Attachment 2
Quad Cities Nuclear Power Station
Quad Cities Off-Site Dose Calculation Manual
SVP-07-025

Offsite Dose Calculation Manual

Quad Cities Station Units 1 and 2

Effective: December 2006

Note: Revision 7 is a major rewrite of the ODCM. No revision bars were used to annotate the changes.

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PART I

RADIOLOGICAL EFFLUENTS CONTROLS

FOR

QUAD CITIES STATION

UNITS 1 AND 2

1.0 USE AND APPLICATION

1.1 Definitions

--NOTE--
The defined terms of this section appear in capitalized type and are applicable throughout these OFFSITE DOSE CALCULATION MANUAL Specifications and Bases.

Term	Definition
ACTIONS	ACTIONS shall be that part of a Specification that prescribes Required Actions to be taken under designated Conditions within specified Completion Times.
ACTUAL DOSE	Refers to using known release data to project the dose to the public for the previous month. These data are stored in the database and used to demonstrate compliance with the reporting requirements of RECS.
BATCH RELEASE	A BATCH RELEASE is the discharge of liquid wastes of a discrete volume.
CHANNEL CALIBRATION	A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds within the necessary range and accuracy to known values of the parameter that the channel monitors. The CHANNEL CALIBRATION shall encompass all devices in the channel required for channel OPERABILITY and the CHANNEL FUNCTIONAL TEST. Calibration of instrument channels with resistance temperature detector (RTD) or thermocouple sensors may consist of an inplace 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, or total channel steps.
CHANNEL CHECK	A CHANNEL CHECK shall be the qualitative 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.

CHANNEL FUNCTIONAL TEST	A CHANNEL FUNCTIONAL TEST shall be the injection of a simulated or actual signal into the channel as close to the sensor as practicable to verify OPERABILITY of all devices in the channel required for channel OPERABILITY. The CHANNEL FUNCTIONAL TEST may be performed by means of any series of sequential, overlapping, or total channel steps.
COMMUNITY WATER SYSTEM	A public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents. This definition is per 40CFR141, National Primary Drinking Water Regulations. For purposes of the ODCM, COMMUNITY WATER SYSTEM is further defined as water taken from rivers, lakes or reservoirs (not well water) which is used for drinking.
CONTINUOUS RELEASE	A CONTINUOUS RELEASE is the discharge of liquid wastes of a non-discrete volume; e.g., from a volume or system that has an input flow during the release.
CONTINUOUS SAMPLING	Uninterrupted sampling with the exception of sampling interruptions of short duration (no longer than 2 hours) for required surveillances.
DOSE EQUIVALENT I-131	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 thyroid 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;" 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."
GASEOUS RADWASTE TREATMENT SYSTEM	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.
IMMEDIATELY	IMMEDIATELY means that the required action should be pursued without delay in a controlled manner.

LOWER LIMIT OF DETECTION	The LOWER LIMIT OF DETECTION (LLD) 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.
MEMBERS OF THE PUBLIC	Any individual except when that individual is receiving an OCCUPATIONAL DOSE.
MODE	A MODE shall correspond to any one inclusive combination of MODE switch position, average reactor coolant temperature, and reactor vessel head closure bolt tensioning specified in Technical Specifications with fuel in the reactor vessel.
OCCUPATIONAL DOSE	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.
OFFSITE DOSE CALCULATION MANUAL (ODCM)	The 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 Environmental Radiological 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 Radioactive Effluent Release Reports.
OPERABLE - OPERABILITY	A system, subsystem, division, component, or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified safety function(s) and 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, division, component, or device to perform its specified safety function(s) are also capable of performing their related support function(s).

PROCESS CONTROL PROGRAM (PCP)	Contains the current formulas, sampling, analyses, tests, and determinations 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 20, 10 CFR 61, and 10 CFR 71, State regulations, burial ground requirements, and other requirements governing the disposal of solid radioactive waste.
PROJECTED DOSE	Refers to using known release data from the previous month or estimated release data to forecast a future dose to the public. These data are <u>NOT</u> incorporated into the database.
PURGE-PURGING	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.
RATED THERMAL POWER (RTP)	RTP shall be a total reactor core heat transfer rate to the reactor coolant as defined in Technical Specifications.
RADIOLOGICAL EFFLUENT CONTROLS (RECS)	A compilation of the various regulatory requirements, surveillance and bases, commitments and/or components of the radiological effluent and environmental monitoring programs for Quad Cities Station. To assist in the understanding of the relationship between effluent regulations, ODCM equations, RECS and related Technical Specification requirements, Table 1-1 is a matrix that relates these various components, as well as the Radiological Environmental Monitoring Program fundamental requirements.
SITE BOUNDARY	That line beyond which the land is not owned, leased, or otherwise controlled by licensee as defined in ODCM Part II Figure 1-3.
SOURCE CHECK	The qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.
UNRESTRICTED AREA	An area, access to which is neither limited nor controlled by the licensee.

VENTILATION EXHAUST TREATMENT SYSTEM	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 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 to be VENTILATION EXHAUST TREATMENT SYSTEM components.
VENTING	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. Vent, used in system names does not imply a VENTING process.

Table 1-1

COMPLIANCE MATRIX

Regulation	Dose Component Limit	ODCM Equation	RECS	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	REC 12.4.2	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	REC 12.4.3	5.5.4.i
	3. Dose for all organs and all four age groups due to radioactivity in liquid effluents.	3-3	REC 12.3.2	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).	5-3	REC 12.5.2	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.	5-2	REC 12.5.1	5.5.4.j
	2. Organ doses to an adult due to all pathways.	5-3		
Technical Specifications	1. "Instantaneous" whole body, skin, and organ dose rates due to radioactivity in airborne effluents. For the organ dose, only child inhalation is considered.	4-1 4-2 4-3	REC 12.4.1	5.5.4.g
	2. "Instantaneous" concentration limits for liquid effluents.	3-1	REC 12.3.1	5.5.4.b
10CFR50 Appendix I Section IV.B.2	1. Implement environmental monitoring program.	N/A	REC 12.6.1	N/A
10CFR50 Appendix I Section IV.B.3	1. Land Use Census	N/A	REC 12.6.2	N/A
10CFR50 Appendix I Section IV.B.2	1. Interlaboratory Comparison Program	N/A	REC 12.6.3	N/A
Technical Specifications	1. Radioactive Effluent Release Report	NA	12.7.3	5.6.3
10CFR50 Appendix I Section IV.B.2 and Technical Specifications	1. Annual Radiological Environmental Operating Report	N/A	12.7.2	N/A

1.0 USE AND APPLICATION

1.2 Logical Connectors

PURPOSE

The purpose of this section is to explain the meaning of logical connectors.

Logical connectors are used in ODCM to discriminate between, and yet connect, discrete Conditions, Required Actions, Completion Times, Surveillances, and Frequencies. The only logical connectors that appear in ODCM are AND and OR. The physical arrangement of these connectors constitutes logical conventions with specific meanings.

BACKGROUND

Several levels of logic may be used to state Required Actions. These levels are identified by the placement (or nesting) of the logical connectors and by the number assigned to each Required Action. The first level of logic is identified by the first digit of the number assigned to a Required Action and the placement of the logical connector in the first level of nesting (i.e., left justified with the number of the Required Action). The successive levels of logic are identified by additional digits of the Required Action number and by successive indentations of the logical connectors.

When logical connectors are used to state a Condition, Completion Time, Surveillance, or Frequency, only the first level of logic is used, and the logical connector is left justified with the statement of the Condition, Completion Time, Surveillance, or Frequency.

EXAMPLES

The following examples illustrate the use of logical connectors.

(continued)

1.2 Logical Connectors

EXAMPLES (continued)

EXAMPLE 1.2-1

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. REC not met.	A.1 Verify . . . <u>AND</u> A.2 Restore . . .	

In this example, the logical connector <u>AND</u> is used to indicate that, when in Condition A, both Required Actions A.1 and A.2 must be completed.

(continued)

1.2 Logical Connectors

EXAMPLES (continued)

EXAMPLE 1.2-2

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. REC not met.	A.1 Trip . . . OR A.2.1 Verify . . . AND A.2.2.1 Reduce . . . OR A.2.2.2 Perform . . . OR A.3 Align	

This example represents a more complicated use of logical connectors. Required Actions A.1, A.2 and A.3 are alternate choices, only one of which must be performed as indicated by the use of the logical connector OR and the left justified placement. Any one of these three ACTIONS may be chosen. If A.2 is chosen, then both A.2.1 and A.2.2 must be performed as indicated by the logical connector AND. Required Action A.2.2 is met by performing A.2.2.1 or A.2.2.2. The indented position of the logical connector OR indicates that A.2.2.1 and A.2.2.2 are alternative choices, only one of which must be performed.

1.0 USE AND APPLICATION

1.3 Completion Times

PURPOSE	The purpose of this section is to establish the Completion Time convention and to provide guidance for its use.
BACKGROUND	ODCM Radiological Effluent Controls (RECs) specify minimum requirements for ensuring safe operation of the unit. The ACTIONS associated with a REC state Conditions that typically describe the ways in which the requirements of the REC can fail to be met. Specified with each stated Condition are Required Action(s) and Completion Times.
DESCRIPTION	The Completion Time is the amount of time allowed for completing a Required Action. It is referenced to the time of discovery of a situation (e.g., inoperable equipment or variable not within limits) that requires entering an Actions Condition unless otherwise specified, providing the unit is in a MODE or specified condition stated in the Applicability of the REC. Required Actions must be completed prior to the expiration of the specified Completion Time. An Actions Condition remains in effect and the Required Actions apply until the Condition no longer exists or the unit is not within the REC Applicability. If situations are discovered that require entry into more than one Condition at a time within a single REC (multiple Conditions), the Required Actions for each Condition must be performed within the associated Completion Time. When in multiple Conditions, separate Completion Times are tracked for each Condition starting from the time of discovery of the situation that required entry into the Condition. Once a Condition has been entered, subsequent divisions, subsystem, components or variables expressed in the Condition, discovered to be inoperable or not within limits, will <u>not</u> result in separate entry into the Condition unless specifically stated. The Required Actions of the Condition continue to apply to each additional failure, with Completion Times based on initial entry into the Condition.

(continued)

DESCRIPTION (continued)

However, when a subsequent division, subsystem, component, or variable expressed in the Condition is discovered to be inoperable or not within limits, the Completion Time(s) may be extended. To apply this Completion Time extension, two criteria must first be met. The subsequent inoperability:

a. Must exist concurrent with the first inoperability; and

b. Must remain inoperable or not within limits after the first inoperability is resolved.

The total Completion Time allowed for completing a Required Action to address the subsequent inoperability shall be limited to the more restrictive of either:

a. The stated Completion Time, as measured from the initial entry into the Condition, plus an additional 24 hours; or

b. The stated Completion Time as measured from discovery of the subsequent inoperability.

The above Completion Time extension does not apply to those RECs that have exceptions that allow completely separate re-entry into the Condition (for each division, subsystem, component, or variable expressed in the Condition) and separate tracking of Completion Times based on this re-entry. These exceptions are stated in individual RECs.

The above Completion Time extension does not apply to a Completion Time with a modified "time zero." This modified "time zero" may be expressed as a repetitive time (i.e., "once per 8 hours," where the Completion Time is referenced from a previous completion of the Required Action versus the time of Condition entry) or as a time modified by the phrase "from discovery . . ." example 1.3-3 illustrates one use of this type of Completion Time. The 10 day Completion Time specified for Condition A and B in example 1.3-3 may not be extended.

EXAMPLES

The following examples illustrate the use of Completion Times with different types of Conditions and changing Conditions.

(continued)

EXAMPLES (continued)

EXAMPLE 1.3-1

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 3. AND B.2 Be in MODE 4.	12 hours 36 hours

Condition B has two Required Actions. Each Required Action has its own separate Completion Time. Each Completion Time is referenced to the time that Condition B is entered.

The Required Actions of Condition B are in to be in MODE 3 within 12 hours AND in MODE 4 within 36 hours. A total of 12 hours is allowed for reaching MODE 3 and a total of 36 hours (not 48 hours) is allowed for reaching MODE 4 from the time that Condition B was entered. If MODE 3 is reached within 6 hours, the time allowed for reaching MODE 4 is the next 30 hours because the total time allowed for reaching MODE 4 is 36 hours.

If Condition B is entered while in MODE 3, the time allowed for reaching MODE 4 is the next 36 hours.

(continued)

EXAMPLES (continued)

EXAMPLE 1.3-2

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One monitor inoperable.	A.1 Restore monitor to OPERABLE status.	7 days
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 3.	12 hours
	AND	
	B.2 Be in MODE 4.	36 hours

When a monitor is declared inoperable, Condition A is entered. If the monitor is not restored to OPERABLE status within 7 days, Condition B is also entered and the Completion Time clocks for Required Action B.1 and B.2 start. If the inoperable monitor is restored to OPERABLE status after Condition B is entered, Condition A and B are exited, and therefore, the Required Actions of Condition B may be terminated.

When a monitor is declared inoperable while the first monitor is still inoperable, Condition A is not re-entered for the second monitor. REC 12.0.3 is entered, since the ACTIONS do not include a Condition from more than one inoperable monitor. The Completion Time clock for Condition A does not stop after REC 12.0.3 is entered, but continues to be tracked from the time Condition A was initially entered.

While in REC 12.0.3, if one of the inoperable monitors is restored to OPERABLE status and the Completion Time for Condition A has not expired, REC 12.0.3 may be exited and operation continued in accordance with Condition A.

(continued)

1.3 Completion Times

EXAMPLES EXAMPLE 1.3-2 (continued)

While in REC 12.0.3, if one of the inoperable monitors is restored to OPERABLE status and the Completion Time for Condition A has expired, REC 12.0.3 may be exited and operation continued in accordance with Condition B. The Completion Time for Condition B is tracked from the time the Condition A Completion Time expired.

On restoring one of the monitors to OPERABLE status, the Condition A Completion Time is not reset, but continues from the time the first monitor was declared inoperable. This Completion Time may be extended if the monitor restored to OPERABLE status was the first inoperable monitor. A 24 hour extension to the stated 7 days is allowed, provided this does not result in the second monitor being inoperable for > 7 days.

(continued)

EXAMPLES (continued)

EXAMPLE 1.3-3

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One Function X subsystem inoperable.	A.1 Restore Function X subsystem to OPERABLE status.	7 days AND 10 days from discovery of failure to meet the REC
B. One Function Y subsystem inoperable.	B.1 Restore Function Y subsystem to OPERABLE status.	72 hours AND 10 days from discovery to meet REC
C. One Function X subsystem inoperable. AND One Function Y subsystem inoperable.	C.1 Restore Function X subsystem to OPERABLE status. OR C.2 Restore Function Y subsystem to OPERABLE status.	72 hours 72 hours

(continued)

1.3 Completion Times

EXAMPLES EXAMPLE 1.3-3 (continued)

When one Function X subsystem and one Function Y subsystem are inoperable, Condition A and Condition B are concurrently applicable. The Completion Times for Condition A and Condition B are tracked separately for each subsystem, starting from the time each subsystem was declared inoperable and the Condition was entered. A separate Completion Time is established for Condition C and tracked from the time the second subsystem was declared inoperable (i.e., the time the situation described in Condition C was discovered).

If Required Action C.2 is completed within the specified Completion Time, Conditions B and C are exited. If the Completion Time for Required Action A.1 has not expired, operation may continue in accordance with Condition A. The remaining Completion Time in Condition A is measured from the time the affected subsystem was declared inoperable (i.e., initial entry into Condition A).

The Completion Times of Conditions A and B are modified by a logical connector, with a separate 10 day Completion Time measured from the time it was discovered the REC was not met. In this example, without the separate Completion Time, it would be possible to alternate between Conditions A, B, and C in such a manner that operation could continue indefinitely without ever restoring systems to meet the REC. The separate Completion Time modified by the phrase "from discovery of failure to meet the Control" is designed to prevent indefinite continued operation while not meeting the REC. This Completion Time allows for an exception to the normal "time zero" for beginning the Completion Time "clock." In this instance, the Completion Time "time zero" is specified as commencing at the time the associated Condition was entered.

(continued)

EXAMPLES (continued)

EXAMPLE 1.3-4

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more instruments inoperable.	A.1 Restore instrument(s) to OPERABLE status.	4 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 3. AND B.2 Be in MODE 4.	12 hours 36 hours

A single Completion Time is used for any number of instruments inoperable at the same time. The Completion Time associated with Condition A is based on the initial entry into Condition A and is not tracked on a per instrument basis. Declaring subsequent instruments inoperable, while Condition A is still in effect, does not trigger the tracking of separate Completion Times.

Once one of the instruments has been restored to OPERABLE status, the Condition A Completion Time is not reset, but continues from the time the first instrument was declared inoperable. The Completion Time may be extended if the instrument restored to OPERABLE status was the first inoperable instrument. The Condition A Completion Time may be extended for up to 4 hours provided this does not result in any subsequent instrument being inoperable for > 4 hours.

If the Completion Time of 4 hours (plus the extension) expires while one or more instruments are still inoperable, Condition B is entered.

(continued)

1.3 Completion Times

EXAMPLES (continued)

EXAMPLE 1.3-5

ACTIONS

---NOTE---
Separate Condition entry is allowed for each inoperable instrument.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more instruments inoperable.	A.1 Restore instrument(s) to OPERABLE status.	4 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 3. <u>AND</u> B.2 Be in MODE 4.	12 hours 36 hours

The Note above the Actions Table is a method of modifying how the Completion Time is tracked. If this method of modifying how the Completion Time is tracked was applicable only to a specific Condition, the Note would appear in that Condition rather than at the top of the Actions Table.

The Note allows Condition A to be entered separately for each inoperable instrument, and Completion Times tracked on a per instrument basis. When an instrument is declared inoperable, Condition A is entered and its Completion Time starts. If subsequent instruments are declared inoperable, Condition A is entered for each instrument and separate Completion Times start and are tracked for each instrument.

If the Completion Time associated with an instrument in Condition A expires, Condition B is entered for that instrument. If the Completion Times associated with subsequent instruments in Condition A expire, Condition B is entered separately for each instrument and separate Completion Times start and are tracked for each instrument. If a instrument that caused entry into Condition B is restored to OPERABLE status, Condition B is exited for that instrument.

Since the Note in this example allows multiple Condition entry and tracking of separate Completion Times, Completion Time extensions do not apply.

(continued)

EXAMPLES (continued)

EXAMPLE 1.3-6

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One channel inoperable.	A.1 Perform RSR 12.x.x.x. OR A.2 Reduce THERMAL POWER to ≤ 50% RTP.	Once per 8 hours 8 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 3.	12 hours

Entry into Condition A offers a choice between Required Action A.1 or A.2. Required Action A.1 has a "once per" Completion Time, which qualifies for the 25% extension, per RSR 12.0.2 to each performance after the initial performance. The initial 8 hour interval of Required Action A.1 begins when Condition A is entered and the initial performance of Required Action A.1 must be completed within the first 8 hour interval. If Required Action A.1 is followed and the Required Action is not met within the Completion Time (plus the extension allowed by RSR 12.0.2), Condition B is entered. If Required Action A.2 is followed and the Completion Time of 8 hours is not met, Condition B is entered.

If after entry into Condition B, Required Action A.1 or A.2 is met, Condition B is exited and operation may then continue in Condition A.

(continued)

EXAMPLES (continued)

EXAMPLE 1.3-7

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One subsystem inoperable.	A.1 Verify affected subsystem isolated.	1 hour
	<u>AND</u>	<u>AND</u>
		Once per 8 hours thereafter
	A.2 Restore subsystem to OPERABLE status.	72 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 3.	12 hours
	<u>AND</u>	
	B.2 Be in MODE 4.	36 hours

Required Action A.1 has two Completion Times. The 1 hour Completion Time begins at the time the Condition is entered and each "Once per 8 hours thereafter" interval begins upon performance of Required Action A.1.

If after Condition A is entered, Required Action A.1 is not met within either the initial 1 hour or any subsequent 8 hour interval from the previous performance (plus the extension allowed by RSR 12.0.2), Condition B is entered. The Completion Time clock for Condition A does not stop after Condition B is entered, but continues from the time Condition A was initially entered. If Required Action A.1 is met after Condition B is entered, Condition B is exited and operation may continue in accordance with Condition A, provided the Completion Time for Required Action A.2 has not expired.

IMMEDIATE COMPLETION TIME

When "Immediately" is used as a Completion Time, the Required Action should be pursued without delay and in a controlled manner.

1.0 USE AND APPLICATION

1.4 Frequency

PURPOSE	The purpose of this section is to define the proper use and application of Frequency requirements.

DESCRIPTION

Each ODCM Radiological Effluent Surveillance Requirement (RSR) has a specified Frequency in which the Surveillance must be met in order to meet the associated ODCM REC. An understanding of the correct application of the specified Frequency is necessary for compliance with the RSR.

The "specified Frequency" is referred to throughout this section and each of the Requirements of Section 12.0, ODCM Surveillance Requirement (RSR) Applicability. The "specified Frequency" consists of the requirements of the Frequency column of each RSR, as well as certain Notes in the Surveillance column that modify performance requirements.

Sometimes special situations dictate when the requirements of a Surveillance are to be met. They are "otherwise stated" conditions allowed by RSR 12.0.1. They may be stated as clarifying Notes in the Surveillance, as part of the Surveillance, or both. Example 1.4-4 discusses these special situations.

Situations where a Surveillance could be required (i.e., its Frequency could expire), but where it is not possible or not desired that it be performed until sometime after the associated REC is within its Applicability, represent potential RSR 12.0.4 conflicts. To avoid these conflicts, the RSR (i.e., the Surveillance or the Frequency) is stated such that it is only "required" when it can be and should be performed. With a RSR satisfied, RSR 12.0.4 imposes no restriction.

The use of "met" or "performed" in these instances conveys specified meanings. A Surveillance is "met" only when the acceptance criteria are satisfied. Known failure of the requirements of a Surveillance, even without a Surveillance specifically being "performed," constitutes a Surveillance not "met." "Performance" refers only to the requirement to

(continued)

1.4 Frequency

DESCRIPTION (continued)

specifically determine the ability to meet the acceptance criteria.
RSR 12.0.4 restrictions would not apply if both the following conditions are satisfied:

a. The Surveillance is not required to be performed; and

b. The Surveillance is not required to be met or, even if required to be met, is not known to be failed.

EXAMPLES

The following examples illustrate the various ways that Frequencies are specified. In these examples, the Applicability of the REC (REC not shown) is MODES 1, 2, and 3.

EXAMPLE 1.4-1

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
Perform CHANNEL CHECK	12 hours

Example 1.4-1 contains the type of RSR most often encountered in the ODCM. The Frequency specifies an interval (12 hours) during which the associated Surveillance must be performed at least one time. Performance of the Surveillance initiates the subsequent interval. Although the Frequency is stated as 12 hours, an extension of the time interval to 1.25 times the interval specified in the Frequency is allowed by RSR 12.0.2 for operational flexibility. The measurement of this interval continues at all times, event when the RSR is not required to be met per RSR 12.0.1 (such as when the equipment is inoperable, a variable is outside specified limits, or the unit is outside the Applicability of the REC). If the interval specified by RSR 12.0.2 is exceeded while the unit is in a MODE or other specified condition in the Applicability of the REC,

(continued)

EXAMPLES

EXAMPLE 1.4-1 (continued)

and the performance of the Surveillance is not otherwise modified (refer to Examples 1.4-3 and 1.4-4), then RSR 12.0.3 becomes applicable.

If the interval as specified by RSR 12.0.2 is exceeded while the unit is not in a MODE or other specified condition in the Applicability of the REC for which performance of the RSR is required, the Surveillance must be performed within the Frequency requirements of RSR 12.0.2 prior to entry into the MODE or other specified condition. Failure to do so would result in a violation of RSR 12.0.4.

EXAMPLE 1.4-2

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
Verify flow is within limits.	Once within 12 hours after $\geq$ 25% RTP AND 24 hours thereafter

Example 1.4-2 has two Frequencies. The first is a one time performance Frequency, and the second is of the type shown in Example 1.4-1. The logical connector "AND" indicates that both Frequency requirements must be met. Each time reactor power is increased from a power level < 25% RTP to $\geq$ 25% RTP, the Surveillance must be performed within 12 hours.

(continued)

EXAMPLES

EXAMPLE 1.4-2 (continued)

The use of "once" indicates a single performance will satisfy the specified Frequency (assuming no other Frequencies are connected by "AND"). This type of Frequency does not qualify for the extension allowed by RSR 12.0.2.

"Thereafter" indicates future performances must be established per RSR 12.0.2, but only after a specified condition is first met (i.e., the "once" performance in this example). If reactor power decreases to < 25% RTP, the measurement of both intervals stops. New intervals start upon reactor power reaching 25% RTP.

EXAMPLE 1.4-3

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
-----------------------NOTE----------------------- Not required to be performed until 12 hours after ≥ 25% RTP. --	
Perform channel adjustment.	7 days

The interval continues whether or not the unit operation is < 25% RTP between performances.

As the Note modifies the required performance of the Surveillance, it is construed to be part of the "specified Frequency." Should the 7 day interval be exceeded while operation is < 25% RTP, this Note allows 12 hours after power reaches ≥ 25% RTP to perform the Surveillance. The Surveillance is still considered to be within the "specified Frequency." Therefore, if the Surveillance were not performed within the 7 day interval (plus the extension allowed by RSR 12.0.2), but operation was < 25% RTP,

(continued)

EXAMPLES

EXAMPLE 1.4-3 (continued)

it would not constitute a failure of the RSR or failure to meet the REC. Also, no violation of RSR 12.0.4 occurs when changing MODES, even with the 7 day Frequency not met, provided operation does not exceed 12 hours with power $\geq$ 25% RTP.

Once the unit reaches 25% RTP, 12 hours would be allowed for completing the Surveillance. If the Surveillance were not performed within this 12 hour interval, there would then be a failure to perform a Surveillance within the specified Frequency, and the provisions of RSR 12.0.3 would apply.

EXAMPLE 1.4-4

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
------------------------NOTE------------------------ Only required to be met in MODE 1. --	
Verify leakage rates are within limits.	24 hours

Example 1.4-4 specifies that the requirements of this Surveillance do not have to be met until the unit is in MODE 1. The interval measurement for the Frequency of this Surveillance continues at all times, as described in Example 1.4-1. However, the Note constitutes an "otherwise stated" exception to the Applicability of this Surveillance. Therefore, if the Surveillance were not performed within the 24 hour interval (plus the extension allowed by RSR 12.0.2), but the unit was not in MODE 1, there would be no failure of the RSR nor failure to meet the REC. Therefore, no violation of RSR 12.0.4 occurs when changing MODES, even with the 24 hour Frequency exceeded, provided the MODE change was not made into MODE 1. Prior to entering MODE 1 (assuming again that the 24 hour Frequency were not met), RSR 12.0.4 would require satisfying the RSR.

1.0 USE AND APPLICATION

1.5 REC and RSR Implementation

The ODCM provides those limitations upon plant operations which are part of the licensing basis for the station but do not meet the criteria for continued inclusion in the Technical Specifications.

It also provides information which supplements the Technical Specifications by implementing the requirements of Technical Specification Sections 5.5.1, 5.5.4, 5.6.2, and 5.6.3. Nothing in the ODCM shall supersede any Technical Specification requirement.

RECs and RSRs are implemented the same as Technical Specifications (see ODCM 12.0 Applicability). However, RECs and RSRs are treated as plant procedures and are not part of the Technical Specifications. Therefore the following exceptions apply:

a. Violations of the Action or Surveillance requirements in a REC are not reportable as conditions prohibited by, or deviations from, the Technical Specifications per 10 CFR 50.72 or 10 CFR 50.73.

b. Power reduction or plant shutdowns required to comply with the Actions of a REC are not reportable per 10 CFR 50.72 or 10 CFR 50.73.

2.0 through 11.0 NOT USED

INTENTIONALLY BLANK

Sections 2.0 through 11.0 are not used in the ODCM in order to maintain the Original ODCM numbering convention

12.0 RADIOLOGICAL EFFLUENT CONTROL (REC) and RADIOLOGICAL EFFLUENT SURVEILLANCE REQUIREMENT (RSR) APPLICABILITY

REC 12.0.1 RECs shall be met during the MODES or other specified conditions in the Applicability, except as provided in REC 12.0.2.

REC 12.0.2 Upon discovery of a failure to meet a REC, the Required Actions of the associated Conditions shall be met, except as provided in REC 12.0.5.

If the REC is met or is no longer applicable prior to expiration of the specified Completion Time(s), completion of the Required Action(s) is not required, unless otherwise stated.

REC 12.0.3 When a REC is not met and the associated ACTIONS are not met, an associated ACTION is not provided, or if directed by the associated ACTIONS, action shall be initiated within 1 hour to:

a. Implement appropriate compensatory actions as needed;

b. Verify that the plant is not in an unanalyzed condition(s) or that a required safety function is not compromised by the inoperabilities; and

c. Within 12 hours, obtain Shift Manager or designee approval of the compensatory actions and the plan for exiting REC 12.0.3.

Exceptions to this REC are stated in the individual RECs.

Where corrective measures are completed that permit operation in accordance with the REC or ACTIONS, completion of the actions required by REC 12.0.3 is not required.

REC 12.0.3 is only applicable in MODES 1, 2, and 3.

REC 12.0.4 When a REC is not met, entry into a MODE or other specified condition in the Applicability shall not be made except when the associated ACTIONS to be entered permit continued operation in the MODE or other specified condition in the Applicability for an unlimited period of time. This REC shall not prevent changes in

(continued)

12.0 RADIOLOGICAL EFFLUENT CONTROL (REC) and RADIOLOGICAL EFFLUENT SURVEILLANCE REQUIREMENT (RSR) APPLICABILITY

REC 12.0.4 (continued)	MODES or other specified conditions in the Applicability that are required to comply with ACTIONS or that are part of a shutdown of the unit. Exceptions to this REC are stated in the individual RECs. REC 12.0.4 is only applicable for entry into a MODE or other specified condition in the Applicability in MODES 1, 2, and 3.
REC 12.0.5	Equipment removed from service or declared INOPERABLE to comply with ACTIONS may be returned to service under administrative control solely to perform testing required to demonstrate its OPERABILITY or the OPERABILITY of other equipment. This is an exception to REC 12.0.2 for the system returned to service under administrative control to perform the testing required to demonstrate OPERABILITY.
REC 12.0.6	RECs, including associated ACTIONS, shall apply to each unit individually, unless otherwise indicated. Whenever the REC refers to a system or component that is shared by both units, the ACTIONS will apply to both units simultaneously.

12.0 RADIOLOGICAL EFFLUENT CONTROL (REC) and RADIOLOGICAL EFFLUENT SURVEILLANCE REQUIREMENT (RSR) APPLICABILITY

RSR 12.0.1 RSRs shall be met during the MODES or other specified conditions in the Applicability for individual RECs, unless otherwise stated in the RSR. Failure to meet a RSR, whether such failure is experienced during the performance of the RSR or between performances of the RSR, shall be failure to meet the REC. Failure to perform a RSR within the specified Frequency shall be failure to meet the REC except as provided in RSR 12.0.3. RSRs do not have to be performed on inoperable equipment or variables outside specified limits.

RSR 12.0.2 The specified Frequency for each RSR is met if the RSR is performed within 1.25 times the interval specified in the Frequency, as measured from the previous performance or as measured from the time a specified condition of the Frequency is met.

For Frequencies specified as "once," the above interval extension does not apply.

If a Completion Time requires periodic performance on a "once per..." basis, the above Frequency extension applies to each performance after the initial performance.

Exceptions to this RSR are stated in the individual RSRs.

RSR 12.0.3 If it is discovered that a RSR was not performed within its specified Frequency, then compliance with the requirement to declare the REC not met may be delayed, from the time of discovery, up to 24 hours or up to the limit of the specified Frequency, whichever is greater. This delay period is permitted to allow performance of the RSR. A risk evaluation shall be performed for any Surveillance delayed greater than 24 hours and the risk impact shall be managed.

If the RSR is not performed within the delay period, the REC must immediately be declared not met, and the applicable Condition(s) must be entered.

When the RSR is performed within the delay period and the RSR is not met, the REC must immediately be declared not met, and the applicable Condition(s) must be entered.

