

ODCM TABLE OF CONTENTS

PART I - RADIOLOGICAL EFFLUENT CONTROLS

1.0	DEFINITIONS	1.1-1
3.11	RADIOLOGICAL EFFLUENT CONTROLS AND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM	1.3-1
3.13	METEOROLOGICAL MONITORING PROGRAM	1.3-2
4.0	BASES	1.4-1
5.0	ADMINISTRATIVE REQUIREMENTS	1.5-1

PART II - ODCM

1.0	INTRODUCTION - ODCM GENERAL INFORMATION	11.1-1
1.1	Structure of the ODCM	11.1-1
1.2	Regulations	11.1-2
1.2.1	Code of Federal Regulations	11.1-2
1.2.2	Radiological Effluent Technical Standards	11.1-5
1.2.3	Offsite Dose Calculation Manual	11.1-5
1.2.4	Overlapping Requirements	11.1-5
1.2.5	Dose Receiver Methodology	11.1-6
1.3	Offsite Dose Calculation Parameters	11.1-10
1.4	References	11.1-10
2.0	INSTRUMENTATION AND SYSTEMS	11.2-1
2.1	Liquid Effluent System Description	11.2-1
2.1.1	Release Tanks	11.2-1
2.1.2	Turbine Building Fire and Oil Sump	11.2-1
2.1.3	Condensate Polisher Sump	11.2-1
2.2	Liquid Effluent Radiation Monitors	11.2-2
2.2.1	Liquid Radwaste Effluent Monitor	11.2-2
2.2.2	Station Blowdown Monitor	11.2-2
2.2.3	Reactor Containment Fan Cooler (RCFC) and Essential Service Water (SX) Outlet Line Monitor	11.2-2
2.2.4	Turbine Building Fire and Oil Sump Monitor	11.2-2
2.2.5	Condensate Polisher Sump Monitor	11.2-2
2.2.6	Component Cooling Water Monitors	11.2-2
2.3	Liquid Radiation Effluent Monitors Alarm and Trip Setpoints	11.2-3
2.3.1	Station Blowdown Monitor	11.2-3
2.3.2	Liquid Radwaste Effluent Monitor	11.2-3
2.3.3	Other Liquid Effluent Monitors	11.2-5
2.3.4	Conversion Factors	11.2-6

PART II - ODCM

2.3.5	Allocation of Effluent from Common Release Points	II.2-6
2.3.6	Solidification of Wastes/Process Control Program	II.2-6
2.4	Gaseous Effluent System Description.....	II.2-6
2.4.1	Waste Gas Holdup System	II.2-6
2.4.2	Ventilation Exhaust Treatment System	II.2-6
2.5	Gaseous Effluent Radiation Monitors.....	II.2-7
2.5.1	Auxiliary Building Vent Effluent Monitors.....	II.2-7
2.5.2	Containment Purge Effluent Monitors.....	II.2-7
2.5.3	Waste Gas Decay Tank Monitors.....	II.2-8
2.5.4	Gland Steam and Condenser Air Ejector Monitors	II.2-8
2.5.5	Radwaste Building Ventilation Monitor	II.2-8
2.6	Gaseous Effluent Monitor Alarm and Trip Setpoints	II.2-8
2.6.1	Auxiliary Building Vent Effluent Monitors.....	II.2-8
2.6.2	Containment Purge Effluent Monitors.....	II.2-9
2.6.3	Waste Gas Decay Tank Effluent Monitors.....	II.2-9
2.6.4	Gaseous Effluent Release Limits	II.2-9
2.6.5	Release Mixture	II.2-10
2.6.6	Conversion Factors	II.2-10
2.6.7	HVAC Dilution Flow Rates	II.2-10
2.6.8	Allocation of Effluents from Common Release Points	II.2-10
2.6.9	Dose Projections for Batch Releases	II.2-10
3.0	LIQUID EFFLUENTS.....	II.3-1
3.1	Liquid Effluent Releases – General Information.....	II.3-1
3.2	Liquid Effluent Concentrations	II.3-2
3.3	Liquid Effluent Dose Calculation Requirements	II.3-4
3.4	Dose Methodology	II.3-4
3.5	Site Specific Dose Factors and Bioaccumulation Factors.....	II.3-7
4.0	GASEOUS EFFLUENTS	II.4-1
4.1	Gaseous Effluents – General Information	II.4-1
4.2	Gaseous Effluents – Dose and Dose Rate Calculation Requirements.....	II.4-2
4.2.1	Instantaneous Dose Rates	II.4-2
4.2.2	Time Averaged Dose from Noble Gas.....	II.4-5
4.2.3	Time Averaged Dose from Non-Noble Gas Radionuclides.....	II.4-9

PART II – ODCM

5.0	TOTAL DOSE.....	II.5-1
5.1	Total Dose Calculation Requirements.....	II.5-1
5.1.1	Total Effective Dose Equivalent Limits, 10CFR20 and 40CFR190.....	II.5-1
5.1.2	ISFSI	II.5-1
5.1.3	Total Dose Calculation Methodology	II.5-2
5.2	Onsite Radwaste and Rad Material Storage Facilities	II.5-2
5.2.1	Process Waste Storage Facilities.....	II.5-2
5.2.2	DAW Storage Facilities	II.5-2
5.2.3	Replaced Steam Generator Storage Facilities	II.5-3
5.2.4	ISFSI Facilities	II.5-3
5.3	Methodology	II.5-3
5.4	Total Dose.....	II.5-4
5.5	Compliance to Total Dose Limits	II.5-4
5.5.1	Total Effective Dose Equivalent Limit – 10CFR20 Compliance	II.5-4
5.5.2	Dose to a Member of the Public in the Unrestricted Area	II.5-4
5.5.3	Dose to a Member of the Public in the Restricted Area.....	II.5-5
5.5.4	Total Dose Due to the Uranium Fuel Cycle (40CFR190).....	II.5-5
5.6	When Compliance Assessment is Required	II.5-6
6.0	RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM.....	II.6-1

ODCM TABLE OF CONTENTS

LIST OF TABLES

PART I – RADIOLOGICAL EFFLUENT CONTROLS

Table 1-1	Frequency Notations	I.1-4
Table 1-2	Compliance Matrix.....	I.1-5

PART II - ODCM

Table 1-1	Regulatory Dose Limit Matrix	II.1-7
Table 1-2	Dose Assessment Receivers.....	II.1-8
Table 1-3	Miscellaneous Dose Assessment Factors: Environmental Parameters	II.1-17
Table 1-4	Stable Element Transfer Data	II.1-18
Table 2-1	Liquid Radioactive Effluent Monitors	II.2-11
Table 2-2	Gaseous Radioactive Effluent Monitors	II.2-12
Table 2-3	Assumed Composition of the Byron Station Noble Gas Effluent	II.2-13
Table 2-4	Assumed Composition of the Byron Station Liquid Effluent	II.2-14
Table 3-1	Site Specific Potable Water Dose Factors for Adult Age Group	II.3-9
Table 3-2	Site Specific Potable Water Dose Factors for Teen Age Group	II.3-11
Table 3-3	Site Specific Potable Water Dose Factors for Child Age Group	II.3-13
Table 3-4	Site Specific Potable Water Dose Factors for Infant Age Group	II.3-15
Table 3-5	Site Specific Fish Ingestion Dose Factors for Adult Age Group	II.3-17
Table 3-6	Site Specific Fish Ingestion Dose Factors for Teen Age Group	II.3-19
Table 3-7	Site Specific Fish Ingestion Dose Factors for Child Age Group	II.3-21
Table 3-8	Bioaccumulation Factors (BF _i) to be used in the Absence of Site-Specific Data	II.3-23
Table 4-1	X/Q and D/Q Maxima at or Beyond the Unrestricted Area Boundary	II.4-20
Table 4-2	X/Q and D/Q Maxima at or Beyond the Restricted Area Boundary	II.4-21
Table 4-3	Maximum Offsite Gamma-X/Q.....	II.4-22
Table 4-4	X/Q and D/Q at the Nearest Resident Locations within 5 miles.....	II.4-23

