+04	6.190E+04	1.170E+07
MN-54	0.000E+00	3.110E+08	5.940E+07	0.000E+00	9.270E+07	0.000E+00	9.540E+08
MN-56	0.000E+00	1.610E+01	2.850E+00	0.000E+00	2.040E+01	0.000E+00	5.130E+02
FE-55	2.090E+08	1.450E+08	3.370E+07	0.000E+00	0.000E+00	8.060E+07	8.290E+07
FE-59	1.270E+08	2.990E+08	1.140E+08	0.000E+00	0.000E+00	8.350E+07	9.960E+08
CO-57	0.000E+00	1.170E+07	1.950E+07	0.000E+00	0.000E+00	0.000E+00	2.970E+08
CO-58	0.000E+00	3.090E+07	6.920E+07	0.000E+00	0.000E+00	0.000E+00	6.260E+08
CO-60	0.000E+00	1.670E+08	3.690E+08	0.000E+00	0.000E+00	0.000E+00	3.140E+09
NI-63	1.040E+10	7.210E+08	3.490E+08	0.000E+00	0.000E+00	0.000E+00	1.500E+08
NI-65	6.150E+01	7.990E+00	3.650E+00	0.000E+00	0.000E+00	0.000E+00	2.030E+02
CU-64	0.000E+00	9.270E+03	4.350E+03	0.000E+00	2.340E+04	0.000E+00	7.900E+05
ZN-65	3.170E+08	1.010E+09	4.560E+08	0.000E+00	6.750E+08	0.000E+00	6.360E+08
ZN-69	8.750E-06	1.670E-05	1.160E-06	0.000E+00	1.090E-05	0.000E+00	2.510E-06
BR-82	0.000E+00	0.000E+00	1.510E+06	0.000E+00	0.000E+00	0.000E+00	1.730E+06
BR-83	0.000E+00	0.000E+00	3.210E+00	0.000E+00	0.000E+00	0.000E+00	4.630E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.190E+08	1.020E+08	0.000E+00	0.000E+00	0.000E+00	4.320E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	9.960E+09	0.000E+00	2.860E+08	0.000E+00	0.000E+00	0.000E+00	1.600E+09
SR-90	6.050E+11	0.000E+00	1.480E+11	0.000E+00	0.000E+00	0.000E+00	1.750E+10
SR-91	3.200E+05	0.000E+00	1.290E+04	0.000E+00	0.000E+00	0.000E+00	1.520E+06
SR-92	4.270E+02	0.000E+00	1.850E+01	0.000E+00	0.000E+00	0.000E+00	8.460E+03
Y-90	1.330E+04	0.000E+00	3.560E+02	0.000E+00	0.000E+00	0.000E+00	1.410E+08
Y-91M	5.830E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.710E-08
Y-91	5.130E+06	0.000E+00	1.370E+05	0.000E+00	0.000E+00	0.000E+00	2.820E+09
Y-92	9.010E-01	0.000E+00	2.630E-02	0.000E+00	0.000E+00	0.000E+00	1.580E+04
Y-93	1.740E+02	0.000E+00	4.800E+00	0.000E+00	0.000E+00	0.000E+00	5.520E+06
ZR-95	1.190E+06	3.810E+05	2.580E+05	0.000E+00	5.970E+05	0.000E+00	1.210E+09
ZR-97	3.330E+02	6.730E+01	3.080E+01	0.000E+00	1.020E+02	0.000E+00	2.080E+07
NB-95	1.420E+05	7.910E+04	4.250E+04	0.000E+00	7.810E+04	0.000E+00	4.800E+08
NB-97	2.900E-06	7.340E-07	2.680E-07	0.000E+00	8.560E-07	0.000E+00	2.710E-03
MO-99	0.000E+00	6.250E+06	1.190E+06	0.000E+00	1.410E+07	0.000E+00	1.450E+07
TC-99M	3.060E+00	8.660E+00	1.100E+02	0.000E+00	1.320E+02	4.240E+00	5.120E+03
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	4.800E+06	0.000E+00	2.070E+06	0.000E+00	1.830E+07	0.000E+00	5.610E+08
RU-105	5.390E+01	0.000E+00	2.130E+01	0.000E+00	6.960E+02	0.000E+00	3.300E+04
RU-106	1.930E+08	0.000E+00	2.440E+07	0.000E+00	3.720E+08	0.000E+00	1.250E+10

ATTACHMENT 12

VEGETATION DOSE FACTORS

ADULT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	1.060E+07	9.760E+06	5.800E+06	0.000E+00	1.920E+07	0.000E+00	3.980E+09
SB-124	1.040E+08	1.960E+06	4.110E+07	2.520E+05	0.000E+00	8.080E+07	2.950E+09
SB-125	1.360E+08	1.520E+06	3.250E+07	1.390E+05	0.000E+00	1.050E+08	1.500E+09
TE-125M	9.660E+07	3.500E+07	1.290E+07	2.900E+07	3.930E+08	0.000E+00	3.860E+08
TE-127M	3.490E+08	1.250E+08	4.260E+07	8.920E+07	1.420E+09	0.000E+00	1.170E+09
TE-127	5.760E+03	2.070E+03	1.250E+03	4.270E+03	2.350E+04	0.000E+00	4.540E+05
TE-129M	2.550E+08	9.500E+07	4.030E+07	8.750E+07	1.060E+09	0.000E+00	1.280E+09
TE-129	6.650E-04	2.500E-04	1.620E-04	5.100E-04	2.790E-03	0.000E+00	5.020E-04
TE-131M	9.120E+05	4.460E+05	3.720E+05	7.060E+05	4.520E+06	0.000E+00	4.430E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	4.290E+06	2.770E+06	2.600E+06	3.060E+06	2.670E+07	0.000E+00	1.310E+08
I-130	3.960E+05	1.170E+06	4.610E+05	9.900E+07	1.820E+06	0.000E+00	1.010E+06
I-131	8.090E+07	1.160E+08	6.630E+07	3.790E+10	1.980E+08	0.000E+00	3.050E+07
I-132	5.740E+01	1.540E+02	5.380E+01	5.380E+03	2.450E+02	0.000E+00	2.890E+01
I-133	2.120E+06	3.690E+06	1.120E+06	5.420E+08	6.440E+06	0.000E+00	3.310E+06
I-134	1.060E-04	2.880E-04	1.030E-04	5.000E-03	4.590E-04	0.000E+00	2.510E-07
I-135	4.080E+04	1.070E+05	3.940E+04	7.040E+06	1.710E+05	0.000E+00	1.210E+05
CS-134	4.660E+09	1.110E+10	9.070E+09	0.000E+00	3.590E+09	1.190E+09	1.940E+08
CS-136	4.200E+07	1.660E+08	1.190E+08	0.000E+00	9.240E+07	1.270E+07	1.890E+07
CS-137	6.360E+09	8.700E+09	5.700E+09	0.000E+00	2.950E+09	9.810E+08	1.680E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	2.950E-02	2.100E-05	8.640E-04	0.000E+00	1.960E-05	1.190E-05	5.230E-02
BA-140	1.290E+08	1.620E+05	8.430E+06	0.000E+00	5.490E+04	9.250E+04	2.650E+08
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	1.970E+03	9.920E+02	2.620E+02	0.000E+00	0.000E+00	0.000E+00	7.280E+07
LA-142	1.400E-04	6.350E-05	1.580E-05	0.000E+00	0.000E+00	0.000E+00	4.640E-01
CE-141	1.960E+05	1.330E+05	1.510E+04	0.000E+00	6.170E+04	0.000E+00	5.080E+08
CE-143	1.000E+03	7.420E+05	8.210E+01	0.000E+00	3.260E+02	0.000E+00	2.770E+07
CE-144	3.290E+07	1.380E+07	1.770E+06	0.000E+00	8.160E+06	0.000E+00	1.110E+10
PR-143	6.340E+04	2.540E+04	3.140E+03	0.000E+00	1.470E+04	0.000E+00	2.780E+08
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	3.340E+04	3.860E+04	2.310E+03	0.000E+00	2.250E+04	0.000E+00	1.850E+08
W-187	3.820E+04	3.190E+04	1.120E+04	0.000E+00	0.000E+00	0.000E+00	1.050E+07
NP-239	1.420E+03	1.400E+02	7.720E+01	0.000E+00	4.370E+02	0.000E+00	2.870E+07

ATTACHMENT 12

VEGETATION DOSE FACTORS

TEEN

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	2.590E+03	2.590E+03	2.590E+03	2.590E+03	2.590E+03	2.590E+03
C-14	1.450E+06	2.910E+05	2.910E+05	2.910E+05	2.910E+05	2.910E+05	2.910E+05
NA-24	2.450E+05	2.450E+05	2.450E+05	2.450E+05	2.450E+05	2.450E+05	2.450E+05
P-32	1.610E+09	9.960E+07	6.230E+07	0.000E+00	0.000E+00	0.000E+00	1.350E+08
CR-51	0.000E+00	0.000E+00	6.200E+04	3.720E+04	1.360E+04	8.850E+04	1.040E+07
MN-54	0.000E+00	4.520E+08	8.970E+07	0.000E+00	1.350E+08	0.000E+00	9.270E+08
MN-56	0.000E+00	1.450E+01	2.580E+00	0.000E+00	1.830E+01	0.000E+00	9.540E+02
FE-55	3.250E+08	2.310E+08	5.380E+07	0.000E+00	0.000E+00	1.460E+08	9.980E+07
FE-59	1.810E+08	4.220E+08	1.630E+08	0.000E+00	0.000E+00	1.330E+08	9.980E+08
CO-57	0.000E+00	1.790E+07	3.000E+07	0.000E+00	0.000E+00	0.000E+00	3.340E+08
CO-58	0.000E+00	4.380E+07	1.010E+08	0.000E+00	0.000E+00	0.000E+00	6.040E+08
CO-60	0.000E+00	2.490E+08	5.600E+08	0.000E+00	0.000E+00	0.000E+00	3.240E+09
NI-63	1.610E+10	1.130E+09	5.450E+08	0.000E+00	0.000E+00	0.000E+00	1.810E+08
NI-65	5.730E+01	7.320E+00	3.330E+00	0.000E+00	0.000E+00	0.000E+00	3.970E+02
CU-64	0.000E+00	8.400E+03	3.950E+03	0.000E+00	2.120E+04	0.000E+00	6.510E+05
ZN-65	4.240E+08	1.470E+09	6.860E+08	0.000E+00	9.410E+08	0.000E+00	6.230E+08
ZN-69	8.190E-06	1.560E-05	1.090E-06	0.000E+00	1.020E-05	0.000E+00	2.880E-05
BR-82	0.000E+00	0.000E+00	1.330E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	3.010E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.730E+08	1.280E+08	0.000E+00	0.000E+00	0.000E+00	4.050E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	1.510E+10	0.000E+00	4.330E+08	0.000E+00	0.000E+00	0.000E+00	1.800E+09
SR-90	7.510E+11	0.000E+00	1.850E+11	0.000E+00	0.000E+00	0.000E+00	2.110E+10
SR-91	2.990E+05	0.000E+00	1.190E+04	0.000E+00	0.000E+00	0.000E+00	1.360E+06
SR-92	3.970E+02	0.000E+00	1.690E+01	0.000E+00	0.000E+00	0.000E+00	1.010E+04
Y-90	1.240E+04	0.000E+00	3.340E+02	0.000E+00	0.000E+00	0.000E+00	1.020E+08
Y-91M	5.430E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.560E-07
Y-91	7.870E+06	0.000E+00	2.110E+05	0.000E+00	0.000E+00	0.000E+00	3.230E+09
Y-92	8.470E-01	0.000E+00	2.450E-02	0.000E+00	0.000E+00	0.000E+00	2.320E+04
Y-93	1.630E+02	0.000E+00	4.470E+00	0.000E+00	0.000E+00	0.000E+00	4.980E+06
ZR-95	1.740E+06	5.490E+05	3.780E+05	0.000E+00	8.070E+05	0.000E+00	1.270E+09
ZR-97	3.090E+02	6.110E+01	2.810E+01	0.000E+00	9.260E+01	0.000E+00	1.650E+07
NB-95	1.920E+05	1.060E+05	5.860E+04	0.000E+00	1.030E+05	0.000E+00	4.550E+08
NB-97	2.690E-06	6.670E-07	2.440E-07	0.000E+00	7.800E-07	0.000E+00	1.590E-02
MO-99	0.000E+00	5.740E+06	1.090E+06	0.000E+00	1.310E+07	0.000E+00	1.030E+07
TC-99M	2.700E+00	7.540E+00	9.770E+01	0.000E+00	7.120E+02	4.190E+00	4.950E+03
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.000E+00	0.000E+00	0.000E+00
RU-103	6.870E+06	0.000E+00	2.940E+06	0.000E+00	2.420E+07	0.000E+00	5.740E+08
RU-105	5.000E+01	0.000E+00	1.940E+01	0.000E+00	1.310E+02	0.000E+00	4.040E+04
RU-106	3.090E+08	0.000E+00	3.900E+07	0.000E+00	5.970E+08	0.000E+00	1.480E+10

ATTACHMENT 12

VEGETATION DOSE FACTORS

TEEN

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	1.520E+07	1.440E+07	8.740E+06	0.000E+00	2.740E+07	0.000E+00	4.040E+09
SB-124	1.550E+08	2.850E+06	6.030E+07	3.510E+05	0.000E+00	1.350E+08	3.110E+09
SB-125	2.140E+08	2.340E+06	5.000E+07	2.040E+05	0.000E+00	1.880E+08	1.660E+09
TE-125M	1.480E+08	5.340E+07	1.980E+07	4.140E+07	0.000E+00	0.000E+00	4.370E+08
TE-127M	5.510E+08	1.960E+08	6.560E+07	1.310E+08	2.240E+09	0.000E+00	1.370E+09
TE-127	5.430E+03	1.920E+03	1.170E+03	3.740E+03	2.200E+04	0.000E+00	4.190E+05
TE-129M	3.670E+08	1.360E+08	5.810E+07	1.180E+08	1.540E+09	0.000E+00	1.380E+09
TE-129	6.220E-04	2.320E-04	1.510E-04	4.450E-04	2.610E-03	0.000E+00	3.400E-03
TE-131M	8.440E+05	4.050E+05	3.380E+05	6.090E+05	4.220E+06	0.000E+00	3.250E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	3.900E+06	2.470E+06	2.320E+06	2.600E+06	2.370E+07	0.000E+00	7.820E+07
I-130	3.540E+05	1.020E+06	4.090E+05	8.350E+07	1.580E+06	0.000E+00	7.870E+05
I-131	7.700E+07	1.080E+08	5.790E+07	3.140E+10	1.850E+08	0.000E+00	2.130E+07
I-132	5.180E+01	1.360E+02	4.870E+01	4.570E+03	2.140E+02	0.000E+00	5.910E+01
I-133	1.970E+06	3.340E+06	1.020E+06	4.660E+08	5.860E+06	0.000E+00	2.530E+06
I-134	9.590E-05	2.540E-04	9.130E-05	4.240E-03	4.010E-04	0.000E+00	3.350E-06
I-135	3.680E+04	9.480E+04	3.520E+04	6.100E+06	1.500E+05	0.000E+00	1.050E+05
CS-134	7.090E+09	1.670E+10	7.740E+09	0.000E+00	5.300E+09	2.020E+09	2.080E+08
CS-136	4.290E+07	1.690E+08	1.130E+08	0.000E+00	9.190E+07	1.450E+07	1.360E+07
CS-137	1.010E+10	1.350E+10	4.690E+09	0.000E+00	4.590E+09	1.780E+09	1.920E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	2.770E-02	1.950E-05	8.080E-04	0.000E+00	1.840E-05	1.340E-05	2.470E-01
BA-140	1.380E+08	1.690E+05	8.910E+06	0.000E+00	5.750E+04	1.140E+05	2.130E+08
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	1.800E+03	8.840E+02	2.350E+02	0.000E+00	0.000E+00	0.000E+00	5.080E+07
LA-142	1.280E-04	5.690E-05	1.420E-05	0.000E+00	0.000E+00	0.000E+00	1.730E+00
CE-141	2.820E+05	1.880E+05	2.160E+04	0.000E+00	8.860E+04	0.000E+00	5.380E+08
CE-143	9.370E+02	6.820E+05	7.620E+01	0.000E+00	3.060E+02	0.000E+00	2.050E+07
CE-144	5.270E+07	2.180E+07	2.830E+06	0.000E+00	1.300E+07	0.000E+00	1.330E+10
PR-143	7.120E+04	2.840E+04	3.550E+03	0.000E+00	1.650E+04	0.000E+00	2.340E+08
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	3.630E+04	3.940E+04	2.360E+03	0.000E+00	2.320E+04	0.000E+00	1.420E+08
W-187	3.550E+04	2.900E+04	1.020E+04	0.000E+00	0.000E+00	0.000E+00	7.840E+06
NP-239	1.380E+03	1.300E+02	7.240E+01	0.000E+00	4.090E+02	0.000E+00	2.100E+07

ATTACHMENT 12

VEGETATION DOSE FACTORS

CHILD

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	4.010E+03	4.010E+03	4.010E+03	4.010E+03	4.010E+03	4.010E+03
C-14	3.500E+06	7.010E+05	7.010E+05	7.010E+05	7.010E+05	7.010E+05	7.010E+05
NA-24	3.830E+05	3.830E+05	3.830E+05	3.830E+05	3.830E+05	3.830E+05	3.830E+05
P-32	3.370E+09	1.580E+08	1.300E+08	0.000E+00	0.000E+00	0.000E+00	9.300E+07
CR-51	0.000E+00	0.000E+00	1.180E+05	6.540E+04	1.790E+04	1.190E+05	6.250E+06
MN-54	0.000E+00	6.610E+08	1.760E+08	0.000E+00	1.850E+08	0.000E+00	5.550E+08
MN-56	0.000E+00	1.900E+01	4.280E+00	0.000E+00	2.290E+01	0.000E+00	2.750E+03
FE-55	8.000E+08	4.240E+08	1.310E+08	0.000E+00	0.000E+00	2.400E+08	7.860E+07
FE-59	4.010E+08	6.490E+08	3.230E+08	0.000E+00	0.000E+00	1.880E+08	6.760E+08
CO-57	0.000E+00	2.990E+07	6.040E+07	0.000E+00	0.000E+00	0.000E+00	2.450E+08
CO-58	0.000E+00	6.470E+07	1.980E+08	0.000E+00	0.000E+00	0.000E+00	3.770E+08
CO-60	0.000E+00	3.780E+08	1.120E+09	0.000E+00	0.000E+00	0.000E+00	2.100E+09
NI-63	3.950E+10	2.110E+09	1.340E+09	0.000E+00	0.000E+00	0.000E+00	1.420E+08
NI-65	1.050E+02	9.890E+00	5.770E+00	0.000E+00	0.000E+00	0.000E+00	1.210E+03
CU-64	0.000E+00	1.110E+04	6.690E+03	0.000E+00	2.680E+04	0.000E+00	5.200E+05
ZN-65	8.120E+08	2.160E+09	1.350E+09	0.000E+00	1.360E+09	0.000E+00	3.800E+08
ZN-69	1.510E-05	2.180E-05	2.020E-06	0.000E+00	1.320E-05	0.000E+00	1.380E-03
BR-82	0.000E+00	0.000E+00	2.040E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	5.550E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.520E+08	2.780E+08	0.000E+00	0.000E+00	0.000E+00	2.910E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.590E+10	0.000E+00	1.030E+09	0.000E+00	0.000E+00	0.000E+00	1.390E+09
SR-90	1.240E+12	0.000E+00	3.150E+11	0.000E+00	0.000E+00	0.000E+00	1.670E+10
SR-91	5.500E+05	0.000E+00	2.080E+04	0.000E+00	0.000E+00	0.000E+00	1.210E+06
SR-92	7.280E+02	0.000E+00	2.920E+01	0.000E+00	0.000E+00	0.000E+00	1.380E+04
Y-90	2.300E+04	0.000E+00	6.170E+02	0.000E+00	0.000E+00	0.000E+00	6.560E+07
Y-91M	9.940E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.950E-05
Y-91	1.870E+07	0.000E+00	5.010E+05	0.000E+00	0.000E+00	0.000E+00	2.490E+09
Y-92	1.560E+00	0.000E+00	4.460E-02	0.000E+00	0.000E+00	0.000E+00	4.510E+04
Y-93	3.010E+02	0.000E+00	8.250E+00	0.000E+00	0.000E+00	0.000E+00	4.480E+06
ZR-95	3.900E+06	8.580E+05	7.640E+05	0.000E+00	1.230E+06	0.000E+00	8.950E+08
ZR-97	5.640E+02	8.150E+01	4.810E+01	0.000E+00	1.170E+02	0.000E+00	1.230E+07
NB-95	4.100E+05	1.590E+05	1.140E+05	0.000E+00	1.500E+05	0.000E+00	2.950E+08
NB-97	4.900E-06	8.850E-07	4.130E-07	0.000E+00	9.820E-07	0.000E+00	2.730E-01
MO-99	0.000E+00	7.830E+06	1.940E+06	0.000E+00	1.670E+07	0.000E+00	6.480E+06
TC-99M	4.650E+00	9.120E+00	1.510E+02	0.000E+00	1.330E+02	4.630E+00	5.190E+03
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.550E+07	0.000E+00	5.940E+06	0.000E+00	3.890E+07	0.000E+00	3.990E+08
RU-105	9.170E+01	0.000E+00	3.330E+01	0.000E+00	8.060E+02	0.000E+00	5.980E+04
RU-106	7.450E+08	0.000E+00	9.300E+07	0.000E+00	1.010E+09	0.000E+00	1.160E+10