(continued)

12.0 RADIOLOGICAL EFFLUENT CONTROL (REC) and RADIOLOGICAL EFFLUENT SURVEILLANCE REQUIREMENT (RSR) APPLICABILITY

RSR 12.0.4 Entry into a MODE or other specified condition in the Applicability of a REC shall not be made unless the REC's RSRs have been met within their specified Frequency. This provision shall not prevent entry into MODES or other specified conditions in the Applicability that are required to comply with ACTIONS or that are part of a shutdown of the unit.

RSR 12.0.4 is only applicable for entry into a MODE or other specified condition in the Applicability in MODES 1, 2, and 3.

RSR 12.0.5 RSRs shall apply to each unit individually, unless otherwise indicated.

12.1 NOT USED

INTENTIONALLY BLANK

12.2 INSTRUMENTATION

12.2.1 Radioactive Liquid Effluent Monitoring Instrumentation

REC 12.2.1 The effluent monitoring instrumentation in Table 12.2.1-1 shall be OPERABLE with alarm setpoints set to ensure the limits of REC 12.3.1 are not exceeded. The instrument alarm setpoints shall be determined in accordance with the ODCM.

APPLICABILITY: When flow is present in the system.

-----------------------------NOTE----------------------------------
1. Separate Condition entry is allowed for each inoperable instrument channel.
2. The provisions of REC 12.0.4 are not applicable.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Required instrument channel alarm /trip setpoint less conservative than required.	A.1 Suspend release of radioactive liquid effluents monitored by the instrument channel. <u>OR</u> A.2 Enter the Condition referenced in Table 12.2.1-1 for the instrument channel.	Immediately Immediately
B. One or more required instrument channels with less than the minimum number of OPERABLE channels for reasons other than Condition A.	B.1 Enter the Condition referenced in Table 12.2.1-1 for the instrument channel	Immediately
C. Service Water Effluent Gross Activity Monitor with less than the minimum number of OPERABLE channels.	C.1 Collect and analyze grab samples for beta or gamma activity at an LLD $\leq$ 1E-07 μCi/ml. <u>AND</u> C.2 Restore the instrument channel to OPERABLE status.	Once per 12 hours 30 days

(continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. Liquid Radwaste Effluent Gross Activity Monitor with less than the minimum number of OPERABLE channels.	D.1 Perform RSR 12.3.1.1 on at least two independent samples of the tank's contents.	Prior to each release
	AND	
	D.2 Perform independent verification of the release rate calculations and discharge line valve line-up using at least two technically qualified members of the facility staff.	Prior to each release
	AND	
	D.3 Return instrument channel to OPERABLE status.	30 days
E. Required Action and Completion Time of Condition D not met	E.1 Suspend release of radioactive effluents via this pathway.	Immediately
F. Liquid Radwaste Flow Rate Monitor with less than the minimum number of OPERABLE channels.	------------------NOTE-------------------- Pump curves may be used to estimate flow. --	
	F.1 Estimate flow rate for the release in progress via the affected pathway.	Once per 4 hours
	AND	
	F.2 Return instrument channel to OPERABLE status.	30 days
-------------NOTE--------------- Required Action G.1 shall be completed if this Condition is entered. ------------------------------------ G. Required Action C.2, or D.3, or F.2 and associated Completion Time not met.	G.1 Explain why the inoperability was not corrected in a timely manner in the next Radioactive Effluent Release Report.	In accordance with Section 12.7.3

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT		FREQUENCY
RSR 12.2.1.1	Perform CHANNEL CHECK.	24 hours
RSR 12.2.1.2	Perform CHANNEL CHECK. The test shall verify flow during periods of release.	24 hours
RSR 12.2.1.3	Perform CHANNEL FUNCTIONAL TEST. The test shall also demonstrate that the control room alarm annunciates if any of the following conditions exist, where applicable: a. Instrument indicates measured levels above the alarm setpoint. b. Circuit failure. c. Instrument indicates a downscale failure. d. Instrument controls not set in the normal operating mode.	92 days
RSR 12.2.1.4	Perform SOURCE CHECK. For instrument 3, the test shall include observing instrument response during a discharge.	24 months
RSR 12.2.1.5	Perform CHANNEL CALIBRATION. For instruments 1, 2, and 3, the test shall also include a SOURCE CHECK per RSR 12.2.1.4.	24 months

Table 12.2.1-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM NUMBER OF OPERABLE CHANNELS	CONDITION REFERENCED FROM REQUIRED ACTION A.2 AND B.1	SURVEILLANCE REQUIREMENTS
1. Service Water Effluent Gross Activity Monitor (Unit 1)	1	C	RSR 12.2.1.1 RSR 12.2.1.3 RSR 12.2.1.4 RSR 12.2.1.5
2. Service Water Effluent Gross Activity Monitor (Unit 2)	1	C	RSR 12.2.1.1 RSR 12.2.1.3 RSR 12.2.1.4 RSR 12.2.1.5
3. Liquid Radwaste Effluent Gross Activity Monitor	1	D	RSR 12.2.1.1 RSR 12.2.1.3 RSR 12.2.1.4 RSR 12.2.1.5
4. Liquid Radwaste Effluent Flow Rate Monitor	1	F	RSR 12.2.1.2 RSR 12.2.1.5

12.2 INSTRUMENTATION

12.2.2 Radioactive Gaseous Effluent Monitoring Instrumentation

REC 12.2.2 The Radioactive Gaseous Effluent Monitoring Instrumentation in Table 12.2.2-1 shall be OPERABLE with alarm/trip setpoints set to ensure the limits of REC 12.4.1, REC 12.4.2, and REC 12.4.3 are not exceeded. The alarm trip/setpoints shall be determined in accordance with the ODCM.

APPLICABILITY: According to Table 12.2.2-1.

------------------------------NOTE----------------------------------
1. Separate Condition entry is allowed for each inoperable instrument channel.
2. The provisions of REC 12.0.4 are not applicable.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Required instrument channel alarm /trip setpoint less conservative than required.	A.1 Suspend release of radioactive gaseous effluents monitored by the instrument channel.	Immediately
	<u>OR</u>	
	A.2 Enter the Condition referenced in Table 12.2.2-1 for the instrument channel.	Immediately
B. One or more required instrument channels with less than the minimum number of OPERABLE channels for reasons other than Condition A.	B.1 Enter the Condition referenced in Table 12.2.2-1 for the instrument channel.	Immediately
C. Steam Jet Air Ejector Radiation Monitors with less than the minimum number of OPERABLE channels.	C.1 Verify at least one Main Chimney Noble Gas Activity Monitor OPERABLE.	Immediately
	<u>AND</u>	
	C.2 Restore at least one instrument channel to OPERABLE status.	72 hours

(continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. Required Action and associated Completion Times of Required Action C.1 or C.2 not met.	D.1 Be in MODE 2 with all main steam lines isolated.	12 hours
	<u>AND</u>	
	D.2 Restore instrument channel to OPERABLE status.	30 days
E. Main Chimney Noble Gas Activity Monitor with less than the minimum number of OPERABLE channels.	E.1 Obtain grab samples.	Once per 8 hours
	<u>AND</u>	
	E.2 Analyze grab samples for noble gas emitters.	Within 24 hours following each grab sample
	<u>AND</u>	
	E.3 Restore instrument channel to OPERABLE status.	30 days
F. Main Chimney High Range Noble Gas Monitor with less than the minimum number of OPERABLE channels.	F.1 Establish the preplanned alternate method of monitoring the appropriate parameters.	72 hours
	<u>AND</u>	
	F.2 Restore instrument channel to OPERABLE status.	7 days
G. Main Chimney Iodine Sampler with less than the minimum number of OPERABLE channels.	G.1 Establish CONTINUOUS SAMPLING with auxiliary sampling equipment as required in Table 12.4.1-1.	Immediately
	<u>AND</u>	
	G.2 Restore instrument channel to OPERABLE status.	30 days

(continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
H. Main Chimney Particulate Sampler with less than the minimum number of OPERABLE channels.	H.1 Establish CONTINUOUS SAMPLING with auxiliary sampling equipment as required in Table 12.4.1-1.	Immediately
	AND	
	H.2 Restore instrument channel to OPERABLE status.	30 days
I. Main Chimney Sampler Flow Rate Monitor with less than the minimum number of OPERABLE channels.	I.1 Estimate sample flow rate.	Once per 4 hours
	AND	
	I.2 Restore instrument channel to OPERABLE status.	30 days
J. Main Chimney Flow Rate Monitor with less than the minimum number of OPERABLE channels.	J.1 Estimate flow rate.	Once per 4 hours
	AND	
	J.2 Restore instrument channel to OPERABLE status.	30 days
K. Reactor Building Vent Noble Gas Monitor with less than the minimum number of OPERABLE channels.	K.1 Suspend release of radioactive effluents via this pathway.	Immediately
	AND	
	K.2 Restore instrument channel to OPERABLE status.	30 days
L. Reactor Building Vent Iodine Sampler with less than the minimum number of OPERABLE channels.	L.1 Establish CONTINUOUS SAMPLING with auxiliary sampling equipment as required in Table 12.4.1-1.	Immediately
	AND	
	L.2 Restore instrument channel to OPERABLE status.	30 days

(continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
M. Reactor Building Vent Particulate Sampler with less than the minimum number of OPERABLE channels.	M.1 Establish CONTINUOUS SAMPLING with auxiliary sampling equipment as required in Table 12.4.1-1.	Immediately
	AND	
	M.2 Restore instrument channel to OPERABLE status.	30 days
N. Reactor Building Vent Sampler Flow Rate Monitor with less than the minimum number of OPERABLE channels.	N.1 Estimate sample flow rate.	Once per 4 hours
	AND	
	N.2 Restore instrument channel to OPERABLE status.	30 days
------------NOTE---------------- Required Action O.1 shall be completed if this Condition is entered. ------------------------------------		
O. Required Action and associated Completion Time of Required Action F.2 not met.	O.1 Submit Special Report to NRC outlining the action(s) taken, the cause of the inoperability, and the plans and schedule for restoring the system to OPERABLE status.	30 days
------------NOTE---------------- Required Action P.1 shall be completed if this condition is entered. ------------------------------------		
P. Required Action and associated Completion Time of Required Action D.2, or E.3, or G.2, or H.2, or I.2, or J.2, or K.2, or L.2, or M.2, or N.2 not met.	P.1 Explain why the inoperability was not corrected in a timely manner in the next Radioactive Effluent Release Report.	In accordance with Section 12.7.3

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT		FREQUENCY
RSR 12.2.2.1	Perform CHANNEL CHECK. For instruments 2.b, 2.c, 2.d, 3.b, and 3.c, the test shall verify that the instrument is in place and functioning properly.	24 hours
RSR 12.2.2.2	Perform SOURCE CHECK.	31 days
RSR 12.2.2.3	Perform SOURCE CHECK.	92 days
RSR 12.2.2.4	Perform SOURCE CHECK.	24 months
----------------------------NOTE--------------------------------- For instruments 2.e and 3.d, the test shall be performed on local switches providing low flow alarm. ---		
RSR 12.2.2.5	Perform CHANNEL FUNCTIONAL TEST. The test shall also demonstrate that the control room alarm annunciates if any of the following conditions exist, where applicable: a. Instrument indicates measured levels above the alarm setpoint. b. Circuit failure. c. Instrument indicates a downscale failure. d. Instrument controls not set in the normal operating mode.	92 days
RSR 12.2.2.6	Perform CHANNEL CALIBRATION. The test shall include a CHANNEL FUNCTIONAL TEST per RSR 12.2.2.5.	24 months

Table 12.2.2-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	APPLICABLE MODES OR OTHER SPECIFIED CONDITIONS	MINIMUM NUMBER OF OPERABLE CHANNELS	CONDITION REFERENCED FROM REQUIRED ACTION A.2 AND B.1	SURVEILLANCE REQUIREMENTS
1. Steam Jet Air Ejector Radiation Monitor	(a)	1	C	RSR 12.2.2.1 RSR 12.2.2.4 RSR 12.2.2.5 RSR 12.2.2.6
2. Main Chimney Monitoring System				
2.a. Main Chimney Noble Gas Activity Monitor	At all times	1	E	RSR 12.2.2.1 RSR 12.2.2.2 RSR 12.2.2.5 RSR 12.2.2.6
2.b. Main Chimney High Range Noble Gas Monitor	At all times	1	F	RSR 12.2.2.1 RSR 12.2.2.2 RSR 12.2.2.5 RSR 12.2.2.6
2.c. Main Chimney Iodine Sampler	At all times	1	G	RSR 12.2.2.1
2.d. Main Chimney Particulate Sampler	At all times	1	H	RSR 12.2.2.1
2.e. Main Chimney Sampler Flow Rate Monitor	At all times	1	I	RSR 12.2.2.1 RSR 12.2.2.5 RSR 12.2.2.6
2.f. Main Chimney Flow Rate Monitor	At all times	1	J	RSR 12.2.2.1 RSR 12.2.2.6
3. Reactor Building Vent Monitoring System				
3.a. Reactor Building Vent Noble Gas Activity Monitor	At all times	1	K	RSR 12.2.2.1 RSR 12.2.2.3 RSR 12.2.2.5 RSR 12.2.2.6
3.b. Reactor Building Vent Iodine Sampler	At all times	1	L	RSR 12.2.2.1
3.c. Reactor Building Vent Particulate Sampler	At all times	1	M	RSR 12.2.2.1
3.d. Reactor Building Vent Sampler Flow Rate Monitor	At all times	1	N	RSR 12.2.2.1 RSR 12.2.2.5 RSR 12.2.2.6

(a) Modes 1, 2, and 3 with any main steam line not isolated and steam jet air ejector in operation.

12.3 LIQUID EFFLUENTS

12.3.1 Liquid Effluent Concentration

REC 12.3.1 The concentration of radioactive material released from the site to areas at or beyond the SITE BOUNDARY shall be limited to:

a. 10 times the concentration specified in 10 CFR 20.1001-20.2402 Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases; and

b. the values listed in Table 12.3.1-1 for total activity concentration for all dissolved or entrained noble gases.

APPLICABILITY: At all times.

-----------------------------NOTE---------------------------------
The provisions of REC 12.0.4 are not applicable.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Concentration of radioactive material released to areas at or beyond the SITE BOUNDARY exceeding limits.	A.1 Decrease the release rate of radioactive materials to restore concentration to within limits.	Immediately
	<u>OR</u>	
	A.2 Increase the dilution flow rate to restore concentration within limits.	Immediately
	<u>OR</u>	
	A.3 Decrease the release rate of radioactive materials and increase the dilution flow rate to restore concentration within limits.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT		FREQUENCY
RSR 12.3.1.1	Determine radioactivity content of batch release tanks using calculational methods described in the ODCM to determine that the concentration of radioactive material in UNRESTRICTED AREAS is within the limits of REC 12.3.1.	In accordance with Table 12.3.1-2
RSR 12.3.1.2	Determine radioactivity content of plant continuous releases using calculational methods described in the ODCM to determine that the concentration of radioactive material in UNRESTRICTED AREAS is within the limits of REC 12.3.1.	In accordance with Table 12.3.1-2

Table 12.3.1-1

ALLOWABLE CONCENTRATION OF DISSOLVED
OR ENTRAINED NOBLE GASES RELEASED FROM
THE SITE TO UNRESTRICTED AREAS
IN LIQUID WASTE

NUCLIDE	ALLOWABLE CONCENTRATION (μCi/ml)*
Kr-85m	2×10^{-4}
Kr-85	5×10^{-4}
Kr-87	4×10^{-5}
Kr-88	9×10^{-5}
Ar-41	7×10^{-5}
Xe-131m	7×10^{-4}
Xe-133m	5×10^{-4}
Xe-133	6×10^{-4}
Xe-135m	2×10^{-4}
Xe-135	2×10^{-4}

* Computed from Equation 20 of ICRP Publication 2 (1959), adjusted for infinite cloud submersion in water, and R = 0.01 rem/week, density = 1.0 g/cc and Pw/Pt = 1.0.

Table 12.3.1-2 (Page 1 of 3)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

LIQUID RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD)[(a)] (µCi/ml)
A. BATCH RELEASE Tanks	Prior to each Batch[(d)]	Prior to each Batch	Principal Gamma Emitters[(e)]	$5x10^{-7}$
			I-131	$1x10^{-6}$
	Prior to each Batch[(d)]	31 days Composite[(b)]	Gross Alpha	$1x10^{-7}$
			H-3	$1x10^{-5}$
	Prior to each Batch[(d)]	92 days Composite [(b)]	Fe-55	$1x10^{-6}$
			Sr-89, Sr-90	$5x10^{-8}$
	Prior to one Batch per month[(d)]	31 days	Dissolved & Entrained Gases [(f)] (Gamma Emitters)	$1x10^{-5}$
B. Plant CONTINUOUS RELEASEs	31 days[(c)] (Grab Sample)	31 days[(c)]	I-131	$1x10^{-6}$
	31 days[(c)] (Grab Sample)	31 days[(c)]	Principal Gamma Emitters[(e)]	$5x10^{-7}$
	31 days[(c)] (Grab Sample)	31 days[(c)]	Dissolved & Entrained Gases[(f)] (Gamma Emitters)	$1x10^{-5}$
	31 days[(c)] (Grab Sample)	31 days[(c)]	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	92 days[(c)] (Grab Sample)	92 days[(c)]	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$

Table 12.3.1-2 (Page 2 of 3)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM
TABLE NOTATION

(a) LOWER LIMIT OF DETECTION is defined as an *a priori* (before the fact) limit representing the capabilities of a measurement system, and not as an *a posteriori* (after the fact) limit for a particular measurement.

For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{4.66S_b}{E \cdot V \cdot 2.22E+06 \cdot Y \cdot e^{(-\lambda\Delta t)}}$$

Where:

LLD = the a priori LOWER LIMIT OF DETECTION (microcuries per unit mass or volume),

s_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),

$$= \frac{\sqrt{(TotalCounts)}}{t_b}$$

E = the counting efficiency (counts per disintegration),

V = the sample size (units of mass or volume),

2.22*E+06* = the number of disintegrations per minute per microcurie,

Y = the fractional radiochemical yield, when applicable,

t_b = counting time of the background or blank (minutes)

λ= the radioactive decay constant for the particular radionuclide (sec $^{-1}$), and

Δt = the elapsed time between the midpoint of sample collection and the time of counting (sec).

Typical values of E, V, Y, and Δt should be used in the calculation.

(b) A composite sample is one in which the quantity of liquid samples is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen that is representative of the liquids released.

(c) If the alarm setpoint of the service water effluent monitor as determined in the ODCM is exceeded, the FREQUENCY of analysis shall be increased to daily until the condition no longer exists.

(d) Prior to sampling for analyses, each batch shall be isolated and then thoroughly mixed to assure representative sampling.

Table 12.3.1-2 (Page 3 of 3)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM
TABLE NOTATION

(e) The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-60, Zn-65, Co-58, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. Ce-144 shall be measured with an LLD of $5x10^{-6}$. Other peaks that are measurable and identifiable by gamma ray spectrometry together with the above nuclides shall be also identified and reported when the ACTUAL analysis is performed on a sample. Nuclides that are below the LLD for the analyses shall not be reported as being present at the LLD level for that nuclide.

(f) The dissolved and entrained gases (gamma emitters) for which the LOWER LIMIT OF DETECTION specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138. Other dissolved and entrained gases (gamma emitters) that are measurable and identifiable by gamma ray spectrometry, together with the above nuclides, shall also be identified and reported when an ACTUAL analysis is performed on a sample. Nuclides that are below the LOWER LIMIT OF DETECTION for the analyses shall not be reported as being present at the LOWER LIMIT OF DETECTION level for that nuclide.

12.3 LIQUID EFFLUENTS

12.3.2 Dose From Liquid Effluents

REC 12.3.2 The dose or dose commitment above background to a MEMBER OF THE PUBLIC from radioactive material in liquid effluent releases from each unit to the areas at or beyond the SITE BOUNDARY shall be limited to:

a. ≤ 1.5 mrem to the whole body and ≤ 5.0 mrem to any organ during any calendar quarter; and

b. ≤ 3.0 mrem to the whole body and ≤ 10.0 mrem to any organ during any calendar year, and

c. < 1.0 mrem projected annual dose to the total body or any internal organ calculated at the nearest downstream COMMUNITY WATER SYSTEM.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE------------ Required Action A.1 shall be completed if this condition is entered. ------------------------------------ A. Calculated dose not within limits of REC 12.3.2.a. or REC 12.3.2.b.	A.1 Submit a Special Report to the NRC that identifies cause(s) for exceeding limits, actions taken to reduce releases of radioactive materials in liquid effluents, and proposed actions to ensure future releases are in compliance with REC 12.3.2.a and REC 12.3.2.b.	--------NOTE---------- This action is in lieu of an LER. --------------------------- 30 days
B. Calculated dose exceeds two times (2x) the limits of REC 12.3.2.a or REC 12.3.2.b.	B.1 Enter Condition A of REC 12.5.1.	Immediately

(continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE--------------- Required Action C.1 shall be completed if this condition is entered. C. PROJECTED dose computed at the nearest downstream COMMUNITY WATER SYSTEM exceeds limits of REC 12.3.2.c.	C.1 Submit a Special Report to the COMMUNITY WATER SYSTEM operator, with copy to the NRC, to assist the operator in meeting 40 CFR 141, EPA Primary Drinking Water Standards.	--------NOTE---------- This action is in lieu of an LER. --------------------------- 30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT		FREQUENCY
RSR 12.3.2.1	Calculate whole body and organ dose contribution from measured quantities of radioactive material.	-----------NOTE--------- Provisions of RSR 12.0.2 are not applicable. --------------------------- 31 days
RSR 12.3.2.2	Determine cumulative whole body and organ dose contributions for the current calendar quarter and current calendar year.	-----------NOTE--------- Provisions of RSR 12.0.2 are not applicable. --------------------------- 31 days
RSR 12.3.2.3	Determine PROJECTED DOSES at the nearest COMMUNITY WATER SYSTEM considering only the drinking water pathway using the methods prescribed in the ODCM.	92 days

12.3 LIQUID EFFLUENTS

12.3.3 Liquid Radwaste Treatment Systems

REC 12.3.3 Liquid effluent releases shall be processed prior to being discharged when the PROJECTED DOSE from liquid effluent releases from each unit to UNRESTRICTED AREAS exceeds ≤ 0.06 mrem to the whole body or ≤ 0.20 mrem to any organ when averaged over 31 days.

APPLICABILITY: At all times.

-----------------------------NOTE-----------------------------
The provisions of REC 12.0.4 are not applicable.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE------------ Required Action A.1 shall be completed if this condition is entered. -------------------------------	---------------- NOTE ---------------- IF limited and/or associated ACTION requirements cannot be satisfied because of circumstances in excess of this section, THEN no changes in plant operational condition are required, and entry into any OPERATING MODE is not prohibited. --	
A. Liquid waste discharged without required processing. AND PROJECTED DOSE limits of REC 12.3.3 exceeded.	A.1 Submit a Special Report to the NRC that includes: (i) Identification and cause of defective equipment. (ii) Action taken to restore the INOPERABLE equipment to OPERABLE status (iii) Length of time OPERABILITY was not satisfied. (iv) Waste discharge volume and curie content. (v) Explanation of why liquid radwaste was discharged without required processing. (vi) Action(s) taken to prevent recurrence.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT		FREQUENCY
RSR 12.3.3.1	Determine PROJECTED DOSES due to liquid releases at or beyond the SITE BOUNDARY in accordance with the ODCM.	---------NOTE--------- Provisions of RSR 12.0.2 are not applicable. --------------------------- 31 days

12.4 GASEOUS EFFLUENTS

12.4.1 Gaseous Effluent Dose Rates

REC 12.4.1 The dose rate at or beyond the SITE BOUNDARY due to radioactive materials in gaseous effluents released from the site shall be limited to the following:

a. For noble gases, < 500 mrem/year to the whole body and < 3000 mrem/year to the skin

b. For iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives > 8 days, < 1500 mrem/year.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE---------------- Required Action A.2 shall be completed if this condition is entered. ------------------------------------	A.1 Decrease release rates to comply with limits.	Immediately
	AND	
A. Dose rate(s) not within limits.	A.2 Describe in next Radioactive Effluent Report.	In accordance with Section 12.7.3.

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT		FREQUENCY
RSR 12.4.1.1	Verify dose rates due to noble gases, iodine-131, iodine-133, tritium, and all radionuclides in particulate form with halflives > 8 days in gaseous effluents are within limits using methods prescribed in the ODCM by obtaining and analyzing representative samples.	In accordance with Table 12.4.1-1.

Table 12.4.1-1 (Page 1 of 3)

RADIOACTIVE GASEOUS WASTE SAMPLING
AND ANALYSIS PROGRAM

GASEOUS RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD)[a] (μCi/ml)
A. Main Chimney and Reactor Bldg. Vent Stack	31 days (Grab Sample)	31 days[b]	Principal Gamma Emitters[e]	1×10^{-4}
		31 days	Tritium	1×10^{-6}
B. All Release Types as Listed in A above	Continuous[d]	7 days[c] Charcoal Sample	I-131	1×10^{-12}
			I-133	1×10^{-10}
	Continuous[d]	7 days[c] Particulate Sample	Principal Gamma Emitters [e] (I-131, others)	1×10^{-11}
	Continuous[d]	92 days Composite Particulate Sample	Sr-89	1×10^{-11}
			Sr-90	1×10^{-11}
	Continuous[d]	31 days Composite Particulate Sample	Gross Alpha	1×10^{-11}
C. Main Chimney	Continuous[d]	Noble Gas Monitor	Noble Gases	1×10^{-6}
D. Reactor Bldg. Vent Stack	Continuous[d]	Noble Gas Monitor	Noble Gases	1×10^{-4}

Table 12.4.1-1 (Page 2 of 3)

RADIOACTIVE GASEOUS WASTE SAMPLING
AND ANALYSIS PROGRAM
TABLE NOTATION

(a) LOWER LIMIT OF DETECTION is defined as an *a priori* (before the fact) limit representing the capabilities of a measurement system, and not as an *a posteriori* (after the fact) limit for a particular measurement.

For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{4.66S_b}{E \cdot V \cdot 2.22E+06 \cdot Y \cdot e^{(-\lambda\Delta t)}}$$

Where:

LLD = the a priori LOWER LIMIT OF DETECTION (microcuries per unit mass or volume),

s_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),

$$= \frac{\sqrt{(TotalCounts)}}{t_b}$$

E = the counting efficiency (counts per disintegration),

V = the sample size (units of mass or volume),

2.22*E*+*06* = the number of disintegrations per minute per microcurie,

Y = the fractional radiochemical yield, when applicable,

t_b = counting time of the background or blank (minutes)

λ= the radioactive decay constant for the particular radionuclide (sec $^{-1}$), and

Δt = the elapsed time between the midpoint of sample collection and the time of counting (sec).

Typical values of E, V, Y, and Δt should be used in the calculation.

(b) Sampling and analyses shall also be performed following shutdown, startup, or a thermal power change exceeding 20% rated thermal power 1 hour unless (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has not increased more than a factor of 5, and (2) the noble gas activity monitor shows that effluent activity has not increased by more than a factor of 3.

(c) Samples shall be changed at least once per 7 days and the analyses completed within 48 hours after removal from the sampler. Sampling shall also be performed within 24 hours following each shutdown, startup, or thermal power level change exceeding 20% RTP in one hour. This requirement does not apply if 1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has not increased more than a factor of 5, and 2) the noble gas activity monitor shows that effluent activity has not increased by more than a factor of 3. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10.

Table 12.4.1-1 (Page 3 of 3)

RADIOACTIVE GASEOUS WASTE SAMPLING
AND ANALYSIS PROGRAM
TABLE NOTATION

(d) The ratio of sample flow rate to the sampled stream flow rate shall be known.

(e) The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emissions, and Mn-54, Fe-59, Co-60, Zn-65, Co-58, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144 for particulate emissions. Other peaks that are measurable and identifiable by gamma ray spectrometry, together with the above nuclides, shall be also identified and reported when an ACTUAL analysis is performed on a sample. Nuclides that are below the LLD for the analyses shall not be reported as being present at the LLD level for the nuclide.

12.4 GASEOUS EFFLUENTS

12.4.2 Dose from Noble Gases

REC 12.4.2 The air dose at or beyond the SITE BOUNDARY due to noble gases in gaseous effluents released from each unit at the site shall be limited to the following:

a. For gamma radiation, ≤ 5 mrad during any calendar quarter;

b. For beta radiation, ≤ 10 mrad during any calendar quarter;

c. For gamma radiation, ≤ 10 mrad during any calendar year;

d. For beta radiation, ≤ 20 mrad during any calendar year.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE---------------- Required Action A.1 shall be completed if this condition is entered. ------------------------------------ A. Calculated air dose not within limits.	A.1 Submit a Special Report to the NRC that identifies causes for exceeding limits, corrective actions taken to reduce the releases, and corrective actions to ensure that future releases are within limits.	---------- NOTE ---------- This is in lieu of an LER -------------------------------- 30 days
B. Calculated air dose exceeds two times (2x) the limits of REC 12.4.2.	B.1 Enter Condition A of REC 12.5.1.	Immediately

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE REQUIREMENT	FREQUENCY
RSR 12.4.2.1	Determine the cumulative dose contributions due to noble gases released in gaseous effluents for the current calendar quarter and current calendar year in accordance with the ODCM.	----------NOTE---------- Provisions of RSR 12.0.2 are not applicable. ---------------------------- 31 days
RSR 12.4.2.2	Determine effluents allocation between units having shared effluent control systems per the ODCM.	----------NOTE---------- Provisions of RSR 12.0.2 are not applicable. ---------------------------- 31 days

12.4 GASEOUS EFFLUENTS

12.4.3 Dose From Iodine -131, Iodine -133, Tritium, and Radioactive Materials in Particulate Form

REC 12.4.3 The dose to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY from iodine-131, iodine-133, tritium and all radionuclides in particulate form, with half-lives > 8 days, in gaseous effluents released from each unit at the site shall be limited to:

a. ≤ 7.5 mrem to any organ during any calendar quarter; and

b. ≤ 15 mrem to any organ during any calendar year.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE---------------- Required Action A.1 shall be completed if this condition is entered. ------------------------------------- A. Calculated dose not within limits.	A.1 Submit a Special Report to the NRC that identifies causes for exceeding limit(s), corrective action(s) taken, and proposed corrective action(s) to ensure that subsequent releases are within limits.	---------- NOTE --------- This is in lieu of an LER ---------------------------- 30 days
B. Calculated dose exceeds two times (2x) the limits.	B.1 Enter Condition A of REC 12.5.1.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT		FREQUENCY
RSR 12.4.3.1	Determine the cumulative dose for the current calendar quarter and current calendar year to a MEMBER OF THE PUBLIC due to releases of iodine-131, iodine-133, tritium, and radionuclides in particulate form with half-lives > 8 days using methodology and parameters in the ODCM.	----------NOTE---------- Provisions of RSR 12.0.2 are not applicable. --------------------------- 31 days

12.4 GASEOUS EFFLUENTS

12.4.4 Gaseous Radwaste Treatment System

REC 12.4.4 Process and control equipment shall be operated during processing for discharge to the environs to reduce the amount or concentration of radioactive materials released at or beyond the SITE BOUNDARY.

a. The release rate of the sum of activities from noble gases measured at the Main Condenser air ejector shall be limited to ≤ 251,100 μCi/sec after 30 minutes decay.

b. The Off-Gas Charcoal Adsorber beds shall be in operation above 30% rated thermal power.

APPLICABILITY: MODES 1, 2, and 3 with any main steam line not isolated and steam jet air ejector in operation.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE--------------- Required Action A.1 shall be completed if this condition is entered. ------------------------------------ A. All charcoal beds bypassed for more than 7 days in a calendar quarter while OPERATING above 30% rated thermal power.	A.1 Submit a Special Report to the NRC that includes: (i) identification and cause of defective equipment (ii) actions taken to restore the INOPERABLE equipment to OPERABLE status (iii) length of time REC 12.4.4 was not met (iv) waste discharge volume and curie content that was not processed but required processing, (v) actions taken to prevent recurrence of equipment failures.	30 days
B. Release rate of REC 12.4.4.a exceeded.	B.1 Restore release rate to within limits.	72 hours

(continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Required ACTIONS and associated Completion Time of Condition B not met.	C.1 Refer to Technical Specification 3.7.6.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT		FREQUENCY
RSR 12.4.4.1	Monitor noble gas radioactivity rate at (near) the Main Condenser air ejector outlet.	Continuously per REC 12.2.2.
----------NOTE---------- Not required to be performed until 31 days after any Main Steam line not isolated and SJAE in operation. --------------------		31 days
RSR 12.4.4.2	Perform isotope analysis of a representative sample of gases taken at either the recombiner outlet, or at the air ejector outlet if the recombiner is bypassed, to determine if the release rate of the noble gas sum of the activities is within REC 12.4.4 limits.	<u>AND</u> Once within 4 hours after a > 50% increase in nominal steady state fission gas release after factoring out increases due to changes in thermal power level.