ODCM TABLE OF CONTENTS

LIST OF TABLES

PART II - ODCM

Table 4-5	X/Q and D/Q at the Nearest Cow Milk Locations within 5 miles.....	II.4-24
Table 4-6	X/Q and D/Q at the Nearest Cow Milk Meat Locations within 5 miles.....	II.4-25
Table 4-7	Ground Plane Dose Factors.....	II.4-26
Table 4-8	External Dose Factors for Standing on Contaminated Ground	II.4-28
Table 4-9	Adult Inhalation Dose Factors	II.4-31
Table 4-10	Teen Inhalation Dose Factors	II.4-33
Table 4-11	Child Inhalation Dose Factors	II.4-35
Table 4-12	Infant Inhalation Dose Factors.....	II.4-37
Table 4-13	Adult Vegetation Dose Factors.....	II.4-39
Table 4-14	Teen Vegetation Dose Factors.....	II.4-41
Table 4-15	Child Vegetation Dose Factors.....	II.4-43
Table 4-16	Adult Grass-Cow-Milk Dose Factors	II.4-45
Table 4-17	Teen Grass-Cow-Milk Dose Factors	II.4-47
Table 4-18	Child Grass-Cow-Milk Dose Factors	II.4-49
Table 4-19	Infant Grass-Cow-Milk Dose Factors.....	II.4-51
Table 4-20	Adult Grass-Goat-Milk Dose Factors.....	II.4-53
Table 4-21	Teen Grass-Goat-Milk Dose Factors.....	II.4-55
Table 4-22	Child Grass-Goat-Milk Dose Factors.....	II.4-57
Table 4-23	Infant Grass-Goat-Milk Dose Factors.....	II.4-59
Table 4-24	Adult Grass-Cow-Meat Dose Factors.....	II.4-61
Table 4-25	Teen Grass-Cow-Meat Dose Factors.....	II.4-63
Table 4-26	Child Grass-Cow-Meat Dose Factors.....	II.4-65
Table 4-27	Byron Station Characteristics	II.4-67
Table 4-28	Dose Factors for Noble Gases	II.4-68
Table 6-1	Radiological Environmental Monitoring Program.....	II.6-2
Table 6-2	Latitude/Longitude Positions of REMP samples	II.6-15

ODCM TABLE OF CONTENTS

LIST OF FIGURES

PART I – RADIOLOGICAL EFFLUENT CONTROLS

NONE

PART II - ODCM

Figure 1-1	Radiation Exposure Pathways to Humans.....	II.1-9
Figure 1-2	Removed – See Figure 6-1	
Figure 1-3	Restricted Area Boundary	II.1-20
Figure 2-1	Simplified HVAC & Gaseous Effluent Flow Diagram	II.2-15
Figure 2-2	Simplified Liquid Radwaste Processing Diagram	II.2-17
Figure 2-3	Liquid Release Flow Path.....	II.2-18
Figure 6-1	Onsite Air Sampling Locations and Site Boundary	II.6-11
Figure 6-2	Offsite Air Sampling Locations	II.6-12
Figure 6-3	Inner Ring & Outer Ring TLD Locations	II.6-13
Figure 6-4	Ingestion & Waterborne Exposure Pathway Sample Locations.....	II.6-14
Figure 6-5	Site Layout and Exclusion Area.....	II.6-16

RADIOLOGICAL EFFLUENTS CONTROLS

FOR

BYRON STATION

UNITS 1 AND 2

REVISION 7 |

1.0 DEFINITIONS

- 1.1 **ACTIONS** shall be that part of a Requirement that prescribes Required Actions to be taken under designated Conditions within specified Completion Times.
- 1.2 **CHANNEL CALIBRATION** shall be the adjustment, as necessary, of the channel so that it responds within the required range and accuracy to known inputs. The CHANNEL CALIBRATION shall encompass the entire channel, including the required sensor, alarm, interlock, display, and trip functions. Calibration of instrument channels with Resistance Temperature Detector (RTD) or thermocouple sensors may consist of an in place qualitative assessment of sensor behavior and normal calibration of the remaining adjustable devices in the channel. The CHANNEL CALIBRATION may be performed by means of any series of sequential, overlapping calibrations or total channel steps so that the entire channel is calibrated.
- 1.3 **CHANNEL CHECK** shall be the quantitative assessment, by observation, of channel behavior during operation. This determination shall include, where possible, comparison of the channel indication and status to other indications or status derived from independent instrument channels measuring the same parameter.
- 1.4 **CHANNEL OPERATIONAL TEST (COT)** shall be the injection of a simulated or actual signal into the channel as close to the sensor as practicable to verify the OPERABILITY of required alarm, interlock, display and trip functions. The COT shall include adjustments, as necessary, of the required alarm, interlock, and trip setpoints so that the setpoints are within the required range and accuracy.
- 1.5 **DOSE EQUIVALENT I-131** shall be that concentration of I-131 (microcuries/gram) that 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 dose conversion factors used for this calculation shall be those listed in Table III of TID-14844, AEC, 1962. "Calculation of Distance Factors for Power and Test Reactor Sites," or those listed in Table E-7 of Regulatory Guide 1.109, Rev.1, NRC, 1977, or ICRP 30, Supplement to Part 1, pages 192-212, Table Titled, "Committed Dose Equivalent in Target Organs or Tissues per Intake of Unit Activity, or Federal Guidance Report 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion," 1989, (Table 2.1, Exposure-to-Dose Conversion Factors for Inhalation).
- 1.6 **FREQUENCY** - Table 1-1 provides the definitions of various frequencies for which surveillances, sampling, etc., are performed unless defined otherwise. The 25% variance shall not be applied to Operability Action statements. The bases to Improved Technical Specification 3.0.2 provide clarifications to this requirement.
- 1.7 **IMMEDIATELY** - When "immediately" is used as a completion time the Required Action should be pursued without delay and in a controlled manner.
- 1.8 **MEMBER(S) OF THE PUBLIC** shall include all persons who are not occupationally associated with the plant. This category does not include employees of the licensee, its contractors or vendors and 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.
- 1.9 **MODE** shall correspond to any one inclusive combination of core reactivity condition, power level, average reactor coolant temperature, and reactor vessel head closure bolt tensioning specified in TRM Table T1.1-1 with fuel in the reactor vessel.

- 1.10 **OCCUPATIONAL DOSE** means the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation and/or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the public.
- 1.11 A system, subsystem, train, component, or device shall be **OPERABLE** or have **OPERABILITY** when it is capable of performing its specified safety functions(s) and when all necessary attendant instrumentation, controls, normal or emergency electrical power, cooling and seal water, lubrication, and other auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its specified safety function(s) are also capable of performing their related support function(s).
- 1.12 **PROCESS CONTROL PROGRAM (PCP)** shall contain the current formulas, sampling, analyses, tests, and determinations to be made to ensure that processing and packaging of solid radioactive wastes based on demonstrated processing of actual or simulated wet solid wastes will be accomplished in such a way as to assure compliance with 10 CFR Parts 20, 61, and 71, State regulations, burial ground requirements and other requirements governing the disposal of solid radioactive waste.
- 1.13 **PURGE/PURGING** shall be any 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 required to purify the confinement.
- 1.14 **RATED THERMAL POWER** shall be a total core heat transfer rate to the reactor coolant of 3586.6 MWT.
- 1.15 **RADIOLOGICAL EFFLUENT CONTROLS AND SURVEILLANCES (RECS)** are in accordance with Byron Technical Requirements Manual (TRM) and the Code of Federal Regulations.
- 1.16 **RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)** are in accordance with Byron Technical Requirements Manual (TRM) and the Code of Federal Regulations.
- 1.17 **SITE BOUNDARY** shall be that line beyond which, the land is neither owned, nor leased, nor otherwise controlled by the licensee.
- 1.18 **SOLIDIFICATION** shall be the conversion of wet wastes into a form that meets shipping and burial ground requirements.
- 1.19 **SOURCE CHECK** shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.
- 1.20 **THERMAL POWER** shall be the total reactor core heat transfer rate to the reactor coolant.
- 1.21 **TLCO-TECHNICAL LIMITING CONDITION FOR OPERATION** Limiting Condition for Operation as listed in the TRM.
- 1.22 **TECHNICAL REQUIREMENTS MANUAL (TRM)** Chapter 3.11 contains the Radiological Effluent Controls and Surveillances (RECS). Chapter 3.12 contains the Radiological Environmental Monitoring Program (REMP).
- 1.23 **UNRESTRICTED AREA** means an area, access to which is neither limited nor controlled by the licensee.