ATTACHMENT 12

VEGETATION DOSE FACTORS

CHILD

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	3.220E+07	2.170E+07	1.740E+07	0.000E+00	4.050E+07	0.000E+00	2.580E+09
SB-124	3.520E+08	4.570E+06	1.230E+08	7.780E+05	0.000E+00	1.960E+08	2.200E+09
SB-125	4.990E+08	3.850E+06	1.050E+08	4.620E+05	0.000E+00	2.780E+08	1.190E+09
TE-125M	3.510E+08	9.500E+07	4.670E+07	9.840E+07	0.000E+00	0.000E+00	3.380E+08
TE-127M	1.320E+09	3.560E+08	1.570E+08	3.160E+08	3.770E+09	0.000E+00	1.070E+09
TE-127	1.000E+04	2.700E+03	2.150E+03	6.930E+03	2.850E+04	0.000E+00	3.910E+05
TE-129M	8.540E+08	2.390E+08	1.330E+08	2.750E+08	2.510E+09	0.000E+00	1.040E+09
TE-129	1.150E-03	3.220E-04	2.740E-04	8.220E-04	3.370E-03	0.000E+00	7.170E-02
TE-131M	1.540E+06	5.330E+05	5.680E+05	1.100E+06	5.160E+06	0.000E+00	2.160E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	6.980E+06	3.090E+06	3.730E+06	4.500E+06	2.870E+07	0.000E+00	3.110E+07
I-130	6.210E+05	1.260E+06	6.470E+05	1.380E+08	1.880E+06	0.000E+00	5.870E+05
I-131	1.430E+08	1.440E+08	8.180E+07	4.760E+10	2.360E+08	0.000E+00	1.280E+07
I-132	9.200E+01	1.690E+02	7.770E+01	7.840E+03	2.590E+02	0.000E+00	1.990E+02
I-133	3.590E+06	4.440E+06	1.680E+06	8.250E+08	7.400E+06	0.000E+00	790E+06
I-134	1.700E-04	3.160E-04	1.460E-04	7.280E-03	4.840E-04	0.000E+0	400E-04
I-135	6.540E+04	1.180E+05	5.570E+04	1.040E+07	1.810E+05	0.000E+0	8.980E+04
CS-134	1.600E+10	2.630E+10	5.540E+09	0.000E+00	8.140E+09	2.920E+09	1.420E+08
CS-136	8.060E+07	2.220E+08	1.430E+08	0.000E+00	1.180E+08	1.760E+07	7.790E+06
CS-137	2.390E+10	2.290E+10	3.380E+09	0.000E+00	7.460E+09	2.680E+09	1.430E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	5.110E-02	2.730E-05	1.480E-03	0.000E+00	2.380E-05	1.610E-05	2.950E+00
BA-140	2.770E+08	2.430E+05	1.620E+07	0.000E+00	7.900E+04	1.450E+05	1.400E+08
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	3.230E+03	1.130E+03	3.810E+02	0.000E+00	0.000E+00	0.000E+00	3.150E+07
LA-142	2.320E-04	7.400E-05	2.320E-05	0.000E+00	0.000E+00	0.000E+00	1.470E+01
CE-141	6.350E+05	3.260E+05	4.840E+04	0.000E+00	1.430E+05	0.000E+00	4.070E+08
CE-143	1.730E+03	9.360E+05	1.360E+02	0.000E+00	3.930E+02	0.000E+00	1.370E+07
CE-144	1.270E+08	3.980E+07	6.780E+06	0.000E+00	2.210E+07	0.000E+00	1.040E+10
PR-143	1.480E+05	4.460E+04	7.370E+03	0.000E+00	2.410E+04	0.000E+00	1.500E+08
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	7.160E+04	5.800E+04	4.490E+03	0.000E+00	3.180E+04	0.000E+00	9.180E+07
W-187	6.470E+04	3.830E+04	1.720E+04	0.000E+00	0.000E+00	0.000E+00	5.380E+06
NP-239	2.550E+03	1.830E+02	1.290E+02	0.000E+00	5.300E+02	0.000E+00	1.360E+07

ATTACHMENT 12

VEGETATION DOSE FACTORS

INFANT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract

ATTACHMENT 12

VEGETATION DOSE FACTORS

INFANT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract

ATTACHMENT 12

GROUND PLANE DOSE FACTORS

ADULT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract

ATTACHMENT 12

GROUND PLANE DOSE FACTORS

ADULT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract

ATTACHMENT 12

GROUND PLANE DOSE FACTORS

TEEN

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.210E+07	1.210E+07	1.210E+07	1.210E+07	1.210E+07	1.210E+07	1.210E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.680E+06	4.680E+06	4.680E+06	4.680E+06	4.680E+06	4.680E+06	4.680E+06
MN-54	1.340E+09	1.340E+09	1.340E+09	1.340E+09	1.340E+09	1.340E+09	1.340E+09
MN-56	9.050E+05	9.050E+05	9.050E+05	9.050E+05	9.050E+05	9.050E+05	9.050E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.750E+08	2.750E+08	2.750E+08	2.750E+08	2.750E+08	2.750E+08	2.750E+08
CO-58	3.820E+08	3.820E+08	3.820E+08	3.820E+08	3.820E+08	3.820E+08	3.820E+08
CO-60	2.160E+10	2.160E+10	2.160E+10	2.160E+10	2.160E+10	2.160E+10	2.160E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05
CU-64	6.090E+05	6.090E+05	6.090E+05	6.090E+05	6.090E+05	6.090E+05	6.090E+05
ZN-65	7.450E+08	7.450E+08	7.450E+08	7.450E+08	7.450E+08	7.450E+08	7.450E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.890E+03	4.890E+03	4.890E+03	4.890E+03	4.890E+03	4.890E+03	4.890E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.980E+06	8.980E+06	8.980E+06	8.980E+06	8.980E+06	8.980E+06	8.980E+06
RB-88	3.290E+04	3.290E+04	3.290E+04	3.290E+04	3.290E+04	3.290E+04	3.290E+04
RB-89	1.210E+05	1.210E+05	1.210E+05	1.210E+05	1.210E+05	1.210E+05	1.210E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.190E+06	2.190E+06	2.190E+06	2.190E+06	2.190E+06	2.190E+06	2.190E+06
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05
Y-90	4.480E+03	4.480E+03	4.480E+03	4.480E+03	4.480E+03	4.480E+03	4.480E+03
Y-91M	1.010E+05	1.010E+05	1.010E+05	1.010E+05	1.010E+05	1.010E+05	1.010E+05
Y-91	1.080E+06	1.080E+06	1.080E+06	1.080E+06	1.080E+06	1.080E+06	1.080E+06
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05
Y-93	1.850E+05	1.850E+05	1.850E+05	1.850E+05	1.850E+05	1.850E+05	1.850E+05
ZR-95	2.480E+08	2.480E+08	2.480E+08	2.480E+08	2.480E+08	2.480E+08	2.480E+08
ZR-97	2.940E+06	2.940E+06	2.940E+06	2.940E+06	2.940E+06	2.940E+06	2.940E+06
NB-95	1.360E+08	1.360E+08	1.360E+08	1.360E+08	1.360E+08	1.360E+08	1.360E+08
MO-99	4.050E+06	4.050E+06	4.050E+06	4.050E+06	4.050E+06	4.050E+06	4.050E+06
TC-99M	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04
RU-103	1.090E+08	1.090E+08	1.090E+08	1.090E+08	1.090E+08	1.090E+08	1.090E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05
RU-106	4.210E+08	4.210E+08	4.210E+08	4.210E+08	4.210E+08	4.210E+08	4.210E+08
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	3.470E+09	3.470E+09	3.470E+09	3.470E+09	3.470E+09	3.470E+09	3.470E+09

ATTACHMENT 12

GROUND PLANE DOSE FACTORS

TEEN

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06
TE-127M	9.170E+04	9.170E+04	9.170E+04	9.170E+04	9.170E+04	9.170E+04	9.170E+04
TE-127	3.000E+03	3.000E+03	3.000E+03	3.000E+03	3.000E+03	3.000E+03	3.000E+03
TE-129M	2.000E+07	2.000E+07	2.000E+07	2.000E+07	2.000E+07	2.000E+07	2.000E+07
TE-129	2.600E+04	2.600E+04	2.600E+04	2.600E+04	2.600E+04	2.600E+04	2.600E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06
TE-131	2.930E+04	2.930E+04	2.930E+04	2.930E+04	2.930E+04	2.930E+04	2.930E+04
TE-132	4.220E+06	4.220E+06	4.220E+06	4.220E+06	4.220E+06	4.220E+06	4.220E+06
I-130	5.530E+06	5.530E+06	5.530E+06	5.530E+06	5.530E+06	5.530E+06	5.530E+06
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07
I-132	1.240E+06	1.240E+06	1.240E+06	1.240E+06	1.240E+06	1.240E+06	1.240E+06
I-133	2.470E+06	2.470E+06	2.470E+06	2.470E+06	2.470E+06	2.470E+06	2.470E+06
I-134	4.490E+05	4.490E+05	4.490E+05	4.490E+05	4.490E+05	4.490E+05	4.490E+05
I-135	2.560E+06	2.560E+06	2.560E+06	2.560E+06	2.560E+06	2.560E+06	2.560E+06
CS-134	6.750E+09	6.750E+09	6.750E+09	6.750E+09	6.750E+09	6.750E+09	6.750E+09
CS-136	1.490E+08	1.490E+08	1.490E+08	1.490E+08	1.490E+08	1.490E+08	1.490E+08
CS-137	1.040E+10	1.040E+10	1.040E+10	1.040E+10	1.040E+10	1.040E+10	1.040E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07
BA-141	4.180E+04	4.180E+04	4.180E+04	4.180E+04	4.180E+04	4.180E+04	4.180E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04
LA-140	1.910E+07	1.910E+07	1.910E+07	1.910E+07	1.910E+07	1.910E+07	1.910E+07
LA-142	7.360E+05	7.360E+05	7.360E+05	7.360E+05	7.360E+05	7.360E+05	7.360E+05
CE-141	1.360E+07	1.360E+07	1.360E+07	1.360E+07	1.360E+07	1.360E+07	1.360E+07
CE-143	2.320E+06	2.320E+06	2.320E+06	2.320E+06	2.320E+06	2.320E+06	2.320E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03
ND-147	8.400E+06	8.400E+06	8.400E+06	8.400E+06	8.400E+06	8.400E+06	8.400E+06
W-187	2.360E+06	2.360E+06	2.360E+06	2.360E+06	2.360E+06	2.360E+06	2.360E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06

ATTACHMENT 12

GROUND PLANE DOSE FACTORS

CHILD

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.210E+07	1.210E+07	1.210E+07	1.210E+07	1.210E+07	1.210E+07	1.210E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.680E+06	4.680E+06	4.680E+06	4.680E+06	4.680E+06	4.680E+06	4.680E+06
MN-54	1.340E+09	1.340E+09	1.340E+09	1.340E+09	1.340E+09	1.340E+09	1.340E+09
MN-56	9.050E+05	9.050E+05	9.050E+05	9.050E+05	9.050E+05	9.050E+05	9.050E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.750E+08	2.750E+08	2.750E+08	2.750E+08	2.750E+08	2.750E+08	2.750E+08
CO-58	3.820E+08	3.820E+08	3.820E+08	3.820E+08	3.820E+08	3.820E+08	3.820E+08
CO-60	2.160E+10	2.160E+10	2.160E+10	2.160E+10	2.160E+10	2.160E+10	2.160E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05
CU-64	6.090E+05	6.090E+05	6.090E+05	6.090E+05	6.090E+05	6.090E+05	6.090E+05
ZN-65	7.450E+08	7.450E+08	7.450E+08	7.450E+08	7.450E+08	7.450E+08	7.450E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.890E+03	4.890E+03	4.890E+03	4.890E+03	4.890E+03	4.890E+03	4.890E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.980E+06	8.980E+06	8.980E+06	8.980E+06	8.980E+06	8.980E+06	8.980E+06
RB-88	3.290E+04	3.290E+04	3.290E+04	3.290E+04	3.290E+04	3.290E+04	3.290E+04
RB-89	1.210E+05	1.210E+05	1.210E+05	1.210E+05	1.210E+05	1.210E+05	1.210E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.190E+06	2.190E+06	2.190E+06	2.190E+06	2.190E+06	2.190E+06	2.190E+06
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05
Y-90	4.480E+03	4.480E+03	4.480E+03	4.480E+03	4.480E+03	4.480E+03	4.480E+03
Y-91M	1.010E+05	1.010E+05	1.010E+05	1.010E+05	1.010E+05	1.010E+05	1.010E+05
Y-91	1.080E+06	1.080E+06	1.080E+06	1.080E+06	1.080E+06	1.080E+06	1.080E+06
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05
Y-93	1.850E+05	1.850E+05	1.850E+05	1.850E+05	1.850E+05	1.850E+05	1.850E+05
ZR-95	2.480E+08	2.480E+08	2.480E+08	2.480E+08	2.480E+08	2.480E+08	2.480E+08
ZR-97	2.940E+06	2.940E+06	2.940E+06	2.940E+06	2.940E+06	2.940E+06	2.940E+06
NB-95	1.360E+08	1.360E+08	1.360E+08	1.360E+08	1.360E+08	1.360E+08	1.360E+08
MO-99	4.050E+06	4.050E+06	4.050E+06	4.050E+06	4.050E+06	4.050E+06	4.050E+06
TC-99M	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04
RU-103	1.090E+08	1.090E+08	1.090E+08	1.090E+08	1.090E+08	1.090E+08	1.090E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05
RU-106	4.210E+08	4.210E+08	4.210E+08	4.210E+08	4.210E+08	4.210E+08	4.210E+08
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	3.470E+09	3.470E+09	3.470E+09	3.470E+09	3.470E+09	3.470E+09	3.470E+09

ATTACHMENT 12

GROUND PLANE DOSE FACTORS

CHILD

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06
TE-127M	9.170E+04	9.170E+04	9.170E+04	9.170E+04	9.170E+04	9.170E+04	9.170E+04
TE-127	3.000E+03	3.000E+03	3.000E+03	3.000E+03	3.000E+03	3.000E+03	3.000E+03
TE-129M	2.000E+07	2.000E+07	2.000E+07	2.000E+07	2.000E+07	2.000E+07	2.000E+07
TE-129	2.600E+04	2.600E+04	2.600E+04	2.600E+04	2.600E+04	2.600E+04	2.600E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06
TE-131	2.930E+04	2.930E+04	2.930E+04	2.930E+04	2.930E+04	2.930E+04	2.930E+04
TE-132	4.220E+06	4.220E+06	4.220E+06	4.220E+06	4.220E+06	4.220E+06	4.220E+06
I-130	5.530E+06	5.530E+06	5.530E+06	5.530E+06	5.530E+06	5.530E+06	5.530E+06
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07
I-132	1.240E+06	1.240E+06	1.240E+06	1.240E+06	1.240E+06	1.240E+06	1.240E+06
I-133	2.470E+06	2.470E+06	2.470E+06	2.470E+06	2.470E+06	2.470E+06	2.470E+06
I-134	4.490E+05	4.490E+05	4.490E+05	4.490E+05	4.490E+05	4.490E+05	4.490E+05
I-135	2.560E+06	2.560E+06	2.560E+06	2.560E+06	2.560E+06	2.560E+06	2.560E+06
CS-134	6.750E+09	6.750E+09	6.750E+09	6.750E+09	6.750E+09	6.750E+09	6.750E+09
CS-136	1.490E+08	1.490E+08	1.490E+08	1.490E+08	1.490E+08	1.490E+08	1.490E+08
CS-137	1.040E+10	1.040E+10	1.040E+10	1.040E+10	1.040E+10	1.040E+10	1.040E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07
BA-141	4.180E+04	4.180E+04	4.180E+04	4.180E+04	4.180E+04	4.180E+04	4.180E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04
LA-140	1.910E+07	1.910E+07	1.910E+07	1.910E+07	1.910E+07	1.910E+07	1.910E+07
LA-142	7.360E+05	7.360E+05	7.360E+05	7.360E+05	7.360E+05	7.360E+05	7.360E+05
CE-141	1.360E+07	1.360E+07	1.360E+07	1.360E+07	1.360E+07	1.360E+07	1.360E+07
CE-143	2.320E+06	2.320E+06	2.320E+06	2.320E+06	2.320E+06	2.320E+06	2.320E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03
ND-147	8.400E+06	8.400E+06	8.400E+06	8.400E+06	8.400E+06	8.400E+06	8.400E+06
W-187	2.360E+06	2.360E+06	2.360E+06	2.360E+06	2.360E+06	2.360E+06	2.360E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06

ATTACHMENT 12

GROUND PLANE DOSE FACTORS

INFANT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.210E+07	1.210E+07	1.210E+07	1.210E+07	1.210E+07	1.210E+07	1.210E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.680E+06	4.680E+06	4.680E+06	4.680E+06	4.680E+06	4.680E+06	4.680E+06
MN-54	1.340E+09	1.340E+09	1.340E+09	1.340E+09	1.340E+09	1.340E+09	1.340E+09
MN-56	9.050E+05	9.050E+05	9.050E+05	9.050E+05	9.050E+05	9.050E+05	9.050E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.750E+08	2.750E+08	2.750E+08	2.750E+08	2.750E+08	2.750E+08	2.750E+08
CO-58	3.820E+08	3.820E+08	3.820E+08	3.820E+08	3.820E+08	3.820E+08	3.820E+08
CO-60	2.160E+10	2.160E+10	2.160E+10	2.160E+10	2.160E+10	2.160E+10	2.160E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05
CU-64	6.090E+05	6.090E+05	6.090E+05	6.090E+05	6.090E+05	6.090E+05	6.090E+05
ZN-65	7.450E+08	7.450E+08	7.450E+08	7.450E+08	7.450E+08	7.450E+08	7.450E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.890E+03	4.890E+03	4.890E+03	4.890E+03	4.890E+03	4.890E+03	4.890E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.980E+06	8.980E+06	8.980E+06	8.980E+06	8.980E+06	8.980E+06	8.980E+06
RB-88	3.290E+04	3.290E+04	3.290E+04	3.290E+04	3.290E+04	3.290E+04	3.290E+04
RB-89	1.210E+05	1.210E+05	1.210E+05	1.210E+05	1.210E+05	1.210E+05	1.210E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.190E+06	2.190E+06	2.190E+06	2.190E+06	2.190E+06	2.190E+06	2.190E+06
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05
Y-90	4.480E+03	4.480E+03	4.480E+03	4.480E+03	4.480E+03	4.480E+03	4.480E+03
Y-91M	1.010E+05	1.010E+05	1.010E+05	1.010E+05	1.010E+05	1.010E+05	1.010E+05
Y-91	1.080E+06	1.080E+06	1.080E+06	1.080E+06	1.080E+06	1.080E+06	1.080E+06
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05
Y-93	1.850E+05	1.850E+05	1.850E+05	1.850E+05	1.850E+05	1.850E+05	1.850E+05
ZR-95	2.480E+08	2.480E+08	2.480E+08	2.480E+08	2.480E+08	2.480E+08	2.480E+08
ZR-97	2.940E+06	2.940E+06	2.940E+06	2.940E+06	2.940E+06	2.940E+06	2.940E+06
NB-95	1.360E+08	1.360E+08	1.360E+08	1.360E+08	1.360E+08	1.360E+08	1.360E+08
MO-99	4.050E+06	4.050E+06	4.050E+06	4.050E+06	4.050E+06	4.050E+06	4.050E+06
TC-99M	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04
RU-103	1.090E+08	1.090E+08	1.090E+08	1.090E+08	1.090E+08	1.090E+08	1.090E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05
RU-106	4.210E+08	4.210E+08	4.210E+08	4.210E+08	4.210E+08	4.210E+08	4.210E+08
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	3.470E+09	3.470E+09	3.470E+09	3.470E+09	3.470E+09	3.470E+09	3.470E+09