12.4 GASEOUS EFFLUENTS

12.4.5 Ventilation Exhaust Treatment System

REC 12.4.5 The appropriate portions of the VENTILATION EXHAUST TREATMENT SYSTEM shall be OPERABLE and be used to reduce releases of radioactivity when the PROJECTED DOSES in 31 days due to gaseous effluents at or beyond the SITE BOUNDARY would exceed:

a. 0.2 mrad to air from gamma radiation, or

b. 0.4 mrad to air from beta radiation, or

c. 0.3 mrem to any organ of a MEMBER OF THE PUBLIC

APPLICABILITY: At all times.

------------------------------NOTE----------------------------------
1. The provisions of REC 12.0.4 are not applicable.
2. Separate Condition entry is allowed for each VENTILATION EXHAUST TREATMENT system pathway.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE---------------- Required Action A.1 shall be completed if this condition is entered. ------------------------------------ A. Gaseous waste being discharged without treatment, AND PROJECTED DOSE limits of REC 12.4.5 exceeded.	---------------- NOTE ---------------- IF limited and/or associated ACTION requirements cannot be satisfied because of circumstances in excess of this section, THEN no changes in plant operational condition are required, and entry into any OPERATING MODE is not prohibited. -- A.1 Submit a Special Report to the NRC that includes INOPERABLE equipment or subsystem identification and reason, actions taken to restore the INOPERABLE equipment to OPERABLE status, and summary description of actions taken to prevent a recurrence.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT		FREQUENCY
RSR 12.4.5.1	Project doses due to treated gaseous effluent releases at and beyond the SITE BOUNDARY in accordance with the ODCM.	-----------NOTE---------- Provisions of RSR 12.0.2 are not applicable. ------------------------------ 31 days

12.4 GASEOUS EFFLUENTS

12.4.6 Mark I Containment

REC 12.4.6 VENTING or PURGING of the Drywell Containment shall be:

a. Through the Reactor Building Ventilation Exhaust System or Standby Gas Treatment System when:

i. Drywell noble gas activity < 3.2×10^{-3} µCi/cc, AND
ii. Drywell iodine and particulate activity < 3.9×10^{-5} µCi/cc

OR

b. Through the Standby Gas Treatment System.

APPLICABILITY: During drywell VENTING or PURGING in MODES 1, 2, or 3.

-----------------------------NOTE---------------------------------
The provisions of REC 12.0.4 are not applicable.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Requirements of REC 12.4.6 not met.	A.1 Suspend drywell VENTING or PURGING	Immediately
B. Required actions and Completion Time of Condition A not met.	B.1 Perform RSR 12.4.1.1, RSR 12.4.2.1, RSR 12.4.3.1, and RSR 12.4.5.1.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT		FREQUENCY
RSR 12.4.6.1	Determine Containment Drywell VENTING or PURGING pathway.	Prior to Containment Drywell VENTING or PURGING

12.5 TOTAL DOSE

12.5.1 Total Dose

REC 12.5.1 The dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and radiation from all uranium fuel cycle sources over 12 consecutive months shall be limited to:

a. ≤ 25 mrem to the total body; and

b. ≤ 75 mrem to the thyroid; and

c. ≤ 25 mrem to any other organ (except thyroid).

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE---------------- Required Action A.1 and A.2 shall be completed if this condition is entered. ----------------------------------- A. As required by Required Action B.1 of REC 12.3.2, REC 12.4.2, or REC 12.4.3. <u>OR</u> Calculated Total Dose not within limits.	A.1 Submit a report to the NRC that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the limits to include estimates of radiation exposure to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for a 12 consecutive month period that includes the release(s) covered by this report. <u>AND</u>	----------NOTE---------- This is in lieu of an LER. ---------------------------- 30 days

(continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. (continued)	---------------- NOTE ---------------- Only applicable if the release condition resulting in violation of 40 CFR 190 has not been corrected. --	
	A.2 Submit a request for a variance in accordance with 40 CFR 190, including the specified information of 40 CFR 190.11.	30 days

SURVEILLANCE REQUIREMENTS

--NOTE--
Cumulative dose contributions from liquid and gaseous effluents are determined per RSR 12.3.2.2, RSR 12.4.2.1, and RSR 12.4.3.1.

None.

12.5 TOTAL DOSE

12.5.2 Dose Limits for MEMBERS OF THE PUBLIC

REC 12.5.2 Operations shall be conducted such that:

a. TEDE to individual MEMBERS OF THE PUBLIC does not exceed 100 mrem/year;

b. The dose rate in any UNRESTRICTED AREA from external sources does not exceed 2 mrem in any one hour, and;

c. The Effluents Program shall implement monitoring, sampling, and analysis of radioactive liquid and gaseous effluents in accordance with 10CFR20.1302 and the methodology and parameters in the ODCM.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE---------------- Required Action A.1 shall be completed if this condition is entered. ------------------------------------- A. Dose limit of REC 12.5.2.a exceeded.	A.1 Submit a report to the NRC in accordance with 10CFR20.2203.	30 days
------------NOTE---------------- Required Action B.1 shall be completed if this condition is entered. ------------------------------------- B. Dose rate limit of REC 12.5.2.b exceeded.	B.1 Submit a report to the NRC in accordance with 10CFR20.2203.	30 days

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE REQUIREMENT	FREQUENCY
RSR 12.5.2.1	Calculate the total dose to individual MEMBERS OF THE PUBLIC to determine compliance with REC 12.5.2.a limits in accordance with the ODCM.	12 months
RSR 12.5.2.2	Determine and/or evaluate if direct radiation exposures exceed the cumulative dose contribution from direct radiation REC 12.5.2.b limits.	12 months

12.6 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

12.6.1 Radiological Environmental Monitoring Program

REC 12.6.1 The Radiological Environmental Monitoring Program (REMP) shall be conducted as specified in Table 12.6.1-1.

APPLICABILITY: At all times.

------------NOTE------------
The provisions of REC 12.0.3 and REC 12.0.4 are not applicable.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE------------ Required Action A.2 shall be completed if this condition is entered. ---------------------------- A. Sample type or location(s) required by Table 12.6.1-1 permanently unavailable.	A.1 Initiate action to identify suitable, alternative sampling media and/or specific locations for the pathway of interest and add them to the Radiological Environmental Monitoring Program as soon as practical. Delete locations from which samples are unavailable.	Immediately
	<u>AND</u>	
	A.2 Prepare and submit controlled revision of the ODCM, including revised figures and tables reflecting the new location(s) with supporting information identifying the sample unavailability cause and justification of the new sampling location(s).	In accordance with Section 12.7.2.

(continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE---------------- Required Action B.1 shall be completed if this condition is entered. ------------------------------------- B. Level of radioactivity in an environmental sampling medium at an ODCM specified location exceeds the reporting levels of Table 12.6.1-2 when averaged over any calendar quarter.	B.1 Submit a Special Report to the NRC that identifies the cause(s) for exceeding the limits and defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year reporting level of REC 12.3.2, REC 12.4.2, or REC 12.4.3. The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.	30 days
C. More than one radionuclide in Table 12.6.1-2 is detected in the sampling medium, AND $\frac{C_1}{RL_1} + \frac{C_2}{RL_2} + \ldots \geq 1.0$ where; C = concentration RL = reporting level.	C.1 Submit a Special Report to the NRC that identifies the cause(s) for exceeding the limits and defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year reporting level of REC 12.3.2, REC 12.4.2, or REC 12.4.3. The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.	30 days

(continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE---------------- Required Action D.1 and D.2 shall be completed if this condition is entered. ------------------------------------	----------------NOTE--------------- Only required if the radionuclides detected are the result of plant effluents. ---------------------------------------	
D. Radionuclides other than those in Table 12.6.1-2 are detected AND The potential annual dose to a MEMBER OF THE PUBLIC is greater than or equal to the calendar year limits of REC 12.3.2, REC 12.4.2, or REC 12.4.3.	D.1 Submit a Special Report to the NRC that identifies the cause(s) for exceeding the limits and defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year reporting level. The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.	30 days
	AND ----------------NOTE--------------- Only required if the radionuclides detected are not the result of plant effluents. ---------------------------------------	
	D.2 Describe the condition in the Annual Radiological Environmental Operating Report.	In accordance with Section 12.7.2.
------------NOTE---------------- Required Action E.1 shall be completed if this condition is entered. ------------------------------------ E. Requirements of RSR 12.6.1.1 not met.	E.1 Prepare and submit to the NRC, in the Annual Radiological Environmental Operating Report, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.	In accordance with Section 12.7.2.

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT		FREQUENCY
--NOTE-- Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal availability, malfunction of sampling equipment, if a person/business who participates in the program goes out of business or can no longer provide a sample, or contractor omission which is corrected as soon as discovered. If the equipment malfunctions, corrective actions shall be completed as soon as practical. If a person/business supplying samples goes out of business, a replacement supplier shall be found as soon as possible. All deviations from the sampling schedule will be described in the Annual Radiological Environmental Operating Report.		
RSR 12.6.1.1	Collect and analyze samples in accordance with Table 12.6.1-1 to the detection capabilities required by Table 12.6.1-3.	In accordance with Table 12.6.1-1

Table 12.6.1-1 (Page 1 of 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/ OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS(1)	SAMPLING AND COLLECTION FREQUENCY(11)	TYPE AND FREQUENCY OF ANALYSIS(11)
1. Airborne			
Radioiodine and Particulates	Samples from a total of eight locations: a. Indicator- Near Field Four samples from locations within 4.0 km (2.5 mi) in different sectors. b. Indicator- Far Field Three additional locations within 4.0 to 10 km (2.5 to 6.2 mi) in different sectors. c. Control One sample from a control location within 10 to 30 km (6.2 to 18.6 mi).	Sampler Operation Continuous Filter change 7 days or more frequently as required due to dust loading.	Radioiodine Canister: I-131 analysis on each sample. Particulate Sample: Gross beta analysis on each sample. Gamma isotopic analysis(4) once per 92 days on composite filters by location.

Table 12.6.1-1 (Page 2 of 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/ OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY[11]	TYPE AND FREQUENCY OF ANALYSIS[11]
2. Direct Radiation[5]	Forty routine monitoring stations, either with a thermoluminescent dosimeter (TLD) or with one instrument for measuring dose rate continuously, placed as follows:	92 days	Gamma dose on each TLD once per 92 days.
a. Indicator- Inner Ring	One in each meteorological sector, in the general area of the SITE BOUNDARY (0.1 to 3 miles);		
b. Indicator- Outer Ring	One in each meteorological sector, within 6.0 to 8.0 km (3.7 to 5.0 mi); and		
c. Other	One at each Airborne location given in part 1.a. and 1.b. The balance of the TLDs to be placed at special interest locations in the UNRESTRICTED AREA where either a MEMBER OF THE PUBLIC or Exelon Nuclear employees have routine access.		
d. Control	One at each airborne control location given in part 1.c.		

Table 12.6.1-1 (Page 3 of 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/ OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS(1)	SAMPLING AND COLLECTION FREQUENCY(11)	TYPE AND FREQUENCY OF ANALYSIS(11)
3. Waterborne			
a. *Ground/ Well*	a. *Indicator* Samples from two sources only if likely to be affected.(6)	92 days	Gamma isotopic(4) and tritium analysis on each sample.
b. Drinking(7)	a. Indicator One Sample from each COMMUNITY WATER SYSTEM that could be affected by the station discharge within 8 km (5.0 mi) downstream of discharge.	Grab samples once per 7 days.	Gross beta and gamma isotopic analyses(4) on 31-day composite(2); tritium analysis on 92-day composite(2). I-131(9) on 14-day composite(2) when calculated dose > 1 mrem/year.
c. Surface Water(7)	If no COMMUNITY WATER SYSTEM (Drinking Water) exists within 10 km downstream of discharge then surface water sampling shall be performed. a. Indicator One sample downstream b. Control One sample upstream of discharge	Grab samples once per 7 days.	Gross beta and gamma isotopic analyses(4) on 31-day composite(2); tritium analysis on 92-day composite(2).
d. Sediment	a. Indicator At least one sample from downstream(7) area within 10 Km (6.2 mi).	184 days	Gamma isotopic analysis(4) on each sample.

Table 12.6.1-1 (Page 4 of 6)
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/ OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY[11]	TYPE AND FREQUENCY OF ANALYSIS[11]
4. Ingestion			
a. Milk[8]	a. Indicator Samples from milking animals from a maximum of three locations within 8.0 km (5 mi) distance. b. Control One sample from milking animals at a control location within 15 to 30 km (9.3 to 18.6 mi).	Once per 14 days when animals are on pasture (May through October), 31 days at other times (November through April).	Gamma isotopic[4] and I-131[9] analysis on each sample.
b. Fish	a. Indicator Representative samples of commercially and recreationally important species in discharge area. b. Control Representative samples of commercially and recreationally important species in control locations upstream of discharge.	184 days	Gamma isotopic analysis[4] on edible portions of each sample.
c. Food Products	a. Indicator Two representative samples from the principal food pathways grown in each of four major quadrants within 8 km (5 mi): At least one root vegetable sample[10] At least one broad leaf vegetable (or vegetation)[10] b. Control Two representative samples similar to indicator samples grown within 15 to 30 km (9.3 to 18.6 mi).	12 months	Gamma isotopic[4] analysis on each sample.

Table 12.6.1-1 (Page 5 of 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/ OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY[11]	TYPE AND FREQUENCY OF ANALYSIS[11]
4. Ingestion (continued)			
d. Vegetation	----------NOTE---------- These vegetation samples are only required if milk sampling is not performed. ---------- a. Indicator Samples of 3 different types of broadleaf vegetation within 8 Km (5 miles) in the highest D/Q sector. b. Control Sample of 3 different types of broadleaf vegetation 15 to 30 Km (9.4 to 18.7 miles) in the lowest D/Q sector.	31 days during the growing season (May through October).	Gamma isotopic[4] on each sample.

Table 12.6.1-1 (Page 6 of 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

TABLE NOTATIONS

(1) Specific parameters of distance and direction from the centerline of the midpoint of the two units and additional description where pertinent, shall be provided for each and every sample location in Table 6-1 of the ODCM. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978, and to Radiological Assessment Branch Technical Position, Revision 1, November 1979.

(2) A composite sample is one in which the aliquot of liquid sampled is proportional to the quantity of flowing liquid and in which the method of sampling results in a representative sample.

(3) Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

(4) Gamma isotopic analysis means the identification and quantification of gamma emitting radionuclides that may be attributable to the effluents from the station.

(5) One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. The 40 locations is not an absolute number. The number of direct radiation monitoring stations may be reduced according to geographical limitations; e.g., if a station is adjacent to a lake, some sectors may be over water thereby reducing the number of dosimeters that could be placed at the indicated distances. The FREQUENCY of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.

(6) Groundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

(7) The "downstream" sample shall be taken in an area beyond but near the mixing zone. The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. Upstream samples in an estuary must be taken far enough upstream to be beyond the station influence.

(8) If milking animals are not found in the designated indicator locations, or if the owners decline to participate in the REMP, all milk sampling may be discontinued.

(9) I-131 analysis means the analytical separation and counting procedure are specific for this radionuclide.

(10) One sample shall consist of a volume/weight of sample large enough to fill contractor specified container.

(11) The provisions of RSR 12.0.3 are not applicable to the REMP.

Table 12.6.1-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	FOOD PRODUCTS (pCi/kg, wet)
H-3	20,000[(1)]				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	2[(2)]	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200			300	

(1) For drinking water samples. This is 40 CFR 141 value. If no drinking water pathway exists, a value of 30,000 pCi/l may be used.
(2) If no drinking water pathway exists, a value of 20 pCi/l may be used.

Table 12.6.1-3 (Page 1 of 3)

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS(1)

LOWER LIMIT OF DETECTION (LLD)(2)(3)

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	FOOD PRODUCTS (pCi/kg, wet)	SEDIMENT (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	2,000					
Mn-54	15		130			
Fe-59	30		260			
Co-58	15		130			
Co-60	15		130			
Zn-65	30		260			
Zr-95	30					
Nb-95	15					
I-131	1(4)	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140	60			60		
La-140	15			15		

Table 12.6.1-3 (Page 2 of 3)

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS(1)
LOWER LIMIT OF DETECTION (LLD)(2)(3)
TABLE NOTATIONS

(1) The nuclides on this list are not the only nuclides intended to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report.

(2) Required detection capabilities for thermoluminescent dosimeters used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13.

(3) The LOWER LIMIT OF DETECTION (LLD) is defined, for purposes of these specifications, as 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.

For a particular measurement system, which may include radiochemical separation, the LLD is defined as follows:

$$LLD = \frac{4.66 S_b}{E \cdot V \cdot 2.22 \cdot Y \cdot e^{(-\lambda \Delta t)}}$$

where:

LLD = the "a priori" LOWER LIMIT OF DETECTION (picocuries per unit mass or volume),

s_b = the standard deviation of the background counting rate or of the counting rate of a blank sample, as appropriate (counts per minute),

$= \dfrac{\sqrt{TotalCounts}}{t_b}$

E = the counting efficiency (counts per disintegration),

V = the sample size (units of mass or volume),

2.22 = the number of disintegrations per minute per picocurie,

Y = the fractional radiochemical yield, when applicable,

λ = the radioactive decay constant for the particular radionuclide (sec^{-1}),

t_b = counting time of the background or blank (minutes), and

Δt = the elapsed time between sample collection or end of the sample collection period, and the time of counting (sec).

Table 12.6.1-3 (Page 3 of 3)

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS(1)
LOWER LIMIT OF DETECTION (LLD)(2)(3)
TABLE NOTATIONS

Typical values of E, V, Y, and Δt should be used in the calculation.

It should be recognized that the LLD is defined as a before the fact limit representing the capability of a measurement system and not as an after the fact limit for a particular measurement.

Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally, background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report.

(4) If no drinking water pathway exists, the value of 15 pCi/l may be used.

12.6 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

12.6.2 Land Use Census

REC 12.6.2 A Land Use Census shall be conducted and shall identify within a distance of 8.0 km (5.0 miles) the location in each of the 16 meteorological sectors of the nearest milk animal and the nearest residence. For dose calculation, a garden will be assumed at the nearest residence.

APPLICABILITY: At all times.

---NOTE---

1. The 16 meteorological sectors requirement may be reduced according to geographical limitations; e.g. at a lake site where some sectors will be over water.

2. The nearest industrial facility shall also be documented if closer than the nearest residence.

3. REC 12.0.3 and REC 12.0.4 are not applicable.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE--------------- Required Action A.1 and A.2 shall be completed if this condition is entered. ----------------------------------- A. Land use census identifies a location which yields a calculated dose or dose commitment, via the same exposure pathway, that is at least 20% greater than at a location from which samples are currently being obtained in accordance with REC 12.6.1.	A.1 Add the new location to the Radiological Environmental Monitoring Program. <u>AND</u>	30 days (continued)

ACTIONS (Continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
(continued) A. Land use census identifies a location which yields a calculated dose or dose commitment, via the same exposure pathway, that is at least 20% greater than at a location from which samples are currently being obtained in accordance with REC 12.6.1.	---------------NOTE----------------- The indicator sampling location having the lowest calculated dose or dose commitment, via the same exposure pathway, may be deleted from the radiological environmental monitoring program after October 31 of the year in which Land Use Census was conducted. -------------------------------------	
	A.2 Submit the documentation for a change in the ODCM in the Annual Radiological Environmental Operating Report and include the revised figures and tables for the ODCM reflecting the new location(s) with information supporting the change in sampling locations.	In accordance with Section 12.7.2

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE REQUIREMENT	FREQUENCY
RSR 12.6.2.1	Conduct a land use census during the growing season, between June 1 and October 1, using information that will provide the best results, such as by a door-to-door survey, aerial survey, or by consulting local agriculture authorities or by some other appropriate means.	-----------NOTE----------- RSR 12.0.2 and RSR 12.0.3 are not applicable. ------------------------------ 12 months

12.6 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

12.6.3 Interlaboratory Comparison Program

REC 12.6.3 Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program that is traceable to the National Institute of Standards and Technology.

--------------------NOTE---------------------
REC 12.0.3 and REC 12.0.4 are not applicable.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
-----------NOTE--------------- Required Action A.1 shall be completed if this condition is entered. ----------------------------------- A. Requirements of REC 12.6.3 not met.	A.1 Report corrective actions to prevent recurrence to the NRC in the Annual Radiological Environmental Operating Report.	In accordance with Section 12.7.2.

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT		FREQUENCY
RSR 12.6.3.1	Include a summary of the results of the Interlaboratory Comparison Program in the Annual Radiological Environmental Operating Report.	In accordance with Section 12.7.2.

12.6 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

12.6.4 Meteorological Monitoring Instrumentation

REC 12.6.4 The meteorological monitoring instrumentation channels shown in Table 12.6.4-1 shall be OPERABLE such that the Annual Data recovery is ≥ 90%.

APPLICABILITY: At all times.

--------------------NOTE--------------------
REC 12.0.3 and REC 12.0.4 are not applicable.

ACTIONS

----------------------------NOTE----------------------------
Separate condition entry is allowed for each instrument.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Annual data recovery less than 90% for any instrument in Table 12.6.4-1.	A.1 Report reasons for instrument INOPERABILITY in next Radiological Environmental Operating Report.	In accordance with Section 12.7.2.

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT	FREQUENCY
RSR 12.6.4.1 Perform CHANNEL CALIBRATION of instrumentation shown in Table 12.6.4-1.	6 months

Table 12.6.4-1
METEOROLOGICAL MONITORING INSTRUMENTATION

Instrument		CONDITION REFERENCED FROM REQUIRED ACTION A.1	SURVEILLANCE REQUIREMENTS
1.	33 foot elevation		
1.a	Wind Speed	A	RSR 12.6.4.1
1.b	Wind Direction	A	RSR 12.6.4.1
1.c	Air Temperature	A	RSR 12.6.4.1
2.	196 foot elevation		
2.a	Wind Speed	A	RSR 12.6.4.1
2.b	Wind Direction	A	RSR 12.6.4.1
2.c	Air Differential Temperature	A	RSR 12.6.4.1
3.	296 foot elevation		
3.a	Wind Speed	A	RSR 12.6.4.1
3.b	Wind Direction	A	RSR 12.6.4.1
3.c	Air Differential Temperature	A	RSR 12.6.4.1

12.7 ADMINISTRATIVE REQUIREMENTS

12.7.1 Station Operating Records

12.7.1.1 Records and/or logs relative to the following items shall be kept in a manner convenient for review and shall be retained for at least five years.

12.7.1.1.1 Records and periodic checks, inspection and/or calibrations performed to verify the surveillance requirements (See the applicable surveillance in the Instrumentation, Liquid Effluents, Gaseous Effluents, and Radiological Environmental Monitoring Sections) are being met. All equipment failing to meet surveillance requirements and the corrective action taken shall be recorded.

12.7.1.1.2 Records of radioactive shipments.

12.7.1.2 Records and/or logs relative to the following items shall be recorded in a manner convenient for review and shall be retained for the life of the plant.

12.7.1.2.1 Records of offsite environmental monitoring surveys.

12.7.1.2.2 Records of radioactivity in liquid and gaseous wastes released to the environment.

12.7.1.2.3 Records of reviews performed for changes made to the ODCM.

12.7.2 Annual Radiological Environmental Operating Report

----------------------------NOTE----------------------------
A single submittal may be made for a multiple unit station. The submittal should combine sections common to all units at the station.

12.7.2.1 The Annual Radiological Environmental Operating Report covering the operation of the unit during the previous calendar year shall be submitted prior to May 15 of each year.

12.7.2.2 The report shall include summaries, interpretations, and an analysis of trends of the results of The Radiological Environmental Monitoring Program for the report period. The material provided shall be consistent with the objectives outlined in the ODCM, and in 10CFR50, Appendix I, Sections IV.B.2, IV.B.3, and IV.C. The report shall include a comparison with preoperational studies, 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.

12.7.2.3 The 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 ODCM Part II Section 6.0, 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.

12.7.2.4 The report shall also include the following:

1. A summary description of the Radiological Environmental Monitoring Program
2. At least two maps covering all sampling locations keyed to a table giving distances and directions from the midpoint between the two units
3. A discussion of all deviations from the sampling schedule described in Section 12.6.1
4. Discussion of environmental sample measurements that exceed the reporting levels of Table 12.6.1-2 but are not the result of plant effluents
5. Discussion of all analyses in which the LLD required by Table 12.6.1-3 was not achievable
6. Result of the Land Use Census required by Section 12.6.2
7. 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 Section 12.6.3.

12.7.3 Annual Radioactive Effluent Release Report

------------------------------NOTE------------------------------

A single submittal may be made for a multiple unit station. The submittal should combine 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.

12.7.3.1 The report covering the operation of the unit during the previous calendar year of operation shall be submitted in accordance with 10CFR50.36.9 prior to May 1 of each year.

12.7.3.2 The report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit. The material provided shall be consistent with the objectives outlined in the ODCM and the PCP and in accordance with 10CFR50.36 and 10CFR50, Appendix I, Section IV.B.1 The report shall be outlined consistent with 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.

12.7.3.3 The report 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.

12.7.3.4 The report 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 Section 12.7.4.

12.7.3.5 The report shall also include the following: an explanation as to why the INOPERABILITY of liquid or gaseous effluent monitoring instrumentation was not corrected within the specified time and description of the events leading to liquid holdup tanks or gas storage tanks exceeding the limits of Technical Specifications.

12.7.3.6 The 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 Radioactive Effluent Release 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

(continued)

12.7.3.7 The 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 190, "Environmental Radiation Protection Standards for Nuclear Power Operation."

12.7.4 Off site Dose Calculation Manual (ODCM)

12.7.4.1 The ODCM shall contain the methodology and parameters used in the calculation of offsite doses due to radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring alarm and trip setpoints, and in the conduct of the Radiological Environmental Monitoring Program.

12.7.4.2 The ODCM shall also contain the radioactive effluent controls and radiological environmental monitoring activities (described in Sections 12.2 - 12.6) and descriptions of the information that should be included in the Annual Radioactive Effluent Release and Radiological Environmental Operating Reports required by Sections 12.7.2 and12.7.3, and Technical Specifications 5.6.2 and 5.6.3.

12.7.4.3 Licensee initiated changes to the ODCM:

12.7.4.3.1 Shall be documented and records of reviews performed shall be retained as required by the Quality Assurance (QA) Manual. This documentation shall contain:

12.7.4.3.1.1 Sufficient information to support the change together with appropriate analyses or evaluations justifying the change(s); and

12.7.4.3.1.2 A determination that the change(s) will maintain the level of radioactive effluent control required by 10 CFR 20.1302, 40 CFR 190, 10 CFR 50.36a, and 10 CFR 50, Appendix I, and do not adversely impact the accuracy or reliability of effluent, dose, or set point calculations.

12.7.4.3.2 Shall become effective after approval of the Station Manager on the date specified by the Onsite Review and Investigative Function.

12.7.4.3.3 Shall be submitted to the NRC in the form of a complete, legible copy of the entire ODCM as a part of or concurrent with the 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 (i.e. month and date) the change was implemented.

12.7.5 Major Changes to Radioactive Waste Treatment Systems (Liquid and Gaseous)

12.7.5.1 Licensee initiated major changes to the radioactive waste systems may be made provided:

12.7.5.1.1 The change is reported in the Monthly Operating Report for the period in which the evaluation was reviewed by Onsite Review Function. The discussion of each change shall contain:

12.7.5.1.1.1 A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR 50.59;

12.7.5.1.1.2 Sufficient detailed information to support the reason for the change;

12.7.5.1.1.3 A detailed description of the equipment, components, and process involved and the interfaces with other plant systems;

12.7.5.1.1.4 An evaluation of the change which shows the predicted releases of radioactive materials in liquid and gaseous effluents (or quantity of solid waste that differ from those previously predicted in the license application and amendments);

12.7.5.1.1.5 A comparison of the predicted releases of radioactive materials in liquid and gaseous effluents and in solid waste to the ACTUAL releases for the period in which the changes were made;

12.7.5.1.1.6 An estimate of the exposure to plant OPERATING personnel as a result of the change; and

12.7.5.1.1.7 Documentation of the fact that the change was reviewed and found acceptable by Onsite Review Function.

12.7.5.2 The change shall become effective upon review and acceptance by Onsite Review Function.

12.8 ODCM BASES

General	It is expected that releases of radioactive material in effluents will be kept at small fractions of the limits specified in 10 CFR 20.1302. At the same time, the licensee is permitted the flexibility of operation, compatible with consideration of health and safety, to assure that the public is provided a dependable source of power even under unusual OPERATING conditions which may temporarily result in releases higher than such small fractions, but still within the limits specified in 10 CFR 20.1302. It is expected that in using this operational flexibility under unusual OPERATING conditions the licensee will exert his best efforts to keep levels of radioactive material in effluents as low as practicable.
RECs	REC 12.0.1 through REC 12.0.6 establish the general requirements applicable to all RECs in Sections 12.1 through 12.6 and apply at all times, unless otherwise stated.
RSRs	RSR 12.0.1 through RSR 12.0.5 establish the general requirements applicable to all Requirements in 12.1 through 12.5 and apply at all times, unless otherwise stated.
REC 12.0.1	REC 12.0.1 establishes the Applicability statement within each individual REC as the requirement for when the REC is required to be met (i.e., when the unit is in the MODES or other specified conditions of the Applicability statement of each Requirement).
RSR 12.0.1	RSR 12.0.1 establishes the requirement that RSRs must be met during the MODES or other specified conditions in the Applicability for which the requirements of the REC apply, unless otherwise specified in the individual RSRs. This REC is to ensure that RSRs are performed to verify the OPERABILITY of systems and components, and that variables are within specified limits. Failure to meet a RSR within the specified Frequency, in accordance with RSR 12.0.2, constitutes a failure to meet a REC. Systems and components are assumed to be OPERABLE when the associated RSRs have been met. Nothing in this RSR, however, is to be construed as implying that systems or components are OPERABLE when:

(continued)

RSR 12.0.1 (continued)

a. The systems or components are known to be INOPERABLE, although still meeting the RSRs; or

b. The requirements of the RSR(s) are known to be not met between required RSR performances.

RSR do not have to be performed when the unit is in a MODE or other specified condition for which the requirements of the associated REC are not applicable, unless otherwise specified.

Unplanned events may satisfy the requirements (including applicable acceptance criteria) for a given RSR. In this case, the unplanned event may be credited as fulfilling the performance of the RSR.

RSRs, including RSRs invoked by Required Actions, do not have to be performed on INOPERABLE equipment because the ACTIONS define the remedial measures that apply. RSRs have to be met and performed in accordance with RSR 12.0.2, prior to returning equipment to OPERABLE status.

Upon completion of maintenance, appropriate post maintenance testing is required to declare equipment OPERABLE. This includes ensuring applicable RSRs are not failed and their most recent performance is in accordance with RSR 12.0.2. Post maintenance testing may not be possible in the current MODE or other specified conditions in the Applicability due to the necessary unit parameters not having been established. In these situations, the equipment may be considered OPERABLE provided testing has been satisfactorily completed to the extent possible and the equipment is not otherwise believed to be incapable of performing its function. This will allow operation to proceed to a MODE or other specified condition where other necessary post maintenance tests can be completed.

REC 12.0.2

REC 12.0.2 establishes that upon discovery of a failure to meet a REC, the associated ACTIONS shall be met. The Completion Time of each Required Action for an ACTIONS Condition is applicable from the point in time that an ACTIONS Condition is entered. The Required Actions establish those remedial measures that must be taken within specified Completion Times when the requirements of a REC are not met. This Requirement establishes that:

a. Completion of the Required Actions within the specified Completion Times constitutes compliance with a REC; and

(continued)

REC 12.0.2 (continued)

b. Completion of the Required Actions is not required when a REC is met within the specified Completion Time, unless otherwise specified.