- 1.24 **VENTILATION EXHAUST TREATMENT SYSTEM** shall be any system designed and installed to reduce gaseous radiiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and/or 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 Features Atmospheric Cleanup Systems are not considered VENTILATION EXHAUST TREATMENT SYSTEM components.
- 1.25 **VENTING** shall be any 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.
- 1.26 **WASTE GAS HOLDUP SYSTEM** shall be any system designed and installed to reduce radioactive gaseous effluents by collecting Reactor Coolant System off-gases from the Reactor Coolant System and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.
- 1.27 Definitions Peculiar to Estimating Dose to Members of the Public using the OFFSITE DOSE CALCULATION MANUAL (ODCM) Computer Program.
- a. **ACTUAL** - ACTUAL refers to using known release data to project the dose to members of the public for the previous time period. This data is stored in the database and used to demonstrate compliance with the reporting requirements of the ODCM.
 - b. **PROJECTED** - PROJECTED refers to using known release data from the previous time period or estimated release data to forecast a future dose to members of the public. This data is not incorporated into the database.

Table 1-1
FREQUENCY NOTATIONS*

<u>Notation</u>	<u>Frequency</u>
S - Shiftly	At least once per 12 hours
D - Daily	At least once per 24 hours
W - Weekly	At least once per 7 days
B- Biweekly	At least once every 14 days
M - Monthly	At least once per 31 days
Q - Quarterly	At least once per 92 days
SA - Semiannually	At least once per 184 days
A - Annually	At least once per 366 days
R - Refuel Cycle	At least once per 18 months
S/U - Startup	Prior to each reactor startup
N.A.	Not applicable
P - Prior	Prior to each radioactive release

*Each frequency requirement shall be performed within the specified time interval with the maximum allowable extension not to exceed 25% of the frequency interval. The 25% variance shall not be applied to Operability Action statements. The bases to ITS 3.0.2 provide clarifications to this requirement. These frequency notations do not apply to the Radiological Environmental Monitoring Program as described in TRM 3.12.

Table 1-2

COMPLIANCE MATRIX

Regulation	Dose Component Limit	ODCM Equation	REC	Technical Specification
10 CFR 50 Appendix I	1. Gamma air dose and beta air dose due to airborne radioactivity in effluent plume.	4-4 4-5	3.11.g	5.5.4.h
	a. Total body and skin dose due to airborne radioactivity in effluent plume are reported only if certain gamma and beta air dose criteria are exceeded.	4-6 4-7	N/A	N/A
	2. Dose for all organs and all four age groups due to iodines and particulates in effluent plume. All pathways are considered.	4-8	3.11.h	5.5.4.i
	3. Dose for all organs and all four age groups due to radioactivity in liquid effluents.	3-3	3.11.d	5.5.4.d
10 CFR 20	1. Total Dose, totaling all external dose components (direct, ground and plume shine) and internal dose (all pathways, both airborne and liquid-borne).	5-2		5.5.4.c
40 CFR 190 (now by reference, also part of 10 CFR 20)	1. Total body dose due to direct dose, ground and plume shine from all sources at a station.	5-1	3.11.k	5.5.4.j
	2. Organ doses to an adult due to all pathways.	3-3 4-8		
Technical Specifications	1. "Instantaneous" total body, skin and organ dose rates to a child due to radioactivity in airborne effluents. For the organ dose, only inhalation is considered.	4-1 4-2 4-3	3.11.f	5.5.4.g
	2. "Instantaneous" concentration limits for liquid effluents.	3-1	3.11.c	5.5.4.b
Technical Specifications	1. Radioactive Effluent Release Report	NA	5.2	5.6.2

Table 1-2
Page 2 of 2
COMPLIANCE MATRIX

Regulation	Component Limit	ODCM Equation	TRM	Technical Specification
10CFR50 Appendix I Section IV.B.2	1. Implement Environmental Monitoring Program.	N/A	3.12.a	N/A
10CFR50 Appendix I Section IV.B.3	1. Land Use Census	N/A	3.12.b	N/A
10CFR50 Appendix I Section IV.B.2	1. Interlaboratory Comparison Program	N/A	3.12.c	N/A
10CFR50 Appendix I Section IV.B.2 and Technical Specifications	1. Annual Radiological Environmental Operating Report	N/A	5.1	5.6.2

NOTE: 3.0.5 through 3.10 Not Used

3.11 Radiological Effluent Controls and Radiological Environmental Monitoring Program

NOTE: SEE TRM Chapter 3.11 for Radiological Effluents Controls and Surveillances (RECS) and TRM Chapter 3.12 for Radiological Environmental Monitoring Program (REMP).

3.13 METEOROLOGICAL MONITORING PROGRAM

3.13.1 METEOROLOGICAL MONITORING

Meteorological parameters are measured in the vicinity of each nuclear power station in order to provide data for calculating radiation doses due to airborne effluent radioactivity. Some nuclear power stations' Technical Specifications state applicable requirements (typically under the subheading, "Meteorological Instrumentation," in the instrumentation section). Regulatory guidance is given in Regulatory Guide 1.23 (Reference 5). Wind speed, wind direction and the temperature gradient are measured using instruments at two or more elevations on a meteorological tower at each Exelon Nuclear station. The elevations are chosen to provide meteorological data representative of the elevations of the airborne releases from the station. The Annual Radiological Environmental Operating Report includes a summary of meteorological data collected over the reporting year. These data are used to calculate optional isopleths of radiation dose and radioactivity concentration.

3.13.2 METEOROLOGICAL CONTRACTOR

The meteorological contractor operates and maintains the meteorological tower instrumentation at each nuclear power station. The contractor collects and analyzes the data and issues periodic reports. The contractor prepares the meteorological data summary required for the Annual Radiological Environmental Operating Report (AREOR) and also computes and plots isopleths included in the AREOR.

4.0 BASES

4.1 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION (TRM 3.11.a)

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The alarm/trip setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding 10 times the EFFLUENT CONCENTRATION values specified in Appendix B, Table 2, Column 2 to 10 CFR 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50. The purpose of tank level indicating devices is to assure the detection and control of leaks that if not controlled could potentially result in the transport of radioactive materials to UNRESTRICTED AREAS.

4.2 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION (TRM 3.11.b)

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The alarm/trip setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50.

4.3 LIQUID EFFLUENT CONCENTRATION (TRM 3.11.c)

This Control is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than 10 times the EFFLUENT CONCENTRATION values specified in Appendix B, Table 2, Column 2 to 10 CFR 20. The Control provides operational flexibility for releasing liquid effluents in concentrations to follow the Section II.A and II.C design objectives of Appendix I to 10 CFR Part 50. This limitation provides reasonable assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, to a MEMBER OF THE PUBLIC and (2) the restrictions authorized by 10 CFR Part 20.1301(e). The concentration limit for the dissolved or entrained noble gases is based upon the assumption that Xe-133 is the controlling radionuclide and its EFFLUENT CONCENTRATION in air (submersion) was converted to an equivalent concentration in water. This control does not affect the requirement to comply with the annual limitations of 10 CFR Part 20.1301(a).

This Control applies to the release of radioactive materials in liquid effluents from all units at the site.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD and other detection limits can be found in Currie, L.A., "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," NUREG/CR-4007 (September 1984), and in the HASL Procedures Manual, HASL-300 (revised annually).