ATTACHMENT 12

GROUND PLANE DOSE FACTORS

INFANT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06
TE-127M	9.170E+04	9.170E+04	9.170E+04	9.170E+04	9.170E+04	9.170E+04	9.170E+04
TE-127	3.000E+03	3.000E+03	3.000E+03	3.000E+03	3.000E+03	3.000E+03	3.000E+03
TE-129M	2.000E+07	2.000E+07	2.000E+07	2.000E+07	2.000E+07	2.000E+07	2.000E+07
TE-129	2.600E+04	2.600E+04	2.600E+04	2.600E+04	2.600E+04	2.600E+04	2.600E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06
TE-131	2.930E+04	2.930E+04	2.930E+04	2.930E+04	2.930E+04	2.930E+04	2.930E+04
TE-132	4.220E+06	4.220E+06	4.220E+06	4.220E+06	4.220E+06	4.220E+06	4.220E+06
I-130	5.530E+06	5.530E+06	5.530E+06	5.530E+06	5.530E+06	5.530E+06	5.530E+06
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07
I-132	1.240E+06	1.240E+06	1.240E+06	1.240E+06	1.240E+06	1.240E+06	1.240E+06
I-133	2.470E+06	2.470E+06	2.470E+06	2.470E+06	2.470E+06	2.470E+06	2.470E+06
I-134	4.490E+05	4.490E+05	4.490E+05	4.490E+05	4.490E+05	4.490E+05	4.490E+05
I-135	2.560E+06	2.560E+06	2.560E+06	2.560E+06	2.560E+06	2.560E+06	2.560E+06
CS-134	6.750E+09	6.750E+09	6.750E+09	6.750E+09	6.750E+09	6.750E+09	6.750E+09
CS-136	1.490E+08	1.490E+08	1.490E+08	1.490E+08	1.490E+08	1.490E+08	1.490E+08
CS-137	1.040E+10	1.040E+10	1.040E+10	1.040E+10	1.040E+10	1.040E+10	1.040E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07
BA-141	4.180E+04	4.180E+04	4.180E+04	4.180E+04	4.180E+04	4.180E+04	4.180E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04
LA-140	1.910E+07	1.910E+07	1.910E+07	1.910E+07	1.910E+07	1.910E+07	1.910E+07
LA-142	7.360E+05	7.360E+05	7.360E+05	7.360E+05	7.360E+05	7.360E+05	7.360E+05
CE-141	1.360E+07	1.360E+07	1.360E+07	1.360E+07	1.360E+07	1.360E+07	1.360E+07
CE-143	2.320E+06	2.320E+06	2.320E+06	2.320E+06	2.320E+06	2.320E+06	2.320E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03
ND-147	8.400E+06	8.400E+06	8.400E+06	8.400E+06	8.400E+06	8.400E+06	8.400E+06
W-187	2.360E+06	2.360E+06	2.360E+06	2.360E+06	2.360E+06	2.360E+06	2.360E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06

ATTACHMENT 12

INHALATION DOSE FACTORS

ADULT

(mrem/yr per uCi/m^3)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	1.260E+03	1.260E+03	1.260E+03	1.260E+03	1.260E+03	1.260E+03
C-14	1.820E+04	3.410E+03	3.410E+03	3.410E+03	3.410E+03	3.410E+03	3.410E+03
NA-24	1.020E+04	1.020E+04	1.020E+04	1.020E+04	1.020E+04	1.020E+04	1.020E+04
P-32	1.320E+06	7.710E+04	5.010E+04	0.000E+00	0.000E+00	0.000E+00	8.640E+04
CR-51	0.000E+00	0.000E+00	1.000E+02	5.950E+01	2.280E+01	1.440E+04	3.320E+03
MN-54	0.000E+00	3.960E+04	6.300E+03	0.000E+00	9.840E+03	1.400E+06	7.740E+04
MN-56	0.000E+00	1.240E+00	1.830E-01	0.000E+00	1.300E+00	9.440E+03	2.020E+04
FE-55	2.460E+04	1.700E+04	3.940E+03	0.000E+00	0.000E+00	7.210E+04	6.030E+03
FE-59	1.180E+04	2.780E+04	1.060E+04	0.000E+00	0.000E+00	1.020E+06	1.880E+05
CO-57	0.000E+00	6.920E+02	6.710E+02	0.000E+00	0.000E+00	3.700E+05	3.140E+04
CO-58	0.000E+00	1.580E+03	2.070E+03	0.000E+00	0.000E+00	9.280E+05	1.060E+05
CO-60	0.000E+00	1.150E+04	1.480E+04	0.000E+00	0.000E+00	5.970E+06	2.850E+05
NI-63	4.320E+05	3.140E+04	1.450E+04	0.000E+00	0.000E+00	1.780E+05	1.340E+04
NI-65	1.540E+00	2.100E-01	9.120E-02	0.000E+00	0.000E+00	5.600E+03	1.230E+04
CU-64	0.000E+00	1.460E+00	6.150E-01	0.000E+00	4.620E+00	6.780E+03	4.900E+04
ZN-65	3.240E+04	1.030E+05	4.660E+04	0.000E+00	6.900E+04	8.640E+05	5.340E+04
ZN-69	3.380E-02	6.510E-02	4.520E-03	0.000E+00	4.220E-02	9.200E+02	1.630E+01
BR-82	0.000E+00	0.000E+00	1.350E+04	0.000E+00	0.000E+00	0.000E+00	1.040E+04
BR-83	0.000E+00	0.000E+00	2.410E+02	0.000E+00	0.000E+00	0.000E+00	2.320E+02
BR-84	0.000E+00	0.000E+00	3.130E+02	0.000E+00	0.000E+00	0.000E+00	1.640E-03
BR-85	0.000E+00	0.000E+00	1.280E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.350E+05	5.900E+04	0.000E+00	0.000E+00	0.000E+00	1.660E+04
RB-88	0.000E+00	3.870E+02	1.930E+02	0.000E+00	0.000E+00	0.000E+00	3.340E-09
RB-89	0.000E+00	2.560E+02	1.700E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.040E+05	0.000E+00	8.720E+03	0.000E+00	0.000E+00	1.400E+06	3.500E+05
SR-90	9.920E+07	0.000E+00	6.100E+06	0.000E+00	0.000E+00	9.600E+06	7.220E+05
SR-91	6.190E+01	0.000E+00	2.500E+00	0.000E+00	0.000E+00	3.650E+04	1.910E+05
SR-92	6.740E+00	0.000E+00	2.910E-01	0.000E+00	0.000E+00	1.650E+04	4.300E+04
Y-90	2.090E+03	0.000E+00	5.610E+01	0.000E+00	0.000E+00	1.700E+05	5.060E+05
Y-91M	2.610E-01	0.000E+00	1.020E-02	0.000E+00	0.000E+00	1.920E+03	1.330E+00
Y-91	4.620E+05	0.000E+00	1.240E+04	0.000E+00	0.000E+00	1.700E+06	3.850E+05
Y-92	1.030E+01	0.000E+00	3.020E-01	0.000E+00	0.000E+00	1.570E+04	7.350E+04
Y-93	9.440E+01	0.000E+00	2.610E+00	0.000E+00	0.000E+00	4.850E+04	4.220E+05
ZR-95	1.070E+05	3.440E+04	2.330E+04	0.000E+00	5.420E+04	1.770E+06	1.500E+05
ZR-97	9.680E+01	1.960E+01	9.040E+00	0.000E+00	2.970E+01	7.870E+04	5.230E+05
NB-95	1.410E+04	7.820E+03	4.210E+03	0.000E+00	7.740E+03	5.050E+05	1.040E+05
NB-97	2.220E-01	5.620E-02	2.050E-02	0.000E+00	6.540E-02	2.400E+03	2.420E+02
MO-99	0.000E+00	1.210E+02	2.300E+01	0.000E+00	2.910E+02	9.120E+04	2.480E+05
TC-99M	1.030E-03	2.910E-03	3.700E-02	0.000E+00	4.420E-02	7.640E-02	4.160E+03
TC-101	4.180E-05	6.020E-05	5.900E-04	0.000E+00	1.080E-03	3.990E+02	0.000E+00
RU-103	1.530E+03	0.000E+00	6.580E+02	0.000E+00	5.830E+03	5.050E+05	1.100E+05
RU-105	7.900E-01	0.000E+00	3.110E-01	0.000E+00	1.020E+00	1.100E+04	4.820E+04
RU-106	6.910E+04	0.000E+00	8.720E+03	0.000E+00	1.340E+05	9.360E+06	9.120E+05

ATTACHMENT 12

INHALATION DOSE FACTORS

ADULT

(mrem/yr per uCi/m^3)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	1.080E+04	1.000E+04	5.940E+03	0.000E+00	1.970E+04	4.630E+06	3.020E+05
SB-124	3.120E+04	5.890E+02	1.240E+04	7.550E+01	0.000E+00	2.480E+06	4.060E+05
SB-125	5.340E+04	5.950E+02	1.260E+04	5.400E+01	0.000E+00	1.740E+06	1.010E+05
TE-125M	3.420E+03	1.580E+03	4.670E+02	1.050E+03	1.240E+04	3.140E+05	7.060E+04
TE-127M	1.260E+04	5.770E+03	1.570E+03	3.290E+03	4.580E+04	9.600E+05	1.500E+05
TE-127	1.400E+00	6.420E-01	3.100E-01	1.060E+00	5.100E+00	6.510E+03	5.740E+04
TE-129M	9.760E+03	4.670E+03	1.580E+03	3.440E+03	3.660E+04	1.160E+06	3.830E+05
TE-129	4.980E-02	2.390E-02	1.240E-02	3.900E-02	1.870E-01	1.940E+03	1.570E+02
TE-131M	6.990E+01	4.360E+01	2.900E+01	5.500E+01	3.090E+02	1.460E+05	5.560E+05
TE-131	1.110E-02	5.950E-03	3.590E-03	9.360E-03	4.370E-02	1.390E+03	1.840E+01
TE-132	2.600E+02	2.150E+02	1.620E+02	1.900E+02	1.460E+03	2.880E+05	5.100E+05
I-130	4.580E+03	1.340E+04	5.280E+03	1.140E+06	2.090E+04	7.690E+03	0.000E+00
I-131	2.520E+04	3.580E+04	2.050E+04	1.190E+07	6.130E+04	0.000E+00	6.280E+03
I-132	1.160E+03	3.260E+03	1.160E+03	1.140E+05	5.180E+03	0.000E+00	4.060E+02
I-133	8.640E+03	1.480E+04	4.520E+03	2.150E+06	2.580E+04	0.000E+00	8.880E+03
I-134	6.440E+02	1.730E+03	6.150E+02	2.980E+04	2.750E+03	0.000E+00	1.010E+00
I-135	2.680E+03	6.980E+03	2.570E+03	4.480E+05	1.110E+04	0.000E+00	5.250E+03
CS-134	3.730E+05	8.480E+05	7.280E+05	0.000E+00	2.870E+05	9.760E+04	1.040E+04
CS-136	3.900E+04	1.460E+05	1.100E+05	0.000E+00	8.560E+04	1.200E+04	1.170E+04
CS-137	4.780E+05	6.210E+05	4.280E+05	0.000E+00	2.220E+05	7.520E+04	8.400E+03
CS-138	3.310E+02	6.210E+02	3.240E+02	0.000E+00	4.800E+02	4.860E+01	1.860E-03
BA-139	9.360E-01	6.660E-04	2.740E-02	0.000E+00	6.220E-04	3.760E+03	8.960E+02
BA-140	3.900E+04	4.900E+01	2.570E+03	0.000E+00	1.670E+01	1.270E+06	2.180E+05
BA-141	1.000E-01	7.530E-05	3.360E-03	0.000E+00	7.000E-05	1.940E+03	1.160E-07
BA-142	2.630E-02	2.700E-05	1.660E-03	0.000E+00	2.290E-05	1.190E+03	0.000E+00
LA-140	3.440E+02	1.740E+02	4.580E+01	0.000E+00	0.000E+00	1.360E+05	4.580E+05
LA-142	6.830E-01	3.100E-01	7.720E-02	0.000E+00	0.000E+00	6.330E+03	2.110E+03
CE-141	1.990E+04	1.350E+04	1.530E+03	0.000E+00	6.260E+03	3.620E+05	1.200E+05
CE-143	1.860E+02	1.380E+02	1.530E+01	0.000E+00	6.080E+01	7.980E+04	2.260E+05
CE-144	3.430E+06	1.430E+06	1.840E+05	0.000E+00	8.480E+05	7.780E+06	8.160E+05
PR-143	9.360E+03	3.750E+03	4.640E+02	0.000E+00	2.160E+03	2.810E+05	2.000E+05
PR-144	3.010E-02	1.250E-02	1.530E-03	0.000E+00	7.050E-03	1.020E+03	2.150E-08
ND-147	5.270E+03	6.100E+03	3.650E+02	0.000E+00	3.560E+03	2.210E+05	1.730E+05
W-187	8.480E+00	7.080E+00	2.480E+00	0.000E+00	0.000E+00	2.900E+04	1.550E+05
NP-239	2.300E+02	2.260E+01	1.240E+01	0.000E+00	7.000E+01	3.760E+04	1.190E+05

ATTACHMENT 12

INHALATION DOSE FACTORS

TEEN

(mrem/yr per uCi/m^3)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	1.270E+03	1.270E+03	1.270E+03	1.270E+03	1.270E+03	1.270E+03
C-14	2.600E+04	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03
NA-24	1.380E+04	1.380E+04	1.380E+04	1.380E+04	1.380E+04	1.380E+04	1.380E+04
P-32	1.890E+06	1.100E+05	7.160E+04	0.000E+00	0.000E+00	0.000E+00	9.280E+04
CR-51	0.000E+00	0.000E+00	1.350E+02	7.500E+01	3.070E+01	2.100E+04	3.000E+03
MN-54	0.000E+00	5.110E+04	8.400E+03	0.000E+00	1.270E+04	1.980E+06	6.680E+04
MN-56	0.000E+00	1.700E+00	2.520E-01	0.000E+00	1.790E+00	1.520E+04	5.740E+04
FE-55	3.340E+04	2.380E+04	5.540E+03	0.000E+00	0.000E+00	1.240E+05	6.390E+03
FE-59	1.590E+04	3.700E+04	1.430E+04	0.000E+00	0.000E+00	1.530E+06	1.780E+05
CO-57	0.000E+00	6.920E+02	9.200E+02	0.000E+00	0.000E+00	5.860E+05	3.140E+04
CO-58	0.000E+00	2.070E+03	2.780E+03	0.000E+00	0.000E+00	1.340E+06	9.520E+04
CO-60	0.000E+00	1.510E+04	1.980E+04	0.000E+00	0.000E+00	8.720E+06	2.590E+05
NI-63	5.800E+05	4.340E+04	1.980E+04	0.000E+00	0.000E+00	3.070E+05	1.420E+04
NI-65	2.180E+00	2.930E-01	1.270E-01	0.000E+00	0.000E+00	9.360E+03	3.670E+04
CU-64	0.000E+00	2.030E+00	8.480E-01	0.000E+00	6.410E+00	1.110E+04	6.140E+04
ZN-65	3.860E+04	1.340E+05	6.240E+04	0.000E+00	8.640E+04	2.240E+06	4.660E+04
ZN-69	4.830E-02	9.200E-02	6.460E-03	0.000E+00	6.020E-02	1.580E+03	2.850E+02
BR-82	0.000E+00	0.000E+00	1.820E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	3.440E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	4.330E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	1.830E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.900E+05	8.400E+04	0.000E+00	0.000E+00	0.000E+00	1.770E+04
RB-88	0.000E+00	5.460E+02	2.720E+02	0.000E+00	0.000E+00	0.000E+00	2.920E-05
RB-89	0.000E+00	3.520E+02	2.330E+02	0.000E+00	0.000E+00	0.000E+00	3.380E-07
SR-89	4.340E+05	0.000E+00	1.250E+04	0.000E+00	0.000E+00	2.420E+06	3.710E+05
SR-90	1.080E+08	0.000E+00	6.680E+06	0.000E+00	0.000E+00	1.650E+07	7.650E+05
SR-91	8.800E+01	0.000E+00	3.510E+00	0.000E+00	0.000E+00	6.070E+04	2.590E+05
SR-92	9.520E+00	0.000E+00	4.060E-01	0.000E+00	0.000E+00	2.740E+04	1.190E+05
Y-90	2.980E+03	0.000E+00	8.000E+01	0.000E+00	0.000E+00	2.930E+05	5.590E+05
Y-91M	3.700E-01	0.000E+00	1.420E-02	0.000E+00	0.000E+00	3.200E+03	3.020E+01
Y-91	6.610E+05	0.000E+00	1.770E+04	0.000E+00	0.000E+00	2.940E+06	4.090E+05
Y-92	1.470E+01	0.000E+00	4.290E-01	0.000E+00	0.000E+00	2.680E+04	1.650E+05
Y-93	1.350E+02	0.000E+00	3.720E+00	0.000E+00	0.000E+00	8.320E+04	5.790E+05
ZR-95	1.460E+05	4.580E+04	3.150E+04	0.000E+00	6.740E+04	2.690E+06	1.490E+05
ZR-97	1.380E+02	2.720E+01	1.260E+01	0.000E+00	4.120E+01	1.300E+05	6.300E+05
NB-95	1.860E+04	1.030E+04	5.660E+03	0.000E+00	1.000E+04	7.510E+05	9.680E+04
NB-97	3.140E-01	7.780E-02	2.840E-02	0.000E+00	9.120E-02	3.930E+03	2.170E+03
MO-99	0.000E+00	1.690E+02	3.220E+01	0.000E+00	4.110E+02	1.540E+05	2.690E+05
TC-99M	1.380E-03	3.860E-03	4.990E-02	0.000E+00	5.760E-02	1.150E+03	6.130E+03
TC-101	5.920E-05	8.400E-05	8.240E-04	0.000E+00	1.520E-03	6.670E+02	8.720E-07
RU-103	2.100E+03	0.000E+00	8.960E+02	0.000E+00	7.430E+03	7.830E+05	1.090E+05
RU-105	1.120E+00	0.000E+00	4.340E-01	0.000E+00	1.410E+00	1.820E+04	9.040E+04
RU-106	9.840E+04	0.000E+00	1.240E+04	0.000E+00	1.900E+05	1.610E+07	9.600E+05