There are two basic types of Required Actions. The first type of Required Action specifies a time limit in which the REC must be met. This time limit is the Completion Time to restore an INOPERABLE system or component to OPERABLE status or to restore variables to within specified limits. If this type of Required Action is not completed within the specified Completion Time, a shutdown may be required to place the unit in a MODE or condition in which the REC is not applicable. (Whether stated as a Required Action or not, correction of the entered Condition is an action that may always be considered upon entering ACTIONS.) The second type of Required Action specifies the remedial measures that permit continued operation of the unit that is not further restricted by the Completion Time. In this case, compliance with the Required Actions provides an acceptable level of safety for continued operation.

Completing the Required Actions is not required when a REC is met or is no longer applicable, unless otherwise stated in the individual RECs.

The nature of some Required Actions of some Conditions necessitates that, once the Condition is entered, the Required Actions must be completed even though the associated Condition no longer exists. The individual REC's ACTIONS specify the Required Actions where this is the case. An example of this is in REC 12.4.2, "Dose from Noble Gases."

The Completion Times of the Required Actions are also applicable when a system or component is removed from service intentionally. The reasons for intentionally relying on the ACTIONS include, but are not limited to, performance of Surveillances, preventive maintenance, corrective maintenance, or investigation of operational problems. Entering ACTIONS for these reasons must be done in a manner that does not compromise safety. Intentional entry into ACTIONS should not be made for operational convenience. Additionally, if intentional entry into ACTIONS would result in redundant equipment being INOPERABLE, alternatives should be used instead. Doing so limits the time both subsystems/divisions of a function are INOPERABLE and limits the time conditions exist which may result in REC 12.0.3 being entered. Individual RECs may

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12.8 ODCM BASES (continued)

REC 12.0.2 (continued)

specify a time limit for performing a RSR when equipment is removed from service or bypassed for testing. In this case, the Completion Times of the Required Actions are applicable when this time limit expires, if the equipment remains removed from service or bypassed.

When a change in MODE or other specified condition is required to comply with Required Actions, the unit may enter a MODE or other specified condition in which another REC becomes applicable. In this case, the Completion Times of the associated Required Actions would apply from the point in time that the new REC becomes applicable and the ACTIONS Condition(s) are entered.

RSR 12.0.2

RSR 12.0.2 establishes the requirements for meeting the specified Frequency for RSRs and any Required Action with a Completion Time that requires the periodic performance of the Required Action on a "once per..." interval.

RSR 12.0.2 permits a 25% extension of the interval specified in the Frequency. This extension facilitates RSR scheduling and considers plant operating conditions that may not be suitable for conducting the RSR (e.g., transient conditions or other ongoing RSR or maintenance activities).

The 25% extension does not significantly degrade the reliability that results from performing the RSR at its specified Frequency. This is based on the recognition that the most probable result of any particular RSR being performed is the verification of conformance with the RSRs.

As stated in RSR 12.0.2, the 25% extension also does not apply to the initial portion of a periodic Completion Time that requires performance on a "once per..." basis. The 25% extension applies to each performance after the initial performance. The initial performance of the Required Action, whether it is a particular RSR or some other remedial action, is considered a single action with a single Completion Time. One reason for not allowing the 25% extension to this Completion Time is that such an action usually verifies that no loss of function has occurred by checking the status of redundant or diverse components or accomplishes the function of the INOPERABLE equipment in an alternative manner.

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12.8 ODCM BASES (continued)

RSR 12.0.2 (continued)

The provisions of RSR 12.0.2 are not intended to be used repeatedly merely as an operational convenience to extend RSR intervals (other than those consistent with refueling intervals) or periodic Completion Time intervals beyond those specified.

REC 12.0.3

REC 12.0.3 establishes the actions that must be implemented when a REC is not met and:

a. An associated Required Action and Completion Time is not met and no other Condition applies; or

b. The condition of the unit is not specifically addressed by the associated ACTIONS. This means that no combination of Conditions stated in the ACTIONS can be made that exactly corresponds to the actual condition of the unit. Sometimes, possible combinations of Conditions are such that entering REC 12.0.3 is warranted; in such cases, the ACTIONS specifically state a Condition corresponding to such combinations and also that REC 12.0.3 be entered immediately.

Upon entering REC 12.0.3, 1 hour is allowed to implement appropriate compensatory actions and verify the plant is not in an unanalyzed condition or that a required safety function is not compromised. Within 12 hours, Shift Operations Superintendent or designee approval of the compensatory actions and the plan for exiting REC 12.0.3 must be obtained. The use and interpretation of specified times to complete the actions of REC 12.0.3 are consistent with the discussion of Section 1.3, Completion Times.

The actions required in accordance with REC 12.0.3 may be terminated and REC 12.0.3 exited if any of the following occurs:

a. The REC is now met.

b. A Condition exists for which the Required Actions have now been performed.

c. ACTIONS exist that do not have expired Completion Times. These Completion Times are applicable from the point in time that the Condition is initially entered and not from the time REC 12.0.3 is exited.

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12.8 ODCM BASES (continued)

REC 12.0.3 (continued)	In MODES 1, 2, and 3, REC 12.0.3 provides actions for Conditions not covered in other Requirements. The requirements of REC 12.0.3 do not apply in MODES 4 and 5 because the unit is already in the most restrictive Condition. The requirements of REC 12.0.3 do not apply in other specified conditions of the Applicability (unless in MODE 1, 2, or 3) because the ACTIONS of individual RECs sufficiently define the remedial measures to be taken.

RSR 12.0.3

RSR 12.0.3 establishes the flexibility to defer declaring affected equipment INOPERABLE or an affected variable outside the specified limits when a RSR has not been completed within the specified Frequency. A delay period of up to 24 hours or up to the limit of the specified Frequency, whichever is greater, applies from the point in time it is discovered that the RSR has not been performed in accordance with RSR 12.0.2, and not at the time that the specified Frequency was not met. This delay period provides adequate time to complete RSRs that have been missed. This delay period permits the completion of a RSR before complying with Required Actions or other remedial measures that might preclude completion of the RSR.

The basis for this delay period includes consideration of unit conditions, adequate planning, availability of personnel, the time required to perform the RSR, the safety significance of the delay in completing the required RSR, and the recognition that the most probable result of any particular RSR being performed is the verification of conformance with the requirements.

When a RSR with a Frequency based not on time intervals, but upon specified unit conditions, operating situations, or requirements of regulations (e.g., prior to each release, or in accordance with the Radioactive Liquid Waste Sampling and Analysis Program, etc.) is discovered to not have been performed when specified, RSR 12.0.3 allows for the full delay period of up to the specified Frequency to perform the RSR. However, since there is not a time interval specified, the missed RSR should be performed at the first reasonable opportunity.

RSR 12.0.3 provides a time limit for, and allowances for the performance of, RSRs that become applicable as a consequence of MODE changes imposed by Required Actions.

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12.8 ODCM BASES (continued)

RSR 12.0.3 (continued)

Failure to comply with specified Frequencies for RSRs is expected to be an infrequent occurrence. Use of the delay period established by RSR 12.0.3 is a flexibility which is not intended to be used as an operational convenience to extend RSR intervals. While up to 24 hours or the limit of the specified Frequency is provided to perform the missed RSR, it is expected that the missed RSR will be performed at the first reasonable opportunity. The determination of the first reasonable opportunity should include consideration of the impact on plant risk (from delaying the RSR as well as any plant configuration changes required or shutting the plant down to perform the RSR) and impact on any analysis assumptions, in addition to unit conditions, planning, availability of personnel, and the time required to perform the RSR. This risk impact should be managed through the program in place to implement 10 CFR 50.65(a)(4) and its implementation guidance, NRC Regulatory Guide 1.182, "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants." This Regulatory Guide addresses consideration of temporary and aggregate risk impacts, determination of risk management action thresholds, and risk management action up to and including plant shutdown. The missed RSR should be treated as an emergent condition as discussed in the Regulatory Guide. The risk evaluation may use quantitative, qualitative, or blended methods. The degree of depth and rigor of the evaluation should be commensurate with the importance of the component. Missed RSRs for important components should be analyzed quantitatively. If the results of the risk evaluation determine the risk increase is significant, this evaluation should be used to determine the safest course of action. All missed RSRs will be placed in the station's Corrective Action Program.

If a RSR is not completed within the allowed delay period, then the equipment is considered INOPERABLE or the variable then is considered outside the specified limits and the Completion Times of the Required Actions for the applicable REC Conditions begin immediately upon expiration of the delay period. If a RSR is failed within the delay period, then the equipment is INOPERABLE, or the variable is outside the specified limits and the Completion Times of the Required Actions for the applicable REC Conditions begin immediately upon the failure of the RSR.

Completion of the RSR within the delay period allowed by this RSR, or within the Completion Time of the ACTIONS, restores compliance with RSR 12.0.1.

12.8 ODCM BASES (continued)

REC 12.0.4

REC 12.0.4 establishes limitations on changes in MODES or other specified conditions in the Applicability when an REC is not met. It precludes placing the unit in a MODE or other specified condition stated in that Applicability (e.g., Applicability desired to be entered) when the following exist:

a. Unit conditions are such that the requirements of the REC would not be met in the Applicability desired to be entered; and

b. Continued noncompliance with the REC requirements, if the Applicability were entered, would result in the unit being required to exit the Applicability desired to be entered to comply with the Required Actions.

Compliance with Required Actions that permit continued operation of the unit for an unlimited period of time in a MODE or other specified condition provides an acceptable level of safety for continued operation. This is without regard to the status of the unit before or after the MODE change. Therefore, in such cases, entry into a MODE or other specified condition in the Applicability may be made in accordance with the provisions of the Required Actions. The provisions of this REC should not be interpreted as endorsing the failure to exercise the good practice of restoring systems or components to OPERABLE status before entering an associated MODE or other specified condition in the Applicability.

The provisions of REC 12.0.4 shall not prevent changes in MODES or other specified conditions in the Applicability that are required to comply with ACTIONS. In addition, the provisions of REC 12.0.4 shall not prevent changes in MODES or other specified conditions in the Applicability that result from any unit shutdown.

Exceptions to REC 12.0.4 are stated in the individual RECs. The exceptions allow entry into MODES or other specified conditions in the Applicability when the associated ACTIONS to be entered do not provide for continued operation for an unlimited period of time. Exceptions may apply to all the ACTIONS or to a specific Required Action of a REC.

Surveillances do not have to be performed on the associated INOPERABLE equipment (or on variables outside the specified limits), as permitted by RSR 12.0.1. Therefore, changing MODES or

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REC 12.0.4 (continued)	other specified conditions while in an ACTIONS Condition, either in compliance with REC 12.0.4, or where an exception to REC 12.0.4 is stated, is not a violation of RSR 12.0.1 or RSR 12.0.4 for those Surveillances that do not have to be performed due to the associated INOPERABLE equipment. However, RSRs must be met to ensure OPERABILITY prior to declaring the associated equipment OPERABLE (or variable within limits) and restoring compliance with the affected REC. REC 12.0.4 is only applicable when entering MODE 3 from MODE 4, MODE 2 from MODE 3 or 4, or MODE 1 from MODE 2. Furthermore, REC 12.0.4 is applicable when entering any other specified condition in the Applicability only while operating in MODE 1, 2, or 3. The requirements of REC 12.0.4 do not apply in MODES 4 and 5, or in other specified conditions of the Applicability (unless in MODE 1, 2, or 3) because the ACTIONS of individual Requirements sufficiently define the remedial measures to be taken.
RSR 12.0.4	RSR 12.0.4 establishes the requirement that all applicable RSRs must be met before entry into a MODE or other specified condition in the Applicability. This RSR ensures that system and component OPERABILITY requirements and variable limits are met before entry into MODES or other specified conditions in the Applicability for which these systems and components ensure safe operation of the unit. The provisions of this RSR should not be interpreted as endorsing the failure to exercise the good practice of restoring systems or components to OPERABLE status before entering an associated MODE or other specified condition in the Applicability. However, in certain circumstances, failing to meet a RSR will not result in RSR 12.0.4 restricting a MODE change or other specified condition change. When a system, subsystem, division, component, device, or variable is INOPERABLE or outside its specified limits, the associated RSR(s) are not required to be performed per RSR 12.0.1 which states that RSRs do not have to be performed on INOPERABLE equipment. When equipment is INOPERABLE, RSR 12.0.4 does not apply to the associated RSR(s) since the requirement for the RSR(s) to be performed is removed. Therefore, failing to perform the RSRs within the specified Frequency, on equipment that is INOPERABLE, does not result in a RSR 12.0.4

(continued)

RSR 12.0.4 (continued)

restriction to changing MODES or other specified conditions of the Applicability. However, since the REC is not met in this instance, RSR 12.0.4 will govern any restrictions that may (or may not) apply to MODE or other specified condition changes.

The provisions of RSR 12.0.4 shall not prevent changes in MODES or other specified conditions in the Applicability that are required to comply with ACTIONS. In addition, the provisions of RSR 12.0.4 shall not prevent changes in MODES or other specified conditions in the Applicability that result from any unit shutdown.

The precise requirements for performance of RSRs are specified such that exceptions to RSR 12.0.4 are not necessary. The specific time frames and conditions necessary for meeting the RSRs are specified in the Frequency, in the RSR, or both. This allows performance of RSRs when the prerequisite condition(s) specified in a RSR procedure require entry into the MODE or other specified condition in the Applicability of the associated REC prior to the performance or completion of a RSR. A RSR that could not be performed until after entering the REC Applicability would have its Frequency specified such that it is not "due" until the specific conditions needed are met. Alternately, the RSR may be stated in the form of a Note as not required (to be met or performed) until a particular event, condition, or time has been reached. Further discussion of the specific formats of RSRs' annotation is found in Section 1.4, Frequency.

RSR 12.0.4 is only applicable when entering MODE 3 from MODE 4, MODE 2 from MODE 3 or 4, or MODE 1 from MODE 2. Furthermore, RSR 12.0.4 is applicable when entering any other specified condition in the Applicability only while operating in MODE 1, 2, or 3. The requirements of RSR 12.0.4 do not apply in MODES 4 and 5, or in other specified conditions of the Applicability (unless in MODE 1, 2, or 3) because the ACTIONS of individual Controls sufficiently define the remedial measures to be taken.

REC 12.0.5

REC 12.0.5 establishes the allowance for restoring equipment to service under administrative controls when it has been removed from service or declared INOPERABLE to comply with ACTIONS. The sole purpose of this Requirement is to provide an exception to REC 12.0.2 (e.g., to not comply with the applicable Required Action(s)) to allow the performance of required testing to demonstrate:

(continued)

12.8 ODCM BASES (continued)

REC 12.0.5 (continued)

a. The OPERABILITY of the equipment being returned to service; or

b. The OPERABILITY of other equipment.

The administrative controls ensure the time the equipment is returned to service in conflict with the requirements of the ACTIONS is limited to the time absolutely necessary to perform the required testing to demonstrate OPERABILITY. This Requirement does not provide time to perform any other preventive or corrective maintenance.

An example of demonstrating the OPERABILITY of other equipment is taking an INOPERABLE channel or TRIP SYSTEM out of the tripped condition to prevent the trip function from occurring during the performance of required testing on another channel in the other TRIP SYSTEM. A similar example of demonstrating the OPERABILITY of other equipment is taking an INOPERABLE channel or TRIP SYSTEM out of the tripped condition to permit the logic to function and indicate the appropriate response during the performance of required testing on another channel in the same TRIP SYSTEM.

RSR 12.0.5

RSR 12.0.5 establishes the applicability of each RSR to both Unit 1 and Unit 2 operation. Whenever a requirement applies to only one unit, or is different for each unit, this will be identified with parenthetical reference, Notes, or other appropriate presentation within the RSR.

REC 12.0.6

REC 12.0.6 establishes the applicability of each REC to both Unit 1 and Unit 2 operation. Whenever a requirement applies to only one unit, or is different for each unit, this will be identified in the appropriate section of the REC (e.g., Applicability, RSR, etc.) with parenthetical reference, Notes, or other appropriate presentation within the body of the requirement.

12.8 ODCM BASES (continued)

12.1 NOT USED

12.8 ODCM BASES (continued)

12.2 INSTRUMENTATION

12.2.1 Radioactive Liquid Effluent Monitoring Instrumentation

BASES

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the release of radioactive materials in liquid effluents during ACTUAL or potential release of liquid effluents. The alarm setpoints shall be calculated in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of RECS and 10CFR20. 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 50.

12.8 ODCM BASES (continued)

12.2 INSTRUMENTATION

12.2.2 Radioactive Gaseous Effluent Monitoring Instrumentation

BASES

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 shall be calculated in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of RECS and 10CFR20. The OPERABILITY and use of instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR 50.

12.8 ODCM BASES (continued)

12.3 LIQUID EFFLUENTS

12.3.1 Liquid Effluent Concentration

BASES

This specification is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to areas at and beyond the SITE BOUNDARY will be less than 10 times the concentration levels specified in 10 CFR 20.1001-20.2402, Appendix B, Table 2, Column 2. The concentration limit for noble gases was converted to an equivalent concentration in water using the International Commission on Radiological Protection (ICRP) Publication 2.

12.8 ODCM BASES (continued)

12.3 LIQUID EFFLUENTS

12.3.2 Dose From Liquid Effluents

BASES

This specification is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR 50. Control REC 12.3.2 implements the guidance set forth in Section II.A of Appendix I. The 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 reasonably achievable." The dose calculations 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 described 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 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. NUREG-0113 provides methods for dose calculations consistent with Reg. Guide 1.109 and 1.113.

12.8 ODCM BASES (continued)

12.3 LIQUID EFFLUENTS

12.3.3 Liquid Radwaste Treatment Systems

BASES

The liquid radwaste treatment system OPERABILITY ensures the 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 reasonably achievable." This specification implements the requirements of 10 CFR 50.36a, General Design Criterion 60 of Appendix A to 10 CFR 50 and design objective Section II.D of Appendix I to 10 CFR 50.

12.8 ODCM BASES (continued)

12.4 GASEOUS EFFLUENTS

12.4.1 Gaseous Effluent Dose Rates

BASES

This specification 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 10CFR50. This specification 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 design objectives of appendix I to 10 CFR 50. For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy 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 appropriate occupancy factors, shall be given in the ODCM. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to an individual at or beyond the UNRESTRICTED AREA boundary to less than or equal to a dose rate of 500 mrem/year to the total body or to not less than or equal to a dose rate of 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 not less than or equal to a dose rate of 1500 mrem/year. For purposes of calculating doses resulting from airborne releases the main chimney is considered to be an elevated release point, and the reactor vent stack is considered to be a mixed MODE release point.

12.8 ODCM BASES (continued)

12.4 GASEOUS EFFLUENTS

12.4.2 Dose from Noble Gases

BASES

This specification is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR 50. The Limiting Conditions for Operation implements the guides set forth in Section II.B of Appendix I. The 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 is to be shown by calculational procedures based on models and data such that the ACTUAL exposure of a MEMBER OF THE PUBLIC through the appropriate pathways is unlikely to be substantially underestimated. The dose calculations established in the ODCM for calculating the doses due to the ACTUAL release rates of radioactive noble gases in gaseous effluents will be 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 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 provide for determining the air doses at the unrestricted boundary based upon the historical average atmospheric conditions. NUREG-0133 provides methods for dose calculations consistent with Regulatory Guides 1.109 and 1.111.

12.8 ODCM BASES (continued)

12.4 GASEOUS EFFLUENTS

12.4.3 Dose From Iodine -131, Iodine -133, Tritium, and Radioactive Materials in Particulate Form

BASES

This specification is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR 50. The Limiting Conditions for Operation are the guides set forth in Section II.C of Appendix I. The 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 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 methods approved by NRC for calculating the doses due to the ACTUAL release rates of the subject materials are required to be 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 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 limits for radioiodine, radioactive material in particulate form and radionuclides other than noble gases are dependent on 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 specifications were: 1) individual inhalation of airborne radionuclides, 2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man and 3) deposition onto grassy areas where milk animals graze with consumption of the milk by man.

12.8 ODCM BASES (continued)

12.4 GASEOUS EFFLUENTS

12.4.4 Gaseous Radwaste Treatment System

BASES

The OPERABILITY of the gaseous waste treatment (off-gas) system that reduces amounts or concentrations of radioactive materials ensures that the system will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of this system be OPERABLE when specified provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as reasonably achievable". This specification implements the requirements of 10 CFR 50.36a, General Design Criterion 60 of Appendix A to 10 CFR 50, and the design objectives given in Section 11.0 of Appendix I to 10 CFR 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 11.3 and 11.0 of Appendix I, 10CFR50, for gaseous effluents. To determine if gaseous effluents shall be processed through installed treatment equipment, the average PROJECTED DOSE will be determined. For gaseous effluent pathways other than the specified unmonitored exhausts, treatment and monitoring will only be required for pathways that are significant. Regulatory Guide 1.109, "Calculations of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I", states that a pathway is considered significant if a conservative evaluation yields an additional dose increment equal to or more than 10 percent of the total from all pathways. Therefore, the total dose from all release pathways that do not require treatment or monitoring can not exceed 10 percent of the limit specified in Section II.C of Appendix I, 10 CFR 50.

12.8 ODCM BASES (continued)

12.4 GASEOUS EFFLUENTS

12.4.5 Ventilation Exhaust Treatment System

BASES

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

12.8 ODCM BASES (continued)

12.4 GASEOUS EFFLUENTS

12.4.6 Mark I Containment

BASES

During normal conditions, drywell VENTING and PURGING is normally performed directly to the Reactor Building Ventilation System. The provisions of this REC provide reasonable assurance that the requirements of REC 12.4.1, REC 12.4.2, and REC 12.4.3 are met.

The noble gas activity limit is based on not exceeding the alarm trip setpoint of the Reactor Building Vent Noble Gas Activity monitors assuming a Containment Drywell purge flow rate of 9500 cfm and one Reactor Building Ventilation Exhaust fan in operation.

The iodine and particulate activity limit is based on not exceeding the requirements of REC 12.4.1 or REC 12.4.3.

12.8 ODCM BASES (continued)

12.5 TOTAL DOSE

12.5.1 Total Dose

BASES

This Control is provided to meet the dose limitations of 40 CFR 190 that have been incorporated into 10 CFR 20 by 46 FR 18525. 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 mrems to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems. For sites containing up to four reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR 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 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 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 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR 190 have not already been corrected), in accordance with the provisions of 40 CFR 190.11 and 10 CFR 20.2203, is considered to be a timely request and fulfills the requirements of 40 CFR 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR 20, as addressed in Sections 12.3.1 and 12.4.1. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

12.8 ODCM BASES (continued)

12.5 TOTAL DOSE

12.5.2 Dose Limits for MEMBERS OF THE PUBLIC

BASES

This section applies to direct exposure of radioactive materials as well as radioactive materials released in gaseous and liquid effluents. 10CFR20.1301 sets forth the 100 mrem/year dose limit to MEMBERS OF THE PUBLIC; 2 mrem in any one-hour limit in the UNRESTRICTED AREA; and reiterates that the licensee is also required to meet the 40CFR190 standards. 10CFR20.1302 provides options to determine compliance to 10CFR20.1301. Compliance to the above OPERABILITY requirement is based on 10CFR20, 40CFR190 and Quad Cities Station Technical Specification 5.5.4.j.

12.8 ODCM BASES (continued)

12.6 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

12.6.1 Radiological Environmental Monitoring Program

BASES

The Radiological Environmental Monitoring Program required by this specification 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 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. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. The initially specified monitoring program will be effective for at least the first 3 years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 12.6.1-3 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as a before the fact limit representing the capability of a measurement system and not as an after the fact limit for a particular measurement.

Detailed discussion of the LLD, and other detection limits, can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, LA, "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J.K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

Table 12.6.1-1 requires "one sample of each COMMUNITY WATER SYSTEM downstream of the plant within 10 kilometers." Drinking water supply is defined as water taken from rivers, lakes, or reservoirs (not well water) that is used for drinking.

12.8 ODCM BASES (continued)

12.6 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

12.6.2 Land Use Census

BASES

This specification 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 given in the ODCM are made if required by the results of this census.

This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR 50. An annual garden census will not be required since the licensee will assume that there is a garden at the nearest residence in each sector for dose calculations.

12.8 ODCM BASES (continued)

12.6 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

12.6.3 Interlaboratory Comparison Program

BASES

The requirement for participation in an 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 50.

12.8 ODCM BASES (continued)

12.6 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

12.6.4 Meteorological Monitoring Instrumentation

BASES

The OPERABILITY of the meteorological monitoring instrumentation ensures that sufficient meteorological data is available for estimating potential radiation doses to the public as a result of routine or accidental release of radioactive materials to the atmosphere. This capability is required to evaluate the need for initiating measures to protect the health and safety of the public. These requirements are consistent with the recommendations of Regulatory Guide 1.23 "Onsite Meteorological Programs," February, 1972.

PART II

OFFSITE DOSE CALCULATION MANUAL

QUAD CITIES STATION

UNITS 1 AND 2

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:

1.0 USE AND APPLICATION
2.0 -
11.0 Not Used
12.0 RADIOLOGICAL EFFLUENT CONTROL (REC) and RADIOLOGICAL EFFLUENT SURVEILLANCE REQUIREMENT (RSR) APPLICABILITY
12.1 NOT USED
12.2 INSTRUMENTATION
- 12.2.1 Radioactive Liquid Effluent Monitoring Instrumentation
- 12.2.2 Radioactive Gaseous Effluent Monitoring Instrumentation

12.3 LIQUID EFFLUENTS
- 12.3.1 Liquid Effluent Concentration
- 12.3.2 Dose From Liquid Effluents
- 12.3.3 Liquid Radwaste Treatment Systems

12.4 GASEOUS EFFLUENTS
- 12.4.1 Gaseous Effluent Dose Rates
- 12.4.2 Dose from Noble Gases
- 12.4.3 Dose From Iodine -131, Iodine -133, Tritium, and Radioactive Materials in Particulate Form

12.4.4 Gaseous Radwaste Treatment System
12.4.5 Ventilation Exhaust Treatment System
12.4.6 Mark I Containment
12.5 TOTAL DOSE
12.5.1 Total Dose
12.5.2 Dose Limits for MEMBERS OF THE PUBLIC
12.6 RADIOLOGICAL ENVIRONMENTAL MONITORING
12.6.1 Radiological Environmental Monitoring
12.6.2 Land Use Census
12.6.3 Interlaboratory Comparison Program
12.6.4 Meteorological Monitoring Instrumentation
12.7 ADMINISTRATIVE REQUIREMENTS
12.7.1 Station Operating Records
12.7.2 Annual Radiological Environmental Operating Report
12.7.3 Annual Radioactive Effluent Release Report
12.7.4 Off site Dose Calculation Manual (ODCM)
12.7.5 Major Changes to Radioactive Waste Treatment Systems (Liquid and Gaseous)
12.8 ODCM BASES

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:

1.0 INTRODUCTION - ODCM GENERAL INFORMATION
2.0 INSTRUMENTATION AND SYSTEMS
3.0 LIQUID EFFLUENTS
4.0 GASEOUS EFFLUENTS
5.0 TOTAL DOSE
6.0 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.

- <u>10CFR20, Standards for Protection Against Radiation</u>

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

  <u>Design Criteria (Appendix A of 10CFR50)</u>

  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.

- <u>ALARA Provisions (Appendix I of 10CFR50)</u>

  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.

- <u>40CFR190, Environmental Radiation Protection Standards for Nuclear Power Operations</u>

  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-0473 (Rev.2) for BWR's, implements the LWR provisions to meet 40CFR190". (See Reference 103 and 49.)

  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.

- <u>40CFR141, National Primary Drinking Water Regulations</u>

  The following radioactivity limits for COMMUNITY WATER SYSTEMS were established in the July, 1976 Edition of 40CFR141:

  - Combined Ra-226 and Ra-228: $\leq$ 5 pCi/L.
  - Gross alpha (particle activity including Ra-226 but excluding radon and uranium): $\leq$ 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. There are no drinking water supplies affected by the operation of the Quad Cities Station. Therefore Quad Cities has no requirements related to 40CFR141 in the RECS.

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

  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 BWRs (Reference 3) 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 ODCM 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 RECS. 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.

The dose limits of 40CFR190 and 10CFR72.104 are the same.

Table 1-1
Regulatory Dose Limit Matrix

REGULATION	DOSE TYPE	DOSE LIMIT(s)		ODCM Section
Airborne Releases:		(quarterly)	(annual)	
10CFR50 App. I[3]	Gamma Dose to Air due to Noble Gas Radionuclides (per reactor unit)	5 mrad	10 mrad	4.2.2.1
	Beta Dose to Air Due to Noble Gas Radionuclides (per reactor unit)	10 mrad	20 mrad	4.2.2.2
	Organ Dose Due to Specified Non-Noble Gas Radionuclides (per reactor unit)	7.5 mrem	15 mrem	4.2.3
	Total Body and Skin Dose (if air dose is exceeded): Total Body	2.5 mrem	5 mrem	4.2.2.3
	Total Body and Skin Dose (if air dose is exceeded): Skin	7.5 mrem	15 mrem	4.2.2.4
Technical Specifications	Total Body Dose Rate Due to Noble Gas Radionuclides (instantaneous limit, per site)	500 mrem/yr		4.2.1.1
	Skin Dose Rate Due to Noble Gas Radionuclides (instantaneous limit, per site)	3,000 mrem/yr		4.2.1.2
	Organ Dose Rate Due to Specified Non-Noble Gas Radionuclides (instantaneous limit, per site)	1,500 mrem/yr		4.2.1.3
Liquid Releases:		(quarterly)	(annual)	
10CFR50 App. I[3]	Whole (Total) Body Dose (per reactor unit)	1.5 mrem	3 mrem	3.4
	Organ Dose (per reactor unit)	5 mrem	10 mrem	3.4
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 in note 5 below for Noble Gases		3.2
Total Doses [1]:				
10 CFR 20.1301 (a)(1)	Total Effective Dose Equivalent [4]	100 mrem/yr		5.2
10CFR20.1301 (d) And 40CFR190	Total Body Dose	25 mrem/yr		5.2
	Thyroid Dose	75 mrem/yr		5.2
	Other Organ Dose	25 mrem/yr		5.2
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 Quad Cities 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.