4.4 DOSE FROM LIQUID EFFLUENTS (TRM 3.11.d)

This Control is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The Control statement implements the guides set forth in Section II.A of Appendix I. The Action statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents will be kept "as low as is reasonably achievable." Also, for fresh water sites with drinking water supplies that can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR Part 141. The dose calculation methodology and parameters in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

This Control applies to the release of liquid effluents from each reactor at the site. For units with shared radwaste treatment systems, the liquid effluents from the shared system are proportioned among the units sharing that system.

4.5 LIQUID RADWASTE TREATMENT SYSTEM (TRM 3.11.e)

The OPERABILITY of the Liquid Radwaste Treatment System ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment. The requirement that the appropriate portions of this system be used, when specified, provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable". This Control implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR part 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

This Control applies to the release of liquid effluents from each reactor at the site. For units with shared radwaste treatment systems, the liquid effluents from the shared system are proportioned among the units sharing that system.

4.6

GASEOUS EFFLUENTS DOSE RATES (TRM 3.11.0)

This Control provides reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a MEMBER OF THE PUBLIC in an UNRESTRICTED AREA, either at or beyond the SITE BOUNDARY in excess of the design objectives of Appendix I to 10 CFR Part 50. This Control is provided to ensure that gaseous effluents from all units on the site will be appropriately controlled. It provides operational flexibility for releasing gaseous effluents to satisfy the Section II.A and II.C design objectives of Appendix I to 10 CFR Part 50. For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of that MEMBER OF THE PUBLIC will usually be sufficiently low to compensate for the reduced atmospheric dispersion of gaseous effluents relative to that for the SITE BOUNDARY. Examples of calculations for such MEMBERS OF THE PUBLIC, with the appropriate occupancy factors, shall be given in the ODCM. The specified release rate limits restrict, at all times, the corresponding dose rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrem/year to the total body or to less than or equal to 3000 mrem/year to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a child via the inhalation pathway to less than or equal to 1500 mrem/year. This Control does not affect the requirement to comply with the annual limitations of 10 CFR 20.1301(a).

This Control applies to the release of gaseous effluents from all units at the site.

The required detection capabilities for radioactive materials in gaseous waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD and other detection limits can be found in Currie, L.A., "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," NUREG/CR-4007 (September 1984), and in the HASL Procedures Manual, HASL-300 (revised annually).

4.7

DOSE FROM NOBLE GASES (TRM 3.11.0)

This Control is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The Control statements implement the guides set forth in Section II.B of Appendix I. The Action statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low as is reasonably achievable." The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated.

The dose calculation methodology and parameters established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and 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. The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

This Control applies to the release of gaseous effluents from each reactor at the site. For units with shared radwaste treatment systems, the gaseous effluents from the shared system are proportioned among the units sharing that system.

4.8 DOSE FROM IODINE-131, TRITIUM, AND RADIOACTIVE MATERIAL IN PARTICULATE FORM (TRM 3.11.h)

This Control is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Controls are the guides set forth in Section II.C of Appendix I. The Action statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." The ODCM calculational methods specified in the Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated.

The ODCM calculational methodology and parameters for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and 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. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate controls for Iodine-131, Tritium, and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man, in the areas at and beyond the SITE BOUNDARY. The pathways that were examined in the development of these calculations were: 1) individual inhalation of airborne radionuclides, 2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, 3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and 4) deposition on the ground with subsequent exposure of man.

This Control applies to the release of gaseous effluents from each reactor at the site. For units with shared radwaste treatment systems, the gaseous effluents from the shared systems are proportioned among the units sharing that system.

4.9 GASEOUS RADWASTE TREATMENT SYSTEM (TRM 3.11.i)

The OPERABILITY of the Gaseous Radwaste Treatment System ensures that the system will be available for use whenever gaseous effluents require treatment prior to release of the environment. The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the release of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." This Control implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50.

The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

This Control applies to the release of gaseous effluents from each reactor at the site. For units with shared radwaste treatment systems, the gaseous effluents from the shared systems are proportioned among the units sharing that system.

4.10 **TOTAL DOSE (TRM 3.11.k)**

This Control is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20.1301(d). The Control requires the preparation and submittal of a Special Report whenever the calculated doses due to releases of radioactivity and to radiation from uranium fuel cycle sources exceed 25 mrem to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem.

For sites containing up to 4 reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR Part 190 if the individual reactors remain within twice the dose design objectives of Appendix I, and if direct radiation doses from the reactor units and outside storage tanks, etc., are kept small. The Special Report will describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR Part 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, submittal of the Special Report within 30 days with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR Part 190.11 and 10 CFR Part 20.2203(a)(4), is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 until NRC staff action is completed.

Demonstration of compliance with the limits of 40 CFR Part 190 or with the design objectives of Appendix I to 10 CFR Part 50 will be considered to demonstrate compliance with the 0.1 rem limit of 10 CFR Part 20.1301.

4.11 **RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (TRM 3.12)**

The Radiological Environmental Monitoring Program required by this Control provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the station operation.

This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the Radiological Effluent Monitoring Program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Isotopes identified in REMP are compared to those identified in the applicable Annual Effluent Report. Program changes may be initiated based on these operational experiences.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table T3.12.a-3 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Detailed discussion of the LLD and other detection limits can be found in Currie, L.A., "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," NUREG/CR-4007 (September 1984), and in the HASL Procedures Manual, HASL-300 (revised annually).

4.12 LAND USE CENSUS (TRM 3.12.b)

This Control is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the Radiological Environmental Monitoring Program are made if required by the results of this census. The best information from the door-to-door survey, from aerial survey or from consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than 50 m² provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/year) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made: 1) 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and 2) a vegetation yield of 2 kg/m².

4.13 INTERLABORATORY COMPARISON PROGRAM (TRM 3.12.c)

The requirement for participation in an approved Interlaboratory Comparison Program is provided 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 in order to demonstrate that the results are reasonably valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

5.0 ADMINISTRATIVE REQUIREMENTS

5.1 Annual Radiological Environmental Operating Report*

Routine Annual Radiological Environmental Operating Report covering the operation of the Unit(s) during the previous calendar year shall be submitted prior to May 15 of each year.

The Annual Radiological Environmental Operating Report shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with operational controls as appropriate, and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment.

The Annual Radiological Environmental Operating Report shall include the results of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the locations specified in the tables and figures in Part II Section 6 of the ODCM, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following: a summary description of the Radiological Environmental Monitoring Program; legible maps covering all sampling locations keyed to a table giving distances and directions from the midpoint between the two units; reasons for not conducting the Radiological Environmental Monitoring Program as required by TLCO 3.12.a, a Table of Missed Samples and a Table of Sample Anomalies for all deviations from the sampling schedule of TRM Table T3.12.a-1; discussion of environmental sample measurements that exceed the reporting levels of TRM Table T3.12.a-2 but are not the result of plant effluents, discussion of all analyses in which the LLD required by TRM Table T3.12.a-3 was not achievable; result of the Land Use Census required by TRM TLCO 3.12.b; and the results of the licensee participation in an Interlaboratory Comparison Program and the corrective actions being taken if the specified program is not being performed as required by TRM TLCO 3.12.c.

The Annual Radiological Environmental Operating Report shall also include an annual summary of hourly meteorological data collected over the applicable year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability. In lieu of submission with the Annual Radiological Environmental Operating Report, the licensee has the option of retaining this summary of required meteorological data on site in a file that shall be provided to the NRC upon request.

The Annual Radiological Environmental Operating Report shall also include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the Unit or Station during the previous calendar year. This report shall also include an assessment of the radiation doses to the most likely exposed MEMBER OF THE PUBLIC from reactor releases and other near-by uranium fuel cycle sources including doses from primary effluent pathways and direct radiation, for the previous calendar year. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the ODCM, and in compliance with 10CFR20 and 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation."

*A single submittal may be made for a multiple unit station.