ATTACHMENT 12

INHALATION DOSE FACTORS

TEEN

(mrem/yr per uCi/m^3)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	1.380E+04	1.310E+04	7.990E+03	0.000E+00	2.500E+04	6.750E+06	2.730E+05
SB-124	4.300E+04	7.940E+02	1.680E+04	9.760E+01	0.000E+00	3.850E+06	3.980E+05
SB-125	7.380E+04	8.080E+02	1.720E+04	7.040E+01	0.000E+00	2.740E+06	9.920E+04
TE-125M	4.880E+03	2.240E+03	6.670E+02	1.400E+03	0.000E+00	5.360E+05	7.500E+04
TE-127M	1.800E+04	8.160E+03	2.180E+03	4.380E+03	6.540E+04	1.660E+06	1.590E+05
TE-127	2.010E+00	9.120E-01	4.420E-01	1.420E+00	7.280E+00	1.120E+04	8.080E+04
TE-129M	1.390E+04	6.580E+03	2.250E+03	4.580E+03	5.190E+04	1.980E+06	4.050E+05
TE-129	7.100E-02	3.380E-02	1.760E-02	5.180E-02	2.660E-01	3.300E+03	1.620E+03
TE-131M	9.840E+01	6.010E+01	4.020E+01	7.250E+01	4.390E+02	2.380E+05	6.210E+05
TE-131	1.580E-02	8.320E-03	5.040E-03	1.240E-02	6.180E-02	2.340E+03	1.510E+01
TE-132	3.600E+02	2.900E+02	2.190E+02	2.460E+02	1.950E+03	4.490E+05	4.630E+05
I-130	6.240E+03	1.790E+04	7.170E+03	1.490E+06	2.750E+04	0.000E+00	9.120E+03
I-131	3.540E+04	4.910E+04	2.640E+04	1.460E+07	8.400E+04	0.000E+00	6.490E+03
I-132	1.590E+03	4.380E+03	1.580E+03	1.510E+05	6.920E+03	0.000E+00	1.270E+03
I-133	1.220E+04	2.050E+04	6.220E+03	2.920E+06	3.590E+04	0.000E+00	1.030E+04
I-134	8.880E+02	2.320E+03	8.400E+02	3.950E+04	3.660E+03	0.000E+00	2.040E+01
I-135	3.700E+03	9.440E+03	3.490E+03	6.210E+05	1.490E+04	0.000E+00	6.950E+03
CS-134	5.020E+05	1.130E+06	5.490E+05	0.000E+00	3.750E+05	1.460E+05	9.760E+03
CS-136	5.150E+04	1.940E+05	1.370E+05	0.000E+00	1.100E+05	1.780E+04	1.090E+04
CS-137	6.700E+05	8.480E+05	3.110E+05	0.000E+00	3.040E+05	1.210E+05	8.480E+03
CS-138	4.660E+02	8.560E+02	4.460E+02	0.000E+00	6.620E+02	7.870E+01	2.700E-01
BA-139	1.340E+00	9.440E-04	3.900E-02	0.000E+00	8.880E-04	6.460E+03	6.450E+03
BA-140	5.470E+04	6.700E+01	3.520E+03	0.000E+00	2.280E+01	2.030E+06	2.290E+05
BA-141	1.420E-01	1.060E-04	4.740E-03	0.000E+00	9.840E-05	3.290E+03	7.460E-04
BA-142	3.700E-02	3.700E-05	2.270E-03	0.000E+00	3.140E-05	1.910E+03	0.000E+00
LA-140	4.790E+02	2.360E+02	6.260E+01	0.000E+00	0.000E+00	2.140E+05	4.870E+05
LA-142	9.600E-01	4.250E-01	1.060E-01	0.000E+00	0.000E+00	1.020E+04	1.200E+04
CE-141	2.840E+04	1.900E+04	2.170E+03	0.000E+00	8.880E+03	6.140E+05	1.260E+05
CE-143	2.660E+02	1.940E+02	2.160E+01	0.000E+00	8.640E+01	1.300E+05	2.550E+05
CE-144	4.890E+06	2.020E+06	2.620E+05	0.000E+00	1.210E+06	1.340E+07	8.640E+05
PR-143	1.340E+04	5.310E+03	6.620E+02	0.000E+00	3.090E+03	4.830E+05	2.140E+05
PR-144	4.300E-02	1.760E-02	2.180E-03	0.000E+00	1.010E-02	1.750E+03	2.350E-04
ND-147	7.860E+03	8.560E+03	5.130E+02	0.000E+00	5.020E+03	3.720E+05	1.820E+05
W-187	1.200E+01	9.760E+00	3.430E+00	0.000E+00	0.000E+00	4.740E+04	1.770E+05
NP-239	3.380E+02	3.190E+01	1.770E+01	0.000E+00	1.000E+02	6.490E+04	1.320E+05

ATTACHMENT 12

INHALATION DOSE FACTORS

CHILD

(mrem/yr per uCi/m^3)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	1.120E+03	1.120E+03	1.120E+03	1.120E+03	1.120E+03	1.120E+03
C-14	3.590E+04	6.730E+03	6.730E+03	6.730E+03	6.730E+03	6.730E+03	6.730E+03
NA-24	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04
P-32	2.600E+06	1.140E+05	9.880E+04	0.000E+00	0.000E+00	0.000E+00	4.220E+04
CR-51	0.000E+00	0.000E+00	1.540E+02	8.550E+01	2.430E+01	1.700E+04	1.080E+03
MN-54	0.000E+00	4.290E+04	9.510E+03	0.000E+00	1.000E+04	1.580E+06	2.290E+04
MN-56	0.000E+00	1.660E+00	3.120E-01	0.000E+00	1.670E+00	1.310E+04	1.230E+05
FE-55	4.740E+04	2.520E+04	7.770E+03	0.000E+00	0.000E+00	1.110E+05	2.870E+03
FE-59	2.070E+04	3.340E+04	1.670E+04	0.000E+00	0.000E+00	1.270E+06	7.070E+04
CO-57	0.000E+00	9.030E+02	1.070E+03	0.000E+00	0.000E+00	5.070E+05	1.320E+04
CO-58	0.000E+00	1.770E+03	3.160E+03	0.000E+00	0.000E+00	1.110E+06	3.440E+04
CO-60	0.000E+00	1.310E+04	2.260E+04	0.000E+00	0.000E+00	7.070E+06	9.620E+04
NI-63	8.210E+05	4.630E+04	2.800E+04	0.000E+00	0.000E+00	2.750E+05	6.330E+03
NI-65	2.990E+00	2.960E-01	1.640E-01	0.000E+00	0.000E+00	8.180E+03	8.400E+04
CU-64	0.000E+00	1.990E+00	1.070E+00	0.000E+00	6.030E+00	9.580E+03	3.670E+04
ZN-65	4.260E+04	1.130E+05	7.030E+04	0.000E+00	7.140E+04	9.950E+05	1.630E+04
ZN-69	6.700E-02	9.660E-02	8.920E-03	0.000E+00	5.850E-02	1.420E+03	9.510E+03
BR-82	0.000E+00	0.000E+00	2.090E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	4.740E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	5.480E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	2.530E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.980E+05	1.140E+05	0.000E+00	0.000E+00	0.000E+00	7.990E+03
RB-88	0.000E+00	5.620E+02	3.660E+02	0.000E+00	0.000E+00	0.000E+00	1.720E+01
RB-89	0.000E+00	3.450E+02	2.900E+02	0.000E+00	0.000E+00	0.000E+00	1.890E+00
SR-89	5.990E+05	0.000E+00	1.720E+04	0.000E+00	0.000E+00	2.160E+06	1.670E+05
SR-90	1.010E+08	0.000E+00	6.440E+06	0.000E+00	0.000E+00	1.480E+07	3.430E+05
SR-91	1.210E+02	0.000E+00	4.590E+00	0.000E+00	0.000E+00	5.330E+04	1.740E+05
SR-92	1.310E+01	0.000E+00	5.250E-01	0.000E+00	0.000E+00	2.400E+04	2.420E+05
Y-90	4.110E+03	0.000E+00	1.110E+02	0.000E+00	0.000E+00	2.620E+05	2.680E+05
Y-91M	5.070E-01	0.000E+00	1.840E-02	0.000E+00	0.000E+00	2.810E+03	1.720E+03
Y-91	9.140E+05	0.000E+00	2.440E+04	0.000E+00	0.000E+00	2.630E+06	1.840E+05
Y-92	2.040E+01	0.000E+00	5.810E-01	0.000E+00	0.000E+00	2.390E+04	2.390E+05
Y-93	1.760E+02	0.000E+00	5.110E+00	0.000E+00	0.000E+00	7.440E+04	3.890E+05
ZR-95	1.900E+05	4.180E+04	3.700E+04	0.000E+00	5.960E+04	2.230E+06	6.110E+04
ZR-97	1.880E+02	2.720E+01	1.600E+01	0.000E+00	3.890E+01	1.130E+05	3.510E+05
NB-95	2.350E+04	9.180E+03	6.550E+03	0.000E+00	8.620E+03	6.140E+05	3.700E+04
NB-97	4.290E-01	7.700E-02	3.600E-02	0.000E+00	8.550E-02	3.420E+03	2.780E+04
MO-99	0.000E+00	1.720E+02	4.260E+01	0.000E+00	3.920E+02	1.350E+05	1.270E+05
TC-99M	1.780E-03	3.480E-03	5.770E-02	0.000E+00	5.070E-02	9.510E+02	4.810E+03
TC-101	8.100E-05	3.510E-05	1.080E-03	0.000E+00	1.450E-03	5.850E+02	1.630E+01
RU-103	2.790E+03	0.000E+00	1.070E+03	0.000E+00	7.030E+03	6.620E+05	4.480E+04
RU-105	1.530E+00	0.000E+00	5.550E-01	0.000E+00	1.340E+00	1.590E+04	9.950E+04
RU-106	1.360E+05	0.000E+00	1.690E+04	0.000E+00	1.840E+05	1.430E+07	4.290E+05

ATTACHMENT 12

INHALATION DOSE FACTORS

CHILD

(mrem/yr per uCi/m^3)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	1.690E+04	1.140E+04	9.140E+03	0.000E+00	2.120E+04	5.480E+06	1.000E+05
SB-124	5.740E+04	7.400E+02	2.000E+04	1.260E+02	0.000E+00	3.240E+06	1.640E+05
SB-125	9.840E+04	7.590E+02	2.070E+04	9.100E+01	0.000E+00	2.320E+06	4.030E+04
TE-125M	6.730E+03	2.330E+03	9.140E+02	1.920E+03	0.000E+00	4.770E+05	3.380E+04
TE-127M	2.490E+04	8.550E+03	3.020E+03	6.070E+03	6.360E+04	1.480E+06	7.140E+04
TE-127	2.770E+00	9.510E-01	6.110E-01	1.960E+00	7.070E+00	1.000E+04	5.620E+04
TE-129M	1.920E+04	6.850E+03	3.040E+03	6.330E+03	5.030E+04	1.760E+06	1.820E+05
TE-129	9.770E-02	3.500E-02	2.380E-02	7.140E-02	2.570E-01	2.930E+03	2.550E+04
TE-131M	1.340E+02	5.920E+01	5.070E+01	9.770E+01	4.000E+02	2.060E+05	3.080E+05
TE-131	2.170E-02	8.440E-03	6.590E-03	1.700E-02	5.880E-02	2.050E+03	1.330E+03
TE-132	4.810E+02	2.720E+02	2.630E+02	3.170E+02	1.840E+03	3.770E+05	1.380E+05
I-130	8.180E+03	1.640E+04	8.440E+03	1.850E+06	2.450E+04	0.000E+00	5.110E+03
I-131	4.810E+04	4.810E+04	2.730E+04	1.620E+07	7.880E+04	0.000E+00	2.840E+03
I-132	2.120E+03	4.070E+03	1.880E+03	1.940E+05	6.250E+03	0.000E+00	3.200E+03
I-133	1.660E+04	2.030E+04	7.700E+03	3.850E+06	3.380E+04	0.000E+00	5.480E+03
I-134	1.170E+03	2.160E+03	9.950E+02	5.070E+04	3.300E+03	0.000E+00	9.550E+02
I-135	4.920E+03	8.730E+03	4.140E+03	7.920E+05	1.340E+04	0.000E+00	4.440E+03
CS-134	6.510E+05	1.010E+06	2.250E+05	0.000E+00	3.300E+05	1.210E+05	3.850E+03
CS-136	6.510E+04	1.710E+05	1.160E+05	0.000E+00	9.550E+04	1.450E+04	4.180E+03
CS-137	9.070E+05	8.250E+05	1.280E+05	0.000E+00	2.820E+05	1.040E+05	3.620E+03
CS-138	6.330E+02	8.400E+02	5.550E+02	0.000E+00	6.220E+02	6.810E+01	2.700E+02
BA-139	1.840E+00	9.840E-04	5.370E-02	0.000E+00	8.620E-04	5.770E+03	5.770E+04
BA-140	7.400E+04	6.480E+01	4.330E+03	0.000E+00	2.110E+01	1.740E+06	1.020E+05
BA-141	1.960E-01	1.090E-04	6.360E-03	0.000E+00	9.470E-05	2.920E+03	2.750E+02
BA-142	5.000E-02	3.600E-05	2.790E-03	0.000E+00	2.910E-05	1.640E+03	2.740E+00
LA-140	6.440E+02	2.250E+02	7.550E+01	0.000E+00	0.000E+00	1.830E+05	2.260E+05
LA-142	1.300E+00	4.110E-01	1.290E-01	0.000E+00	0.000E+00	8.700E+03	7.590E+04
CE-141	3.920E+04	1.950E+04	2.900E+03	0.000E+00	8.550E+03	5.440E+05	5.660E+04
CE-143	3.660E+02	1.990E+02	2.870E+01	0.000E+00	8.360E+01	1.150E+05	1.270E+05
CE-144	6.770E+06	2.120E+06	3.610E+05	0.000E+00	1.170E+06	1.200E+07	3.890E+05
PR-143	1.850E+04	5.550E+03	9.140E+02	0.000E+00	3.000E+03	4.330E+05	9.730E+04
PR-144	5.960E-02	1.850E-02	3.000E-03	0.000E+00	9.770E-03	1.570E+03	1.970E+02
ND-147	1.080E+04	8.730E+03	6.810E+02	0.000E+00	4.810E+03	3.280E+05	8.210E+04
W-187	1.630E+01	9.660E+00	4.330E+00	0.000E+00	0.000E+00	4.110E+04	9.100E+04
NP-239	4.700E+02	3.340E+01	2.350E+01	0.000E+00	9.730E+01	5.810E+04	6.400E+04

ATTACHMENT 12

INHALATION DOSE FACTORS

INFANT

(mrem/yr per uCi/m^3)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	6.470E+02	6.470E+02	6.470E+02	6.470E+02	6.470E+02	6.470E+02
C-14	2.650E+04	5.310E+03	5.310E+03	5.310E+03	5.310E+03	5.310E+03	5.310E+03
NA-24	1.060E+04	1.060E+04	1.060E+04	1.060E+04	1.060E+04	1.060E+04	1.060E+04
P-32	2.030E+06	1.120E+05	7.740E+04	0.000E+00	0.000E+00	0.000E+00	1.610E+04
CR-51	0.000E+00	0.000E+00	8.950E+01	5.750E+01	1.320E+01	1.280E+04	3.570E+02
MN-54	0.000E+00	2.530E+04	4.980E+03	0.000E+00	4.980E+03	1.000E+06	7.060E+03
MN-56	0.000E+00	1.540E+00	2.210E-01	0.000E+00	1.100E+00	1.250E+04	7.170E+04
FE-55	1.970E+04	1.170E+04	3.330E+03	0.000E+00	0.000E+00	8.690E+04	1.090E+03
FE-59	1.360E+04	2.350E+04	9.480E+03	0.000E+00	0.000E+00	1.020E+06	2.480E+04
CO-57	0.000E+00	6.510E+02	6.410E+02	0.000E+00	0.000E+00	3.790E+05	4.860E+03
CO-58	0.000E+00	1.220E+03	1.820E+03	0.000E+00	0.000E+00	7.770E+05	1.110E+04
CO-60	0.000E+00	8.020E+03	1.180E+04	0.000E+00	0.000E+00	4.510E+06	3.190E+04
NI-63	3.390E+05	2.040E+04	1.160E+04	0.000E+00	0.000E+00	2.090E+05	2.420E+03
NI-65	2.390E+00	2.840E-01	1.230E-01	0.000E+00	0.000E+00	8.120E+03	5.010E+04
CU-64	0.000E+00	1.880E+00	7.740E-01	0.000E+00	3.980E+00	9.300E+03	1.500E+04
ZN-65	1.930E+04	6.260E+04	3.110E+04	0.000E+00	3.250E+04	6.470E+05	5.140E+04
ZN-69	5.390E-02	9.670E-02	7.180E-03	0.000E+00	4.020E-02	1.470E+03	1.320E+04
BR-82	0.000E+00	0.000E+00	1.330E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	3.810E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	4.000E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	2.040E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.900E+05	8.820E+04	0.000E+00	0.000E+00	0.000E+00	3.040E+03
RB-88	0.000E+00	5.570E+02	2.870E+02	0.000E+00	0.000E+00	0.000E+00	3.390E+02
RB-89	0.000E+00	3.210E+02	2.060E+02	0.000E+00	0.000E+00	0.000E+00	6.820E+01
SR-89	3.990E+05	0.000E+00	1.140E+04	0.000E+00	0.000E+00	2.030E+06	6.400E+04
SR-90	4.090E+07	0.000E+00	2.590E+06	0.000E+00	0.000E+00	1.120E+07	1.310E+05
SR-91	9.560E+01	0.000E+00	3.460E+00	0.000E+00	0.000E+00	5.260E+04	7.340E+04
SR-92	1.050E+01	0.000E+00	3.910E-01	0.000E+00	0.000E+00	2.380E+04	1.400E+05
Y-90	3.290E+03	0.000E+00	8.820E+01	0.000E+00	0.000E+00	2.690E+05	1.040E+05
Y-91M	4.070E-01	0.000E+00	1.390E-02	0.000E+00	0.000E+00	2.790E+03	2.350E+03
Y-91	5.880E+05	0.000E+00	1.570E+04	0.000E+00	0.000E+00	2.450E+06	7.030E+04
Y-92	1.640E+01	0.000E+00	4.610E-01	0.000E+00	0.000E+00	2.450E+04	1.270E+05
Y-93	1.500E+02	0.000E+00	4.070E+00	0.000E+00	0.000E+00	7.640E+04	1.670E+05
ZR-95	1.150E+05	2.790E+04	2.030E+04	0.000E+00	3.110E+04	1.750E+06	2.170E+04
ZR-97	1.500E+02	2.560E+01	1.170E+01	0.000E+00	2.590E+01	1.100E+05	1.400E+05
NB-95	1.570E+04	6.430E+03	3.780E+03	0.000E+00	4.720E+03	4.790E+05	1.270E+04
NB-97	3.420E-01	7.290E-02	2.630E-02	0.000E+00	5.700E-02	3.320E+03	2.690E+04
MO-99	0.000E+00	1.650E+02	3.230E+01	0.000E+00	2.650E+02	1.350E+05	4.870E+04
TC-99M	1.400E-03	2.880E-03	3.720E-02	0.000E+00	3.110E-02	8.110E+02	2.030E+03
TC-101	6.510E-05	8.230E-05	8.120E-04	0.000E+00	9.790E-04	5.840E+02	8.440E+02
RU-103	2.020E+03	0.000E+00	6.790E+02	0.000E+00	4.340E+03	5.520E+05	1.610E+04
RU-105	1.220E+00	0.000E+00	4.100E-01	0.000E+00	8.990E-01	1.570E+04	4.840E+04
RU-106	8.680E+04	0.000E+00	1.090E+04	0.000E+00	1.070E+05	1.160E+07	1.640E+05