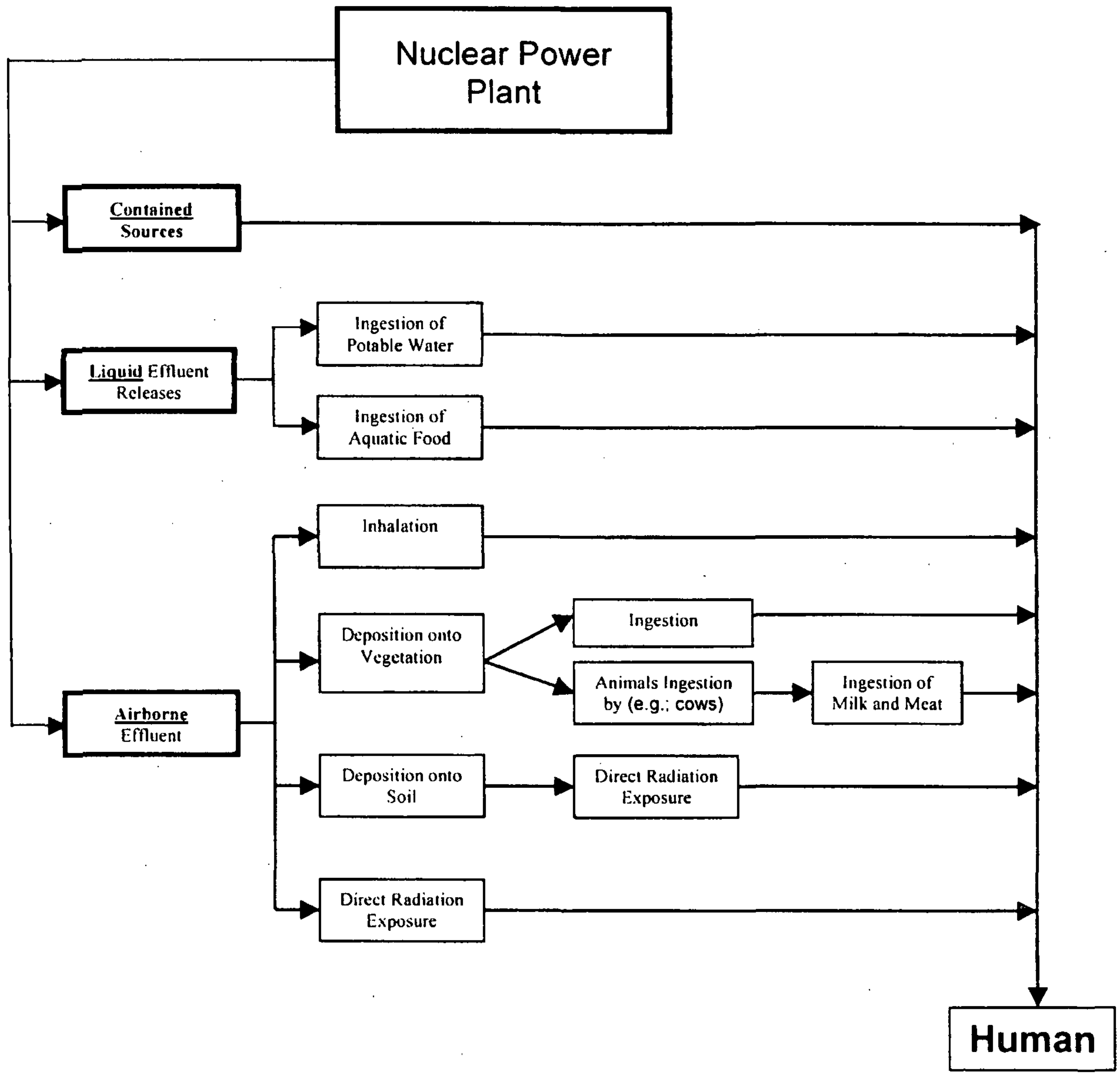
5 Kr-85m, Kr-85, Kr-87, Kr-88, Ar-41, Xe-131m, Xe-133m, Xe-133, Xe-135m and Xe-135 allowable concentration is 2E-4, 5E-4, 4E-5, 9E-5, 7E-5, 7E-4, 5E-4, 6E-4, 2E-4 and 2E-4 µCi/ml, respectively, computed from Equation 17 of ICRP Publication 2 adjusted for infinite cloud submersion in water, and R = 0.01 rem/wk, ρ_w = 1.0 g/cm3, and P_w/P_t = 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 radioiodines, 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 2.0, 4.0, and 5.0 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:

PATHWAY	ADULT	TEENAGER	CHILD	INFANT
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 Quad Cities Station have been deleted, however the numbering has been preserved for ease of reference management throughout the ODCM document; therefore, reference numbering is not sequential.

3. U.S. Nuclear Regulatory Commission, Standard Radiological Effluent Technical Specifications for Boiling Water Reactors, NUREG-0473, Rev. 3, Draft, September 1982 (frequently revised).

4. U.S. Nuclear Regulatory Commission, 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, Regulatory Guide 1.21. Revision 1, June 1974.

5. U.S. Nuclear Regulatory Commission, Onsite Meteorological Programs, Regulatory Guide 1.23, Safety Guide 23, February 17, 1972.

6. U.S. Nuclear Regulatory Commission, 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, Regulatory Guide 1.109, Rev. 1, October 1977.

7. U.S. Nuclear Regulatory Commission, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, Regulatory Guide 1.111, Rev. 1, July 1977.

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Table 1-3
Miscellaneous Dose Assessment Factors: Environmental Parameters

Parameter	Value	Comment	Equation	Basis[a]
f_g	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_s	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 human consumption	4-11	A
t_h	2160 hrs	90 days for produce animal consumption	4-13, 4-15	A
t_L	24 hrs	1 day for leafy vegetables	4-11	A
Q_F	50 Kg/day	Cow Consumption Rate	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

[a]Basis 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 (Page 1 of 2)
Stable Element Transfer Data

Element	F_f 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-06	Footnote 4
Ti	3.4E-02	5.0E-06	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_f 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-06	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-06	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-06	6
Ce	1.2E-03	1.0E-04	6
Pr	4.7E-03	5.0E-06	6
Nd	3.3E-03	5.0E-06	6

Table 1-4 (Page 2 of 2)
Stable Element Transfer Data

Element	F_f 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_f -Footnote 6
W	1.3E-03	5.0E-04	6
Re	1.0E-01	1.3E-03	F_M - Ref. 16; F_f -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_f -Footnote 11
Tl	1.5E-02	1.3E-03	F_M - Ref. 16; F_f -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:

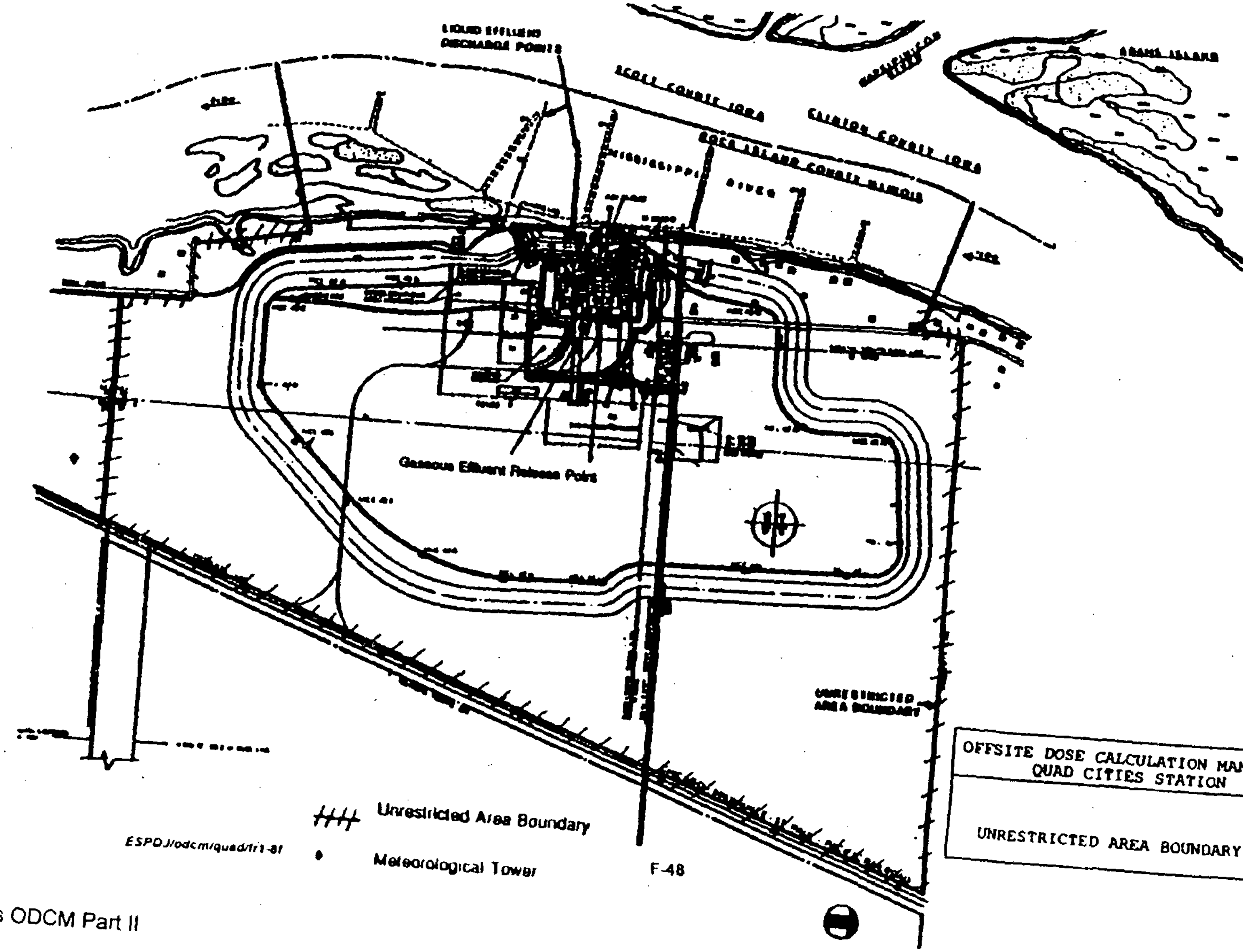
1. NA = It is assumed that noble gases are not deposited on the ground.
2. Elements listed are those considered for 10CFR20 assessment and compliance.

Footnotes:

There are numerous F_f 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 58-71 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.

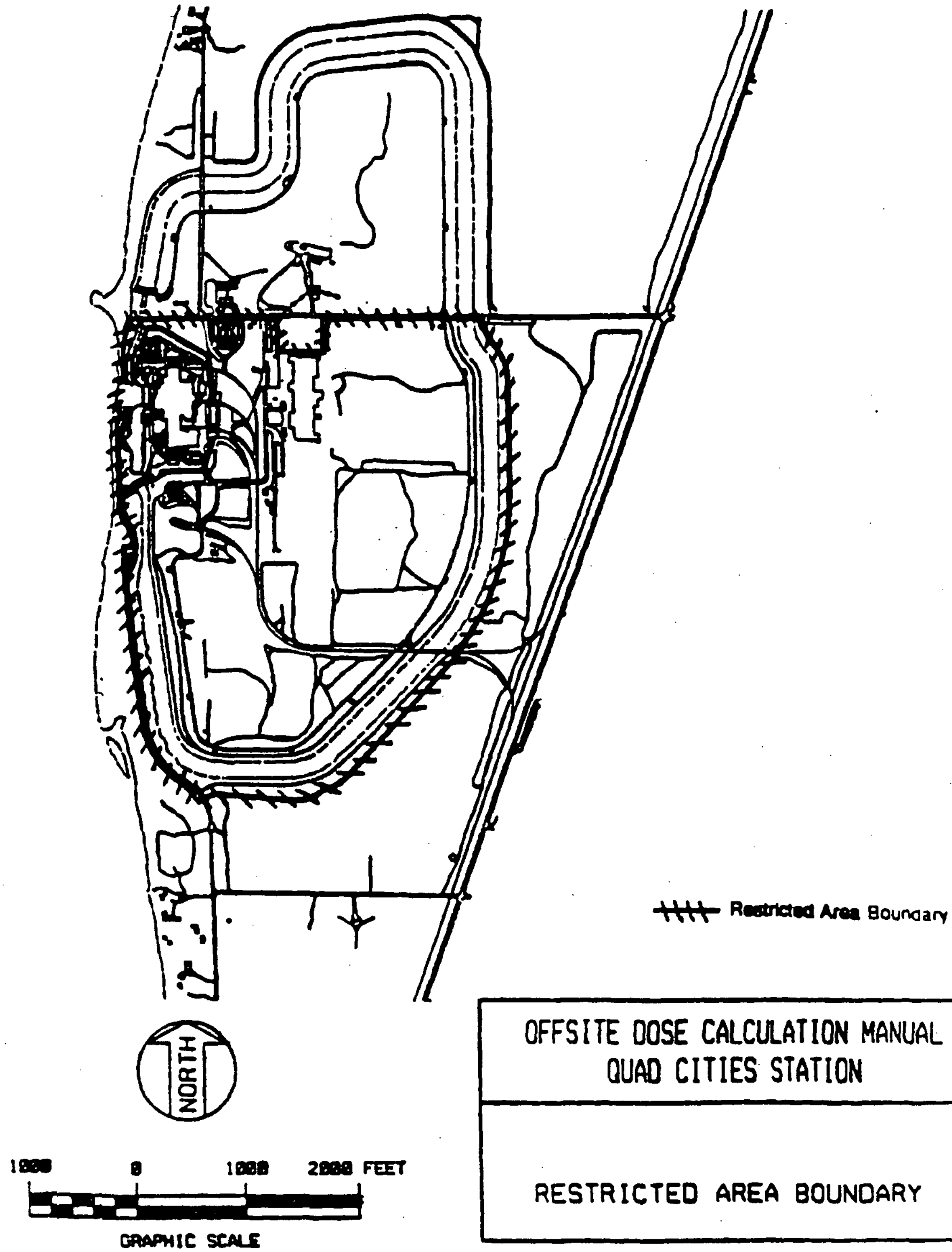
1. Values obtained by averaging Reference 6 values of Ca, Sr, Ba and Ra.
2. F_f value obtained by assigning the Reference 6 value for I. F_M value obtained by averaging I (Ref. 6) and Br (Ref.16).
3. F_f values obtained by averaging Zn (Ref. 6) and Pb (Ref. 98); there were no values for elements in the 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_f 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_f 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.

Figure 1-2



OFFSITE DOSE CALCULATION MANUAL QUAD CITIES STATION
UNRESTRICTED AREA BOUNDARY

Figure 1-3



OFFSITE DOSE CALCULATION MANUAL QUAD CITIES STATION
RESTRICTED AREA BOUNDARY

2.0 INSTRUMENTATION AND SYSTEMS

2.1 Liquid Releases

2.1.1 System Description

Simplified liquid radwaste and liquid effluent flow diagrams are provided in Figure 2-2 & Figure 2-3.

The liquid radwaste treatment system is designed and installed to reduce radioactive liquid effluents by collecting the liquids, providing for retention or holdup, and providing for treatment by demineralizer for the purpose of reducing the total radioactivity prior to release to the environment. The system is described in Section 11.2 of the Quad Cities UFSAR.

2.1.1.1 River Discharge Tank

There is one river discharge tank (65,000 gallons capacity) that receives water for discharge to the Mississippi River. This is the only release path in use.

2.1.2 Radiation Monitors

2.1.2.1 Liquid Radwaste Effluent Monitor

Monitor 1/2-1799-01 is used to monitor all releases from the river discharge tank. On high alarm the release is terminated manually.

Pertinent information on the monitor and associated control devices is provided in Quad Cities UFSAR Sections 11.5.2 and 11.5.3.

2.1.2.2 Service Water Effluent Monitors

Monitors 1(2)-1799-01 continuously monitor the service water effluent. These monitors initiate no control device.

Pertinent information on these monitors is provided in Quad Cities UFSAR 11.5.3.

2.1.3 Alarm and Trip Setpoints

2.1.3.1 Setpoint Calculations

Alarm and trip setpoints of liquid effluent monitors at the principal release points are established to ensure that the limits of RECS are not exceeded in the UNRESTRICTED AREA.

Currently these setpoints are based on the most conservative releases during the previous 18 months. If it is determined that this is no longer conservative, the setpoints are reevaluated.

2.1.3.1.1. Liquid Radwaste Effluent Monitor

The monitor setpoint is found by solving equation 2.0-1 for the total isotopic activity.

$$P \leq (K) \times \left[\frac{\Sigma C_i^T}{\sum \frac{C_i^T}{10 \times DWC_i}} \right] \times \left[\frac{(0.5 F^d_{AVG} + F^r_{max})}{F^r_{max}} \right] + B \qquad (2.0\text{-}1)$$

P	Release Setpoint	[cpm]
$\mathbf{C_i^T}$	Concentration of radionuclide "i" in the release tank.	[µCi/ml]
$\mathbf{F^r_{max}}$	Maximum Release Tank Discharge Flow Rate The flow rate from the radwaste discharge tank.	[gpm]
K	Calibration constant	[cpm/µCi/ml]
$\mathbf{DWC_i}$	Derived Water Concentration of radionuclide "i" From Appendix B, Table 2, Column 2 to 10CFR20. 1001-20.2402.	[µCi/ml]
10	Multiplier granted in Technical Specifications applied to the DWC	
$\mathbf{F^d_{AVG}}$	Average dilution flow of initial dilution stream	[gpm]
B	Background Count Rate	[cpm]

2.1.3.1.2. Service Water Effluent Monitors

The monitor setpoint is found by solving equation 2.0-2.

$$P \le (K) \times \left[\frac{\Sigma C_i}{\sum \frac{Ci}{10 \times DWC_i}} \right] \times \left[\frac{(F^{d}{}_{\rm MG} + F^{r}{}_{\max})}{F^{r}{}_{\max}} \right] + B \qquad (2.0\text{-}2)$$

C_i Concentration of radionuclide "i" in service water

If there is no detectable activity then $\mu C_i/\mu C_i/10*DWC_i$)
is assumed to be1 x 10^{-5}µCi/ml.

F^r_{max} Maximum discharge rate of service water for one unit. [gpm]

All other terms are as defined in equation 2.0-1.

2.1.4 Discharge Flow Rates

2.1.4.1 Release Tank Discharge Flow Rate

Prior to each BATCH RELEASE, a grab sample is obtained.

The results of the analysis of the sample determine the discharge rate of each batch as follows:

$$F_{max}^{r} = 0.1\left[\frac{0.5F^{d}}{\sum\left(\frac{C_i}{10\times DWC_i}\right)}\right] \qquad (2.0\text{-}3)$$

The summation is over radionuclides "i".

0.1 Reduction factor for conservatism.

F^r_{max} Maximum Permitted Discharge Flow Rate [gpm]

The maximum permitted flow rate from the radwaste discharge tank.

F^d Dilution Flow [gpm]

C_i Concentration of Radionuclide "i" in the Release Tank [µCi/ml]

The concentration of radioactivity in the radwaste discharge tank based on measurements of a sample drawn from the tank.

DWC_i Derived Water Concentration of radionuclide "i" [µCi/ml]

From Appendix B, Table 2, Column 2 to 10CFR20.1001-0.2402.

10 Multiplier granted in Technical Specifications applied to the DWC

2.1.5 Release Limits

Release limits are determined from RECS. Calculated maximum permissible discharge rates are divided by 10 and dilution flows are divided by 2 to ensure that releases are well below applicable limits. (The factor of 2 used in the dilution flows accounts for discharging the RDT tank to the south diffuser pipe).

2.1.5.1 Release Mixture

For the liquid radwaste effluent monitor the release mixture used for the setpoint determination is the radionuclide mix identified in the grab sample gamma isotopic analysis. H-3, Sr-89, Sr-90, and Fe-55 are not used in this calculation since the monitor cannot detect pure beta emitters.

2.1.5.2 Conversion Factors

The readout for the liquid radwaste effluent monitor is in CPM. The calibration constant is based on the detector sensitivity to Cs-137.

2.1.5.3 Liquid Dilution Flow Rates

The dilution flow is determined using equation 2.0-4 below.

$$F^{d} = \left(N^{cw} \times F^{cw} + N^{sw} \times F^{sw} - F^{ICE}\right) \quad (2.0\text{-}4)$$

$\mathbf{F^{d}}$ = Dilution flow [gpm]

$\mathbf{N^{cw}}$ = Number of circulating water pumps on.

$\mathbf{F^{cw}}$ = 157000 [gpm]
Flow with one circulating water pump on.

$\mathbf{N^{sw}}$ = Number of service water pumps on

$\mathbf{F^{sw}}$ = 13800 [gpm]
Flow with one service water pump on

$\mathbf{F^{ICE}}$ = Deicing flow

2.1.5.4 Allocation of Effluents from Common Release Points

Radioactive liquid effluent released from the release tank is comprised of contributions from both units.

Allocation of waste is achieved by comparing the pump timer totals for each unit's floor drain and equipment drain pumps to the amount of waste sent to the river discharge tank from the floor drain and waste collector storage tanks. Liquid effluents from laundry and chemical waste are allocated evenly between units. During extended unit shutdown or periods of significant plant input differences, the apportionment is adjusted accordingly. The allocation of the effluents is made on a monthly basis.

2.1.5.5 Projected Concentrations for Releases

If $\sum\left(\frac{Ci}{10\ DWC_i}\right)$ prior to dilution is greater than 25, the PROJECTED DOSE due to liquid effluent releases is calculated. Otherwise, the releases from the previous month are used to estimate the PROJECTED DOSE for the coming month using the methodology in ODCM Part II, Section 3.4.

2.1.6 Solidification of Waste/Process Control Program

The Process Control Program (PCP) contains the current formulas, sampling, analysis, test, 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. Figure 2-4 is a simplified diagram of solid radwaste processing.

2.2 Airborne Releases

2.2.1 System Description

A simplified gaseous radwaste and gaseous effluent flow diagram is provided in Figure 2-1.

Each airborne release point is classified as stack, vent, or ground level in accordance with the definitions in Section 4.1.4. The principal release points for potentially radioactive airborne effluents and their classifications are as follows:

- The ventilation chimney (a stack release point).
- The reactor building ventilation stack (a vent release point).

2.2.1.1 Condenser Offgas Treatment System

The condenser offgas treatment system is designed and installed to reduce radioactive gaseous effluents by collecting non-condensable off-gases from the condenser and providing for holdup to reduce the total radioactivity via decay prior to release to the environment. Charcoal and HEPA filters retain the daughter products. The system is described in Section 11.3.2.1.1 of the Quad Cities UFSAR.

2.2.1.2 Ventilation Exhaust Treatment System

Ventilation exhaust treatment systems are designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in selected effluent streams by passing ventilation or vent exhaust gases through charcoal adsorbers and/or HEPA filters prior to release to the environment. Such a system is not considered to have any effect on noble gas effluents. The ventilation exhaust treatment systems are shown in Figure 2-1.

Engineered safety features atmospheric cleanup systems are not considered to be ventilation exhaust treatment system components.

2.2.2 Radiation Monitors

2.2.2.1 Plant Chimney Monitor

Monitors 1(2)-1730A/B continuously monitor the final effluent from the chimney.

The monitor system has isokinetic sampling, gaseous grab sampling, iodine and particulate sampling, and tritium sampling capability.

The chimney effluent is also monitored by a separate particulate, iodine, and noble gas (SPING-4) system and a Victoreen system. The SPING/Victoreen system has high range capabilities to deal with accident conditions including post accident sampling capability. The Victoreen sampling system automatically begins taking samples after a high signal has been received on the SPING-4 low range noble gas monitor. Output from the SPING/Victoreen system is obtainable in the control room.

These monitors perform no automatic isolation or control functions. Pertinent information on these monitors is provided in the Quad Cities UFSAR Section 11.5.2.3.

2.2.2.2 Reactor Building Vent Stack Effluent Monitor

The combined reactor building ventilation is also monitored by a SPING-4. This monitor has high range capabilities to deal with accident conditions. The SPING-4 noble gas detectors have ranges that envelope the range for the reactor building vent effluent trip point.

The vent stack monitor has isokinetic sampling and iodine and particulate sampling capability.

This monitor performs no automatic isolation or control functions.

Pertinent information on this monitor is provided in the Quad Cities UFSAR Section 11.5.2.4.

2.2.2.3 Reactor Building Ventilation Monitors

Monitors 1(2)-1735A/B continuously monitor the effluent from the Unit 1(2) reactor building. On high high alarm, the monitors automatically initiate closure of valves A01(2)A-5741, A01(2)B-5741, A01(2)A-5742, and A01(2)B-5742 thus isolating the Unit 1(2) reactor building, and initiate startup of the Unit 1(2) standby gas treatment system, and isolates control room HVAC.

In addition to the above monitors, there is continuous iodine and particulate sampling of the reactor building exhaust.

Pertinent information on these monitors is provided in Quad Cities UFSAR Section 11.5.2.4.

The requirement to declare both channels INOPERABLE when the Reactor Building Vent Exhaust is isolated on one unit is discussed in Technical Specifications.

2.2.2.4 Condenser Air Ejector Monitors

Monitors 1(2)-1733A/B continuously monitor gross gamma activity downstream of the steam jet air ejector and prior to release to the main chimney.

On high high alarm the monitors automatically activate an interval timer which in turn initiates closure of air operated valve A01(2)-5406, thus terminating the release.

Monitors 1(2)-1741 continuously monitor the final offgas effluent prior to entering the chimney. These monitors initiate no control device and are not ODCM related monitors.

Monitors 1(2)-1738 (flux tilt monitors) also continuously monitor gross gamma activity downstream of the steam jet air ejector. These monitors are not ODCM related monitors.

Pertinent information on these monitors is found in Quad Cities UFSAR Sections 11.5.2.1 and 11.5.2.2.

2.2.3 Alarm and Trip Setpoints

2.2.3.1 Setpoint Calculations

2.2.3.1.1. Reactor Building Vent Stack Monitors

The setpoint for the reactor building vent stack monitor is conservatively set at 2 mr/hr above background. The reactor building ventilation stack release rate, Q_{tv}, at 2 mr/hr is calculated to be 14,400 μCi/sec. Q_{tv} is then substituted into Equations 2.0-5 and 2.0-6 to determine Q_{ts}.

2.2.3.1.2. Condenser Air Ejector Monitors

The high-high trip setpoint is established at <100 μCi/sec per MWt (≈2.5E5 μCi/sec) and the SJAE monitor high alarm setpoints are selected at 1.5 times normal full power background with hydrogen addition to satisfy the licensing commitments associated with the main steam line monitor Tech Spec amendment.

2.2.3.1.3. Plant Chimney Radiation Monitor

The setpoints for the plant chimney radiation monitor are conservatively set at 10,000 μCi/sec and 20,000 μCi/sec (high and high-high alarms respectively).

At this level the combined release from chimney and vent is approximately 10% of the RECS limit. This is determined by solving Equations 2.0-5 and 2.0-6 below.

2.2.3.2 Release Limits

Alarm and trip setpoints of gaseous effluent monitors are established to ensure that the release rate limits of RECS are not exceeded. The release limit Q_{ts} is found by solving Equations 2.0-5 and 2.0-6.

$$\sum_i K_i\, f_i \left\{ (\chi/Q)_s^{\gamma} Q_{ts} + (\chi/Q)_v^{\gamma} Q_{tv} \right\} < 500\ mrem/yr \qquad (2.0\text{-}5)$$

$$\sum_i f_i \{ L_i [(\chi/Q)_s Q_{ts} + (\chi/Q)_v Q_{tv}] + (1.11) M_i [(\chi/Q)_s^{\gamma} Q_{ts} + (\chi/Q)_v^{\gamma} Q_{tv}] \} < 3000 mrem/yr \qquad (2.0\text{-}6)$$

The summations are over noble gas radionuclides "i".

f_i Fractional Radionuclide Composition

The release rate of noble gas radionuclide "i" divided by the total release rate of all noble gas radionuclides.

Q_{ts} Total Allowed Release Rate, Stack Release [μCi/sec]

The total Allowed release rate of all noble gas radionuclides released as stack releases.

Q_{tv} Total Allowed Release Rate, Vent Release [μCi/sec]

The total allowed release rate of all noble gas radionuclides released as vent releases.

The remaining parameters in Equation 2.0-5 have the same definitions as in ODCM Part II, Section Equation 4-1. The remaining parameters in Equation 2.0-6 have the same definition as in Equation 4-2.

Equation 2.0-5 is based on Equation 4-1 of ODCM Part II and the RECS restriction on whole body dose rate (500 mrem/yr) due to noble gases released in gaseous effluents (see Section 4.2.1.1 of ODCM Part II). Equation 2.0-6 is based on Equation 4-2 and the RECS restriction on skin dose rate (3000 mrem/yr) due to noble gases released in gaseous effluents (see ODCM Part II, Section 4.2.1.2).

Equation 2.0-5 is used as the limiting noble gas release rate.

Calibration methods and surveillance frequency for the monitors will be conducted as specified in the RECS.

2.2.3.3 Release Mixture

In the determination of alarm and trip set points the radioactivity mixture in the exhaust air is assumed to be the same as the calculated effluent during the calendar quarter in which the monitor is recalibrated.

2.2.3.4 Conversion Factors

The conversion factors used to establish gaseous effluent monitor setpoints are obtained as follows.

2.2.3.4.1. Reactor building vent effluent monitor.

The monitor setpoint is established at 2 mr/hr above background. For the purpose of setpoint determination it is assumed that the background is 1 mr/hr. There is sufficient conservatism in the setpoint calculation to accommodate routine variations in the background. However, the isotopic analysis in Section 2.2.3.3 is used to confirm that the setpoint is conservative.

2.2.3.4.2. Condenser air ejector monitor.

The isotopic analysis in Section 2.2.3.3 and the flow and monitor reading at the time of the analysis are used to establish the conversion factor.

2.2.3.4.3. Plant chimney monitor.

Calibration of the plant chimney monitor consists of recirculating an amount of off-gas (see 2.2.3.3) through the noble gas monitors and a Marinelli beaker. After readings have stabilized, the Marinelli beaker is removed and gamma isotopic analysis performed. The efficiency is determined from a plot of average gamma energy of the off-gas sample and net monitor readings.

2.2.3.5 HVAC Flow Rates

The HVAC exhaust flow rates may be obtained from the process computers, indication in the control room, or fan combinations. Setpoints were calculated using the following values:

Chimney Air Flow.. 350,000 cfm
Combined Reactor Vent* (1 fan) .... 48,000 cfm
Combined Reactor Vent* (2 fans) .... 96,000 cfm
* per unit

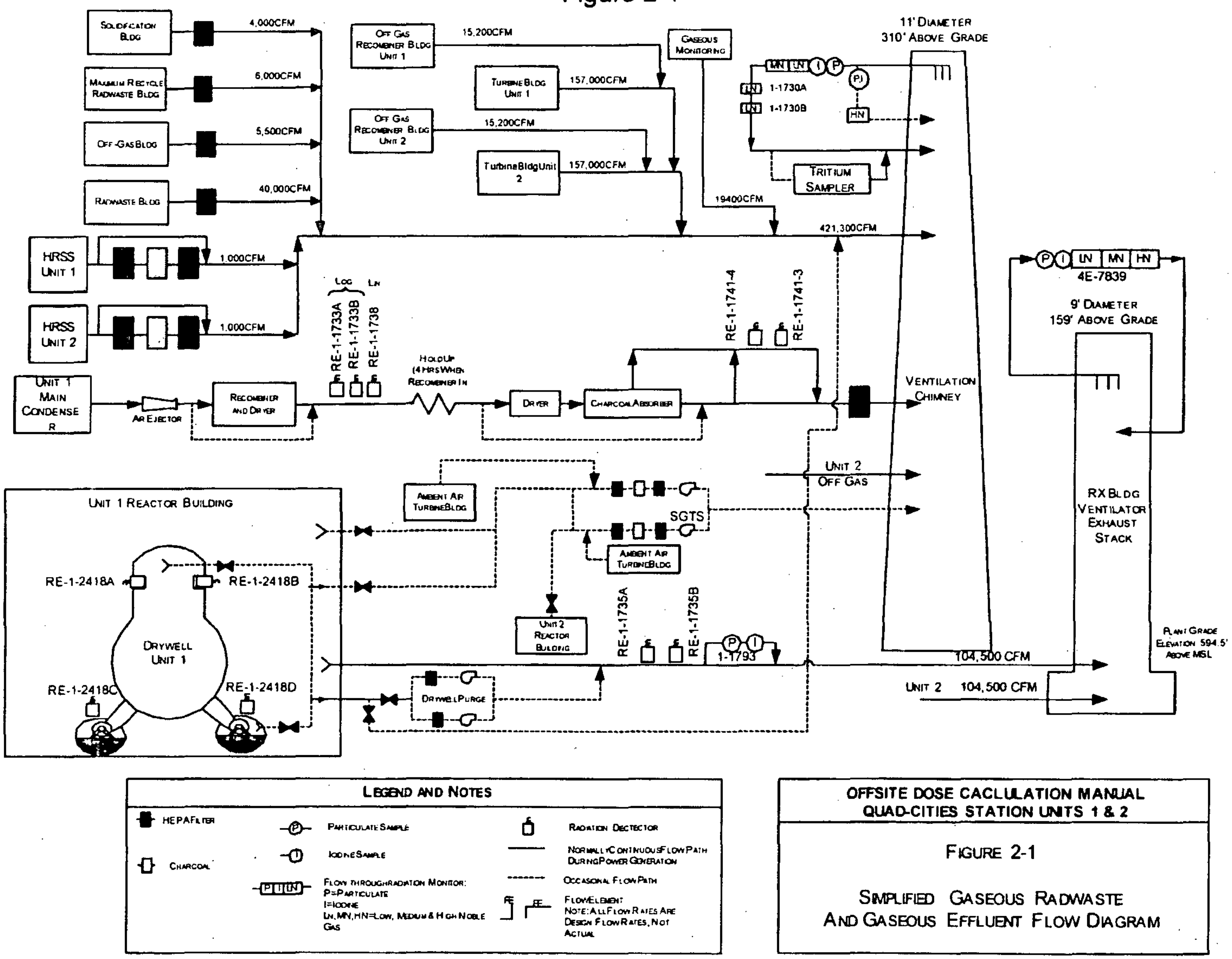
2.2.4 Allocation of Effluents from Common Release Points

Radioactive gaseous effluents released from the main chimney are comprised of contributions from both units. Under normal operating conditions, it is difficult to allocate the non-noble gaseous radioactivity between units due to fuel performance, in-plant leakage, power history, and other variables. Consequently, allocation is normally made evenly between the units. During extended unit shutdowns or periods of known differences, the apportionment is adjusted accordingly. The noble gaseous radioactivity is more easily allocated since the samples used for the calculations are unit specific. The allocation of effluents is estimated on a monthly basis.