5.2

Annual Radioactive Effluent Release Report**

Routine Annual Radioactive Effluent Release Reports covering the operation of the unit during the previous calendar year of operation shall be submitted prior to May 1 of the following year.

The Annual Radioactive Effluent Release Reports shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit as outlined in Regulatory Guide 1.21, "Measuring Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof.

For solid wastes, the format for Table 3 in Appendix B of the report shall be supplemented with three additional categories: class of solid wastes (as defined by 10 CFR Part 61), type of container (e.g., LSA, Type A, Type B, Large Quantity), and SOLIDIFICATION agent or absorbent (e.g., cement, urea formaldehyde).

The Annual Radioactive Effluent Release Reports shall include a list and description of unplanned releases from the site to UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

The Annual Radioactive Effluent Release Reports shall include any changes made during the reporting period to the PCP as well as any major changes to Liquid, Gaseous or Solid Radwaste Treatment Systems, pursuant to Part I Section 5.3.

The Annual Radioactive Effluent Release Reports shall also include the following: an explanation as to why the inoperability of liquid or gaseous effluent monitoring instrumentation was not corrected within the time specified in TRM TLCO 3.11.a or TLCO 3.11.b, respectively; and description of the events leading to liquid holdup tanks or gas storage tanks exceeding the limits of TS 5.5.12.

- ** A single submittal may be made for a multiple unit station. The submittal should combine those sections that are common to all units at the station; however, for units with separate radwaste systems, the submittal shall specify the releases of radioactive material from each unit.

5.3 ODCM

5.3.1 The ODCM shall be submitted to the Commission following proper approval through station processes.

5.3.2 Licensee-initiated changes to the ODCM:

- a. Shall be documented and records of reviews performed shall be retained as required by UFSAR Chapter 17. This documentation shall contain:**
 - 1. Sufficient information to support the change together with the appropriate analyses or evaluations justifying the changes(s); and**
 - 2. A determination that the change will maintain the level of radioactive effluent control required by 10 CFR Part 20, 40 CFR Part 190, 10 CFR 50.36a, and Appendix I to 10 CFR Part 50 and not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.**
- b. Shall become effective after review and acceptance by the Independent Technical Review and PORC and the approval of the Plant Manager on the date specified by the Independent Technical Review and PORC.**
- c. Shall be submitted to the Commission in the form of the complete, legible copy of the entire ODCM, or updated pages if the Commission retains a controlled copy. If an entire copy of the ODCM is submitted, it shall be submitted as a part of or concurrent with the Annual Radioactive Effluent Release Report for the period of the report in which any change to the ODCM was made effective. Each change shall be identified by markings in the margin of the affected pages, clearly indicating the area of the page that was changed, and shall indicate the date (e.g., month/year) the change was implemented.**

5.4 Major Changes to Liquid and Gaseous Radwaste Treatment Systems***

Licensee-initiated major changes to the Radwaste Treatment Systems (liquid and gaseous):

- a. Shall be reported to the Commission in the Annual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the Independent Technical Review and PORC. The discussion of each change shall contain:**
 - 1) A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR 50.59;**
 - 2) Sufficient detailed information to totally support the reason for the change without benefit of additional and supplemental information;**
 - 3) A detailed description of the equipment, components, and processes involved and the interfaces with other plant systems.**
 - 4) An evaluation of the change which shows the predicted releases of radioactive materials in liquid and gaseous effluents that differ from those previously predicted in the License application and amendments thereto;**
 - 5) An evaluation of the change, which shows the expected maximum exposures to a MEMBER OF THE PUBLIC in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the License application and amendments thereto;**
 - 6) A comparison of the predicted releases of radioactive materials, in liquid and gaseous effluents, to the actual releases for the period prior to when the changes are to be made;**
 - 7) An estimate of the exposure to plant operating personnel as a result of the change; and**
 - 8) Documentation of the fact that the change was reviewed and found acceptable by the Independent Technical Review and PORC.**
- b. Shall become effective upon review and acceptance by the Independent Technical Review and PORC.**

***Licensees may choose to submit the information called for in this standard as part of the annual FSAR update.

OFFSITE DOSE CALCULATION MANUAL

Byron Station
Units 1 and 2

Revision 7

|

1.0 INTRODUCTION - ODCM GENERAL INFORMATION

The Offsite Dose Calculation Manual (ODCM) presents a discussion of the following:

- The basic concepts applied in calculating offsite doses from plant effluents.
- The regulations and requirements for the ODCM and related programs.
- The methodology and parameters for the offsite dose calculations to assess impact on the environment and compliance with regulations.

The methodology detailed in this manual is intended for the calculation of radiation doses during routine (i.e., non-accident) conditions. The calculations are normally performed using a computer program. Manual calculations may be performed in lieu of the computer program.

The dose effects of airborne radioactivity releases predominately depend on meteorological conditions (wind speed, wind direction, and atmospheric stability). For airborne effluents, the dose calculations prescribed in this manual are based on historical average atmospheric conditions. This methodology is appropriate for estimating annual average dose effects and is stipulated in the Bases Section of the Radiological Effluents Controls (RECS).

1.1 Structure of the ODCM

Part I of the ODCM is considered to be the Radiological Effluents Controls (RECS), and contains the former Radiological Effluent Technical Specifications that have been removed from the Technical Specifications. Part I is organized as follows:

- Definitions
- Radiological Effluent Controls and Radiological Environmental Monitoring Program
- Meteorological Monitoring Program
- Bases
- Administrative Requirements

Part II of the ODCM is considered to be the Offsite Dose Calculation Manual (ODCM), and contains methods, equations, assumptions, and parameters for calculation of radiation doses from plant effluents. Part II is organized as follows:

- Introduction
- Instrumentation and Systems
- Liquid Effluents
- Gaseous Effluents
- Total Dose
- Radiological Environmental Monitoring Program

1.2 Regulations

This section serves to illustrate the regulations and requirements that define and are applicable to the ODCM. Any information provided in the ODCM concerning specific regulations are not a substitute for the regulations as found in the Code of Federal Regulations (CFR) or Technical Specifications.

1.2.1 Code of Federal Regulations

Various sections of the Code of Federal Regulations (CFR) require nuclear power stations to be designed and operated in a manner that limits the radiation exposure to members of the public. These sections specify limits on offsite radiation doses and on effluent radioactivity concentrations and they also require releases of radioactivity to be "As Low As Reasonably Achievable". These requirements are contained in 10CFR20, 10CFR50 and 40CFR190. In addition, 40CFR141 imposes limits on the concentration of radioactivity in drinking water provided by the operators of public water systems.

- 10CFR20, Standards for Protection Against Radiation

This revision of the ODCM addresses the requirements of 10CFR20. The 10CFR20 dose limits are summarized in Table 1 - 1.

- Design Criteria (Appendix A of 10CFR50)

Section 50.36 of 10CFR50 requires that an application for an operating license include proposed Technical Specifications. Final Technical Specifications for each station are developed through negotiation between the applicant and the NRC. The Technical Specifications are then issued as a part of the operating license, and the licensee is required to operate the facility in accordance with them.

Section 50.34 of 10CFR50 states that an application for a license must state the principal design criteria of the facility. Minimum requirements are contained in Appendix A of 10CFR50.

- ALARA Provisions (Appendix I of 10CFR50)

Sections 50.34a and 50.36a of 10CFR50 require that the nuclear plant design and the station RECS have provisions to keep levels of radioactive materials in effluents to unrestricted areas "As Low As Reasonably Achievable" (ALARA). Although 10CFR50 does not impose specific limits on releases, Appendix I of 10CFR50 does provide numerical design objectives and suggested limiting conditions for operation. According to Section I of Appendix I of 10CFR50, design objectives and limiting conditions for operation, conforming to the guidelines of Appendix I "shall be deemed a conclusive showing of compliance with the "As Low As Reasonably Achievable" requirements of 10CFR50.34a and 50.36a."