ATTACHMENT 12

INHALATION DOSE FACTORS

INFANT

(mrem/yr per uCi/m^3)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	9.980E+03	7.220E+03	5.000E+03	0.000E+00	1.090E+04	3.670E+06	3.300E+04
SB-124	3.790E+04	5.560E+02	1.200E+04	1.010E+02	0.000E+00	2.650E+06	5.910E+04
SB-125	5.170E+04	4.770E+02	1.090E+04	6.230E+01	0.000E+00	1.640E+06	1.470E+04
TE-125M	4.760E+03	1.990E+03	6.580E+02	1.620E+03	0.000E+00	4.470E+05	1.290E+04
TE-127M	1.670E+04	6.900E+03	2.070E+03	4.870E+03	3.750E+04	1.310E+06	2.730E+04
TE-127	2.230E+00	9.530E-01	4.890E-01	1.850E+00	4.860E+00	1.030E+04	2.440E+04
TE-129M	1.410E+04	6.090E+03	2.230E+03	5.470E+03	3.180E+04	1.680E+06	6.900E+04
TE-129	7.880E-02	3.470E-02	1.880E-02	6.750E-02	1.750E-01	3.000E+03	2.630E+04
TE-131M	1.070E+02	5.500E+01	3.630E+01	8.930E+01	2.650E+02	1.990E+05	1.190E+05
TE-131	1.740E-02	8.220E-03	5.000E-03	1.580E-02	3.990E-02	2.060E+03	8.220E+03
TE-132	3.720E+02	2.370E+02	1.760E+02	2.790E+02	1.030E+03	3.400E+05	4.410E+04
I-130	6.360E+03	1.390E+04	5.570E+03	1.600E+06	1.530E+04	0.000E+00	1.990E+03
I-131	3.790E+04	4.440E+04	1.960E+04	1.480E+07	5.180E+04	0.000E+00	1.060E+03
I-132	1.690E+03	3.540E+03	1.260E+03	1.690E+05	3.950E+03	0.000E+00	1.900E+03
I-133	1.320E+04	1.920E+04	5.600E+03	3.560E+06	2.240E+04	0.000E+00	2.160E+03
I-134	9.210E+02	1.880E+03	6.650E+02	4.450E+04	2.090E+03	0.000E+00	1.290E+03
I-135	3.860E+03	7.600E+03	2.770E+03	6.960E+05	8.470E+03	0.000E+00	1.830E+03
CS-134	3.960E+05	7.030E+05	7.450E+04	0.000E+00	1.900E+05	7.970E+04	1.330E+03
CS-136	4.830E+04	1.350E+05	5.290E+04	0.000E+00	5.640E+04	1.180E+04	1.430E+03
CS-137	5.490E+05	6.120E+05	4.550E+04	0.000E+00	1.720E+05	7.130E+04	1.330E+03
CS-138	5.050E+02	7.810E+02	3.980E+02	0.000E+00	4.100E+02	6.540E+01	8.760E+02
BA-139	1.480E+00	9.840E-04	4.300E-02	0.000E+00	5.920E-04	5.950E+03	5.100E+04
BA-140	5.600E+04	5.600E+01	2.900E+03	0.000E+00	1.340E+01	1.600E+06	3.840E+04
BA-141	1.570E-01	1.080E-04	4.970E-03	0.000E+00	6.500E-05	2.970E+03	4.750E+03
BA-142	3.980E-02	3.300E-05	1.960E-03	0.000E+00	1.900E-05	1.550E+03	6.930E+02
LA-140	5.050E+02	2.000E+02	5.150E+01	0.000E+00	0.000E+00	1.680E+05	8.480E+04
LA-142	1.030E+00	3.770E-01	9.040E-02	0.000E+00	0.000E+00	8.220E+03	5.950E+04
CE-141	2.770E+04	1.670E+04	1.990E+03	0.000E+00	5.250E+03	5.170E+05	2.160E+04
CE-143	2.930E+02	1.930E+02	2.210E+01	0.000E+00	5.640E+01	1.160E+05	4.970E+04
CE-144	3.190E+06	1.210E+06	1.760E+05	0.000E+00	5.380E+05	9.840E+06	1.480E+05
PR-143	1.400E+04	5.240E+03	6.990E+02	0.000E+00	1.970E+03	4.330E+05	3.720E+04
PR-144	4.790E-02	1.850E-02	2.410E-03	0.000E+00	6.720E-03	1.610E+03	4.280E+03
ND-147	7.940E+03	8.130E+03	5.000E+02	0.000E+00	3.150E+03	3.220E+05	3.120E+04
W-187	1.300E+01	9.020E+00	3.120E+00	0.000E+00	0.000E+00	3.960E+04	3.560E+04
NP-239	3.710E+02	3.320E+01	1.880E+01	0.000E+00	6.620E+01	5.950E+04	2.490E+04

ATTACHMENT 12

GRASS-COW-MILK DOSE FACTORS

ADULT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	7.630E+02	7.630E+02	7.630E+02	7.630E+02	7.630E+02	7.630E+02
C-14	3.630E+05	7.260E+04	7.260E+04	7.260E+04	7.260E+04	7.260E+04	7.260E+04
NA-24	2.540E+06	2.540E+06	2.540E+06	2.540E+06	2.540E+06	2.540E+06	2.540E+06
P-32	1.710E+10	1.060E+09	6.600E+08	0.000E+00	0.000E+00	0.000E+00	1.920E+09
CR-51	0.000E+00	0.000E+00	2.860E+04	1.710E+04	6.300E+03	3.800E+04	7.200E+06
MN-54	0.000E+00	8.400E+06	1.600E+06	0.000E+00	2.500E+06	0.000E+00	2.570E+07
MN-56	0.000E+00	4.230E-03	7.510E-04	0.000E+00	5.380E-03	0.000E+00	1.350E-01
FE-55	2.510E+07	1.730E+07	4.040E+06	0.000E+00	0.000E+00	9.670E+06	9.950E+06
FE-59	2.980E+07	7.000E+07	2.680E+07	0.000E+00	0.000E+00	1.950E+07	2.330E+08
CO-57	0.000E+00	1.280E+06	2.130E+06	0.000E+00	0.000E+00	0.000E+00	3.250E+07
CO-58	0.000E+00	4.720E+06	1.060E+07	0.000E+00	0.000E+00	0.000E+00	9.570E+07
CO-60	0.000E+00	1.640E+07	3.620E+07	0.000E+00	0.000E+00	0.000E+00	3.080E+08
NI-63	6.730E+09	4.660E+08	2.260E+08	0.000E+00	0.000E+00	0.000E+00	9.730E+07
NI-65	3.700E-01	4.810E-02	2.190E-02	0.000E+00	0.000E+00	0.000E+00	1.220E+00
CU-64	0.000E+00	2.410E+04	1.130E+04	0.000E+00	6.080E+04	0.000E+00	2.050E+06
ZN-65	1.370E+09	4.360E+09	1.970E+09	0.000E+00	2.920E+09	0.000E+00	2.750E+09
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.590E+09	1.210E+09	0.000E+00	0.000E+00	0.000E+00	5.110E+08
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	1.450E+09	0.000E+00	4.160E+07	0.000E+00	0.000E+00	0.000E+00	2.330E+08
SR-90	4.680E+10	0.000E+00	1.150E+10	0.000E+00	0.000E+00	0.000E+00	1.350E+09
SR-91	3.130E+04	0.000E+00	1.270E+03	0.000E+00	0.000E+00	0.000E+00	1.490E+05
SR-92	4.890E-01	0.000E+00	2.110E-02	0.000E+00	0.000E+00	0.000E+00	9.680E+00
Y-90	7.070E+01	0.000E+00	1.900E+00	0.000E+00	0.000E+00	0.000E+00	7.500E+05
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	8.600E+03	0.000E+00	2.300E+02	0.000E+00	0.000E+00	0.000E+00	4.730E+06
Y-92	5.420E-05	0.000E+00	1.580E-06	0.000E+00	0.000E+00	0.000E+00	9.490E-01
Y-93	2.330E-01	0.000E+00	6.430E-03	0.000E+00	0.000E+00	0.000E+00	7.390E+03
ZR-95	9.460E+02	3.030E+02	2.050E+02	0.000E+00	4.760E+02	0.000E+00	9.620E+05
ZR-97	4.260E-01	8.590E-02	3.930E-02	0.000E+00	1.300E-01	0.000E+00	2.660E+04
NB-95	8.250E+04	4.590E+04	2.470E+04	0.000E+00	4.540E+04	0.000E+00	2.790E+08
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.470E-09
MO-99	0.000E+00	2.520E+07	4.800E+06	0.000E+00	5.720E+07	0.000E+00	5.850E+07
TC-99M	3.250E+00	9.190E+00	1.170E+02	0.000E+00	1.400E+02	4.500E+00	5.440E+03
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.020E+03	0.000E+00	4.390E+02	0.000E+00	3.890E+03	0.000E+00	1.190E+05
RU-105	8.570E-04	0.000E+00	3.380E-04	0.000E+00	1.110E-02	0.000E+00	5.240E-01
RU-106	2.040E+04	0.000E+00	2.580E+03	0.000E+00	3.940E+04	0.000E+00	1.320E+06

ATTACHMENT 12

GRASS-COW-MILK DOSE FACTORS

ADULT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	5.830E+07	5.390E+07	3.200E+07	0.000E+00	1.060E+08	0.000E+00	2.200E+10
SB-124	8.580E+08	1.620E+07	3.400E+08	2.080E+06	0.000E+00	6.680E+08	2.440E+10
SB-125	6.810E+08	7.610E+06	1.620E+08	6.930E+05	0.000E+00	5.250E+08	7.500E+09
TE-125M	1.630E+07	5.900E+06	2.180E+06	4.900E+06	6.630E+07	0.000E+00	6.500E+07
TE-127M	4.580E+07	1.640E+07	5.580E+06	1.170E+07	1.860E+08	0.000E+00	1.540E+08
TE-127	6.720E+02	2.410E+02	1.450E+02	4.980E+02	2.740E+03	0.000E+00	5.300E+04
TE-129M	6.040E+07	2.250E+07	9.570E+06	2.080E+07	2.520E+08	0.000E+00	3.040E+08
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	3.610E+05	1.770E+05	1.470E+05	2.800E+05	1.790E+06	0.000E+00	1.750E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	2.390E+06	1.550E+06	1.450E+06	1.710E+06	1.490E+07	0.000E+00	7.320E+07
I-130	4.260E+05	1.260E+06	4.960E+05	1.070E+08	1.960E+06	0.000E+00	1.080E+06
I-131	2.960E+08	4.240E+08	2.430E+08	1.390E+11	7.270E+08	0.000E+00	1.120E+08
I-132	1.640E-01	4.370E-01	1.530E-01	1.530E+01	6.970E-01	0.000E+00	8.220E-02
I-133	3.970E+06	6.900E+06	2.100E+06	1.010E+09	1.200E+07	0.000E+00	6.200E+06
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	1.390E+04	3.630E+04	1.340E+04	2.400E+06	5.830E+04	0.000E+00	4.100E+04
CS-134	5.650E+09	1.340E+10	1.100E+10	0.000E+00	4.350E+09	1.440E+09	2.350E+08
CS-136	2.610E+08	1.030E+09	7.420E+08	0.000E+00	5.740E+08	7.870E+07	1.170E+08
CS-137	7.380E+09	1.010E+10	6.610E+09	0.000E+00	3.430E+09	1.140E+09	1.950E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	4.700E-08	0.000E+00	1.380E-09	0.000E+00	0.000E+00	0.000E+00	8.340E-08
BA-140	2.690E+07	3.380E+04	1.760E+06	0.000E+00	1.150E+04	1.930E+04	5.540E+07
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	4.490E+00	2.260E+00	5.970E-01	0.000E+00	0.000E+00	0.000E+00	1.660E+05
LA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.030E-08
CE-141	4.840E+03	3.270E+03	3.710E+02	0.000E+00	1.520E+03	0.000E+00	1.250E+07
CE-143	4.190E+01	3.090E+04	3.420E+00	0.000E+00	1.360E+01	0.000E+00	1.160E+06
CE-144	3.580E+05	1.500E+05	1.920E+04	0.000E+00	8.870E+04	0.000E+00	1.210E+08
PR-143	1.590E+02	6.370E+01	7.880E+00	0.000E+00	3.680E+01	0.000E+00	6.960E+05
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	9.420E+01	1.090E+02	6.520E+00	0.000E+00	6.370E+01	0.000E+00	5.230E+05
W-187	6.560E+03	5.480E+03	1.920E+03	0.000E+00	0.000E+00	0.000E+00	1.800E+06
NP-239	3.660E+00	3.600E-01	1.980E-01	0.000E+00	1.120E+00	0.000E+00	7.390E+04

ATTACHMENT 12

GRASS-COW-MILK DOSE FACTORS

TEEN

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	9.940E+02	9.940E+02	9.940E+02	9.940E+02	9.940E+02	9.940E+02
C-14	6.700E+05	1.340E+05	1.340E+05	1.340E+05	1.340E+05	1.340E+05	1.340E+05
NA-24	4.440E+06	4.440E+06	4.440E+06	4.440E+06	4.440E+06	4.440E+06	4.440E+06
P-32	3.150E+10	1.950E+09	1.220E+09	0.000E+00	0.000E+00	0.000E+00	2.650E+09
CR-51	0.000E+00	0.000E+00	5.000E+04	2.780E+04	1.100E+04	7.130E+04	8.400E+06
MN-54	0.000E+00	1.400E+07	2.780E+06	0.000E+00	4.170E+06	0.000E+00	2.870E+07
MN-56	0.000E+00	7.510E-03	1.330E-03	0.000E+00	9.500E-03	0.000E+00	4.940E-01
FE-55	4.450E+07	3.160E+07	7.360E+06	0.000E+00	0.000E+00	2.000E+07	1.370E+07
FE-59	5.200E+07	1.210E+08	4.680E+07	0.000E+00	0.000E+00	3.820E+07	2.870E+08
CO-57	0.000E+00	2.250E+06	3.760E+06	0.000E+00	0.000E+00	0.000E+00	4.190E+07
CO-58	0.000E+00	7.950E+06	1.830E+07	0.000E+00	0.000E+00	0.000E+00	1.100E+08
CO-60	0.000E+00	2.780E+07	6.260E+07	0.000E+00	0.000E+00	0.000E+00	3.620E+08
NI-63	1.180E+10	8.350E+08	4.010E+08	0.000E+00	0.000E+00	0.000E+00	1.330E+08
NI-65	6.780E-01	8.660E-02	3.940E-02	0.000E+00	0.000E+00	0.000E+00	4.700E+00
CU-64	0.000E+00	4.290E+04	2.020E+04	0.000E+00	1.090E+05	0.000E+00	3.330E+06
ZN-65	2.110E+09	7.310E+09	3.410E+09	0.000E+00	4.680E+09	0.000E+00	3.100E+09
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.730E+09	2.220E+09	0.000E+00	0.000E+00	0.000E+00	7.000E+08
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	2.670E+09	0.000E+00	7.660E+07	0.000E+00	0.000E+00	0.000E+00	3.180E+08
SR-90	6.610E+10	0.000E+00	1.630E+10	0.000E+00	0.000E+00	0.000E+00	1.860E+09
SR-91	5.750E+04	0.000E+00	2.290E+03	0.000E+00	0.000E+00	0.000E+00	2.610E+05
SR-92	8.950E-01	0.000E+00	3.810E-02	0.000E+00	0.000E+00	0.000E+00	2.280E+01
Y-90	1.300E+02	0.000E+00	3.500E+00	0.000E+00	0.000E+00	0.000E+00	1.070E+06
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	1.580E+04	0.000E+00	4.240E+02	0.000E+00	0.000E+00	0.000E+00	6.480E+06
Y-92	1.000E-04	0.000E+00	2.900E-06	0.000E+00	0.000E+00	0.000E+00	2.750E+00
Y-93	4.300E-01	0.000E+00	1.180E-02	0.000E+00	0.000E+00	0.000E+00	1.310E+04
ZR-95	1.650E+03	5.220E+02	3.590E+02	0.000E+00	7.670E+02	0.000E+00	1.200E+06
ZR-97	7.750E-01	1.530E-01	7.060E-02	0.000E+00	2.320E-01	0.000E+00	4.150E+04
NB-95	1.410E+05	7.800E+04	4.300E+04	0.000E+00	7.570E+04	0.000E+00	3.340E+08
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.340E-08
MO-99	0.000E+00	4.560E+07	8.690E+06	0.000E+00	1.040E+08	0.000E+00	8.160E+07
TC-99M	5.640E+00	1.570E+01	2.040E+02	0.000E+00	2.340E+02	8.730E+00	1.030E+04
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.810E+03	0.000E+00	7.750E+02	0.000E+00	6.400E+03	0.000E+00	1.520E+05
RU-105	1.570E-03	0.000E+00	6.080E-04	0.000E+00	1.970E-02	0.000E+00	1.260E+00
RU-106	3.750E+04	0.000E+00	4.730E+03	0.000E+00	7.230E+04	0.000E+00	1.800E+06

ATTACHMENT 12

GRASS-COW-MILK DOSE FACTORS

TEEN

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	9.630E+07	9.110E+07	5.540E+07	0.000E+00	1.740E+08	0.000E+00	2.560E+10
SB-124	1.530E+09	2.820E+07	5.970E+08	3.470E+06	0.000E+00	1.340E+09	3.080E+10
SB-125	1.220E+09	1.330E+07	2.850E+08	1.160E+06	0.000E+00	1.070E+09	9.480E+09
TE-125M	3.000E+07	1.080E+07	4.020E+06	8.390E+06	0.000E+00	0.000E+00	8.860E+07
TE-127M	8.440E+07	2.990E+07	1.000E+07	2.010E+07	3.420E+08	0.000E+00	2.100E+08
TE-127	1.240E+03	4.410E+02	2.680E+02	8.590E+02	5.040E+03	0.000E+00	9.610E+04
TE-129M	1.110E+08	4.100E+07	1.750E+07	3.570E+07	4.620E+08	0.000E+00	4.150E+08
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.670E-09	0.000E+00	2.180E-09
TE-131M	6.570E+05	3.150E+05	2.630E+05	4.740E+05	3.290E+06	0.000E+00	2.530E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	4.280E+06	2.710E+06	2.550E+06	2.860E+06	2.600E+07	0.000E+00	8.580E+07
I-130	7.490E+05	2.170E+06	8.660E+05	1.770E+08	3.340E+06	0.000E+00	1.670E+06
I-131	5.380E+08	7.530E+08	4.040E+08	2.200E+11	1.300E+09	0.000E+00	1.490E+08
I-132	2.900E-01	7.590E-01	2.720E-01	2.560E+01	1.200E+00	0.000E+00	3.310E-01
I-133	7.240E+06	1.230E+07	3.750E+06	1.720E+09	2.150E+07	0.000E+00	9.300E+06
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	2.470E+04	6.350E+04	2.350E+04	4.080E+06	1.000E+05	0.000E+00	7.030E+04
CS-134	9.810E+09	2.310E+10	1.070E+10	0.000E+00	7.340E+09	2.800E+09	2.870E+08
CS-136	4.450E+08	1.750E+09	1.180E+09	0.000E+00	9.530E+08	1.500E+08	1.410E+08
CS-137	1.340E+10	1.780E+10	6.200E+09	0.000E+00	6.060E+09	2.350E+09	2.530E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	8.690E-08	0.000E+00	2.530E-09	0.000E+00	0.000E+00	0.000E+00	7.750E-07
BA-140	4.850E+07	5.950E+04	3.130E+06	0.000E+00	2.020E+04	4.000E+04	7.490E+07
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	8.060E+00	3.960E+00	1.050E+00	0.000E+00	0.000E+00	0.000E+00	2.270E+05
LA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.230E-07
CE-141	8.870E+03	5.920E+03	6.810E+02	0.000E+00	2.790E+03	0.000E+00	1.690E+07
CE-143	7.690E+01	5.600E+04	6.250E+00	0.000E+00	2.510E+01	0.000E+00	1.680E+06
CE-144	6.580E+05	2.720E+05	3.540E+04	0.000E+00	1.630E+05	0.000E+00	1.660E+08
PR-143	2.920E+02	1.170E+02	1.450E+01	0.000E+00	6.770E+01	0.000E+00	9.610E+05
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	1.810E+02	1.970E+02	1.180E+01	0.000E+00	1.160E+02	0.000E+00	7.110E+05
W-187	1.200E+04	9.780E+03	3.430E+03	0.000E+00	0.000E+00	0.000E+00	2.650E+06
NP-239	6.990E+00	6.590E-01	3.660E-01	0.000E+00	2.070E+00	0.000E+00	1.060E+05