2.2.5 Dose Projections

Because the gaseous releases are continuous, the doses are routinely calculated in accordance with the RECS.

Figure 2-1



OFFSITE DOSE CACLULATION MANUAL QUAD-CITIES STATION UNITS 1 & 2
FIGURE 2-1
SIMPLIFIED GASEOUS RADWASTE AND GASEOUS EFFLUENT FLOW DIAGRAM

Figure 2-2

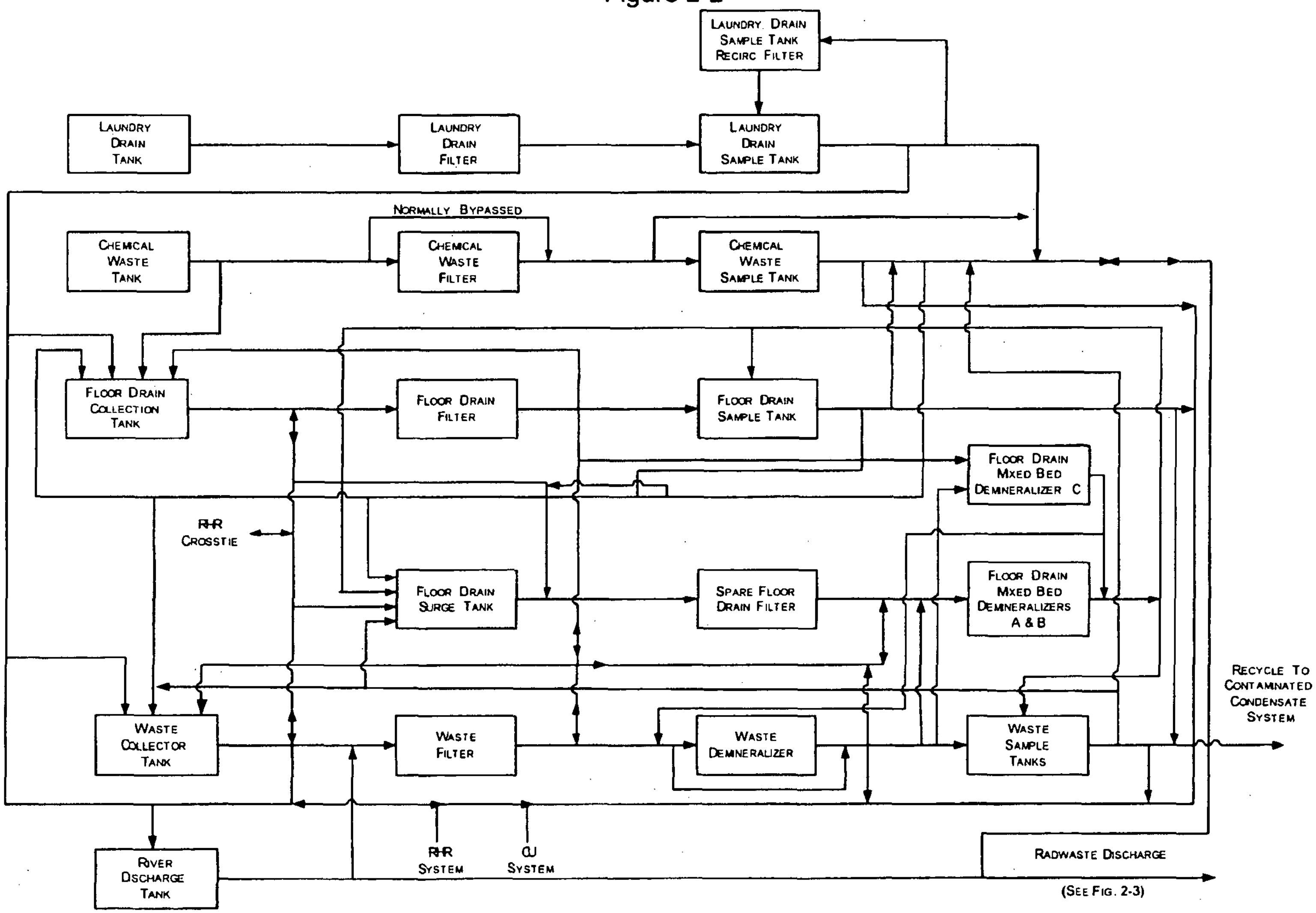


FIGURE 2-2
SIMPLIFIED LIQUID RADWASTE PROCESSING DIAGRAM

Figure 2-3

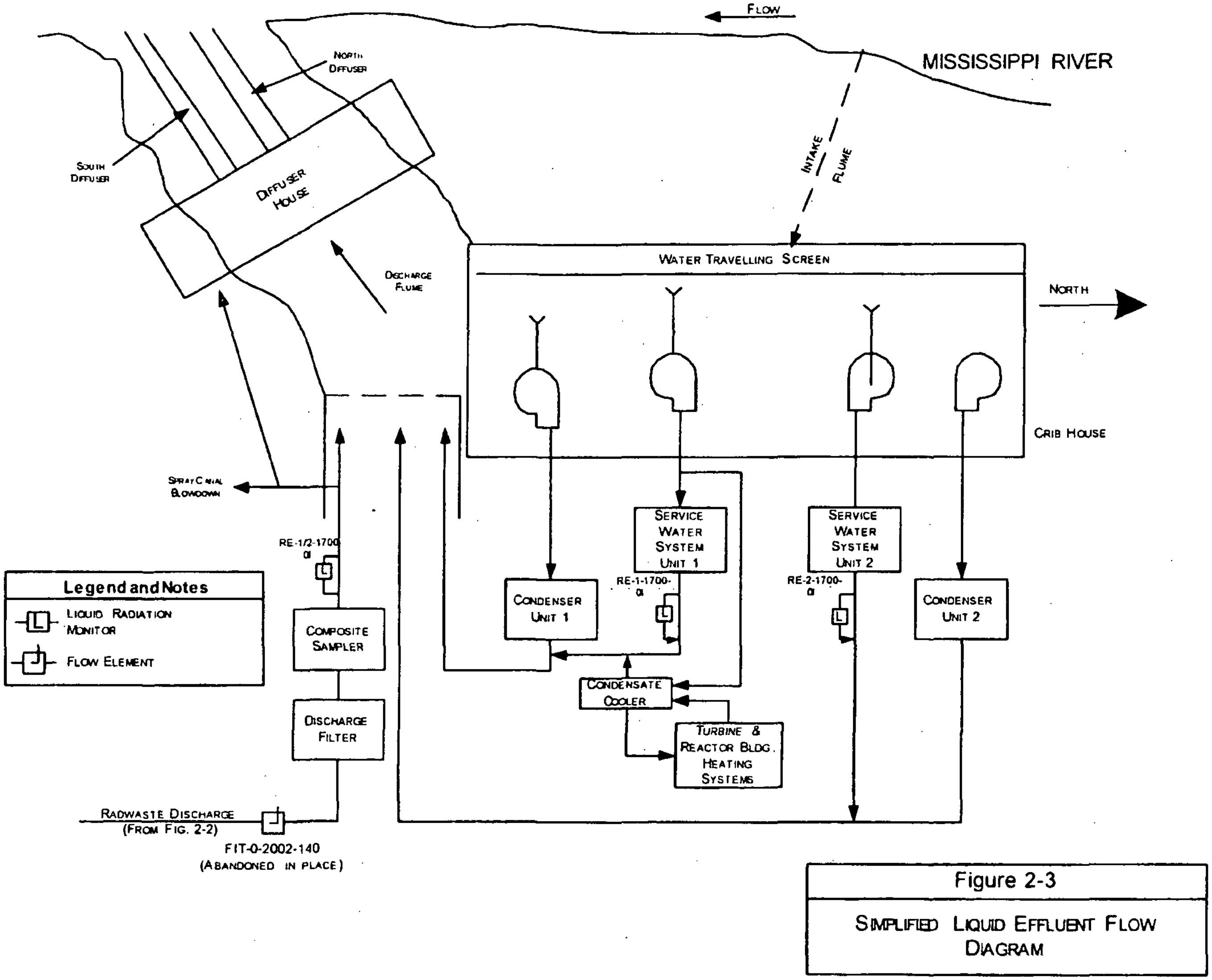


Figure 2-3

SIMPLIFIED LIQUID EFFLUENT FLOW DIAGRAM

Figure 2-4

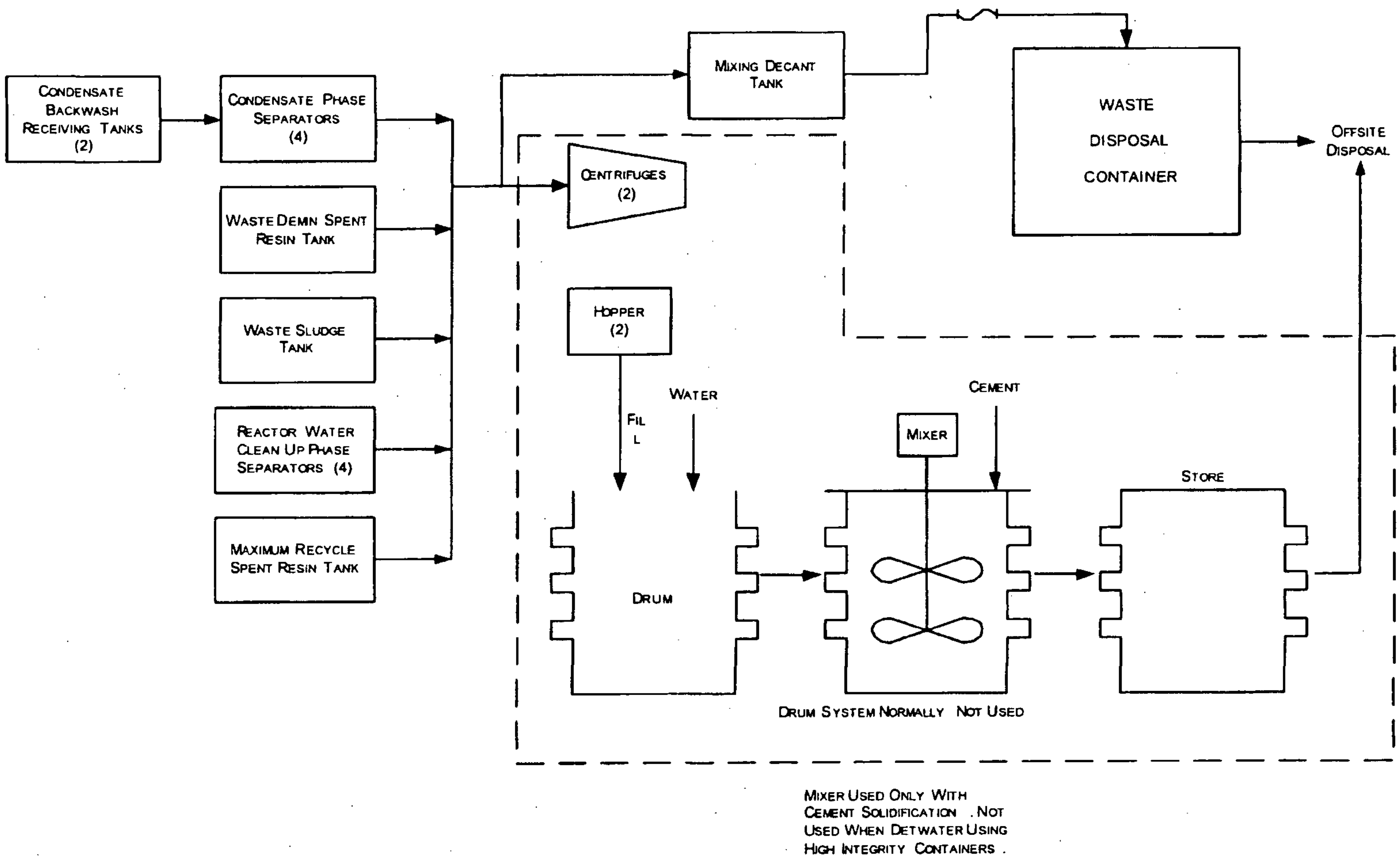


Figure 2-4
Simplified Solid Radwaste Processing Diagram

3.0 LIQUID EFFLUENTS

3.1 Liquid Effluent Releases – General Information

3.1.1 The design objectives of 10CFR50, Appendix I and RECS provide the following limits on the dose to a member of the public from radioactive materials in liquid effluents released from each reactor unit to RESTRICTED AREA boundaries:

- During any calendar quarter, less than or equal to 1.5 mrem to the total body and less than or equal to 5 mrem to any organ.

- During any calendar year, less than or equal to 3 mrem to the total body and less than or equal to 10 mrem to any organ.

3.1.2 The organ doses due to radioactivity in liquid effluents are also used as part of the 40CFR190 compliance and are included in the combination of doses to determine the total dose used to demonstrate 10CFR20 compliance. (See Section 5.0, TOTAL DOSE)

3.1.3 Dose assessments for 10CFR50 Appendix I compliance are made for four age groups (adult, teenager, child, infant) using NUREG 0133 (Reference 14) methodology and Regulatory Guide 1.109 (Reference 6) dose conversion factors.

3.1.4 To limit the consequences of tank overflow, the RECS/Technical Specifications may limit the quantity of radioactivity that may be stored in unprotected outdoor tanks. Unprotected tanks are tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system. The specific objective is to provide assurance that in the event of an uncontrolled release of a tank's contents, the resulting radioactivity concentrations beyond the UNRESTRICTED AREA boundary, at the nearest potable water supply and at the nearest surface water supply, will be less than the limits of 10CFR20 Appendix B, Table 2; Column 2.

The Technical Specifications and RECS may contain a somewhat similar provision. For most nuclear power stations, specific numerical limits are specified on the number of curies allowed in affected tanks.

3.1.5 Cases in which normally non-radioactive liquid streams (such as the Service Water) are found to contain radioactive material are non-routine will be treated on a case specific basis if and when this occurs. Since the station has sufficient capacity to delay a liquid release for reasonable periods of time, it is expected that planned releases will not take place under these circumstances. Therefore, the liquid release setpoint calculations need not and do not contain provisions for treating multiple simultaneous release pathways.

3.2 Liquid Effluent Concentrations

3.2.1 One method of demonstrating compliance to the requirements of 10CFR20.1301 is to demonstrate that the annual average concentrations of radioactive material released in gaseous and liquid effluents do not exceed the values specified in 10CFR20 Appendix B, Table 2, Column 2. (See 10CFR 20.1302(b)(2).) However, as noted in Section 5.6.1, this mode of 10CFR20.1301 compliance has not been elected.

As a means of assuring that annual concentration limits will not be exceeded, and as a matter of policy assuring that doses by the liquid pathway will be ALARA; RECS provides the following restriction:

> "The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS shall be limited to ten times the concentration values in Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402."

This also meets the requirement of Station Technical Specifications and RECS.

3.2.2 According to the footnotes to 10CFR20 Appendix B, Table 2, Column 2, if a radionuclide mix of known composition is released, the concentrations must be such that

$$\sum_i \left(\frac{C_i}{10\ ECL_i} \right) \leq 1 \qquad (3\text{-}1)$$

where the summation is over radionuclide i.

C_i Radioactivity Concentration in Liquid Effluents to the UNRESTRICTED AREA [µCi/ml]

Concentration of radionuclide i in liquid released to the UNRESTRICTED AREA.

ECL_i Effluent Concentration Limit in Liquid Effluents Released to the UNRESTRICTED AREA [µCi/ml]

The allowable annual average concentration of radionuclide "i" in liquid effluents released to the UNRESTRICTED AREA. This concentration is specified in 10CFR20 Appendix B, Table 2, Column 2. Concentrations for noble gases are different and are specified in the stations' Technical Specifications/RECS.

10 Multiplier to meet the requirements of Technical Specifications.

If either the identity or concentration of any radionuclide in the mixture is not known, special rules apply. These are given in the footnotes in 10CFR20 Appendix B, Table 2, Column 2.

3.2.3 When radioactivity is released to the UNRESTRICTED AREA with liquid discharge from a tank (e.g., a radwaste discharge tank), the concentration of a radionuclide in the effluent is calculated as follows:

$$C_i = C_i^t \frac{\text{Waste Flow}}{\text{Dilution Flow}} \tag{3-2}$$

C_i Concentration in Liquid effluent to the UNRESTRICTED AREA. [μCi/ml]

Concentration of radionuclide "i" in liquid released to the UNRESTRICTED AREA.

C_i^t Concentration in the Discharge Tank [μCi/ml]

Measured concentration of radionuclide i in the discharge tank.

Waste Flow Liquid Radioactive Waste Flow [gpm]

The average flow during disposal from the discharge structure release point into the receiving water body.

Dilution Flow Dilution Water Flow During Period of Interest [gpm]

The RECS and Technical Specifications require a specified sampling and analysis program to assure that liquid radioactivity concentrations at the point of release are maintained within the required limits. To comply with this provision, samples are analyzed in accordance with the radioactive liquid waste (or effluent) sampling and analysis program in ODCM Part I, Section 12.3.1. Radioactivity concentrations in tank effluents are determined in accordance with Equation 3-2. Comparison with the Effluent Concentration Limit is made using Equation 3-1.

3.3 Liquid Effluent Dose Calculation Requirements

3.3.1 RECS require determination of cumulative and PROJECTED DOSE contributions from liquid effluents for the current calendar quarter and the current calendar year at least once per 31 days. (See Section 12.3.2 of Part I, RECS.)

For a release attributable to a processing or effluent system shared by more than one reactor unit, the dose due to an individual unit is obtained by proportioning the effluents among the units sharing the system.

3.3.2 Operability and Use of the Liquid Radwaste Treatment System

The design objectives of 10CFR50, Appendix I and RECS/Technical Specifications require that the liquid radwaste treatment system be operable and that appropriate portions be used to reduce releases of radioactivity when PROJECTED DOSES due to the liquid effluent from each reactor unit to RESTRICTED AREA boundaries exceed either of the following (see Section 12.3.3 of Part I, RECS);

- 0.12 mrem to the total body in a 31-day period.
- 0.4 mrem to any organ in a 31-day period.

3.4 Dose Methodology

3.4.1 Liquid Effluent Dose Method: General

The dose from radioactive materials in liquid effluents considers the contributions for consumption of fish and potable water. All of these pathways are considered in the dose assessment unless demonstrated not to be present. While the adult is normally considered the maximum individual, the methodology provides for dose to be calculated for all four age groups. The dose to each organ (and to the total body) is calculated by the following expression:

$$\mathbf{D_{aj}^{Liq} = F\,\Delta t \sum_{p} \sum_{i} A_{aipj} C_i} \qquad (3\text{-}3)$$

The summation is over exposure pathways "**p**" and radionuclides "**i**".

$\mathbf{D_{aj}^{Liq}}$ Organ and Total Body Dose Due to Liquid Effluents [mrem]

Dose to organ "**j**" (including total body) of age group "**a**" due to radioactivity in liquid effluents.

F Near Field Average Dilution Factor [dimensionless]
Dilution in the near field averaged over the period of interest.

Defined as:

$$\mathbf{F = \frac{Waste\ Flow}{Dilution\ Flow \times Z}} \qquad (3\text{-}4)$$

Z Discharge Structure Mixing Factor [dimensionless]

Site-specific factor to account for the mixing effect of the discharge structure. The factor addresses the dilution that occurs in the near field between the discharge structure and the body of water containing the fish in the liquid ingestion pathway.

Δt Duration of Release [hrs]

C_i Average Radionuclide Concentration [µCi/ml]

Average concentration of radionuclide i, in the undiluted liquid effluent during time period Δt.

A_{aipj} Site-Specific Liquid Dose Factor [(mrem/hr)/(µCi/ml)]

Site-specific dose factor for age group "**a**", nuclide "**i**", liquid pathway "**p**" and organ "**j**". The pathways included are potable water and fish ingestion. A_{aipj} is defined for these pathways in the following sections.

All other terms have been previously defined.

3.4.2 Potable Water Pathway

The site-specific potable water pathway dose factor is calculated by the following expression:

$$A_{ai(PW)j} = k_o \left\{ \frac{U_a^w}{D^w} \right\} DFL_{aij} \quad (3\text{-}5)$$

Where:

$A_{ai(PW)j}$ Site-Specific Dose Factor for Potable Water Pathway [(mrem/hr)/(µCi/ml)]

Site-specific potable water ingestion dose actor for age group "**a**", nuclide "**i**" and organ "**j**".

k_o Conversion Constant (1.14E05) [(yr-pCi-ml)/(hr-µCi-l)]

Units constant to convert years to hours, pCi to µCi and liters to ml.

U_a^w Potable Water Consumption Rate [l/yr]

Potable water consumption rate for age group "**a**". Taken from Table E-5 of Regulatory Guide 1.109.

D^w Potable Water Dilution Factor [dimensionless]

Dilution factor from the near field area within one-quarter mile of the release point to the potable water intake.

DFL_{aij} Ingestion Dose Conversion Factor [mrem/pCi]

Ingestion dose conversion factor for age group "**a**", nuclide "**i**" and organ "**j**". Converts pCi ingested to mrem. Taken from Tables E-11 though E-14 of Regulatory Guide 1.109. The value for H-3 and Sr-90 are taken from NUREG 4013 (Reference 107).

3.4.3 Fish Ingestion Pathway

The site-specific fish ingestion pathway dose factor is calculated by the following expression:

$$A_{ai(Fish)j} = k_o U_a^F BF_i DFL_{aij} \tag{3-6}$$

Where:

$A_{ai(Fish)j}$ Site-Specific Dose Factor for Potable Water Pathway [(mrem/hr)/(μCi/ml)]

Site-specific fish ingestion dose factor for age group "**a**", nuclide "**i**" and organ "**j**".

U_a^F Fish Consumption Rate [kg/yr]

Fish consumption rate for age group "**a**". Taken from Table E-5 of Regulatory Guide 1.109.

BF_i Bioaccumulation Factor [(pCi/kg)/(pCi/l)]

Bioaccumulation factor for nuclide "i" in fresh water fish. Taken from Table 3-1.

All other terms have been previously defined.

3.4.4 Offsite Doses

Offsite doses due to projected releases of radioactive materials in liquid effluents are calculated using Equation 3-3. Projected radionuclide release concentrations are used in place of measured concentrations, C_i.

3.4.5 Drinking Water

Quad Cities has requirements for calculation of drinking water dose that are related to 40CFR141, the Environmental Protection Agency National Primary Drinking Water Regulations. These are discussed in Section 1.2.1. Table 3-2 provides specific information on the closest down stream COMMUNITY WATER SYSTEM.

Table 3-1 (Page 1 of 3) Bioaccumulation Factors (BF_i) to be Used in the Absence of Site-Specific Data		
Element	BF_i for Freshwater Fish (pCi/kg per pCi/L)	Reference
H	9.0E-01	6
Be	2.8E+01	Footnote 2
C	4.6E+03	6
F	2.2E+02	Footnote 16
Na	1.0E+02	6
Mg	2.8E+01	Footnote 2
Al	2.2E+03	Footnote 13
P	1.0E+05	6
Cl	2.2E+02	Footnote 16
Ar	NA	NA
K	1.0E+03	Footnote 1
Ca	2.8E+01	Footnote 2
Sc	2.5E+01	Footnote 3
Ti	3.3E+00	Footnote 4
V	3.0E+04	Footnote 5
Cr	2.0E+02	6
Mn	4.0E+02	6
Fe	1.0E+02	6
Co	5.0E+01	6
Ni	1.0E+02	6
Cu	5.0E+01	6
Zn	2.0E+03	6
Ga	2.2E+03	Footnote 13
Ge	2.4E+03	Footnote 12
As	3.3E+04	Footnote 14
Se	4.0E+02	Footnote 15
Br	4.2E+02	6
Kr	NA	NA
Rb	2.0E+03	6
Sr	3.0E+01	6
Y	2.5E+01	6
Zr	3.3E+00	6
Nb	3.0E+04	6
Mo	1.0E+01	6
Tc	1.5E+01	6
Ru	1.0E+01	6
Rh	1.0E+01	6
Pd	1.0E+02	Footnote 9

Table 3-1 (Page 2 of 3)
Bioaccumulation Factors (BF_i) to be Used in the Absence of Site-Specific Data

Cd	2.0E+03	Footnote 11
In	2.2E+03	Footnote 13
Sn	2.4E+03	Footnote 12
Sb	1.0E+00	98
Ag	2.3E+00	56
Te	4.0E+02	6
I	1.5E+01	6
Xe	NA	NA
Cs	2.0E+03	6
Ba	4.0E+00	6
La	2.5E+01	6
Ce	1.0E+00	6
Pr	2.5E+01	6
Nd	2.5E+01	6
Pm	3.0E+01	98
Sm	3.0E+01	Footnote 3
Eu	1.0E+02	Footnote 3
Gd	2.6E+01	Footnote 3
Dy	2.2E+03	Footnote 3
Er	3.3E+04	Footnote 3
Tm	4.0E+02	Footnote 3
Yb	2.2E+02	Footnote 3
Lu	2.5E+01	Footnote 3
Hf	3.3E+00	Footnote 4
Ta	3.0E+04	Footnote 5
W	1.2E+03	6
Re	2.1E+02	Footnote 6
Os	5.5E+01	Footnote 7
Ir	3.0E+01	Footnote 8
Pt	1.0E+02	Footnote 9
Au	2.6E+01	Footnote 10
Hg	2.0E+03	Footnote 11
Tl	2.2E+03	Footnote 13
Pb	3.0E+02	98
Bi	2.0E+01	98
Ra	5.0E+01	98
Th	3.0E+01	98
U	1.0E+01	98
Np	1.0E+01	6
Am	3.0E+01	98

Table 3-1 (Page 3 of 3)
Bioaccumulation Factors (BF_i) to be Used in the Absence of Site-Specific Data

Footnotes:
NA = It is assumed that noble gases are not accumulated.

In Reference 6, see Table A-1.

A number of bioaccumulation factors could not be found in literature. In this case, the periodic table was used in conjunction with published element values. This method was used for periodic table columns except where there were no values for column 3A so the average of columns 2B and 4A was assigned.

1. Value is the average of Reference 6 values in literature for H, Na, Rb and Cs.
2. Value is the average of Ref. 6 values in literature for Sr, Ba and Ref. 98 values for Ra.
3. Value is the same as the Reference 6 value used for Y.
4. Value is the same as the Reference 6 value used for Zr.
5. Value is the same as the Reference 6 value used for Nb.
6. Value is the average of Reference 6 values in literature for Mn and Tc.
7. Value is the average of Reference 6 values in literature for Fe and Ru.
8. Value is the average of Reference 6 values in literature for Co and Rh.
9. Value is the same as the Reference 6 value used for Ni.
10. Value is the average of Reference 6 values in literature for Cu and Reference 56 value for Ag.
11. Value used is the same as the Reference 6 value used for Zn.
12. Value is the average of Reference 6 value in literature for C and Reference 98 value for Pb.
13. Value is the average of columns 2B and 4A, where column 2B is the "Reference 6 value for Zn" and column 4A is the average of "Reference 6 value for C and Reference 98 value for Pb".
14. Value is the average of Ref. 6 value found in literature for P and the Ref. 98 values for Bi and Sb.
15. Value is the same as the Reference 6 value used for Te.
16. Value is the average of Reference 6 values found in literature for Br and I.

Table 3-2
Nearest Downstream COMMUNITY WATER SYSTEM

Station	Exelon Nuclear facilities upstream of Quad Cities	Location and distance of closest COMMUNITY WATER SYSTEM (a)	Other Exelon Nuclear Stations upstream of water supply
Quad Cities	None	East Moline 16 river miles	None

(a) ODCM Bases and Table 0-2 and 0-6 of Reference 101 provide the bases of the location and distance data.

Table 3-3

Aquatic Environmental Dose Parameters

General Information[a]
Existence of irrigation not mentioned in Quad Cities Final Safety Analysis Report (FSAR), UFSAR, or Plant Design Analysis
Recreation includes one or more of the following: boating, water skiing, swimming, and sport fishing.
The station liquid discharge flows into the Mississippi River. Mississippi River Lock and Dam Number 14 is located between the station discharge and the E. Moline intake (see Figure 12 of the Quad Cities Unit 1 Plant Design Analysis, Volume II, and Figure 2.4.1 of the Quad Cities Safety Analysis Report.)
Water and Fish Ingestion Parameters

Parameter[b]	Value
D^w	10
Z	16

Limits on Radioactivity in Unprotected Outdoor Tanks [c]
Outside Storage Tank $\leq$ 10 Ci per Tank [d]
Per Technical Specification 5.5.8.b

[a] Quad Cities Updated Final Safety Analysis Report (USFAR) updated through Amendment 5. (9-3-87) Section 1.5.2 and Quad Cities Plant Design Analysis, Section 4.4
[b] The parameters are defined in ODCM Part II Section 3.1
[c] Refer to ODCM Part II Section 3.1
[d] Tritium and dissolved or entrained noble gasses are excluded from this limit.