An applicant must use calculations to demonstrate conformance with the design objective dose limits of Appendix I. The calculations are to be based on models and data such that the actual radiation exposure of an individual is "unlikely to be substantially underestimated" (see 10CFR50 Appendix I, Section III.A.1).

The guidelines in Appendix I call for an investigation, corrective action and a report to the NRC whenever the calculated dose due to the radioactivity released in a calendar quarter exceeds one-half of an annual design objective. The guidelines also require a surveillance program to monitor releases, monitor the environment and identify changes in land use.

- 40CFR190. Environmental Radiation Protection Standards for Nuclear Power Operations

Under an agreement between the NRC and the EPA, the NRC stipulated to its licensees in Generic Letter 79-041 that "Compliance with Radiological Effluent Technical Specifications (RETS), NUREG-0472 (Rev.2) for PWR's, implements the LWR provisions to meet 40CFR190". (See References 49 and 103.)

The regulations of 40CFR190 limit radiation doses received by members of the public as a result of operations that are part of the uranium fuel cycle. Operations must be conducted in such a manner as to provide reasonable assurance that the annual dose equivalent to any member of the public due to radiation and to planned discharges of radioactive materials does not exceed the following limits:

- 25 mrem to the total body
- 75 mrem to the thyroid

- 25 mrem to any other organ

An important difference between the design objectives of 10CFR50 and the limits of 40CFR190 is that 10CFR50 addresses only doses due to radioactive effluents. 40CFR190 limits doses due to effluents and to radiation sources maintained on site. See Section 1.2.4 for further discussion of the differences between the requirements of 10CFR50 Appendix I and 40CFR190.

- 40CFR141. National Primary Drinking Water Regulations

The following radioactivity limits for community water systems were established in the July, 1976 Edition of 40CFR141:

- Combined Ra-226 and Ra-228: ≤ 5 pCi/L.
- Gross alpha (particle activity including Ra-226 but excluding radon and uranium): ≤ 15 pCi/L.
- The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 mrem/yr.

The regulations specify procedures for determining the values of annual average radionuclide concentration that produce an annual dose equivalent of 4 mrem. Radiochemical analysis methods are also specified. The responsibility for monitoring radioactivity in a community water system falls on the supplier of the water. The Byron Station has requirements related to 40CFR141 in the RECS.

- 10CFR72. Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste

10CFR72.104 states that annual dose to any real individual located beyond the controlled area must not exceed the following:

- 25 mrem to the total body
- 75 mrem to the thyroid
- 25 mrem to any other critical organ

as a result of planned discharges of radioactive material to the environment, direct radiation from ISFSI operation, and other radiation from uranium fuel cycle operation (40CFR190). These requirements are consistent with the requirements of 40CFR190.

1.2.2 Radiological Effluent Technical Standards

The Radiological Effluent Technical Standards (RETS) were formerly a subset of the Technical Specifications. They implement provisions of the Code of Federal Regulations aimed at limiting offsite radiation dose. The NRC published Standard RETS for PWRs (Reference 2) as guidance to assist in the development of technical specifications. These documents have undergone frequent minor revisions to reflect changes in plant design and evolving regulatory concerns. The RETS have been removed from the Technical Specifications and placed in the TRM as the RECS (see Reference 90). The RECS are similar but not identical to the guidance of the Standard Radiological Effluent Technical Specifications.

1.2.3 Offsite Dose Calculation Manual

The NRC in Generic Letter 89-01 defines the ODCM as follows (not verbatim) (see Reference 90):

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/Trip Setpoints, and in the conduct of the Radiological Environmental Monitoring Program. The ODCM shall also contain (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Annual Radioactive Effluent Release Reports.

Additional requirements for the content of the ODCM are contained throughout the text of the RECS.

1.2.4 Overlapping Requirements

In 10CFR20, 10CFR50 and 40CFR190, there are overlapping requirements regarding offsite radiation dose and dose commitment to the total body. In 10CFR20.1301, the total effective dose equivalent (TEDE) to a member of the public is limited to 100 mrem per calendar year. In addition, Appendix I to 10CFR50 establishes design objectives on annual total body dose or dose commitment of 3 mrem per reactor for liquid effluents and 5 mrem per reactor for gaseous effluents (see 10CFR50 Appendix I, Sections II.A and II.B.2(a)). Finally, 40CFR190 limits annual total body dose or dose commitment to a member of the public to 25 mrem due to all uranium fuel cycle operations.

While these dose limits/design objectives appear to overlap, they are different and each is addressed separately by the RETS. Calculations are made and reports are generated to demonstrate compliance to all regulations. Refer to Table 1 - 1 and Table 1 - 2 for additional information regarding instantaneous effluent limits, design objectives and regulatory compliance.

1.2.5 Dose Receiver Methodology

Table 1 - 2 lists the location of the dose recipient and occupancy factors, if applicable. Dose is assessed at the location in the unrestricted area where the combination of existing pathways and receptor age groups indicates the maximum potential exposures. The dose calculation methodology is consistent with the methodology of Regulatory Guide 1.109 (Reference 6) and NUREG 0133 (Reference 14). Dose is therefore calculated to a maximum individual. The maximum individual is characterized as "maximum" with regard to food consumption, occupancy and other usage of the area in the vicinity of the plant site. Such a "maximum individual" represents reasonable deviation from the average for the population in general. In all physiological and metabolic respects, the maximum individual is assumed to have those characteristics that represent averages for their corresponding age group. Thus, the dose calculated is very conservative compared to the "average" (or typical) dose recipient who does not go out of the way to maximize radioactivity uptakes and exposure.

Table 1 - 1
Regulatory Dose Limit Matrix

REGULATION	DOSE TYPE		DOSE LIMIT(s)		TRM Section
Airborne Releases:			(quarterly)	(annual)	
10CFR50 App. I ¹	Gamma Dose to Air due to Noble Gas Radionuclides (per reactor unit)		5 mrad	10 mrad	3.11.g
	Beta Dose to Air Due to Noble Gas Radionuclides (per reactor unit)		10 mrad	20 mrad	3.11.g
	Organ Dose Due to Specified Non-Noble Gas Radionuclides (per reactor unit)		7.5 mrem	15 mrem	3.11.h
	Total Body and Skin Dose (if air dose is exceeded)	Total Body	2.5 mrem	5 mrem	N/A
		Skin	7.5 mrem	15 mrem	N/A
Technical Specifications	Total Body Dose Rate Due to Noble Gas Radionuclides (Instantaneous limit, per site)		500 mrem/yr		3.11.f
	Skin Dose Rate Due to Noble Gas Radionuclides (Instantaneous limit, per site)		3,000 mrem/yr		3.11.f
	Organ Dose Rate Due to Specified Non-Noble Gas Radionuclides (Instantaneous limit, per site)		1,500 mrem/yr		3.11.f
Liquid Releases:			(quarterly)	(annual)	
10CFR50 App. I ¹	Whole (Total) Body Dose (per reactor unit)		1.5 mrem	3 mrem	3.11.d
	Organ Dose (per reactor unit)		5 mrem	10 mrem	3.11.d
Technical Specifications	The concentration of radioactivity in liquid effluents released to unrestricted areas		Ten times the values listed in 10CFR20 Appendix B; Table 2, Column 2, and note 5 below for Noble Gases		3.11.c
Total Doses ¹ :					ODCM Section II
10 CFR 20.1301 (a)(1)	Total Effective Dose Equivalent ⁴		100 mrem/yr		5.5
10CFR20.1301 (d) And 40CFR190	Total Body Dose		25 mrem/yr		5.5
	Thyroid Dose		75 mrem/yr		5.5
	Other Organ Dose		25 mrem/yr		5.5
Other Limits ² :					
40CFR141	Total Body Dose Due to Drinking Water From Public Water Systems		4 mrem/yr		3.4
	Organ Dose Due to Drinking Water From Public Water Systems		4 mrem/yr		3.4

¹ These doses are calculated considering all sources of radiation and radioactivity in effluents.

² These limits are not directly applicable to nuclear power stations. They are applicable to the owners or operators of public water systems. However, the Byron RECS requires assessment of compliance with these limits.