ATTACHMENT 12

GRASS-COW-MILK DOSE FACTORS

CHILD

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	1.570E+03	1.570E+03	1.570E+03	1.570E+03	1.570E+03	1.570E+03
C-14	1.650E+06	3.290E+05	3.290E+05	3.290E+05	3.290E+05	3.290E+05	3.290E+05
NA-24	9.230E+06	9.230E+06	9.230E+06	9.230E+06	9.230E+06	9.230E+06	9.230E+06
P-32	7.770E+10	3.640E+09	3.000E+09	0.000E+00	0.000E+00	0.000E+00	2.150E+09
CR-51	0.000E+00	0.000E+00	1.020E+05	5.660E+04	1.550E+04	1.030E+05	5.410E+06
MN-54	0.000E+00	2.090E+07	5.580E+06	0.000E+00	5.870E+06	0.000E+00	1.760E+07
MN-56	0.000E+00	1.310E-02	2.950E-03	0.000E+00	1.580E-02	0.000E+00	1.900E+00
FE-55	1.120E+08	5.930E+07	1.840E+07	0.000E+00	0.000E+00	3.350E+07	1.100E+07
FE-59	1.200E+08	1.950E+08	9.710E+07	0.000E+00	0.000E+00	5.650E+07	2.030E+08
CO-57	0.000E+00	3.840E+06	7.770E+06	0.000E+00	0.000E+00	0.000E+00	3.140E+07
CO-58	0.000E+00	1.210E+07	3.720E+07	0.000E+00	0.000E+00	0.000E+00	7.080E+07
CO-60	0.000E+00	4.320E+07	1.270E+08	0.000E+00	0.000E+00	0.000E+00	2.390E+08
NI-63	2.960E+10	1.590E+09	1.010E+09	0.000E+00	0.000E+00	0.000E+00	1.070E+08
NI-65	1.660E+00	1.560E-01	9.110E-02	0.000E+00	0.000E+00	0.000E+00	1.910E+01
CU-64	0.000E+00	7.550E+04	4.560E+04	0.000E+00	1.820E+05	0.000E+00	3.540E+06
ZN-65	4.130E+09	1.100E+10	6.850E+09	0.000E+00	6.940E+09	0.000E+00	1.930E+09
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.140E-09
BR-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	8.770E+09	5.390E+09	0.000E+00	0.000E+00	0.000E+00	5.640E+08
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	6.620E+09	0.000E+00	1.890E+08	0.000E+00	0.000E+00	0.000E+00	2.560E+08
SR-90	1.120E+11	0.000E+00	2.830E+10	0.000E+00	0.000E+00	0.000E+00	1.510E+09
SR-91	1.410E+05	0.000E+00	5.330E+03	0.000E+00	0.000E+00	0.000E+00	3.120E+05
SR-92	2.190E+00	0.000E+00	8.760E-02	0.000E+00	0.000E+00	0.000E+00	4.140E+01
Y-90	3.220E+02	0.000E+00	8.610E+00	0.000E+00	0.000E+00	0.000E+00	9.150E+05
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	3.910E+04	0.000E+00	1.040E+03	0.000E+00	0.000E+00	0.000E+00	5.210E+06
Y-92	2.460E-04	0.000E+00	7.030E-06	0.000E+00	0.000E+00	0.000E+00	7.100E+00
Y-93	1.060E+00	0.000E+00	2.900E-02	0.000E+00	0.000E+00	0.000E+00	1.570E+04
ZR-95	3.840E+03	8.450E+02	7.520E+02	0.000E+00	1.210E+03	0.000E+00	8.810E+05
ZR-97	1.890E+00	2.720E-01	1.610E-01	0.000E+00	3.910E-01	0.000E+00	4.130E+04
NB-95	3.180E+05	1.240E+05	8.840E+04	0.000E+00	1.160E+05	0.000E+00	2.290E+08
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.450E-06
MO-99	0.000E+00	8.290E+07	2.050E+07	0.000E+00	1.770E+08	0.000E+00	6.860E+07
TC-99M	1.290E+01	2.540E+01	4.200E+02	0.000E+00	3.680E+02	1.290E+01	1.440E+04
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	4.290E+03	0.000E+00	1.650E+03	0.000E+00	1.080E+04	0.000E+00	1.110E+05
RU-105	3.820E-03	0.000E+00	1.390E-03	0.000E+00	3.360E-02	0.000E+00	2.490E+00
RU-106	9.240E+04	0.000E+00	1.150E+04	0.000E+00	1.250E+05	0.000E+00	1.440E+06

ATTACHMENT 12

GRASS-COW-MILK DOSE FACTORS

CHILD

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	2.090E+08	1.410E+08	1.130E+08	0.000E+00	2.630E+08	0.000E+00	1.680E+10
SB-124	3.620E+09	4.700E+07	1.270E+09	7.990E+06	0.000E+00	2.010E+09	2.260E+10
SB-125	2.900E+09	2.240E+07	6.080E+08	2.690E+06	0.000E+00	1.620E+09	6.930E+09
TE-125M	7.380E+07	2.000E+07	9.840E+06	2.070E+07	0.000E+00	0.000E+00	7.120E+07
TE-127M	2.080E+08	5.600E+07	2.470E+07	4.970E+07	5.930E+08	0.000E+00	1.680E+08
TE-127	3.060E+03	8.50E+02	6.560E+02	2.120E+03	8.710E+03	0.000E+00	1.200E+05
TE-129M	2.720E+08	7.610E+07	4.230E+07	8.780E+07	8.000E+08	0.000E+00	3.320E+08
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.870E-09	0.000E+00	6.120E-08
TE-131M	1.600E+06	5.530E+05	5.890E+05	1.140E+06	5.350E+06	0.000E+00	2.240E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	1.070E+07	4.520E+06	5.460E+06	6.580E+06	4.200E+07	0.000E+00	4.550E+07
I-130	1.750E+06	3.540E+06	1.820E+06	3.900E+08	5.290E+06	0.000E+00	1.660E+06
I-131	1.300E+09	1.310E+09	7.460E+08	4.340E+11	2.150E+09	0.000E+00	1.170E+08
I-132	6.860E-01	1.260E+00	5.800E-01	5.850E+01	1.930E+00	0.000E+00	1.480E+00
I-133	1.760E+07	2.180E+07	8.230E+06	4.040E+09	3.630E+07	0.000E+00	8.770E+06
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	5.840E+04	1.050E+05	4.970E+04	9.300E+06	1.610E+05	0.000E+00	8.000E+04
CS-134	2.260E+10	3.710E+10	7.830E+09	0.000E+00	1.150E+10	4.130E+09	2.000E+08
CS-136	1.000E+09	2.760E+09	1.790E+09	0.000E+00	1.470E+09	2.190E+08	9.700E+07
CS-137	3.220E+10	3.090E+10	4.550E+09	0.000E+00	1.010E+10	3.620E+09	1.930E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	2.140E-07	0.000E+00	6.190E-09	0.000E+00	0.000E+00	0.000E+00	1.230E-05
BA-140	1.170E+08	1.030E+05	6.840E+06	0.000E+00	3.340E+04	6.120E+04	5.940E+07
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	1.930E+01	6.740E+00	2.270E+00	0.000E+00	0.000E+00	0.000E+00	1.880E+05
LA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.510E-06
CE-141	2.190E+04	1.090E+04	1.620E+03	0.000E+00	4.780E+03	0.000E+00	1.360E+07
CE-143	1.890E+02	1.020E+05	1.480E+01	0.000E+00	1.290E+01	0.000E+00	1.500E+06
CE-144	1.620E+06	5.090E+05	8.660E+04	0.000E+00	2.820E+05	0.000E+00	1.330E+08
PR-143	7.230E+02	2.170E+02	3.590E+01	0.000E+00	1.170E+02	0.000E+00	7.800E+05
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	4.450E+02	3.600E+02	2.790E+01	0.000E+00	1.980E+02	0.000E+00	5.710E+05
W-187	2.910E+04	1.720E+04	7.730E+03	0.000E+00	0.000E+00	0.000E+00	2.420E+06
NP-239	1.720E+01	1.230E+00	8.680E-01	0.000E+00	3.570E+00	0.000E+00	9.140E+04

ATTACHMENT 12

GRASS-COW-MILK DOSE FACTORS

INFANT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	2.380E+03	2.380E+03	2.380E+03	2.380E+03	2.380E+03	2.380E+03
C-14	3.230E+06	6.890E+05	6.890E+05	6.890E+05	6.890E+05	6.890E+05	6.890E+05
NA-24	1.610E+07	1.610E+07	1.610E+07	1.610E+07	1.610E+07	1.610E+07	1.610E+07
P-32	1.600E+11	9.420E+09	6.210E+09	0.000E+00	0.000E+00	0.000E+00	2.170E+09
CR-51	0.000E+00	0.000E+00	1.610E+05	1.050E+05	2.300E+04	2.050E+05	4.710E+06
MN-54	0.000E+00	3.890E+07	8.830E+06	0.000E+00	8.630E+06	0.000E+00	1.430E+07
MN-56	0.000E+00	3.210E-02	5.530E-03	0.000E+00	2.760E-02	0.000E+00	2.910E+00
FE-55	1.350E+08	8.720E+07	2.330E+07	0.000E+00	0.000E+00	4.270E+07	1.110E+07
FE-59	2.250E+08	3.930E+08	1.550E+08	0.000E+00	0.000E+00	1.160E+08	1.880E+08
CO-57	0.000E+00	8.950E+06	1.460E+07	0.000E+00	0.000E+00	0.000E+00	3.050E+07
CO-58	0.000E+00	2.430E+07	6.060E+07	0.000E+00	0.000E+00	0.000E+00	6.050E+07
CO-60	0.000E+00	8.810E+07	2.080E+08	0.000E+00	0.000E+00	0.000E+00	2.100E+08
NI-63	3.490E+10	2.160E+09	1.210E+09	0.000E+00	0.000E+00	0.000E+00	1.070E+08
NI-65	3.510E+00	3.970E-01	1.810E-01	0.000E+00	0.000E+00	0.000E+00	3.020E+01
CU-64	0.000E+00	1.880E+05	8.690E+04	0.000E+00	3.170E+05	0.000E+00	3.850E+06
ZN-65	5.550E+09	1.900E+10	8.780E+09	0.000E+00	9.230E+09	0.000E+00	1.610E+10
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.360E-09
BR-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.220E+10	1.100E+10	0.000E+00	0.000E+00	0.000E+00	5.690E+08
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	1.260E+10	0.000E+00	3.610E+08	0.000E+00	0.000E+00	0.000E+00	2.590E+08
SR-90	1.220E+11	0.000E+00	3.100E+10	0.000E+00	0.000E+00	0.000E+00	1.520E+09
SR-91	2.940E+05	0.000E+00	1.060E+04	0.000E+00	0.000E+00	0.000E+00	3.480E+05
SR-92	4.650E+00	0.000E+00	1.730E-01	0.000E+00	0.000E+00	0.000E+00	5.010E+01
Y-90	6.800E+02	0.000E+00	1.820E+01	0.000E+00	0.000E+00	0.000E+00	9.390E+05
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	7.330E+04	0.000E+00	1.950E+03	0.000E+00	0.000E+00	0.000E+00	5.260E+06
Y-92	5.220E-04	0.000E+00	1.470E-05	0.000E+00	0.000E+00	0.000E+00	9.970E+00
Y-93	2.250E+00	0.000E+00	6.130E-02	0.000E+00	0.000E+00	0.000E+00	1.780E+04
ZR-95	6.830E+03	1.660E+03	1.180E+03	0.000E+00	1.790E+03	0.000E+00	8.280E+05
ZR-97	3.990E+00	6.850E-01	3.130E-01	0.000E+00	6.910E-01	0.000E+00	4.370E+04
NB-95	5.930E+05	2.440E+05	1.410E+05	0.000E+00	1.750E+05	0.000E+00	2.060E+08
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.700E-06
MO-99	0.000E+00	2.120E+08	4.130E+07	0.000E+00	3.170E+08	0.000E+00	6.980E+07
TC-99M	2.690E+01	5.550E+01	7.150E+02	0.000E+00	5.970E+02	2.900E+01	1.610E+04
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	8.690E+03	0.000E+00	2.910E+03	0.000E+00	1.810E+04	0.000E+00	1.060E+05
RU-105	8.060E-03	0.000E+00	2.710E-03	0.000E+00	5.920E-02	0.000E+00	3.210E+00
RU-106	1.900E+05	0.000E+00	2.380E+04	0.000E+00	2.250E+05	0.000E+00	1.440E+06

ATTACHMENT 12

GRASS-COW-MILK DOSE FACTORS

INFANT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	3.860E+08	2.820E+08	1.860E+08	0.000E+00	4.030E+08	0.000E+00	1.460E+10
SB-124	6.980E+09	1.030E+08	2.160E+09	1.850E+07	0.000E+00	4.370E+09	2.150E+10
SB-125	4.980E+09	4.820E+07	1.020E+09	6.240E+06	0.000E+00	3.130E+09	6.640E+09
TE-125M	1.510E+08	5.040E+07	2.040E+07	5.070E+07	0.000E+00	0.000E+00	7.180E+07
TE-127M	4.210E+08	1.400E+08	5.100E+07	1.220E+08	1.040E+09	0.000E+00	1.700E+08
TE-127	6.500E+03	2.180E+03	1.400E+03	5.290E+03	1.590E+04	0.000E+00	1.360E+05
TE-129M	5.590E+08	1.920E+08	8.620E+07	2.150E+08	1.400E+09	0.000E+00	3.340E+08
TE-129	2.080E-09	0.000E+00	0.000E+00	1.750E-09	5.180E-09	0.000E+00	1.660E-07
TE-131M	3.380E+06	1.360E+06	1.120E+06	2.760E+06	9.350E+06	0.000E+00	2.290E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	2.100E+07	1.040E+07	9.720E+06	1.540E+07	6.510E+07	0.000E+00	3.850E+07
I-130	3.600E+06	7.920E+06	3.180E+06	8.880E+08	8.700E+06	0.000E+00	1.700E+06
I-131	2.720E+09	3.210E+09	1.410E+09	1.050E+12	3.750E+09	0.000E+00	1.150E+08
I-132	1.420E+00	2.890E+00	1.030E+00	1.350E+02	3.220E+00	0.000E+00	2.340E+00
I-133	3.720E+07	5.410E+07	1.580E+07	9.840E+09	6.360E+07	0.000E+00	9.160E+06
I-134	0.000E+00	0.000E+00	0.000E+00	1.010E-09	0.000E+00	0.000E+00	0.000E+00
I-135	1.210E+05	2.410E+05	8.800E+04	2.160E+07	2.690E+05	0.000E+00	8.740E+04
CS-134	3.650E+10	6.800E+10	6.870E+09	0.000E+00	1.750E+10	7.180E+09	1.850E+08
CS-136	1.960E+09	5.770E+09	2.150E+09	0.000E+00	2.300E+09	4.700E+08	8.760E+07
CS-137	5.150E+10	6.020E+10	4.270E+09	0.000E+00	1.620E+10	6.550E+09	1.880E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	4.550E-07	0.000E+00	1.320E-08	0.000E+00	0.000E+00	0.000E+00	2.880E-05
BA-140	2.410E+08	2.410E+05	1.240E+07	0.000E+00	5.730E+04	1.480E+05	5.920E+07
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	4.030E+01	1.590E+01	4.090E+00	0.000E+00	0.000E+00	0.000E+00	1.870E+05
LA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.210E-06
CE-141	4.330E+04	2.640E+04	3.110E+03	0.000E+00	8.150E+03	0.000E+00	1.370E+07
CE-143	4.000E+02	2.650E+05	3.020E+01	0.000E+00	7.720E+01	0.000E+00	1.550E+06
CE-144	2.330E+06	9.520E+05	1.300E+05	0.000E+00	3.850E+05	0.000E+00	1.330E+08
PR-143	1.490E+03	5.590E+02	7.410E+01	0.000E+00	2.080E+02	0.000E+00	7.890E+05
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	8.820E+02	9.060E+02	5.550E+01	0.000E+00	3.490E+02	0.000E+00	5.740E+05
W-187	6.120E+04	4.260E+04	1.470E+04	0.000E+00	0.000E+00	0.000E+00	2.500E+06
NP-239	3.640E+01	3.250E+00	1.840E+00	0.000E+00	6.490E+00	0.000E+00	9.400E+04

ATTACHMENT 12

GRASS-GOAT-MILK DOSE FACTORS

ADULT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	1.560E+03	1.560E+03	1.560E+03	1.560E+03	1.560E+03	1.560E+03
C-14	3.630E+05	7.260E+04	7.260E+04	7.260E+04	7.260E+04	7.260E+04	7.260E+04
NA-24	3.050E+05	3.050E+05	3.050E+05	3.050E+05	3.050E+05	3.050E+05	3.050E+05
P-32	2.050E+10	1.270E+09	7.930E+08	0.000E+00	0.000E+00	0.000E+00	2.310E+09
CR-51	0.000E+00	0.000E+00	3.430E+03	2.050E+03	7.560E+02	4.560E+03	8.640E+05
MN-54	0.000E+00	1.010E+06	1.920E+05	0.000E+00	3.000E+05	0.000E+00	3.090E+06
MN-56	0.000E+00	5.080E-04	9.010E-05	0.000E+00	6.450E-04	0.000E+00	1.620E-02
FE-55	3.260E+05	2.250E+05	5.260E+04	0.000E+00	0.000E+00	1.260E+05	1.290E+05
FE-59	3.870E+05	9.090E+05	3.490E+05	0.000E+00	0.000E+00	2.540E+05	3.030E+06
CO-57	0.000E+00	1.540E+05	2.550E+05	0.000E+00	0.000E+00	0.000E+00	3.900E+06
CO-58	0.000E+00	5.660E+05	1.270E+06	0.000E+00	0.000E+00	0.000E+00	1.150E+07
CO-60	0.000E+00	1.970E+06	4.340E+06	0.000E+00	0.000E+00	0.000E+00	3.700E+07
NI-63	8.070E+08	5.600E+07	2.710E+07	0.000E+00	0.000E+00	0.000E+00	1.170E+07
NI-65	4.440E-02	5.770E-03	2.630E-03	0.000E+00	0.000E+00	0.000E+00	1.460E-01
CU-64	0.000E+00	2.690E+03	1.260E+03	0.000E+00	6.770E+03	0.000E+00	2.290E+05
ZN-65	1.650E+08	5.240E+08	2.370E+08	0.000E+00	3.500E+08	0.000E+00	3.300E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-82	0.000E+00	0.000E+00	3.900E+06	0.000E+00	0.000E+00	0.000E+00	4.470E+06
BR-83	0.000E+00	0.000E+00	1.240E-02	0.000E+00	0.000E+00	0.000E+00	1.790E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	3.110E+08	1.450E+08	0.000E+00	0.000E+00	0.000E+00	6.140E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.050E+09	0.000E+00	8.740E+07	0.000E+00	0.000E+00	0.000E+00	4.890E+08
SR-90	9.830E+28	0.000E+00	2.410E+28	0.000E+00	0.000E+00	0.000E+00	2.840E+09
SR-91	6.580E+04	0.000E+00	2.660E+03	0.000E+00	0.000E+00	0.000E+00	3.130E+05
SR-92	1.030E+00	0.000E+00	4.440E-02	0.000E+00	0.000E+00	0.000E+00	2.030E+01
Y-90	8.480E+00	0.000E+00	2.280E-01	0.000E+00	0.000E+00	0.000E+00	8.990E+04
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	1.030E+03	0.000E+00	2.760E+01	0.000E+00	0.000E+00	0.000E+00	5.680E+05
Y-92	6.510E-06	0.000E+00	1.900E-07	0.000E+00	0.000E+00	0.000E+00	1.140E-01
Y-93	2.800E-02	0.000E+00	7.720E-04	0.000E+00	0.000E+00	0.000E+00	8.870E+02
ZR-95	1.140E+02	3.640E+01	2.470E+01	0.000E+00	5.710E+01	0.000E+00	1.150E+05
ZR-97	5.110E-02	1.030E-02	4.710E-03	0.000E+00	1.560E-02	0.000E+00	3.190E+03
NB-95	9.900E+03	5.510E+03	2.960E+03	0.000E+00	5.440E+03	0.000E+00	3.340E+07
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO-99	0.000E+00	3.030E+06	5.760E+05	0.000E+00	6.860E+06	0.000E+00	7.020E+06
TC-99M	3.900E-01	1.100E+00	1.400E+01	0.000E+00	1.670E+01	5.400E-01	6.520E+02
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.220E+02	0.000E+00	5.270E+01	0.000E+00	4.670E+02	0.000E+00	1.430E+04
RU-105	1.030E-04	0.000E+00	4.060E-05	0.000E+00	1.330E-03	0.000E+00	6.290E-02
RU-106	2.450E+03	0.000E+00	3.100E+02	0.000E+00	4.730E+03	0.000E+00	1.580E+05