Table 3-4 (Page 1 of 8)

Site Specific Potable Water Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	4.98E-01	4.98E-01	4.98E-01	4.98E-01	4.98E-01	4.98E-01
Na-24	1.41E+01	1.41E+01	1.41E+01	1.41E+01	1.41E+01	1.41E+01	1.41E+01
Cr-51	0.00E+00	0.00E+00	2.21E-02	1.32E-02	4.88E-03	2.94E-02	5.57E+00
Mn-54	0.00E+00	3.80E+01	7.26E+00	0.00E+00	1.13E+01	0.00E+00	1.17E+02
Mn-56	0.00E+00	9.57E-01	1.70E-01	0.00E+00	1.22E+00	0.00E+00	3.05E+01
Fe-55	2.29E+01	1.58E+01	3.69E+00	0.00E+00	0.00E+00	8.82E+00	9.07E+00
Fe-59	3.61E+01	8.49E+01	3.25E+01	0.00E+00	0.00E+00	2.37E+01	2.83E+02
Co-58	0.00E+00	6.20E+00	1.39E+01	0.00E+00	0.00E+00	0.00E+00	1.26E+02
Co-60	0.00E+00	1.78E+01	3.93E+01	0.00E+00	0.00E+00	0.00E+00	3.35E+02
Ni-63	1.08E+03	7.50E+01	3.63E+01	0.00E+00	0.00E+00	0.00E+00	1.56E+01
Ni-65	4.39E+00	5.71E-01	2.60E-01	0.00E+00	0.00E+00	0.00E+00	1.45E+01
Cu-64	0.00E+00	6.93E-01	3.25E-01	0.00E+00	1.75E+00	0.00E+00	5.91E+01
Zn-65	4.03E+01	1.28E+02	5.79E+01	0.00E+00	8.57E+01	0.00E+00	8.07E+01
Zn-69	8.57E-02	1.64E-01	1.14E-02	0.00E+00	1.07E-01	0.00E+00	2.46E-02
Br-83	0.00E+00	0.00E+00	3.35E-01	0.00E+00	0.00E+00	0.00E+00	4.82E-01
Br-84	0.00E+00	0.00E+00	4.34E-01	0.00E+00	0.00E+00	0.00E+00	3.40E-06
Br-85	0.00E+00	0.00E+00	1.78E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.76E+02	8.18E+01	0.00E+00	0.00E+00	0.00E+00	3.46E+01
Rb-88	0.00E+00	5.03E-01	2.67E-01	0.00E+00	0.00E+00	0.00E+00	6.96E-12
Rb-89	0.00E+00	3.34E-01	2.35E-01	0.00E+00	0.00E+00	0.00E+00	1.94E-14
Sr-89	2.56E+03	0.00E+00	7.36E+01	0.00E+00	0.00E+00	0.00E+00	4.11E+02
Sr-90	7.25E+04	0.00E+00	1.46E+03	0.00E+00	0.00E+00	0.00E+00	1.82E+03
Sr-91	4.72E+01	0.00E+00	1.91E+00	0.00E+00	0.00E+00	0.00E+00	2.25E+02
Sr-92	1.79E+01	0.00E+00	7.74E-01	0.00E+00	0.00E+00	0.00E+00	3.55E+02
Y-90	8.01E-02	0.00E+00	2.15E-03	0.00E+00	0.00E+00	0.00E+00	8.49E+02
Y-91M	7.56E-04	0.00E+00	2.93E-05	0.00E+00	0.00E+00	0.00E+00	2.22E-03
Y-91	1.17E+00	0.00E+00	3.14E-02	0.00E+00	0.00E+00	0.00E+00	6.46E+02
Y-92	7.03E-03	0.00E+00	2.06E-04	0.00E+00	0.00E+00	0.00E+00	1.23E+02
Y-93	2.23E-02	0.00E+00	6.16E-04	0.00E+00	0.00E+00	0.00E+00	7.07E+02
Zr-95	2.53E-01	8.11E-02	5.49E-02	0.00E+00	1.27E-01	0.00E+00	2.57E+02
Zr-97	1.40E-02	2.82E-03	1.29E-03	0.00E+00	4.26E-03	0.00E+00	8.74E+02
Nb-95	5.18E-02	2.88E-02	1.55E-02	0.00E+00	2.85E-02	0.00E+00	1.75E+02
Mo-99	0.00E+00	3.59E+01	6.82E+00	0.00E+00	8.12E+01	0.00E+00	8.31E+01
Tc- 99M	2.06E-03	5.81E-03	7.40E-02	0.00E+00	8.82E-02	2.85E-03	3.44E+00
Tc-101	2.11E-03	3.05E-03	2.99E-02	0.00E+00	5.48E-02	1.56E-03	9.15E-15
Ru-103	1.54E+00	0.00E+00	6.63E-01	0.00E+00	5.88E+00	0.00E+00	1.80E+02
Ru-105	1.28E-01	0.00E+00	5.06E-02	0.00E+00	1.66E+00	0.00E+00	7.84E+01
Ru-106	2.29E+01	0.00E+00	2.90E+00	0.00E+00	4.42E+01	0.00E+00	1.48E+03
Ag-110M	1.33E+00	1.23E+00	7.32E-01	0.00E+00	2.42E+00	0.00E+00	5.03E+02
Te-125M	2.23E+01	8.08E+00	2.99E+00	6.71E+00	9.07E+01	0.00E+00	8.90E+01

Table 3-4 (Page 2 of 8)

Site Specific Potable Water Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	5.63E+01	2.01E+01	6.87E+00	1.44E+01	2.29E+02	0.00E+00	1.89E+02
Te-127	9.15E-01	3.29E-01	1.98E-01	6.78E-01	3.73E+00	0.00E+00	7.22E+01
Te-129M	9.57E+01	3.57E+01	1.51E+01	3.29E+01	3.99E+02	0.00E+00	4.82E+02
Te-129	2.61E-01	9.82E-02	6.37E-02	2.01E-01	1.10E+00	0.00E+00	1.97E-01
Te-131M	1.44E+01	7.04E+00	5.87E+00	1.12E+01	7.13E+01	0.00E+00	6.99E+02
Te-131	1.64E-01	6.85E-02	5.18E-02	1.35E-01	7.18E-01	0.00E+00	2.32E-02
Te-132	2.10E+01	1.36E+01	1.27E+01	1.50E+01	1.31E+02	0.00E+00	6.42E+02
I-130	6.29E+00	1.86E+01	7.32E+00	1.57E+03	2.90E+01	0.00E+00	1.60E+01
I-131	3.46E+01	4.95E+01	2.84E+01	1.62E+04	8.49E+01	0.00E+00	1.31E+01
I-132	1.69E+00	4.52E+00	1.58E+00	1.58E+02	7.20E+00	0.00E+00	8.49E-01
I-133	1.18E+01	2.06E+01	6.27E+00	3.02E+03	3.59E+01	0.00E+00	1.85E+01
I-134	8.82E-01	2.40E+00	8.57E-01	4.15E+01	3.81E+00	0.00E+00	2.09E-03
I-135	3.69E+00	9.65E+00	3.56E+00	6.37E+02	1.55E+01	0.00E+00	1.09E+01
Cs-134	5.18E+02	1.23E+03	1.01E+03	0.00E+00	3.99E+02	1.32E+02	2.16E+01
Cs-136	5.42E+01	2.14E+02	1.54E+02	0.00E+00	1.19E+02	1.63E+01	2.43E+01
Cs-137	6.63E+02	9.07E+02	5.94E+02	0.00E+00	3.08E+02	1.02E+02	1.76E+01
Cs-138	4.59E-01	9.07E-01	4.49E-01	0.00E+00	6.67E-01	6.58E-02	3.87E-06
Ba-139	8.07E-01	5.75E-04	2.36E-02	0.00E+00	5.38E-04	3.26E-04	1.43E+00
Ba-140	1.69E+02	2.12E-01	1.11E+01	0.00E+00	7.22E-02	1.22E-01	3.48E+02
Ba-141	3.92E-01	2.96E-04	1.32E-02	0.00E+00	2.75E-04	1.68E-04	1.85E-10
Ba-142	1.77E-01	1.82E-04	1.12E-02	0.00E+00	1.54E-04	1.03E-04	2.50E-19
La-140	2.08E-02	1.05E-02	2.77E-03	0.00E+00	0.00E+00	0.00E+00	7.70E+02
La-142	1.07E-03	4.84E-04	1.21E-04	0.00E+00	0.00E+00	0.00E+00	3.54E+00
Ce-141	7.79E-02	5.27E-02	5.98E-03	0.00E+00	2.45E-02	0.00E+00	2.01E+02
Ce-143	1.37E-02	1.02E+01	1.12E-03	0.00E+00	4.47E-03	0.00E+00	3.79E+02
Ce-144	4.06E+00	1.70E+00	2.18E-01	0.00E+00	1.01E+00	0.00E+00	1.37E+03
Pr-143	7.66E-02	3.07E-02	3.79E-03	0.00E+00	1.77E-02	0.00E+00	3.35E+02
Pr-144	2.50E-04	1.04E-04	1.27E-05	0.00E+00	5.87E-05	0.00E+00	3.60E-11
Nd-147	5.23E-02	6.05E-02	3.62E-03	0.00E+00	3.54E-02	0.00E+00	2.90E+02
W-187	8.57E-01	7.17E-01	2.50E-01	0.00E+00	0.00E+00	0.00E+00	2.35E+02
Np-239	9.90E-03	9.74E-04	5.37E-04	0.00E+00	3.04E-03	0.00E+00	2.00E+02

Notes:

1) Units are mrem/hr per μCi/ml.

Table 3-4 (Page 3 of 8)

Site Specific Potable Water Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	3.51E-01	3.51E-01	3.51E-01	3.51E-01	3.51E-01	3.51E-01
Na-24	1.34E+01	1.34E+01	1.34E+01	1.34E+01	1.34E+01	1.34E+01	1.34E+01
Cr-51	0.00E+00	0.00E+00	2.09E-02	1.16E-02	4.59E-03	2.99E-02	3.52E+00
Mn-54	0.00E+00	3.43E+01	6.80E+00	0.00E+00	1.02E+01	0.00E+00	7.03E+01
Mn-56	0.00E+00	9.19E-01	1.63E-01	0.00E+00	1.16E+00	0.00E+00	6.05E+01
Fe-55	2.20E+01	1.56E+01	3.63E+00	0.00E+00	0.00E+00	9.88E+00	6.74E+00
Fe-59	3.41E+01	7.97E+01	3.08E+01	0.00E+00	0.00E+00	2.51E+01	1.88E+02
Co-58	0.00E+00	5.65E+00	1.30E+01	0.00E+00	0.00E+00	0.00E+00	7.79E+01
Co-60	0.00E+00	1.63E+01	3.68E+01	0.00E+00	0.00E+00	0.00E+00	2.13E+02
Ni-63	1.03E+03	7.27E+01	3.49E+01	0.00E+00	0.00E+00	0.00E+00	1.16E+01
Ni-65	4.35E+00	5.56E-01	2.53E-01	0.00E+00	0.00E+00	0.00E+00	3.02E+01
Cu-64	0.00E+00	6.69E-01	3.15E-01	0.00E+00	1.69E+00	0.00E+00	5.19E+01
Zn-65	3.35E+01	1.16E+02	5.42E+01	0.00E+00	7.44E+01	0.00E+00	4.92E+01
Zn-69	8.55E-02	1.63E-01	1.14E-02	0.00E+00	1.06E-01	0.00E+00	3.00E-01
Br-83	0.00E+00	0.00E+00	3.34E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.77E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.73E+02	8.14E+01	0.00E+00	0.00E+00	0.00E+00	2.56E+01
Rb-88	0.00E+00	4.95E-01	2.64E-01	0.00E+00	0.00E+00	0.00E+00	4.24E-08
Rb-89	0.00E+00	3.20E-01	2.26E-01	0.00E+00	0.00E+00	0.00E+00	4.90E-10
Sr-89	2.56E+03	0.00E+00	7.33E+01	0.00E+00	0.00E+00	0.00E+00	3.05E+02
Sr-90	5.93E+04	0.00E+00	1.19E+03	0.00E+00	0.00E+00	0.00E+00	1.35E+03
Sr-91	4.69E+01	0.00E+00	1.87E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+02
Sr-92	1.77E+01	0.00E+00	7.56E-01	0.00E+00	0.00E+00	0.00E+00	4.52E+02
Y-90	7.97E-02	0.00E+00	2.15E-03	0.00E+00	0.00E+00	0.00E+00	6.57E+02
Y-91M	7.50E-04	0.00E+00	2.87E-05	0.00E+00	0.00E+00	0.00E+00	3.54E-02
Y-91	1.17E+00	0.00E+00	3.13E-02	0.00E+00	0.00E+00	0.00E+00	4.79E+02
Y-92	7.03E-03	0.00E+00	2.03E-04	0.00E+00	0.00E+00	0.00E+00	1.93E+02
Y-93	2.23E-02	0.00E+00	6.10E-04	0.00E+00	0.00E+00	0.00E+00	6.80E+02
Zr-95	2.40E-01	7.56E-02	5.20E-02	0.00E+00	1.11E-01	0.00E+00	1.74E+02
Zr-97	1.38E-02	2.73E-03	1.26E-03	0.00E+00	4.13E-03	0.00E+00	7.38E+02
Nb-95	4.78E-02	2.65E-02	1.46E-02	0.00E+00	2.57E-02	0.00E+00	1.13E+02
Mo-99	0.00E+00	3.51E+01	6.69E+00	0.00E+00	8.02E+01	0.00E+00	6.28E+01
Tc- 99M	1.93E-03	5.38E-03	6.98E-02	0.00E+00	8.02E-02	2.99E-03	3.53E+00
Tc-101	2.09E-03	2.98E-03	2.92E-02	0.00E+00	5.38E-02	1.81E-03	5.09E-10
Ru-103	1.48E+00	0.00E+00	6.34E-01	0.00E+00	5.23E+00	0.00E+00	1.24E+02
Ru-105	1.27E-01	0.00E+00	4.92E-02	0.00E+00	1.60E+00	0.00E+00	1.02E+02
Ru-106	2.28E+01	0.00E+00	2.87E+00	0.00E+00	4.40E+01	0.00E+00	1.09E+03
Ag-110M	1.19E+00	1.13E+00	6.86E-01	0.00E+00	2.15E+00	0.00E+00	3.17E+02
Te-125M	2.23E+01	8.02E+00	2.98E+00	6.22E+00	0.00E+00	0.00E+00	6.57E+01

Table 3-4 (Page 4 of 8)

Site Specific Potable Water Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	5.62E+01	1.99E+01	6.69E+00	1.34E+01	2.28E+02	0.00E+00	1.40E+02
Te-127	9.19E-01	3.26E-01	1.98E-01	6.34E-01	3.72E+00	0.00E+00	7.09E+01
Te-129M	9.48E+01	3.52E+01	1.50E+01	3.06E+01	3.97E+02	0.00E+00	3.56E+02
Te-129	2.60E-01	9.71E-02	6.34E-02	1.86E-01	1.09E+00	0.00E+00	1.42E+00
Te-131M	1.42E+01	6.80E+00	5.67E+00	1.02E+01	7.09E+01	0.00E+00	5.46E+02
Te-131	1.62E-01	6.69E-02	5.07E-02	1.25E-01	7.09E-01	0.00E+00	1.33E-02
Te-132	2.03E+01	1.28E+01	1.21E+01	1.35E+01	1.23E+02	0.00E+00	4.07E+02
I-130	5.99E+00	1.73E+01	6.92E+00	1.41E+03	2.67E+01	0.00E+00	1.33E+01
I-131	3.40E+01	4.76E+01	2.56E+01	1.39E+04	8.20E+01	0.00E+00	9.42E+00
I-132	1.62E+00	4.24E+00	1.52E+00	1.43E+02	6.69E+00	0.00E+00	1.85E+00
I-133	1.17E+01	1.98E+01	6.05E+00	2.77E+03	3.48E+01	0.00E+00	1.50E+01
I-134	8.49E-01	2.25E+00	8.08E-01	3.75E+01	3.55E+00	0.00E+00	2.97E-02
I-135	3.55E+00	9.13E+00	3.38E+00	5.87E+02	1.44E+01	0.00E+00	1.01E+01
Cs-134	4.87E+02	1.15E+03	5.31E+02	0.00E+00	3.64E+02	1.39E+02	1.42E+01
Cs-136	4.99E+01	1.97E+02	1.32E+02	0.00E+00	1.07E+02	1.69E+01	1.58E+01
Cs-137	6.51E+02	8.66E+02	3.02E+02	0.00E+00	2.95E+02	1.15E+02	1.23E+01
Cs-138	4.51E-01	8.66E-01	4.33E-01	0.00E+00	6.40E-01	7.44E-02	3.93E-04
Ba-139	8.08E-01	5.69E-04	2.35E-02	0.00E+00	5.36E-04	3.92E-04	7.21E+00
Ba-140	1.65E+02	2.02E-01	1.06E+01	0.00E+00	6.86E-02	1.36E-01	2.55E+02
Ba-141	3.90E-01	2.91E-04	1.30E-02	0.00E+00	2.70E-04	1.99E-04	8.31E-07
Ba-142	1.74E-01	1.74E-04	1.07E-02	0.00E+00	1.47E-04	1.16E-04	5.34E-13
La-140	2.02E-02	9.94E-03	2.65E-03	0.00E+00	0.00E+00	0.00E+00	5.71E+02
La-142	1.04E-03	4.62E-04	1.15E-04	0.00E+00	0.00E+00	0.00E+00	1.41E+01
Ce-141	7.73E-02	5.16E-02	5.93E-03	0.00E+00	2.43E-02	0.00E+00	1.48E+02
Ce-143	1.37E-02	9.94E+00	1.11E-03	0.00E+00	4.46E-03	0.00E+00	2.99E+02
Ce-144	4.05E+00	1.67E+00	2.17E-01	0.00E+00	1.00E+00	0.00E+00	1.02E+03
Pr-143	7.62E-02	3.04E-02	3.79E-03	0.00E+00	1.77E-02	0.00E+00	2.51E+02
Pr-144	2.50E-04	1.02E-04	1.27E-05	0.00E+00	5.87E-05	0.00E+00	2.76E-07
Nd-147	5.45E-02	5.93E-02	3.55E-03	0.00E+00	3.48E-02	0.00E+00	2.14E+02
W-187	8.49E-01	6.92E-01	2.42E-01	0.00E+00	0.00E+00	0.00E+00	1.87E+02
Np-239	1.02E-02	9.65E-04	5.36E-04	0.00E+00	3.03E-03	0.00E+00	1.55E+02

Notes:

1) Units are mrem/hr per µCi/ml.

Table 3-4 (Page 5 of 8)

Site Specific Potable Water Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	6.74E-01	6.74E-01	6.74E-01	6.74E-01	6.74E-01	6.74E-01
Na-24	3.37E+01	3.37E+01	3.37E+01	3.37E+01	3.37E+01	3.37E+01	3.37E+01
Cr-51	0.00E+00	0.00E+00	5.17E-02	2.87E-02	7.85E-03	5.24E-02	2.74E+00
Mn-54	0.00E+00	6.22E+01	1.66E+01	0.00E+00	1.74E+01	0.00E+00	5.22E+01
Mn-56	0.00E+00	1.94E+00	4.38E-01	0.00E+00	2.35E+00	0.00E+00	2.81E+02
Fe-55	6.69E+01	3.55E+01	1.10E+01	0.00E+00	0.00E+00	2.01E+01	6.57E+00
Fe-59	9.59E+01	1.55E+02	7.73E+01	0.00E+00	0.00E+00	4.50E+01	1.62E+02
Co-58	0.00E+00	1.05E+01	3.20E+01	0.00E+00	0.00E+00	0.00E+00	6.10E+01
Co-60	0.00E+00	3.08E+01	9.07E+01	0.00E+00	0.00E+00	0.00E+00	1.70E+02
Ni-63	3.13E+03	1.67E+02	1.06E+02	0.00E+00	0.00E+00	0.00E+00	1.13E+01
Ni-65	1.29E+01	1.22E+00	7.09E-01	0.00E+00	0.00E+00	0.00E+00	1.49E+02
Cu-64	0.00E+00	1.42E+00	8.60E-01	0.00E+00	3.44E+00	0.00E+00	6.69E+01
Zn-65	7.97E+01	2.12E+02	1.32E+02	0.00E+00	1.34E+02	0.00E+00	3.73E+01
Zn-69	2.55E-01	3.68E-01	3.40E-02	0.00E+00	2.23E-01	0.00E+00	2.32E+01
Br-83	0.00E+00	0.00E+00	9.94E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.15E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	5.30E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	3.90E+02	2.40E+02	0.00E+00	0.00E+00	0.00E+00	2.51E+01
Rb-88	0.00E+00	1.10E+00	7.67E-01	0.00E+00	0.00E+00	0.00E+00	5.42E-02
Rb-89	0.00E+00	6.80E-01	6.05E-01	0.00E+00	0.00E+00	0.00E+00	5.93E-03
Sr-89	7.67E+03	0.00E+00	2.19E+02	0.00E+00	0.00E+00	0.00E+00	2.97E+02
Sr-90	1.49E+05	0.00E+00	2.99E+03	0.00E+00	0.00E+00	0.00E+00	1.33E+03
Sr-91	1.40E+02	0.00E+00	5.27E+00	0.00E+00	0.00E+00	0.00E+00	3.08E+02
Sr-92	5.25E+01	0.00E+00	2.10E+00	0.00E+00	0.00E+00	0.00E+00	9.94E+02
Y-90	2.39E-01	0.00E+00	6.40E-03	0.00E+00	0.00E+00	0.00E+00	6.80E+02
Y-91M	2.22E-03	0.00E+00	8.08E-05	0.00E+00	0.00E+00	0.00E+00	4.35E+00
Y-91	3.50E+00	0.00E+00	9.36E-02	0.00E+00	0.00E+00	0.00E+00	4.66E+02
Y-92	2.09E-02	0.00E+00	5.99E-04	0.00E+00	0.00E+00	0.00E+00	6.05E+02
Y-93	6.63E-02	0.00E+00	1.82E-03	0.00E+00	0.00E+00	0.00E+00	9.88E+02
Zr-95	6.74E-01	1.48E-01	1.32E-01	0.00E+00	2.12E-01	0.00E+00	1.55E+02
Zr-97	4.06E-02	5.87E-03	3.47E-03	0.00E+00	8.43E-03	0.00E+00	8.90E+02
Nb-95	1.31E-01	5.09E-02	3.64E-02	0.00E+00	4.78E-02	0.00E+00	9.42E+01
Mo-99	0.00E+00	7.73E+01	1.91E+01	0.00E+00	1.65E+02	0.00E+00	6.40E+01
Tc- 99M	5.37E-03	1.05E-02	1.74E-01	0.00E+00	1.53E-01	5.34E-03	5.99E+00
Tc-101	6.22E-03	6.51E-03	8.26E-02	0.00E+00	1.11E-01	3.44E-03	2.07E-02
Ru-103	4.25E+00	0.00E+00	1.63E+00	0.00E+00	1.07E+01	0.00E+00	1.10E+02
Ru-105	3.75E-01	0.00E+00	1.36E-01	0.00E+00	3.30E+00	0.00E+00	2.45E+02
Ru-106	6.80E+01	0.00E+00	8.49E+00	0.00E+00	9.19E+01	0.00E+00	1.06E+03
Ag-110M	3.13E+00	2.12E+00	1.69E+00	0.00E+00	3.94E+00	0.00E+00	2.52E+02
Te-125M	6.63E+01	1.80E+01	8.84E+00	1.86E+01	0.00E+00	0.00E+00	6.40E+01

Table 3-4 (Page 6 of 8)

Site Specific Potable Water Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	1.68E+02	4.52E+01	1.99E+01	4.02E+01	4.79E+02	0.00E+00	1.36E+02
Te-127	2.74E+00	7.38E-01	5.87E-01	1.90E+00	7.79E+00	0.00E+00	1.07E+02
Te-129M	2.83E+02	7.91E+01	4.40E+01	9.13E+01	8.31E+02	0.00E+00	3.45E+02
Te-129	7.79E-01	2.17E-01	1.85E-01	5.56E-01	2.28E+00	0.00E+00	4.85E+01
Te-131M	4.19E+01	1.45E+01	1.54E+01	2.98E+01	1.40E+02	0.00E+00	5.87E+02
Te-131	4.83E-01	1.47E-01	1.44E-01	3.69E-01	1.46E+00	0.00E+00	2.53E+00
Te-132	5.87E+01	2.60E+01	3.14E+01	3.78E+01	2.41E+02	0.00E+00	2.62E+02
I-130	1.70E+01	3.43E+01	1.77E+01	3.78E+03	5.13E+01	0.00E+00	1.60E+01
I-131	1.00E+02	1.01E+02	5.72E+01	3.33E+04	1.65E+02	0.00E+00	8.95E+00
I-132	4.65E+00	8.55E+00	3.93E+00	3.97E+02	1.31E+01	0.00E+00	1.01E+01
I-133	3.44E+01	4.26E+01	1.61E+01	7.91E+03	7.09E+01	0.00E+00	1.72E+01
I-134	2.44E+00	4.52E+00	2.08E+00	1.04E+02	6.92E+00	0.00E+00	3.00E+00
I-135	1.02E+01	1.83E+01	8.66E+00	1.62E+03	2.81E+01	0.00E+00	1.40E+01
Cs-134	1.36E+03	2.23E+03	4.71E+02	0.00E+00	6.92E+02	2.48E+02	1.20E+01
Cs-136	1.37E+02	3.76E+02	2.43E+02	0.00E+00	2.00E+02	2.98E+01	1.32E+01
Cs-137	1.90E+03	1.82E+03	2.69E+02	0.00E+00	5.93E+02	2.13E+02	1.14E+01
Cs-138	1.33E+00	1.84E+00	1.17E+00	0.00E+00	1.30E+00	1.40E-01	8.49E-01
Ba-139	2.41E+00	1.28E-03	6.98E-02	0.00E+00	1.12E-03	7.56E-04	1.39E+02
Ba-140	4.83E+02	4.23E-01	2.82E+01	0.00E+00	1.38E-01	2.52E-01	2.45E+02
Ba-141	1.16E+00	6.51E-04	3.78E-02	0.00E+00	5.63E-04	3.83E-03	6.63E-01
Ba-142	5.08E-01	3.66E-04	2.84E-02	0.00E+00	2.96E-04	2.15E-04	6.63E-03
La-140	5.87E-02	2.05E-02	6.92E-03	0.00E+00	0.00E+00	0.00E+00	5.72E+02
La-142	3.05E-03	9.71E-04	3.04E-04	0.00E+00	0.00E+00	0.00E+00	1.92E+02
Ce-141	2.31E-01	1.15E-01	1.71E-02	0.00E+00	5.05E-02	0.00E+00	1.44E+02
Ce-143	4.06E-02	2.20E+01	3.19E-03	0.00E+00	9.24E-03	0.00E+00	3.23E+02
Ce-144	1.21E+01	3.79E+00	6.45E-01	0.00E+00	2.10E+00	0.00E+00	9.88E+02
Pr-143	2.28E-01	6.86E-02	1.13E-02	0.00E+00	3.72E-02	0.00E+00	2.47E+02
Pr-144	7.50E-04	2.32E-04	3.77E-05	0.00E+00	1.23E-04	0.00E+00	4.99E-01
Nd-147	1.62E-01	1.31E-01	1.02E-02	0.00E+00	7.21E-02	0.00E+00	2.08E+02
W-187	2.49E+00	1.48E+00	6.63E-01	0.00E+00	0.00E+00	0.00E+00	2.08E+02
Np-239	3.05E-02	2.19E-03	1.54E-03	0.00E+00	6.34E-03	0.00E+00	1.62E+02

Notes:

1) Units are mrem/hr per µCi/ml.

Table 3-4 (Page 7 of 8)

Site Specific Potable Water Dose Factors

Infant Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	6.62E-01	6.62E-01	6.62E-01	6.62E-01	6.62E-01	6.62E-01
Na-24	3.80E+01	3.80E+01	3.80E+01	3.80E+01	3.80E+01	3.80E+01	3.80E+01
Cr-51	0.00E+00	0.00E+00	5.30E-02	3.46E-02	7.56E-03	6.73E-02	1.55E+00
Mn-54	0.00E+00	7.49E+01	1.70E+01	0.00E+00	1.66E+01	0.00E+00	2.75E+01
Mn-56	0.00E+00	3.08E+00	5.30E-01	0.00E+00	2.64E+00	0.00E+00	2.80E+02
Fe-55	5.23E+01	3.38E+01	9.03E+00	0.00E+00	0.00E+00	1.65E+01	4.29E+00
Fe-59	1.16E+02	2.02E+02	7.98E+01	0.00E+00	0.00E+00	5.98E+01	9.67E+01
Co-58	0.00E+00	1.35E+01	3.38E+01	0.00E+00	0.00E+00	0.00E+00	3.37E+01
Co-60	0.00E+00	4.06E+01	9.59E+01	0.00E+00	0.00E+00	0.00E+00	9.67E+01
Ni-63	2.39E+03	1.47E+02	8.28E+01	0.00E+00	0.00E+00	0.00E+00	7.34E+00
Ni-65	1.77E+01	2.00E+00	9.10E-01	0.00E+00	0.00E+00	0.00E+00	1.52E+02
Cu-64	0.00E+00	2.29E+00	1.06E+00	0.00E+00	3.87E+00	0.00E+00	4.70E+01
Zn-65	6.92E+01	2.37E+02	1.09E+02	0.00E+00	1.15E+02	0.00E+00	2.01E+02
Zn-69	3.51E-01	6.32E-01	4.70E-02	0.00E+00	2.63E-01	0.00E+00	5.15E+01
Br-83	0.00E+00	0.00E+00	1.37E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.44E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	7.30E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	6.40E+02	3.16E+02	0.00E+00	0.00E+00	0.00E+00	1.64E+01
Rb-88	0.00E+00	1.87E+00	1.03E+00	0.00E+00	0.00E+00	0.00E+00	1.82E+00
Rb-89	0.00E+00	1.08E+00	7.41E-01	0.00E+00	0.00E+00	0.00E+00	3.66E-01
Sr-89	9.44E+03	0.00E+00	2.71E+02	0.00E+00	0.00E+00	0.00E+00	1.94E+02
Sr-90	1.06E+05	0.00E+00	2.16E+03	0.00E+00	0.00E+00	0.00E+00	8.69E+02
Sr-91	1.88E+02	0.00E+00	6.81E+00	0.00E+00	0.00E+00	0.00E+00	2.23E+02
Sr-92	7.22E+01	0.00E+00	2.68E+00	0.00E+00	0.00E+00	0.00E+00	7.79E+02
Y-90	3.27E-01	0.00E+00	8.77E-03	0.00E+00	0.00E+00	0.00E+00	4.51E+02
Y-91M	3.05E-03	0.00E+00	1.04E-04	0.00E+00	0.00E+00	0.00E+00	1.02E+01
Y-91	4.25E+00	0.00E+00	1.13E-01	0.00E+00	0.00E+00	0.00E+00	3.05E+02
Y-92	2.88E-02	0.00E+00	8.09E-04	0.00E+00	0.00E+00	0.00E+00	5.49E+02
Y-93	9.14E-02	0.00E+00	2.49E-03	0.00E+00	0.00E+00	0.00E+00	7.22E+02
Zr-95	7.75E-01	1.89E-01	1.34E-01	0.00E+00	2.04E-01	0.00E+00	9.41E+01
Zr-97	5.57E-02	9.56E-03	4.36E-03	0.00E+00	9.63E-03	0.00E+00	6.09E+02
Nb-95	1.58E-01	6.51E-02	3.76E-02	0.00E+00	4.66E-02	0.00E+00	5.49E+01
Mo-99	0.00E+00	1.28E+02	2.49E+01	0.00E+00	1.91E+02	0.00E+00	4.21E+01
Tc- 99M	7.22E-03	1.49E-02	1.92E-01	0.00E+00	1.60E-01	7.79E-03	4.33E+00
Tc-101	8.54E-03	1.08E-02	1.06E-01	0.00E+00	1.28E-01	5.87E-03	1.83E+00
Ru-103	5.57E+00	0.00E+00	1.86E+00	0.00E+00	1.16E+01	0.00E+00	6.77E+01
Ru-105	5.12E-01	0.00E+00	1.72E-01	0.00E+00	3.76E+00	0.00E+00	2.04E+02
Ru-106	9.07E+01	0.00E+00	1.13E+01	0.00E+00	1.07E+02	0.00E+00	6.88E+02
Ag-110M	3.75E+00	2.73E+00	1.81E+00	0.00E+00	3.91E+00	0.00E+00	1.42E+02
Te-125M	8.77E+01	2.93E+01	1.19E+01	2.95E+01	0.00E+00	0.00E+00	4.18E+01

Table 3-4 (Page 8 of 8)

Site Specific Potable Water Dose Factors

Infant Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	2.20E+02	7.30E+01	2.66E+01	6.36E+01	5.42E+02	0.00E+00	8.88E+01
Te-127	3.76E+00	1.26E+00	8.09E-01	3.06E+00	9.18E+00	0.00E+00	7.90E+01
Te-129M	3.76E+02	1.29E+02	5.79E+01	1.44E+02	9.41E+02	0.00E+00	2.25E+02
Te-129	1.07E+00	3.68E-01	2.49E-01	8.95E-01	2.66E+00	0.00E+00	8.54E+01
Te-131M	5.72E+01	2.30E+01	1.90E+01	4.66E+01	1.58E+02	0.00E+00	3.87E+02
Te-131	6.62E-01	2.45E-01	1.86E-01	5.91E-01	1.69E+00	0.00E+00	2.67E+01
Te-132	7.82E+01	3.87E+01	3.62E+01	5.72E+01	2.42E+02	0.00E+00	1.43E+02
I-130	2.26E+01	4.97E+01	1.99E+01	5.57E+03	5.45E+01	0.00E+00	1.06E+01
I-131	1.35E+02	1.59E+02	7.00E+01	5.23E+04	1.86E+02	0.00E+00	5.68E+00
I-132	6.24E+00	1.27E+01	4.51E+00	5.94E+02	1.41E+01	0.00E+00	1.03E+01
I-133	4.70E+01	6.85E+01	2.01E+01	1.25E+04	8.05E+01	0.00E+00	1.16E+01
I-134	3.27E+00	6.70E+00	2.38E+00	1.56E+02	7.49E+00	0.00E+00	6.92E+00
I-135	1.37E+01	2.72E+01	9.93E+00	2.44E+03	3.04E+01	0.00E+00	9.86E+00
Cs-134	1.42E+03	2.64E+03	2.67E+02	0.00E+00	6.81E+02	2.79E+02	7.19E+00
Cs-136	1.73E+02	5.08E+02	1.90E+02	0.00E+00	2.02E+02	4.14E+01	7.71E+00
Cs-137	1.96E+03	2.30E+03	1.63E+02	0.00E+00	6.17E+02	2.50E+02	7.19E+00
Cs-138	1.81E+00	2.94E+00	1.43E+00	0.00E+00	1.47E+00	2.29E-01	4.70E+00
Ba-139	3.31E+00	2.20E-03	9.59E-02	0.00E+00	1.32E-03	1.33E-03	2.10E+02
Ba-140	6.43E+02	6.43E-01	3.31E+01	0.00E+00	1.53E-01	3.95E-01	1.58E+02
Ba-141	1.60E+00	1.09E-03	5.04E-02	0.00E+00	6.58E-04	6.66E-04	1.95E+01
Ba-142	6.92E-01	5.76E-04	3.41E-02	0.00E+00	3.31E-04	3.48E-04	2.86E+00
La-140	7.94E-02	3.13E-02	8.05E-03	0.00E+00	0.00E+00	0.00E+00	3.68E+02
La-142	4.14E-03	1.52E-03	3.64E-04	0.00E+00	0.00E+00	0.00E+00	2.58E+02
Ce-141	2.96E-01	1.81E-01	2.13E-02	0.00E+00	5.57E-02	0.00E+00	9.33E+01
Ce-143	5.57E-02	3.69E+01	4.21E-03	0.00E+00	1.08E-02	0.00E+00	2.16E+02
Ce-144	1.12E+01	4.59E+00	6.28E-01	0.00E+00	1.85E+00	0.00E+00	6.43E+02
Pr-143	3.06E-01	1.14E-01	1.52E-02	0.00E+00	4.25E-02	0.00E+00	1.61E+02
Pr-144	1.03E-03	3.99E-04	5.19E-05	0.00E+00	1.44E-04	0.00E+00	1.85E+01
Nd-147	2.08E-01	2.14E-01	1.31E-02	0.00E+00	8.24E-02	0.00E+00	1.35E+02
W-187	3.40E+00	2.36E+00	8.16E-01	0.00E+00	0.00E+00	0.00E+00	1.39E+02
Np-239	4.18E-02	3.74E-03	2.11E-03	0.00E+00	7.45E-03	0.00E+00	1.08E+02

Notes:

1) Units are mrem/hr per μCi/ml.