³ Note that 10CFR50 provides design objectives, not limits.

⁴ Compliance with 10CFR20.1301(a)(1) is demonstrated by compliance with 40CFR190. Note that it may be necessary to address dose from on-site activity by members of the public as well.

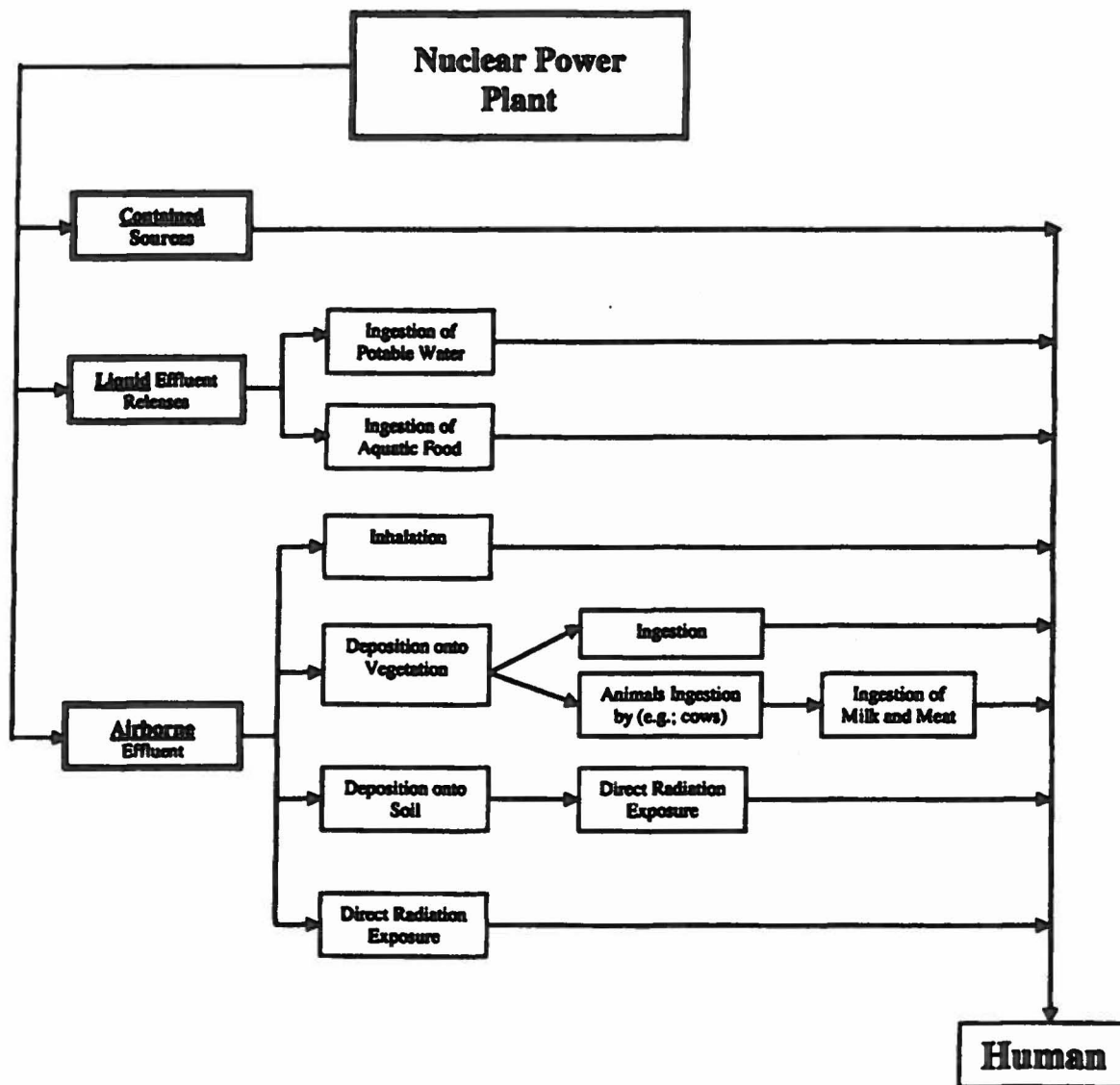
⁵ Kr-85m, Kr-85, Kr-87, Kr-88, Ar-41, Xe-131m, Xe-133m, Xe-133, Xe-135m and Xe-135 allowable concentration is $2E-4 \mu\text{Ci/ml}$ computed from Equation 17 of ICRP Publication 2 adjusted for infinite cloud submersion in water, and $R = 0.01 \text{ rem/wk}$, $\rho_w = 1.0 \text{ g/cm}^3$, and $P_w/P_i = 1.0$.

Table 1 - 2
Dose Assessment Receivers

Dose Component or Pathway	Location; Occupancy if Different than 100%
"Instantaneous" dose rates from airborne radioactivity	Unrestricted area boundary location that results in the maximum dose rate
"Instantaneous" concentration limits in liquid effluents	Point where liquid effluents enter the unrestricted area
Annual average concentration limits for liquid effluents	Point where liquid effluents enter the unrestricted area
Direct dose from contained sources	Receiver spends part of this time in the controlled area and the remainder at his residence or fishing nearby; occupancy factor is considered and is site-specific.
Direct dose from airborne plume	Receiver is at the unrestricted area boundary location that results in the maximum dose.
Dose due to radiiodines, tritium and particulates with half-lives greater than 8 days for inhalation, ingestion of vegetation, milk and meat, and ground plane exposure pathways.	Receiver is at the location in the unrestricted area where the combination of existing pathways and receptor age groups indicates the highest potential exposures.
Ingestion dose from drinking water	The drinking water pathway is considered as an additive dose component in this assessment only if the public water supply serves the community immediately adjacent to the plant.
Ingestion dose from eating fish	The receiver eats fish from the receiving body of water
Total Organ Doses	Summation of ingestion/inhalation doses
Total Dose	Summation of above data (Note it may also be necessary to address dose from on-site activity by members of the public.)

Figure 1 - 1 illustrates some of the potential radiation exposure pathways to humans due to routine operation of a nuclear power station.

Figure 1 - 1
Radiation Exposure Pathways to Humans



1.3 Offsite Dose Calculation Parameters

This section contains offsite dose calculation parameter factors, or values not specific only to one of the gas, liquid, or total dose chapters. Additional parameters are provided in the Sections 2, 4 and 5 of the ODCM.

10CFR50 Dose Commitment Factors

With the exception of H-3, the dose commitment factors for 10CFR50 related calculations are exactly those provided in Regulatory Guide 1.109 (Reference 6). The following table lists the parameters and the corresponding data tables in the RG 1.109:

<u>PATHWAY</u>	<u>ADULT</u>	<u>TEENAGER</u>	<u>CHILD</u>	<u>INFANT</u>
Inhalation	RG 1.109: Table E-7	RG 1.109: Table E-8	RG 1.109: Table E-9	RG 1.109: Table E-10
Ingestion	RG 1.109: Table E-11	RG 1.109: Table E-12	RG 1.109: Table E-13	RG 1.109: Table E-14

These tables are contained in Regulatory Guide 1.109 (Reference 6). Each table (E-7 through E-14) provides dose factors for seven organs for each of 73 radionuclides, and Table E-5 lists Miscellaneous Dose Assessment Factors - Consumption Parameters. For radionuclides not found in these tables, dose factors will be derived from ICRP 2 (Reference 50) or NUREG-0172 (Reference 51). The values for H-3 are taken from NUREG-4013 (Reference 107).

1.4 REFERENCES

The references listed below were transferred from the previous ODCM revision that was common to all former Commonwealth Edison nuclear stations. The references not applicable to Byron have been deleted, however the numbering has been preserved for ease of reference management throughout the ODCM document; therefore, reference numbering is not sequential.