ATTACHMENT 12

GRASS-GOAT-MILK DOSE FACTORS

ADULT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	6.990E+06	6.470E+06	3.840E+06	0.000E+00	1.270E+07	0.000E+00	2.640E+09
SB-124	3.090E+06	5.840E+04	1.220E+06	7.490E+03	0.000E+00	2.410E+06	8.770E+07
SB-125	2.450E+06	2.740E+04	5.840E+05	2.490E+03	0.000E+00	1.890E+06	2.700E+07
TE-125M	1.950E+06	7.080E+05	2.620E+05	5.880E+05	7.950E+06	0.000E+00	7.810E+06
TE-127M	5.490E+06	1.960E+06	6.690E+05	1.400E+06	2.230E+07	0.000E+00	1.840E+07
TE-127	8.060E+01	2.890E+01	1.740E+01	5.970E+01	3.280E+02	0.000E+00	6.360E+03
TE-129M	7.250E+06	2.710E+06	1.150E+06	2.490E+06	3.030E+07	0.000E+00	3.650E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	4.330E+04	2.120E+04	1.770E+04	3.360E+04	2.150E+05	0.000E+00	2.100E+06
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	2.870E+05	1.860E+05	1.740E+05	2.050E+05	1.790E+06	0.000E+00	8.790E+06
I-130	5.110E+05	1.510E+06	5.950E+05	1.280E+08	2.350E+06	0.000E+00	1.300E+06
I-131	3.560E+08	5.090E+08	2.920E+08	1.670E+11	8.720E+08	0.000E+00	1.340E+08
I-132	1.960E-01	5.250E-01	1.840E-01	1.840E+01	8.360E-01	0.000E+00	9.860E-02
I-133	4.760E+06	8.280E+06	2.520E+06	1.220E+09	1.440E+07	0.000E+00	7.440E+06
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	1.670E+04	4.360E+04	1.610E+04	2.880E+06	6.990E+04	0.000E+00	4.920E+04
CS-134	1.700E+10	4.030E+10	3.300E+10	0.000E+00	1.310E+10	4.330E+09	7.060E+08
CS-136	7.840E+08	3.090E+09	2.230E+09	0.000E+00	1.720E+09	2.360E+08	3.520E+08
CS-137	2.210E+10	3.030E+10	1.980E+10	0.000E+00	1.030E+10	3.420E+09	5.860E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	5.640E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.000E-08
BA-140	3.230E+06	4.050E+03	2.110E+05	0.000E+00	1.380E+03	2.320E+03	6.650E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	5.380E-01	2.710E-01	1.990E+04	0.000E+00	0.000E+00	0.000E+00	1.990E+04
LA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.640E-09
CE-141	5.810E+02	3.930E+02	4.450E+01	0.000E+00	1.820E+02	0.000E+00	1.500E+06
CE-143	5.020E+00	3.710E+03	4.110E-01	0.000E+00	1.630E+00	0.000E+00	1.390E+05
CE-144	4.290E+04	1.790E+04	2.300E+03	0.000E+00	1.060E+04	0.000E+00	1.450E+07
PR-143	1.910E+01	7.650E+00	9.450E-01	0.000E+00	4.410E+00	0.000E+00	8.350E+04
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	1.130E+01	1.310E+01	7.820E-01	0.000E+00	7.640E+00	0.000E+00	6.270E+04
W-187	7.870E+02	6.580E+02	2.300E+02	0.000E+00	0.000E+00	0.000E+00	2.160E+05
NP-239	4.390E-01	4.320E-02	2.380E-02	0.000E+00	1.350E-01	0.000E+00	8.860E+03

ATTACHMENT 12

GRASS-GOAT-MILK DOSE FACTORS

TEEN

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	2.030E+03	2.030E+03	2.030E+03	2.030E+03	2.030E+03	2.030E+03
C-14	6.700E+05	1.340E+05	1.340E+05	1.340E+05	1.340E+05	1.340E+05	1.340E+05
NA-24	5.330E+05	5.330E+05	5.330E+05	5.330E+05	5.330E+05	5.330E+05	5.330E+05
P-32	3.780E+10	2.340E+09	1.470E+09	0.000E+00	0.000E+00	0.000E+00	3.180E+09
CR-51	0.000E+00	0.000E+00	6.000E+03	3.330E+03	1.310E+03	8.560E+03	1.010E+06
MN-54	0.000E+00	1.680E+06	3.330E+05	0.000E+00	5.010E+05	0.000E+00	3.440E+06
MN-56	0.000E+00	9.010E-04	1.600E-04	0.000E+00	1.140E-03	0.000E+00	5.930E-02
FE-55	5.790E+05	4.100E+05	9.570E+04	0.000E+00	0.000E+00	2.600E+05	1.780E+05
FE-59	6.750E+05	1.580E+06	6.090E+05	0.000E+00	0.000E+00	4.970E+05	3.730E+06
CO-57	0.000E+00	2.690E+05	4.520E+05	0.000E+00	0.000E+00	0.000E+00	5.030E+06
CO-58	0.000E+00	9.540E+05	2.200E+06	0.000E+00	0.000E+00	0.000E+00	1.310E+07
CO-60	0.000E+00	3.340E+06	7.510E+06	0.000E+00	0.000E+00	0.000E+00	4.350E+07
NI-63	1.420E+09	1.000E+08	4.810E+07	0.000E+00	0.000E+00	0.000E+00	1.590E+07
NI-65	8.130E-02	1.040E-02	4.730E-03	0.000E+00	0.000E+00	0.000E+00	5.640E-01
CU-64	0.000E+00	4.790E+03	2.250E+03	0.000E+00	1.210E+04	0.000E+00	3.710E+05
ZN-65	2.530E+08	8.780E+08	4.090E+08	0.000E+00	5.620E+08	0.000E+00	3.720E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-82	0.000E+00	0.000E+00	6.670E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	2.290E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	5.670E+08	2.670E+08	0.000E+00	0.000E+00	0.000E+00	8.400E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	5.620E+09	0.000E+00	1.160E+08	0.000E+00	0.000E+00	0.000E+00	6.690E+08
SR-90	1.390E+11	0.000E+00	3.430E+11	0.000E+00	0.000E+00	0.000E+00	3.900E+09
SR-91	1.210E+05	0.000E+00	4.810E+03	0.000E+00	0.000E+00	0.000E+00	5.480E+05
SR-92	1.880E+00	0.000E+00	8.010E-02	0.000E+00	0.000E+00	0.000E+00	4.790E+01
Y-90	1.560E+01	0.000E+00	4.200E-01	0.000E+00	0.000E+00	0.000E+00	1.290E+05
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	1.900E+03	0.000E+00	5.090E+01	0.000E+00	0.000E+00	0.000E+00	7.780E+05
Y-92	1.200E-05	0.000E+00	3.480E-07	0.000E+00	0.000E+00	0.000E+00	3.300E-01
Y-93	5.160E-02	0.000E+00	1.410E-03	0.000E+00	0.000E+00	0.000E+00	1.580E+03
ZR-95	1.990E+02	6.260E+01	4.310E+01	0.000E+00	9.200E+01	0.000E+00	1.450E+05
ZR-97	9.300E-02	1.840E-02	8.480E-03	0.000E+00	2.790E-02	0.000E+00	4.980E+03
NB-95	1.690E+04	9.370E+03	5.160E+03	0.000E+00	9.080E+03	0.000E+00	4.010E+07
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.610E-09
MO-99	0.000E+00	5.470E+06	1.040E+06	0.000E+00	1.250E+07	0.000E+00	9.800E+06
TC-99M	6.770E-01	1.890E+00	2.450E+01	0.000E+00	2.810E+01	1.030E+00	1.240E+03
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	2.180E+02	0.000E+00	9.310E+01	0.000E+00	7.670E+02	0.000E+00	1.820E+04
RU-105	1.880E-04	0.000E+00	7.290E-05	0.000E+00	2.370E-03	0.000E+00	1.520E-01
RU-106	4.500E+03	0.000E+00	5.670E+02	0.000E+00	8.680E+03	0.000E+00	2.160E+05

ATTACHMENT 12

GRASS-GOAT-MILK DOSE FACTORS

TEEN

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	1.160E+07	1.090E+07	6.650E+06	0.000E+00	2.090E+07	0.000E+00	3.070E+09
SB-124	5.510E+06	1.020E+05	2.150E+06	1.250E+04	0.000E+00	4.810E+06	1.110E+08
SB-125	4.380E+06	4.790E+04	1.030E+06	4.190E+03	0.000E+00	3.850E+06	3.410E+07
TE-125M	3.600E+06	1.300E+06	4.820E+05	1.010E+06	0.000E+00	0.000E+00	1.060E+07
TE-127M	1.010E+07	3.590E+06	1.200E+06	2.410E+06	4.100E+07	0.000E+00	2.520E+07
TE-127	1.490E+02	5.290E+01	3.210E+01	1.030E+02	6.050E+02	0.000E+00	1.150E+04
TE-129M	1.330E+07	4.920E+06	2.100E+06	4.280E+06	5.550E+07	0.000E+00	4.980E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	7.890E+04	3.780E+04	3.150E+04	5.690E+04	3.940E+05	0.000E+00	3.030E+06
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	5.130E+05	3.250E+05	3.060E+05	3.430E+05	3.120E+06	0.000E+00	1.030E+07
I-130	8.990E+05	2.600E+06	1.040E+06	2.120E+08	4.010E+06	0.000E+00	2.000E+06
I-131	6.450E+08	9.030E+08	4.850E+08	2.640E+11	1.560E+09	0.000E+00	1.790E+08
I-132	3.480E-01	9.110E-01	3.270E-01	3.070E+01	1.430E+00	0.000E+00	3.970E-01
I-133	8.690E+06	1.470E+07	4.500E+06	2.060E+09	2.590E+07	0.000E+00	1.120E+07
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	2.960E+04	7.620E+04	2.820E+04	4.900E+06	1.200E+05	0.000E+00	8.440E+04
CS-134	2.940E+10	6.930E+10	3.210E+10	0.000E+00	2.200E+10	8.410E+09	8.620E+08
CS-136	1.330E+09	5.250E+09	3.530E+09	0.000E+00	2.860E+09	4.510E+08	4.230E+08
CS-137	4.020E+10	5.340E+10	1.860E+10	0.000E+00	1.820E+10	7.060E+09	7.600E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	1.040E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.310E-08
BA-140	5.830E+06	7.140E+03	3.750E+05	0.000E+00	2.420E+03	4.800E+03	8.980E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	9.760E-01	4.750E-01	1.260E-01	0.000E+00	0.000E+00	0.000E+00	2.730E+04
LA-142	1.980E-12	8.780E-13	2.190E-13	0.000E+00	0.000E+00	0.000E+00	2.670E-08
CE-141	1.060E+03	7.110E+02	8.170E+01	0.000E+00	3.350E+02	0.000E+00	2.030E+06
CE-143	9.230E+00	6.720E+03	7.500E-01	0.000E+00	3.010E+00	0.000E+00	2.020E+05
CE-144	7.900E+04	3.270E+04	4.240E+03	0.000E+00	1.950E+04	0.000E+00	1.990E+07
PR-143	3.500E+01	1.400E+01	1.740E+00	0.000E+00	8.130E+00	0.000E+00	1.150E+05
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	2.180E+01	2.370E+01	1.420E+00	0.000E+00	1.390E+01	0.000E+00	8.530E+04
W-187	1.440E+03	1.170E+03	4.110E+02	0.000E+00	0.000E+00	0.000E+00	3.180E+05
NP-239	8.390E-01	7.910E-02	4.390E-02	0.000E+00	2.480E-01	0.000E+00	1.270E+04

ATTACHMENT 12

GRASS-GOAT-MILK DOSE FACTORS

CHILD

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	3.200E+03	3.200E+03	3.200E+03	3.200E+03	3.200E+03	3.200E+03
C-14	1.650E+06	3.290E+05	3.290E+05	3.290E+05	3.290E+05	3.290E+05	3.290E+05
NA-24	1.110E+06	1.110E+06	1.110E+06	1.110E+06	1.110E+06	1.110E+06	1.110E+06
P-32	9.330E+10	4.370E+09	3.600E+09	0.000E+00	0.000E+00	0.000E+00	2.580E+09
CR-51	0.000E+00	0.000E+00	1.220E+04	6.790E+03	1.860E+03	1.240E+04	6.490E+05
MN-54	0.000E+00	2.510E+06	6.690E+05	0.000E+00	7.050E+05	0.000E+00	2.110E+06
MN-56	0.000E+00	1.570E-03	3.550E-04	0.000E+00	1.900E-03	0.000E+00	2.280E-01
FE-55	1.450E+06	7.700E+05	2.390E+05	0.000E+00	0.000E+00	4.360E+05	1.430E+05
FE-59	1.570E+06	2.530E+06	1.260E+06	0.000E+00	0.000E+00	7.350E+05	2.640E+06
CO-57	0.000E+00	4.600E+05	9.320E+05	0.000E+00	0.000E+00	0.000E+00	3.770E+06
CO-58	0.000E+00	1.460E+06	4.460E+06	0.000E+00	0.000E+00	0.000E+00	8.500E+06
CO-60	0.000E+00	5.180E+06	1.530E+07	0.000E+00	0.000E+00	0.000E+00	2.870E+07
NI-63	3.560E+09	1.900E+08	1.210E+08	0.000E+00	0.000E+00	0.000E+00	1.280E+07
NI-65	1.990E-01	1.870E-02	1.090E-02	0.000E+00	0.000E+00	0.000E+00	2.290E+00
CU-64	0.000E+00	8.410E+03	5.080E+03	0.000E+00	2.030E+04	0.000E+00	3.950E+05
ZN-65	4.960E+08	1.320E+09	8.220E+08	0.000E+00	8.330E+08	0.000E+00	2.320E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-82	0.000E+00	0.000E+00	1.390E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	5.620E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.050E+09	6.470E+08	0.000E+00	0.000E+00	0.000E+00	6.770E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	1.390E+10	0.000E+00	3.970E+08	0.000E+00	0.000E+00	0.000E+00	5.380E+08
SR-90	2.350E+11	0.000E+00	5.950E+10	0.000E+00	0.000E+00	0.000E+00	3.190E+09
SR-91	2.970E+05	0.000E+00	1.120E+04	0.000E+00	0.000E+00	0.000E+00	6.550E+05
SR-92	4.590E+10	0.000E+00	1.840E-01	0.000E+00	0.000E+00	0.000E+00	8.690E+01
Y-90	3.860E+01	0.000E+00	1.030E+00	0.000E+00	0.000E+00	0.000E+00	1.100E+05
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	4.690E+03	0.000E+00	1.250E+02	0.000E+00	0.000E+00	0.000E+00	6.250E+05
Y-92	2.950E-05	0.000E+00	8.440E-07	0.000E+00	0.000E+00	0.000E+00	8.520E-01
Y-93	1.270E-01	0.000E+00	3.480E-03	0.000E+00	0.000E+00	0.000E+00	1.890E+03
ZR-95	4.610E+02	1.010E+02	9.030E+01	0.000E+00	1.450E+02	0.000E+00	1.060E+05
ZR-97	2.260E-01	3.270E-02	1.930E-02	0.000E+00	4.690E-02	0.000E+00	4.950E+03
NB-95	3.810E+04	1.480E+04	1.060E+04	0.000E+00	1.390E+04	0.000E+00	2.750E+07
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.740E-07
MO-99	0.000E+00	9.950E+06	2.460E+06	0.000E+00	2.120E+07	0.000E+00	8.230E+06
TC-99M	1.550E+00	3.040E+00	5.040E+01	0.000E+00	4.420E+01	1.550E+00	1.730E+03
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	5.150E+02	0.000E+00	1.980E+02	0.000E+00	1.300E+03	0.000E+00	1.330E+04
RU-105	4.590E-04	0.000E+00	1.660E-04	0.000E+00	4.030E-03	0.000E+00	2.990E-01
RU-106	1.110E+04	0.000E+00	1.380E+03	0.000E+00	1.500E+04	0.000E+00	1.720E+05

ATTACHMENT 12

GRASS-GOAT-MILK DOSE FACTORS

CHILD

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	2.510E+07	1.690E+07	1.350E+07	0.000E+00	3.150E+07	0.000E+00	2.010E+09
SB-124	1.300E+07	1.690E+05	4.570E+06	2.880E+04	0.000E+00	7.240E+06	8.150E+07
SB-125	1.040E+07	8.050E+04	2.190E+06	9.670E+03	0.000E+00	5.820E+06	2.490E+07
TE-125M	8.850E+06	2.400E+06	1.180E+06	2.480E+06	0.000E+00	0.000E+00	8.540E+06
TE-127M	2.500E+07	6.720E+06	2.960E+06	5.970E+06	7.120E+07	0.000E+00	2.020E+07
TE-127	3.670E+02	9.910E+01	7.880E+01	2.540E+02	1.050E+03	0.000E+00	1.440E+04
TE-129M	3.270E+07	9.130E+06	5.080E+06	1.050E+07	9.600E+07	0.000E+00	3.990E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.340E-09
TE-131M	1.920E+05	6.640E+04	7.070E+04	1.370E+05	6.430E+05	0.000E+00	2.690E+06
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	1.230E+06	5.420E+05	6.550E+05	7.900E+05	5.040E+06	0.000E+00	5.460E+06
I-130	2.100E+06	4.250E+06	2.190E+06	4.680E+08	6.350E+06	0.000E+00	1.990E+06
I-131	1.570E+09	1.570E+09	8.950E+08	5.210E+11	2.580E+09	0.000E+00	1.400E+08
I-132	8.230E-01	1.510E+00	6.960E-01	7.020E+01	2.320E+00	0.000E+00	1.780E+00
I-133	2.110E+07	2.610E+07	9.880E+06	4.850E+09	4.350E+07	0.000E+00	1.050E+07
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	7.000E+04	1.260E+05	5.960E+04	1.120E+07	1.930E+05	0.000E+00	9.600E+04
CS-134	6.790E+10	1.110E+11	2.350E+10	0.000E+00	3.450E+10	1.240E+10	6.010E+08
CS-136	3.010E+09	8.280E+09	5.360E+09	0.000E+00	4.410E+09	6.580E+08	2.910E+08
CS-137	9.670E+10	9.260E+10	1.370E+10	0.000E+00	3.020E+10	1.090E+10	5.800E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	2.560E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.480E-06
BA-140	1.410E+07	1.230E+04	8.210E+05	0.000E+00	4.010E+03	7.340E+03	7.120E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	2.310E+00	8.090E-01	2.730E-01	0.000E+00	0.000E+00	0.000E+00	2.260E+04
LA-142	4.770E-12	1.520E-12	4.770E-13	0.000E+00	0.000E+00	0.000E+00	3.020E-07
CE-141	2.620E+03	1.310E+03	1.940E+02	0.000E+00	5.730E+02	0.000E+00	1.630E+06
CE-143	2.270E+01	1.230E+04	1.780E+00	0.000E+00	5.150E+00	0.000E+00	1.800E+05
CE-144	1.950E+05	6.100E+04	1.040E+04	0.000E+00	3.380E+04	0.000E+00	1.590E+07
PR-143	8.670E+01	2.600E+01	4.300E+00	0.000E+00	1.410E+01	0.000E+00	9.350E+04
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	5.340E+01	4.320E+01	3.350E+00	0.000E+00	2.370E+01	0.000E+00	6.850E+04
W-187	3.490E+03	2.070E+03	9.270E+02	0.000E+00	0.000E+00	0.000E+00	2.900E+05
NP-239	2.060E+00	1.480E-01	1.040E-01	0.000E+00	4.280E-01	0.000E+00	1.100E+04