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Table 1 - 3
Miscellaneous Dose Assessment Factors: Environmental Parameters

Parameter	Value	Comment	Equation	Basis ^a
f_a	0.76		4-11, 4-12	A
f_L	1.0		4-11, 4-12	A
f_p	1.0		4-13, 4-15	A
f_g	1.0		4-13, 4-15	A
t_b	262,800 hrs	30 years	4-9	C
t_f	48 hrs	Cow Milk Pathway	4-13	A
t_f	480 hrs	Cow Meat Pathway	4-15	A
t_h	1440 hrs	60 days for produce	4-11	A
t_h	2160 hrs	90 days for produce	4-13, 4-15	A
t_L	24 hrs	1 day for leafy vegetables	4-11	A
Q_F	50 Kg/day		4-13, 4-14, 4-15, 4-16	B
r	1.0	For Iodines	4-11, 4-13, 4-15	A
r	0.2	For Particulates	4-11, 4-13, 4-15	A
Y_p	0.7 Kg/m ²		4-13, 4-15	A
Y_s	2.0 Kg/m ²		4-13, 4-15	A
Y_v	2.0 Kg/m ²		4-11	A
λ_w	0.0021 hr ⁻¹		4-11, 4-13, 4-15	A
H	8 gm/m ³	Absolute Atmospheric Humidity	4-12, 4-14, 4-16	D

^aBasis key:

- A: Reference 6, Table E-15.
- B: Reference 6, Table E-3.
- C: The parameter t_b is taken as the midpoint of plant operating life (based upon an assumed 60 year plant operating lifetime).
- D: Reference 14, Section 5.3.1.3.

Table 1 - 4
Stable Element Transfer Data

Element	F _i Meat (d/kg)	F _M (Cow) Milk (d/L)	Reference
H	1.2E-02	1.0E-02	6
Be	1.5E-03	3.2E-03	Footnote 1
C	3.1E-02	1.2E-02	6
F	2.9E-03	1.4E-02	Footnote 2
Na	3.0E-02	4.0E-02	6
Mg	1.5E-03	3.2E-03	Footnote 1
Al	1.5E-02	1.3E-03	Footnote 3
P	4.6E-02	2.5E-02	6
Cl	2.9E-03	1.4E-02	Footnote 2
Ar	NA	NA	NA
K	1.8E-02	7.2E-03	16
Ca	1.6E-03	1.1E-02	16
Sc	2.4E-03	7.5E-08	Footnote 4
Ti	3.4E-02	5.0E-08	Footnote 5
V	2.8E-01	1.3E-03	Footnote 6
Cr	2.4E-03	2.2E-03	6
Mn	8.0E-04	2.5E-04	6
Fe	4.0E-02	1.2E-03	6
Co	1.3E-02	1.0E-03	6
Ni	5.3E-02	6.7E-03	6
Cu	8.0E-03	1.4E-02	6
Zn	3.0E-02	3.9E-02	6
Ga	1.5E-02	1.3E-03	Footnote 3
Ge	9.1E-04	9.9E-05	Footnote 7
As	1.7E-02	5.0E-04	Footnote 8
Se	7.7E-02	1.0E-03	Footnote 9
Br	2.9E-03	2.2E-02	F _i Footnote 2; F _M from Ref. 16
Kr	NA	NA	NA
Rb	3.1E-02	3.0E-02	6
Sr	6.0E-04	8.0E-04	6
Y	4.6E-03	1.0E-05	6
Zr	3.4E-02	5.0E-08	6
Nb	2.8E-01	2.5E-03	6
Mo	8.0E-03	7.5E-03	6
Tc	4.0E-01	2.5E-02	6
Ru	4.0E-01	1.0E-08	6
Rh	1.5E-03	1.0E-02	6
Pd	5.3E-02	6.7E-03	Footnote 10
Cd	3.0E-02	2.0E-02	Footnote 11
In	1.5E-02	1.3E-03	Footnote 3
Sn	9.1E-04	9.9E-05	Footnote 7
Sb	5.0E-03	2.0E-05	98
Ag	1.7E-02	5.0E-02	6
Te	7.7E-02	1.0E-03	6
I	2.9E-03	6.0E-03	6
Xe	NA	NA	NA
Cs	4.0E-03	1.2E-02	6
Ba	3.2E-03	4.0E-04	6
La	2.0E-04	5.0E-08	6
Ce	1.2E-03	1.0E-04	6
Pr	4.7E-03	5.0E-08	6
Nd	3.3E-03	5.0E-08	6

Table 1 - 4 (Cont'd)
Stable Element Transfer Data

Element	F _i Meat (d/kg)	F _M (Cow) Milk (d/L)	Reference
Pm	2.9E-04	2.0E-05	16
Sm	2.9E-04	2.0E-05	16
Eu	2.9E-04	2.0E-05	16
Gd	2.9E-04	2.0E-05	16
Dy	2.9E-04	2.0E-05	16
Er	2.9E-04	2.0E-05	16
Tm	2.9E-04	2.0E-05	16
Yb	2.9E-04	2.0E-05	16
Lu	2.9E-04	2.0E-05	16
Hf	3.4E-02	5.0E-06	Footnote 5
Ta	2.8E-01	1.3E-03	F _M - Ref.16; F _i -Footnote 6
W	1.3E-03	5.0E-04	6
Re	1.0E-01	1.3E-03	F _M - Ref.16; F _i -Footnote 12
Os	2.2E-01	6.0E-04	Footnote 13
Ir	7.3E-03	5.5E-03	Footnote 14
Pt	5.3E-02	6.7E-03	Footnote 10
Au	1.3E-02	3.2E-02	Footnote 15
Hg	3.0E-02	9.7E-06	F _M - Ref.16; F _i -Footnote 11
Tl	1.5E-02	1.3E-03	F _M - Ref.16; F _i -Footnote 3
Pb	9.1E-04	9.9E-05	98
Bi	1.7E-02	5.0E-04	98
Ra	5.5E-04	5.9E-04	98
Th	1.6E-06	5.0E-06	98
U	1.6E-06	1.2E-04	98
Np	2.0E-04	5.0E-06	6
Am	1.6E-06	2.0E-05	98

Notes:

1. NA = It is assumed that noble gases are not deposited on the ground.
2. Elements listed are those considered for 10CFR20 assessment and compliance.

Footnotes:

- There are numerous F_i and F_M values that were not found in published literature. In these cases, the periodic table was used in conjunction with published values. The periodic table was used based on a general assumption that elements have similar characteristics when in the same column of the periodic table. The values of elements in the same column of the periodic table, excluding atomic numbers 68-71 and 90-103, were averaged then assigned to elements missing values located in the same column of the periodic table. This method was used for all columns where there were missing values except column 3A, where there was no data, hence, the average of column 2B and 4A were used.
1. Values obtained by averaging Reference 6 values of Ca, Sr, Ba and Ra.
 2. F_i value obtained by assigning the Reference 6 value for I. F_M value obtained by averaging I (Ref. 6) and Br (Ref.16).
 3. F_i values obtained by averaging Zn (Ref.6) and Pb (Ref. 98); there were no values for elements in the same column; an average is taken between values of columns 2B and 4A on the periodic table. F_M values obtained by using the value for Tl from Reference 16.
 4. Values obtained by averaging Reference 6 values of Y and La.
 5. Values obtained by assigning the Reference 6 value for Zr.
 6. F_i values obtained from Ref. 6 value for Nb. F_M values obtained by averaging values for Nb (Ref.6) and Ta (Ref. 16).
 7. Values obtained from the Reference 6 values for Pb.
 8. Values obtained from the Reference 6 values for Bi.
 9. Values obtained from the Reference 6 values for Te.
 10. Values obtained from the Reference 6 values for Ni.
 11. F_i values obtained from Ref. 6 values for Zn. F_M values obtained by averaging the Reference 6 values for Zn and Hg.
 12. Values obtained by averaging Reference 6 values for Mn, Tc, Nd and Reference 98 value for U.
 13. Values obtained by averaging Reference 6 values from Fe and Ru.
 14. Values obtained by averaging Reference 6 values from Co and Rh.
 15. Values obtained by averaging Reference 6 values from Cu and Ag.