ATTACHMENT 12

GRASS-GOAT-MILK DOSE FACTORS

INFANT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	4.860E+03	4.860E+03	4.860E+03	4.860E+03	4.860E+03	4.860E+03
C-14	3.230E+06	6.890E+05	6.890E+05	6.890E+05	6.890E+05	6.890E+05	6.890E+05
NA-24	1.930E+06	1.930E+06	1.930E+06	1.930E+06	1.930E+06	1.930E+06	1.930E+06
P-32	1.920E+11	1.130E+10	7.450E+09	0.000E+00	0.000E+00	0.000E+00	2.600E+09
CR-51	0.000E+00	0.000E+00	1.940E+04	1.260E+04	2.760E+03	2.460E+04	5.650E+05
MN-54	0.000E+00	4.670E+06	1.060E+06	0.000E+00	1.040E+06	0.000E+00	1.720E+06
MN-56	0.000E+00	3.850E-03	6.630E-04	0.000E+00	3.310E-03	0.000E+00	3.490E-01
FE-55	1.760E+06	1.130E+06	3.030E+05	0.000E+00	0.000E+00	5.540E+05	1.440E+05
FE-59	2.920E+06	5.110E+06	2.010E+06	0.000E+00	0.000E+00	1.510E+06	2.440E+06
CO-57	0.000E+00	1.070E+06	1.750E+06	0.000E+00	0.000E+00	0.000E+00	3.660E+06
CO-58	0.000E+00	2.910E+06	7.270E+06	0.000E+00	0.000E+00	0.000E+00	7.260E+06
CO-60	0.000E+00	1.060E+07	2.500E+07	0.000E+00	0.000E+00	0.000E+00	2.520E+07
NI-63	4.190E+09	2.590E+08	1.450E+08	0.000E+00	0.000E+00	0.000E+00	1.290E+07
NI-65	4.210E-01	4.770E-02	2.170E-02	0.000E+00	0.000E+00	0.000E+00	3.630E+00
CU-64	0.000E+00	2.090E+04	9.680E+03	0.000E+00	3.540E+04	0.000E+00	4.290E+05
ZN-65	6.660E+08	2.280E+09	1.050E+09	0.000E+00	1.110E+09	0.000E+00	1.930E+09
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-82	0.000E+00	0.000E+00	2.330E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	1.190E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.670E+09	1.320E+09	0.000E+00	0.000E+00	0.000E+00	6.830E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	2.640E+10	0.000E+00	7.580E+08	0.000E+00	0.000E+00	0.000E+00	5.430E+08
SR-90	2.550E+11	0.000E+00	6.500E+10	0.000E+00	0.000E+00	0.000E+00	3.190E+09
SR-91	6.180E+05	0.000E+00	2.240E+04	0.000E+00	0.000E+00	0.000E+00	7.310E+05
SR-92	9.760E+00	0.000E+00	3.620E-01	0.000E+00	0.000E+00	0.000E+00	1.050E+02
Y-90	8.160E+01	0.000E+00	2.190E+00	0.000E+00	0.000E+00	0.000E+00	1.130E+05
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	8.800E+03	0.000E+00	2.340E+02	0.000E+00	0.000E+00	0.000E+00	6.310E+05
Y-92	6.270E-05	0.000E+00	1.760E-06	0.000E+00	0.000E+00	0.000E+00	1.200E+10
Y-93	2.700E-01	0.000E+00	7.350E-03	0.000E+00	0.000E+00	0.000E+00	2.130E+03
ZR-95	8.190E+02	2.000E+02	1.420E+02	0.000E+00	2.150E+02	0.000E+00	9.940E+00
ZR-97	4.790E-01	8.220E-02	3.760E-02	0.000E+00	8.290E-02	0.000E+00	5.240E+03
NB-95	7.120E+04	2.930E+04	1.690E+04	0.000E+00	2.100E+04	0.000E+00	2.470E+07
NB-97	6.590E-12	1.410E-12	5.070E-13	0.000E+00	1.100E-12	0.000E+00	4.440E-07
MO-99	0.000E+00	2.540E+07	4.960E+06	0.000E+00	3.800E+07	0.000E+00	8.830E+06
TC-99M	3.230E+00	6.660E+00	8.570E+01	0.000E+00	7.160E+01	3.480E+00	1.930E+03
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.040E+03	0.000E+00	3.490E+02	0.000E+00	2.170E+03	0.000E+00	1.270E+04
RU-105	9.670E-04	0.000E+00	3.260E-04	0.000E+00	7.110E-03	0.000E+00	3.850E-01
RU-106	2.280E+04	0.000E+00	2.850E+03	0.000E+00	2.700E+04	0.000E+00	1.730E+05

ATTACHMENT 12

GRASS-GOAT-MILK DOSE FACTORS

INFANT

(m^2*mrem/yr per uCi/sec)

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	4.630E+07	3.380E+07	2.240E+07	0.000E+00	4.840E+07	0.000E+00	1.750E+09
SB-124	2.510E+07	3.700E+05	7.790E+06	6.670E+04	0.000E+00	1.570E+07	7.750E+07
SB-125	1.790E+07	1.740E+05	3.690E+06	2.250E+04	0.000E+00	1.130E+07	2.390E+07
TE-125M	1.810E+07	6.050E+06	2.450E+06	6.090E+06	0.000E+00	0.000E+00	8.620E+06
TE-127M	5.050E+07	1.680E+07	6.120E+06	1.460E+07	1.240E+08	0.000E+00	2.040E+07
TE-127	7.800E+02	2.610E+02	1.680E+02	6.350E+02	1.900E+03	0.000E+00	1.640E+04
TE-129M	6.710E+07	2.300E+07	1.030E+07	2.580E+07	1.680E+08	0.000E+00	4.010E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.000E-08
TE-131M	4.050E+05	1.630E+05	1.350E+05	3.310E+00	1.120E+06	0.000E+00	2.750E+06
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	2.520E+06	1.250E+06	1.170E+06	1.840E+06	7.820E+06	0.000E+00	4.620E+06
I-130	4.320E+06	9.510E+06	3.820E+06	1.070E+09	1.040E+07	0.000E+00	2.040E+06
I-131	3.270E+09	3.850E+09	1.690E+09	1.270E+12	4.500E+09	0.000E+00	1.370E+08
I-132	1.710E+00	3.470E+00	1.230E+00	1.630E+02	3.870E+00	0.000E+00	2.810E+00
I-133	4.460E+07	6.490E+07	1.900E+07	1.180E+10	7.630E+07	0.000E+00	1.100E+07
I-134	0.000E+00	0.000E+00	0.000E+00	1.210E-09	0.000E+00	0.000E+00	0.000E+00
I-135	1.460E+05	2.900E+05	1.060E+05	2.600E+07	3.230E+05	0.000E+00	1.050E+05
CS-134	1.090E+11	2.040E+11	2.060E+10	0.000E+00	5.250E+10	2.150E+10	5.540E+08
CS-136	5.880E+09	1.730E+10	6.460E+09	0.000E+00	6.900E+09	1.410E+09	2.630E+08
CS-137	1.540E+11	1.810E+11	1.280E+10	0.000E+00	4.850E+10	1.960E+10	5.650E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	5.450E-08	0.000E+00	1.580E-09	0.000E+00	0.000E+00	0.000E+00	3.450E-06
BA-140	2.890E+07	2.890E+04	1.490E+06	0.000E+00	6.870E+03	1.780E+04	7.110E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	4.840E+00	1.910E+00	4.900E-01	0.000E+00	0.000E+00	0.000E+00	2.240E+04
LA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-141	5.200E+03	3.170E+03	3.730E+02	0.000E+00	9.780E+02	0.000E+00	1.640E+06
CE-143	4.800E+01	3.180E+04	3.630E+00	0.000E+00	9.270E+00	0.000E+00	1.860E+05
CE-144	2.790E+05	1.140E+05	1.560E+04	0.000E+00	4.620E+04	0.000E+00	1.600E+07
PR-143	1.790E+02	6.710E+01	8.890E+00	0.000E+00	2.490E+01	0.000E+00	9.470E+04
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	1.060E+02	1.090E+02	6.660E+00	0.000E+00	4.190E+01	0.000E+00	6.890E+04
W-187	7.350E+03	5.110E+03	1.770E+03	0.000E+00	0.000E+00	0.000E+00	3.000E+05
NP-239	4.360E+00	3.900E-01	2.210E-01	0.000E+00	7.780E-01	0.000E+00	1.130E+04

ATTACHMENT 13

ENVIRONMENTAL MONITORING SITES

SITE	SAMPLE LOCATION	SECTOR	DISTANCE KM	DISTANCE MI	PHYSICAL LOCATION DESCRIPTION
1	DR1	NW	0.6	0.4	Onsite, Along Cliffs
2	DR2	WNW	2.7	1.7	Rt. 765, Auto Dump
3	DR3	W	2.3	1.4	Rt. 765, Giovanni's Tavern (Knotty Pine)
4	DR4	WSW	2.0	1.2	Rt. 765, Across from White Sand Drive
5	DR5	SW	2.4	1.5	Rt. 765 at Johns Creek
6	DR6,A4	SSW	2.9	1.8	Rt. 765 at Lusby
7	DR7,A1,Ib4, Ib5,Ib6	S	0.7	0.5	On site before entrance to Camp Conoy
8	DR8,A2	SSE	2.5	1.5	Camp Conoy Road at Emergency Siren
9	DR9,A3	SE	2.6	1.6	Bay Breeze Road
10	DR10	NW	6.4	4.0	Calvert Beach Rd & Decatur St
11	DR11	WNW	6.6	4.1	Dirt Road off Mackall Rd & Parran Rd
12	DR12	W	6.7	4.2	Bowen Rd & Mackall Rd
13	DR13	WSW	6.1	3.8	Mackall Rd near Wallville
14	DR14	SW	6.4	4.0	Rodney Point
15	DR15	SSW	6.2	3.9	Mill Bridge Rd & Turner Rd
16	DR16	S	6.5	4.1	Across from Appeal School
17	DR17	SSE	5.9	3.7	Cove Point Rd & Little Cove Point Rd
18	DR18	SE	7.1	4.5	Cove Point
19	DR19	NW	4.4	2.8	Long Beach
20	DR20	NNW	0.4	0.3	Onsite near shore
21	DR21,A5,Ib7 Ib8,Ib9	WNW	19.3	12.1	Emergency Offsite Facility off Rt. 231
22	DR22	S	12.5	7.8	Solomons Island
23	DR23	ENE	12.6	7.9	Taylors Island
24	Wa1	NNE	0.2	0.1	Intake Vicinity
25	Wa2,Ia1,Ia2	N	0.3	0.2	Discharge Vicinity
26	Wb1	ESE	0.6	0.4	Camp Conoy Shoreline
27	Ib1,Ib2,Ib3	SSE	2.6	1.6	Garden Plot off Bay Breeze Rd
28	Ia4,Ia5	Area not influenced by Plant Disch.			Patuxent River
29	Ia3	E	0.9	0.6	Camp Conoy
30	Ia6	NNW	10.7	6.7	Kenwood Beach

ATTACHMENT 14

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

SURVEILLANCES FOR DIRECT RADIATION

PARAMETER	UNITS	FREQUENCY	LLD	ACTION LEVEL
GAMMA DOSE[1]	mR	at least quarterly	(2)	N/A

(1) Each sample point shall be monitored using two or more dosimeters **OR** one instrument for measuring and recording dose rate continuously.

(2) LLD for TLDs used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13.

ATTACHMENT 15

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
SURVEILLANCES FOR AIRBORNE ACTIVITY

RADIOIODINE CANNISTER

PARAMETER	UNITS	FREQUENCY	LLD	ACTION LEVEL (5)
I-131	pCi/m^3	at least weekly	0.07	0.9

PARTICULATE FILTER (1)

PARAMETER	UNITS	FREQUENCY	LLD	ACTION LEVEL (5)
Gross Beta Activity	pCi/m^3	at least weekly (2)	0.01	N/A (3)
Cs-134	pCi/m^3	at least quarterly (4)	0.05	10.0
Cs-137	pCi/m^3	at least quarterly (4)	0.06	20.0

(1) All samples consist of continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.

(2) Analyze for gross beta activity 24 hours or more after sampling to allow for radon and thoron daughter decay.

(3) Although there is not an Action Level for gross beta activity, if this parameter is greater than ten times the yearly mean of the control sample, perform gamma isotopic analysis on the individual sample.

(4) Perform a gamma isotopic analysis of a quarterly composite sample. A separate composite sample shall be prepared for each sample location, A1 thru A5. Each composite sample shall be a prepared from individual particulate filter samples collected during the applicable calendar quarter and from a single location.

(5) If an Action Level is exceeded, check the initiating conditions listed in sections VII.A.5.c and VII.A.5.d, and perform the corrective actions specified in section VII.A.7.d and/or VII.A.7.e.

ATTACHMENT 16

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

SURVEILLANCES FOR WATERBORNE ACTIVITY

WATER SAMPLE (SURFACE EXPOSURE PATHWAY)(1)

PARAMETER	UNITS	FREQUENCY	LLD	ACTION LEVEL (2)
H-3	pCi/l	at least quarterly	2000(3)	20,000(4)
Mn-54	pCi/l	at least monthly	15	1000
Fe-59	pCi/l	at least monthly	30	400
Co-58	pCi/l	at least monthly	15	1000
Co-60	pCi/l	at least monthly	15	300
Zn-65	pCi/l	at least monthly	30	300
Zr-95 / Nb-95	pCi/l	at least monthly	15	400
I-131	pCi/l	at least monthly	1	2
Cs-134	pCi/l	at least monthly	15	30
Cs-137	pCi/l	at least monthly	18	50
Ba-140 / La-140	pCi/l	at least monthly	15	200

SHORELINE SEDIMENT SAMPLE

PARAMETER	UNITS	FREQUENCY	LLD	ACTION LEVEL (2)
Cs-134	pCi/kg, dry	at least semiannually	150	N/A
Cs-137	pCi/kg, dry	at least semiannually	180	N/A

(1) The water sample shall be a composite of individual samples collected over a 1 month period.

(2) If an Action Level is exceeded, check the initiating conditions listed in sections VII.A.5.c and VII.A.5.d, and perform the corrective actions specified in section VII.A.7.d and/or VII.A.7.e.

(3) If a drinking water pathway does not exist, a value of 3000 pCi/ml may be used.

(4) If a drinking water pathway does not exist, a value of 30,000 pCi/ml may be used.

ATTACHMENT 17

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

SURVEILLANCES FOR INGESTIBLE ACTIVITY

FISH AND INVERTEBRATES [1]

PARAMETER	UNITS	FREQUENCY	LLD	ACTION LEVEL [5]
Mn-54	pCi/kg, wet	[2]	130	30,000
Fe-59	pCi/kg, wet	[2]	260	10,000
Co-58	pCi/kg, wet	[2]	130	30,000
Co-60	pCi/kg, wet	[2]	130	10,000
Zn-65	pCi/kg, wet	[2]	260	20,000
Cs-134	pCi/kg, wet	[2]	130	1000
Cs-137	pCi/kg, wet	[2]	150	2000

MILK

PARAMETER	UNITS	FREQUENCY	LLD	ACTION LEVEL [5]
I-131	pCi/l, wet	at least monthly [4]	1	3
Cs-134	pCi/l, wet	at least monthly [4]	15	60
Cs-137	pCi/l, wet	at least monthly [4]	18	70
Ba-140 / La-140	pCi/l, wet	at least monthly [4]	15	300

FOOD PRODUCTS

PARAMETER	UNITS	FREQUENCY	LLD	ACTION LEVEL [5]
I-131	pCi/kg, wet	at least monthly [3]	60	100
Cs-134	pCi/kg, wet	at least monthly [3]	60	1000
Cs-137	pCi/kg, wet	at least monthly [3]	80	2000

(1) Edible portions of the fish and invertebrates shall be used for analysis.

(2) The fish and invertebrates shall be sampled at least once per year in season, or semiannually if they are not seasonal.

(3) The food products shall be sampled during the growing season.

(4) The milk samples need be collected and analyzed only if the milk is commercially available in quantities greater than 310 liters per year (see NUGREG-0133, 5.3.1.1).

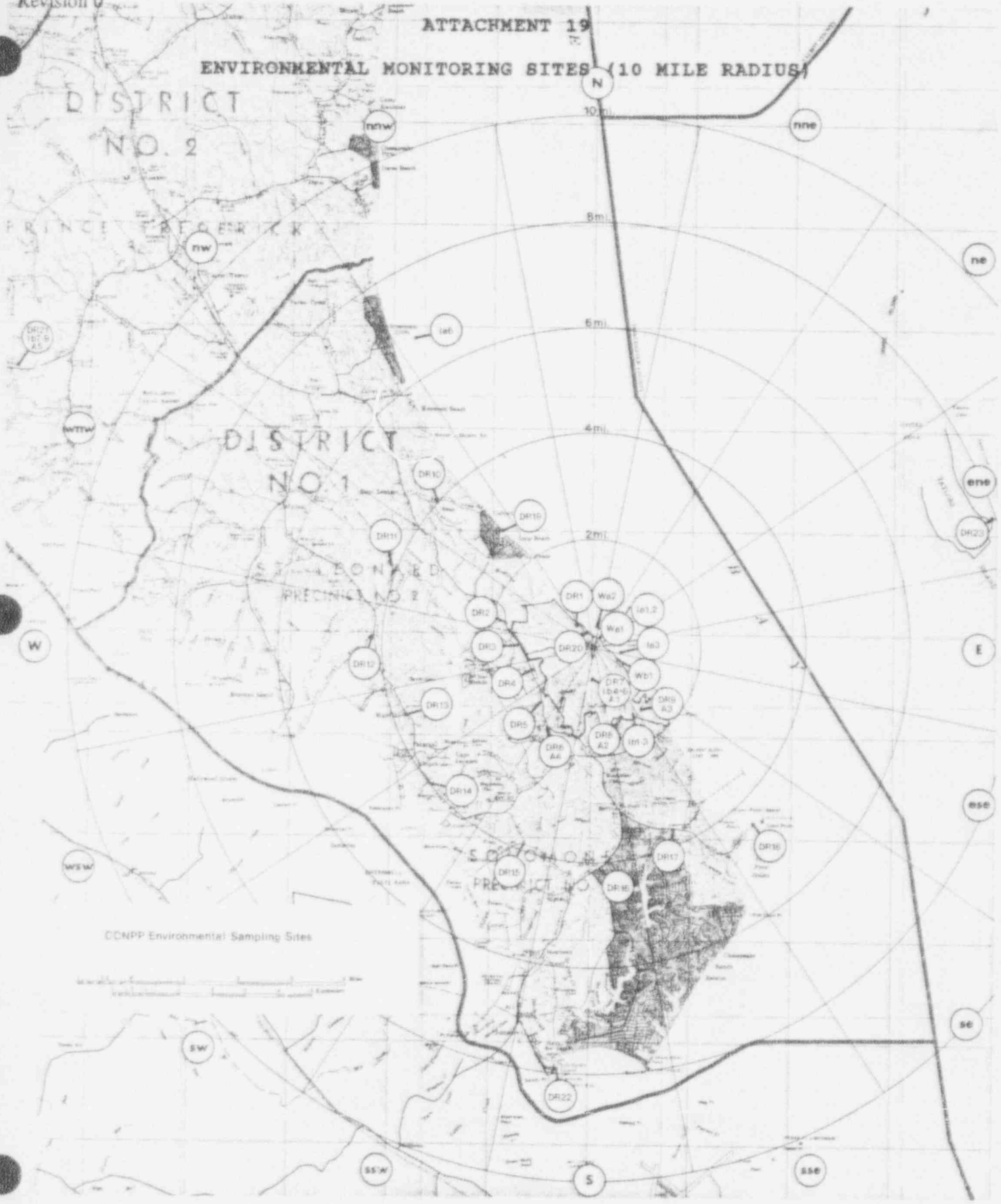
(5) If an Action Level is exceeded, check the initiating conditions listed in sections VII.A.5.c and VII.A.5.d, and perform the corrective actions specified in section VII.A.7.d and/or VII.A.7.e.

ATTACHMENT 18

ENVIRONMENTAL MONITORING SITES (5 KM RADIUS)

ATTACHMENT 19

ENVIRONMENTAL MONITORING SITES (10 MILE RADIUS)



ATTACHMENT 20

EFFLUENT RADIATION MONITORS

Description	Radiation Element	Radiation Indicator
Liquid Waste Discharge Radiation Monitor	0-RE-2201	0-RI-2201
Steam Generator Blowdown Effluent Radiation Monitor	1-RE-4095	1-RI-4095
Steam Generator Blowdown Effluent Radiation Monitor	2-RE-4095	2-RI-4095
Steam Generator Blowdown Tank Radiation Monitor	1-RE-4014	1-RI-4014
Steam Generator Blowdown Tank Radiation Monitor	2-RE-4014	2-RI-4014
Wide Range Gas Monitor, Low Range	1-RE-5416	1-RIC-5415
Wide Range Gas Monitor, Low Range	2-RE-5416	2-RIC-5415
Westinghouse Plant Vent Stack Monitor	1-RE-5415	1-RI-5415
Westinghouse Plant Vent Stack Monitor	2-RE-5415	2-RI-5415
Gaseous Radwaste Treatment System Radiation Monitor	0-RE-2191	0-RI-2191

Accident Monitors Not Addressed By The ODCM

Wide Range Gas Monitor, Mid Range	1-RE-5417
Wide Range Gas Monitor, High Range	1-RE-5418
Wide Range Gas Monitor, Mid Range	2-RE-5417
Wide Range Gas Monitor, High Range	2-RE-5418

ATTACHMENT 21

LIST OF EFFECTIVE PAGES

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ATTACHMENT 21

LIST OF EFFECTIVE PAGES

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ATTACHMENT 21

LIST OF EFFECTIVE PAGES

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ATTACHMENT 21

LIST OF EFFECTIVE PAGES

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