Table 3-5 (Page 1 of 6)

Site Specific Fish Ingestion Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.29E-01	1.29E-01	1.29E-01	1.29E-01	1.29E-01	1.29E-01
Na-24	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02
Cr-51	0.00E+00	0.00E+00	1.27E+00	7.61E-01	2.81E-01	1.69E+00	3.20E+02
Mn-54	0.00E+00	4.38E+03	8.35E+02	0.00E+00	1.30E+03	0.00E+00	1.34E+04
Mn-56	0.00E+00	1.10E+02	1.95E+01	0.00E+00	1.40E+02	0.00E+00	3.51E+03
Fe-55	6.58E+02	4.55E+02	1.06E+02	0.00E+00	0.00E+00	2.54E+02	2.61E+02
Fe-59	1.04E+03	2.44E+03	9.36E+02	0.00E+00	0.00E+00	6.82E+02	8.14E+03
Co-58	0.00E+00	8.92E+01	2.00E+02	0.00E+00	0.00E+00	0.00E+00	1.81E+03
Co-60	0.00E+00	2.56E+02	5.65E+02	0.00E+00	0.00E+00	0.00E+00	4.81E+03
Ni-63	3.11E+04	2.16E+03	1.04E+03	0.00E+00	0.00E+00	0.00E+00	4.50E+02
Ni-65	1.26E+02	1.64E+01	7.49E+00	0.00E+00	0.00E+00	0.00E+00	4.17E+02
Cu-64	0.00E+00	9.97E+00	4.68E+00	0.00E+00	2.51E+01	0.00E+00	8.50E+02
Zn-65	2.32E+04	7.37E+04	3.33E+04	0.00E+00	4.93E+04	0.00E+00	4.64E+04
Zn-69	4.93E+01	9.43E+01	6.56E+00	0.00E+00	6.13E+01	0.00E+00	1.42E+01
Br-83	0.00E+00	0.00E+00	4.04E+01	0.00E+00	0.00E+00	0.00E+00	5.82E+01
Br-84	0.00E+00	0.00E+00	5.24E+01	0.00E+00	0.00E+00	0.00E+00	4.11E-04
Br-85	0.00E+00	0.00E+00	2.15E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.01E+05	4.71E+04	0.00E+00	0.00E+00	0.00E+00	1.99E+04
Rb-88	0.00E+00	2.90E+02	1.54E+02	0.00E+00	0.00E+00	0.00E+00	4.00E-09
Rb-89	0.00E+00	1.92E+02	1.35E+02	0.00E+00	0.00E+00	0.00E+00	1.12E-11
Sr-89	2.21E+04	0.00E+00	6.35E+02	0.00E+00	0.00E+00	0.00E+00	3.55E+03
Sr-90	6.26E+05	0.00E+00	1.26E+04	0.00E+00	0.00E+00	0.00E+00	1.57E+04
Sr-91	4.07E+02	0.00E+00	1.64E+01	0.00E+00	0.00E+00	0.00E+00	1.94E+03
Sr-92	1.54E+02	0.00E+00	6.68E+00	0.00E+00	0.00E+00	0.00E+00	3.06E+03
Y-90	5.76E-01	0.00E+00	1.54E-02	0.00E+00	0.00E+00	0.00E+00	6.10E+03
Y-91M	5.44E-03	0.00E+00	2.11E-04	0.00E+00	0.00E+00	0.00E+00	1.60E-02
Y-91	8.44E+00	0.00E+00	2.26E-01	0.00E+00	0.00E+00	0.00E+00	4.64E+03
Y-92	5.06E-02	0.00E+00	1.48E-03	0.00E+00	0.00E+00	0.00E+00	8.86E+02
Y-93	1.60E-01	0.00E+00	4.43E-03	0.00E+00	0.00E+00	0.00E+00	5.09E+03
Zr-95	2.40E-01	7.70E-02	5.21E-02	0.00E+00	1.21E-01	0.00E+00	2.44E+02
Zr-97	1.33E-02	2.68E-03	1.22E-03	0.00E+00	4.04E-03	0.00E+00	8.30E+02
Nb-95	4.47E+02	2.48E+02	1.34E+02	0.00E+00	2.46E+02	0.00E+00	1.51E+06
Mo-99	0.00E+00	1.03E+02	1.96E+01	0.00E+00	2.34E+02	0.00E+00	2.39E+02
Tc- 99M	8.87E-03	2.51E-02	3.19E-01	0.00E+00	3.81E-01	1.23E-02	1.48E+01
Tc-101	9.12E-03	1.31E-02	1.29E-01	0.00E+00	2.37E-01	6.72E-03	3.95E-14
Ru-103	4.43E+00	0.00E+00	1.91E+00	0.00E+00	1.69E+01	0.00E+00	5.17E+02
Ru-105	3.69E-01	0.00E+00	1.46E-01	0.00E+00	4.76E+00	0.00E+00	2.26E+02
Ru-106	6.58E+01	0.00E+00	8.33E+00	0.00E+00	1.27E+02	0.00E+00	4.26E+03
Ag-110M	8.81E-01	8.15E-01	4.84E-01	0.00E+00	1.60E+00	0.00E+00	3.33E+02

Table 3-5 (Page 2 of 6)

Site Specific Fish Ingestion Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	2.57E+03	9.30E+02	3.44E+02	7.72E+02	1.04E+04	0.00E+00	1.02E+04
Te-127M	6.48E+03	2.32E+03	7.90E+02	1.66E+03	2.63E+04	0.00E+00	2.17E+04
Te-127	1.05E+02	3.78E+01	2.28E+01	7.80E+01	4.29E+02	0.00E+00	8.31E+03
Te-129M	1.10E+04	4.11E+03	1.74E+03	3.78E+03	4.60E+04	0.00E+00	5.54E+04
Te-129	3.01E+01	1.13E+01	7.33E+00	2.31E+01	1.26E+02	0.00E+00	2.27E+01
Te-131M	1.66E+03	8.10E+02	6.75E+02	1.28E+03	8.21E+03	0.00E+00	8.04E+04
Te-131	1.89E+01	7.88E+00	5.96E+00	1.55E+01	8.26E+01	0.00E+00	2.67E+00
Te-132	2.41E+03	1.56E+03	1.47E+03	1.72E+03	1.50E+04	0.00E+00	7.38E+04
I-130	2.71E+01	8.01E+01	3.16E+01	6.79E+03	1.25E+02	0.00E+00	6.89E+01
I-131	1.49E+02	2.14E+02	1.22E+02	7.00E+04	3.66E+02	0.00E+00	5.64E+01
I-132	7.29E+00	1.95E+01	6.82E+00	6.82E+02	3.11E+01	0.00E+00	3.66E+00
I-133	5.10E+01	8.87E+01	2.70E+01	1.30E+04	1.55E+02	0.00E+00	7.97E+01
I-134	3.81E+00	1.03E+01	3.70E+00	1.79E+02	1.64E+01	0.00E+00	9.01E-03
I-135	1.59E+01	4.17E+01	1.54E+01	2.75E+03	6.68E+01	0.00E+00	4.70E+01
Cs-134	2.98E+05	7.09E+05	5.79E+05	0.00E+00	2.29E+05	7.61E+04	1.24E+04
Cs-136	3.12E+04	1.23E+05	8.86E+04	0.00E+00	6.85E+04	9.38E+03	1.40E+04
Cs-137	3.82E+05	5.22E+05	3.42E+05	0.00E+00	1.77E+05	5.89E+04	1.01E+04
Cs-138	2.64E+02	5.22E+02	2.59E+02	0.00E+00	3.84E+02	3.79E+01	2.23E-03
Ba-139	9.29E-01	6.62E-04	2.72E-02	0.00E+00	6.19E-04	3.75E-04	1.65E+00
Ba-140	1.94E+02	2.44E-01	1.27E+01	0.00E+00	8.30E-02	1.40E-01	4.00E+02
Ba-141	4.51E-01	3.41E-04	1.52E-02	0.00E+00	3.17E-04	1.93E-04	2.13E-10
Ba-142	2.04E-01	2.10E-04	1.28E-02	0.00E+00	1.77E-04	1.19E-04	2.87E-19
La-140	1.50E-01	7.54E-02	1.99E-02	0.00E+00	0.00E+00	0.00E+00	5.54E+03
La-142	7.66E-03	3.48E-03	8.68E-04	0.00E+00	0.00E+00	0.00E+00	2.54E+01
Ce-141	2.24E-02	1.52E-02	1.72E-03	0.00E+00	7.04E-03	0.00E+00	5.79E+01
Ce-143	3.95E-03	2.92E+00	3.23E-04	0.00E+00	1.29E-03	0.00E+00	1.09E+02
Ce-144	1.17E+00	4.88E-01	6.27E-02	0.00E+00	2.90E-01	0.00E+00	3.95E+02
Pr-143	5.51E-01	2.21E-01	2.73E-02	0.00E+00	1.27E-01	0.00E+00	2.41E+03
Pr-144	1.80E-03	7.48E-04	9.16E-05	0.00E+00	4.22E-04	0.00E+00	2.59E-10
Nd-147	3.76E-01	4.35E-01	2.60E-02	0.00E+00	2.54E-01	0.00E+00	2.09E+03
W-187	2.96E+02	2.47E+02	8.65E+01	0.00E+00	0.00E+00	0.00E+00	8.10E+04
Np-239	2.85E-02	2.80E-03	1.54E-03	0.00E+00	8.74E-03	0.00E+00	5.75E+02

Notes:

1) Units are mrem/hr per µCi/ml.

Table 3-5 (Page 3 of 6)

Site Specific Fish Ingestion Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	9.92E-02	9.92E-02	9.92E-02	9.92E-02	9.92E-02	9.92E-02
Na-24	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02
Cr-51	0.00E+00	0.00E+00	1.31E+00	7.30E-01	2.88E-01	1.88E+00	2.21E+02
Mn-54	0.00E+00	4.30E+03	8.54E+02	0.00E+00	1.28E+03	0.00E+00	8.83E+03
Mn-56	0.00E+00	1.15E+02	2.05E+01	0.00E+00	1.46E+02	0.00E+00	7.59E+03
Fe-55	6.89E+02	4.89E+02	1.14E+02	0.00E+00	0.00E+00	3.10E+02	2.12E+02
Fe-59	1.07E+03	2.50E+03	9.65E+02	0.00E+00	0.00E+00	7.88E+02	5.91E+03
Co-58	0.00E+00	8.86E+01	2.04E+02	0.00E+00	0.00E+00	0.00E+00	1.22E+03
Co-60	0.00E+00	2.56E+02	5.77E+02	0.00E+00	0.00E+00	0.00E+00	3.34E+03
Ni-63	3.23E+04	2.28E+03	1.09E+03	0.00E+00	0.00E+00	0.00E+00	3.63E+02
Ni-65	1.37E+02	1.75E+01	7.95E+00	0.00E+00	0.00E+00	0.00E+00	9.47E+02
Cu-64	0.00E+00	1.05E+01	4.93E+00	0.00E+00	2.65E+01	0.00E+00	8.14E+02
Zn-65	2.10E+04	7.30E+04	3.40E+04	0.00E+00	4.67E+04	0.00E+00	3.09E+04
Zn-69	5.36E+01	1.02E+02	7.15E+00	0.00E+00	6.68E+01	0.00E+00	1.88E+02
Br-83	0.00E+00	0.00E+00	4.40E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	5.53E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.34E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.09E+05	5.11E+04	0.00E+00	0.00E+00	0.00E+00	1.61E+04
Rb-88	0.00E+00	3.11E+02	1.66E+02	0.00E+00	0.00E+00	0.00E+00	2.66E-05
Rb-89	0.00E+00	2.01E+02	1.42E+02	0.00E+00	0.00E+00	0.00E+00	3.08E-07
Sr-89	2.41E+04	0.00E+00	6.89E+02	0.00E+00	0.00E+00	0.00E+00	2.87E+03
Sr-90	5.58E+05	0.00E+00	1.12E+04	0.00E+00	0.00E+00	0.00E+00	1.27E+04
Sr-91	4.42E+02	0.00E+00	1.76E+01	0.00E+00	0.00E+00	0.00E+00	2.00E+03
Sr-92	1.67E+02	0.00E+00	7.11E+00	0.00E+00	0.00E+00	0.00E+00	4.25E+03
Y-90	6.25E-01	0.00E+00	1.68E-02	0.00E+00	0.00E+00	0.00E+00	5.15E+03
Y-91M	5.88E-03	0.00E+00	2.25E-04	0.00E+00	0.00E+00	0.00E+00	2.78E-01
Y-91	9.17E+00	0.00E+00	2.46E-01	0.00E+00	0.00E+00	0.00E+00	3.76E+03
Y-92	5.52E-02	0.00E+00	1.60E-03	0.00E+00	0.00E+00	0.00E+00	1.51E+03
Y-93	1.75E-01	0.00E+00	4.79E-03	0.00E+00	0.00E+00	0.00E+00	5.34E+03
Zr-95	2.48E-01	7.82E-02	5.38E-02	0.00E+00	1.15E-01	0.00E+00	1.81E+02
Zr-97	1.43E-02	2.82E-03	1.30E-03	0.00E+00	4.28E-03	0.00E+00	7.64E+02
Nb-95	4.50E+02	2.50E+02	1.37E+02	0.00E+00	2.42E+02	0.00E+00	1.07E+06
Mo-99	0.00E+00	1.10E+02	2.10E+01	0.00E+00	2.52E+02	0.00E+00	1.97E+02
Tc- 99M	9.08E-03	2.53E-02	3.28E-01	0.00E+00	3.78E-01	1.41E-02	1.66E+01
Tc-101	9.85E-03	1.40E-02	1.38E-01	0.00E+00	2.53E-01	8.54E-03	2.39E-09
Ru-103	4.65E+00	0.00E+00	1.99E+00	0.00E+00	1.64E+01	0.00E+00	3.89E+02
Ru-105	3.98E-01	0.00E+00	1.54E-01	0.00E+00	5.02E+00	0.00E+00	3.21E+02
Ru-106	7.15E+01	0.00E+00	9.01E+00	0.00E+00	1.38E+02	0.00E+00	3.43E+03
Ag-110M	8.60E-01	8.14E-01	4.95E-01	0.00E+00	1.55E+00	0.00E+00	2.29E+02
Te-125M	2.79E+03	1.01E+03	3.74E+02	7.81E+02	0.00E+00	0.00E+00	8.24E+03

Table 3-5 (Page 4 of 6)

Site Specific Fish Ingestion Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	7.06E+03	2.50E+03	8.39E+02	1.68E+03	2.86E+04	0.00E+00	1.76E+04
Te-127	1.15E+02	4.09E+01	2.48E+01	7.95E+01	4.67E+02	0.00E+00	8.90E+03
Te-129M	1.19E+04	4.41E+03	1.88E+03	3.84E+03	4.98E+04	0.00E+00	4.47E+04
Te-129	3.27E+01	1.22E+01	7.95E+00	2.33E+01	1.37E+02	0.00E+00	1.79E+02
Te-131M	1.78E+03	8.54E+02	7.12E+02	1.28E+03	8.90E+03	0.00E+00	6.85E+04
Te-131	2.04E+01	8.39E+00	6.36E+00	1.57E+01	8.90E+01	0.00E+00	1.67E+00
Te-132	2.55E+03	1.61E+03	1.52E+03	1.70E+03	1.55E+04	0.00E+00	5.11E+04
I-130	2.82E+01	8.15E+01	3.26E+01	6.65E+03	1.26E+02	0.00E+00	6.27E+01
I-131	1.60E+02	2.24E+02	1.20E+02	6.54E+04	3.86E+02	0.00E+00	4.43E+01
I-132	7.63E+00	2.00E+01	7.17E+00	6.73E+02	3.15E+01	0.00E+00	8.70E+00
I-133	5.50E+01	9.33E+01	2.85E+01	1.30E+04	1.64E+02	0.00E+00	7.06E+01
I-134	3.99E+00	1.06E+01	3.80E+00	1.76E+02	1.67E+01	0.00E+00	1.40E-01
I-135	1.67E+01	4.30E+01	1.59E+01	2.76E+03	6.79E+01	0.00E+00	4.76E+01
Cs-134	3.05E+05	7.19E+05	3.33E+05	0.00E+00	2.28E+05	8.72E+04	8.94E+03
Cs-136	3.13E+04	1.23E+05	8.28E+04	0.00E+00	6.71E+04	1.06E+04	9.92E+03
Cs-137	4.09E+05	5.44E+05	1.89E+05	0.00E+00	1.85E+05	7.19E+04	7.73E+03
Cs-138	2.83E+02	5.44E+02	2.72E+02	0.00E+00	4.01E+02	4.67E+01	2.47E-01
Ba-139	1.01E+00	7.14E-04	2.95E-02	0.00E+00	6.73E-04	4.92E-04	9.05E+00
Ba-140	2.07E+02	2.54E-01	1.34E+01	0.00E+00	8.61E-02	1.71E-01	3.20E+02
Ba-141	4.90E-01	3.66E-04	1.63E-02	0.00E+00	3.39E-04	2.50E-04	1.04E-06
Ba-142	2.18E-01	2.18E-04	1.34E-02	0.00E+00	1.85E-04	1.45E-04	6.70E-13
La-140	1.59E-01	7.80E-02	2.07E-02	0.00E+00	0.00E+00	0.00E+00	4.48E+03
La-142	8.16E-03	3.63E-03	9.03E-04	0.00E+00	0.00E+00	0.00E+00	1.10E+02
Ce-141	2.43E-02	1.62E-02	1.86E-03	0.00E+00	7.62E-03	0.00E+00	4.63E+01
Ce-143	4.29E-03	3.12E+00	3.48E-04	0.00E+00	1.40E-03	0.00E+00	9.38E+01
Ce-144	1.27E+00	5.25E-01	6.82E-02	0.00E+00	3.14E-01	0.00E+00	3.19E+02
Pr-143	5.97E-01	2.38E-01	2.97E-02	0.00E+00	1.39E-01	0.00E+00	1.97E+03
Pr-144	1.96E-03	8.03E-04	9.94E-05	0.00E+00	4.61E-04	0.00E+00	2.16E-06
Nd-147	4.28E-01	4.65E-01	2.79E-02	0.00E+00	2.73E-01	0.00E+00	1.68E+03
W-187	3.20E+02	2.60E+02	9.13E+01	0.00E+00	0.00E+00	0.00E+00	7.05E+04
Np-239	3.21E-02	3.03E-03	1.68E-03	0.00E+00	9.50E-03	0.00E+00	4.87E+02

Notes:

1) Units are mrem/hr per µCi/ml.

Table 3-5 (Page 5 of 6)

Site Specific Fish Ingestion Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	8.21E-02	8.21E-02	8.21E-02	8.21E-02	8.21E-02	8.21E-02
Na-24	4.56E+02	4.56E+02	4.56E+02	4.56E+02	4.56E+02	4.56E+02	4.56E+02
Cr-51	0.00E+00	0.00E+00	1.40E+00	7.77E-01	2.12E-01	1.42E+00	7.43E+01
Mn-54	0.00E+00	3.37E+03	8.97E+02	0.00E+00	9.44E+02	0.00E+00	2.83E+03
Mn-56	0.00E+00	1.05E+02	2.37E+01	0.00E+00	1.27E+02	0.00E+00	1.52E+04
Fe-55	9.05E+02	4.80E+02	1.49E+02	0.00E+00	0.00E+00	2.71E+02	8.89E+01
Fe-59	1.30E+03	2.10E+03	1.05E+03	0.00E+00	0.00E+00	6.09E+02	2.19E+03
Co-58	0.00E+00	7.08E+01	2.17E+02	0.00E+00	0.00E+00	0.00E+00	4.13E+02
Co-60	0.00E+00	2.08E+02	6.14E+02	0.00E+00	0.00E+00	0.00E+00	1.15E+03
Ni-63	4.23E+04	2.27E+03	1.44E+03	0.00E+00	0.00E+00	0.00E+00	1.53E+02
Ni-65	1.75E+02	1.64E+01	9.60E+00	0.00E+00	0.00E+00	0.00E+00	2.01E+03
Cu-64	0.00E+00	9.64E+00	5.82E+00	0.00E+00	2.33E+01	0.00E+00	4.52E+02
Zn-65	2.16E+04	5.74E+04	3.57E+04	0.00E+00	3.62E+04	0.00E+00	1.01E+04
Zn-69	6.89E+01	9.96E+01	9.20E+00	0.00E+00	6.04E+01	0.00E+00	6.28E+03
Br-83	0.00E+00	0.00E+00	5.65E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	6.54E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	3.01E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.05E+05	6.48E+04	0.00E+00	0.00E+00	0.00E+00	6.78E+03
Rb-88	0.00E+00	2.99E+02	2.08E+02	0.00E+00	0.00E+00	0.00E+00	1.47E+01
Rb-89	0.00E+00	1.84E+02	1.64E+02	0.00E+00	0.00E+00	0.00E+00	1.60E+00
Sr-89	3.11E+04	0.00E+00	8.90E+02	0.00E+00	0.00E+00	0.00E+00	1.21E+03
Sr-90	6.04E+05	0.00E+00	1.22E+04	0.00E+00	0.00E+00	0.00E+00	5.40E+03
Sr-91	5.66E+02	0.00E+00	2.14E+01	0.00E+00	0.00E+00	0.00E+00	1.25E+03
Sr-92	2.13E+02	0.00E+00	8.54E+00	0.00E+00	0.00E+00	0.00E+00	4.04E+03
Y-90	8.08E-01	0.00E+00	2.16E-02	0.00E+00	0.00E+00	0.00E+00	2.30E+03
Y-91M	7.51E-03	0.00E+00	2.73E-04	0.00E+00	0.00E+00	0.00E+00	1.47E+01
Y-91	1.18E+01	0.00E+00	3.17E-01	0.00E+00	0.00E+00	0.00E+00	1.58E+03
Y-92	7.08E-02	0.00E+00	2.03E-03	0.00E+00	0.00E+00	0.00E+00	2.05E+03
Y-93	2.24E-01	0.00E+00	6.16E-03	0.00E+00	0.00E+00	0.00E+00	3.34E+03
Zr-95	3.01E-01	6.62E-02	5.89E-02	0.00E+00	9.47E-02	0.00E+00	6.90E+01
Zr-97	1.81E-02	2.62E-03	1.55E-03	0.00E+00	3.76E-03	0.00E+00	3.97E+02
Nb-95	5.31E+02	2.07E+02	1.48E+02	0.00E+00	1.94E+02	0.00E+00	3.82E+05
Mo-99	0.00E+00	1.05E+02	2.59E+01	0.00E+00	2.23E+02	0.00E+00	8.65E+01
Tc- 99M	1.09E-02	2.14E-02	3.54E-01	0.00E+00	3.10E-01	1.08E-02	1.22E+01
Tc-101	1.26E-02	1.32E-02	1.68E-01	0.00E+00	2.25E-01	6.99E-03	4.20E-02
Ru-103	5.75E+00	0.00E+00	2.21E+00	0.00E+00	1.45E+01	0.00E+00	1.49E+02
Ru-105	5.07E-01	0.00E+00	1.84E-01	0.00E+00	4.46E+00	0.00E+00	3.31E+02
Ru-106	9.20E+01	0.00E+00	1.15E+01	0.00E+00	1.24E+02	0.00E+00	1.43E+03
Ag-110M	9.75E-01	6.59E-01	5.26E-01	0.00E+00	1.23E+00	0.00E+00	7.83E+01
Te-125M	3.59E+03	9.72E+02	4.78E+02	1.01E+03	0.00E+00	0.00E+00	3.46E+03

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Site Specific Fish Ingestion Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	9.09E+03	2.45E+03	1.08E+03	2.17E+03	2.59E+04	0.00E+00	7.36E+03
Te-127	1.48E+02	4.00E+01	3.18E+01	1.03E+02	4.22E+02	0.00E+00	5.79E+03
Te-129M	1.53E+04	4.28E+03	2.38E+03	4.94E+03	4.50E+04	0.00E+00	1.87E+04
Te-129	4.22E+01	1.18E+01	1.00E+01	3.01E+01	1.23E+02	0.00E+00	2.62E+03
Te-131M	2.27E+03	7.83E+02	8.34E+02	1.61E+03	7.58E+03	0.00E+00	3.18E+04
Te-131	2.61E+01	7.96E+00	7.77E+00	2.00E+01	7.90E+01	0.00E+00	1.37E+02
Te-132	3.18E+03	1.41E+03	1.70E+03	2.05E+03	1.31E+04	0.00E+00	1.42E+04
I-130	3.45E+01	6.96E+01	3.59E+01	7.67E+03	1.04E+02	0.00E+00	3.26E+01
I-131	2.03E+02	2.04E+02	1.16E+02	6.75E+04	3.35E+02	0.00E+00	1.82E+01
I-132	9.44E+00	1.73E+01	7.98E+00	8.05E+02	2.65E+01	0.00E+00	2.04E+01
I-133	6.99E+01	8.64E+01	3.27E+01	1.60E+04	1.44E+02	0.00E+00	3.48E+01
I-134	4.94E+00	9.18E+00	4.22E+00	2.11E+02	1.40E+01	0.00E+00	6.09E+00
I-135	2.06E+01	3.72E+01	1.76E+01	3.29E+03	5.70E+01	0.00E+00	2.83E+01
Cs-134	3.68E+05	6.04E+05	1.27E+05	0.00E+00	1.87E+05	6.72E+04	3.26E+03
Cs-136	3.70E+04	1.02E+05	6.58E+04	0.00E+00	5.41E+04	8.07E+03	3.57E+03
Cs-137	5.14E+05	4.92E+05	7.27E+04	0.00E+00	1.60E+05	5.77E+04	3.08E+03
Cs-138	3.59E+02	4.99E+02	3.16E+02	0.00E+00	3.51E+02	3.78E+01	2.30E+02
Ba-139	1.30E+00	6.95E-04	3.78E-02	0.00E+00	6.07E-04	4.09E-04	7.52E+01
Ba-140	2.61E+02	2.29E-01	1.53E+01	0.00E+00	7.46E-02	1.37E-01	1.32E+02
Ba-141	6.29E-01	3.52E-04	2.05E-02	0.00E+00	3.05E-04	2.07E-03	3.59E-01
Ba-142	2.75E-01	1.98E-04	1.54E-02	0.00E+00	1.60E-04	1.16E-04	3.59E-03
La-140	1.99E-01	6.94E-02	2.34E-02	0.00E+00	0.00E+00	0.00E+00	1.94E+03
La-142	1.03E-02	3.28E-03	1.03E-03	0.00E+00	0.00E+00	0.00E+00	6.51E+02
Ce-141	3.12E-02	1.56E-02	2.31E-03	0.00E+00	6.83E-03	0.00E+00	1.94E+01
Ce-143	5.50E-03	2.98E+00	4.32E-04	0.00E+00	1.25E-03	0.00E+00	4.37E+01
Ce-144	1.64E+00	5.13E-01	8.73E-02	0.00E+00	2.84E-01	0.00E+00	1.34E+02
Pr-143	7.73E-01	2.32E-01	3.83E-02	0.00E+00	1.26E-01	0.00E+00	8.34E+02
Pr-144	2.54E-03	7.85E-04	1.28E-04	0.00E+00	4.15E-04	0.00E+00	1.69E+00
Nd-147	5.49E-01	4.44E-01	3.44E-02	0.00E+00	2.44E-01	0.00E+00	7.04E+02
W-187	4.05E+02	2.40E+02	1.08E+02	0.00E+00	0.00E+00	0.00E+00	3.37E+04
Np-239	4.13E-02	2.97E-03	2.08E-03	0.00E+00	8.57E-03	0.00E+00	2.19E+02

Notes:

1) Units are mrem/hr per μCi/ml.

2) The infant age group is assumed to receive no dose through the fish ingestion pathway, therefore no dose factors are supplied.

4.0 GASEOUS EFFLUENTS

4.1 Gaseous Effluents – General Information

This section reviews the offsite radiological limits applicable to the Quad Cities Station and presents in detail the equations and procedures used to assess compliance with these limits. This approach uses the methodology of NUREG-0133 (Reference 14), and incorporates certain simplifications such as the use of average meteorology.

4.1.1 Pre-calculated atmospheric transport parameters are based on historical average atmospheric conditions. These historical meteorological conditions have resulted in the dispersion parameters shown in Table 4–3 through Table 4-5. Since Land Use Census data may vary yearly, dispersion factors for cow milk, cow meat, and nearest resident are in site specific procedures.

4.1.2 The equations and parameters of this section are for use in calculating offsite radiation doses during routine operating conditions. They are not for use in calculating doses due to non-routine releases (e.g., accident releases).

4.1.3 An overview of the required compliance is given in Table 1-1. The dose components are itemized and referenced, and an indication of their regulatory application is noted. Additionally, the locations of dose receivers for each dose component are given in Table 1-2.

4.1.4 Airborne Release Point Classifications

The pattern of dispersion of airborne releases is dependent on the height of the release point relative to adjacent structures. Each release point is classified as one of the following three height-dependent types:

- Stack (or Elevated) Release Point (denoted by the letter S or subscript s). Quad Cities Main Chimney release point is a stack release.
- Ground Level Release Point (denoted by the letter G or subscript g). Quad Cities does not have any ground level release points.
- Vent (or Mixed Mode) Release Point (denoted by the letter V or subscript v). Quad Cities Reactor Building Ventilation Exhaust is a vent release.

4.1.5 Operability and Use of Gaseous Effluent Treatment Systems

10CFR50 Appendix I and ODCM Part I (RECS) require that the ventilation exhaust treatment system and the waste gas holdup system be used when projected offsite doses in 31 days, due to gaseous effluent releases, from each reactor unit, exceed any of the following limits:

- 0.2 mrad to air from gamma radiation.
- 0.4 mrad to air from beta radiation.
- 0.3 mrem to any organ of a member of the public.

The station must project doses due to gaseous releases from the site at least once per 31 days. The calculational methods shown in sections 4.2.2.1, 4.2.2.2, and 4.2.3 are used for this dose projection.

4.1.6 For a release attributable to a processing or effluent system shared by more than one reactor unit, the dose due to an individual unit is obtained by proportioning the effluents among the units sharing the system.

4.2 Gaseous Effluents – Dose and Dose Rate Calculation Requirements

4.2.1 Instantaneous Dose Rates

4.2.1.1 Noble Gas: Total Body Dose Rate

RECS limits the total body dose rate due to noble gases in gaseous effluents released from a site to areas at and beyond the site boundary to less than or equal to 500 mrem/yr at all times.

The total body dose rate due to noble gases released in gaseous effluents is calculated by the following expression:

$$\dot{D}_{TB} = \sum_i K_i \left\{ (\chi/Q)_s^{\gamma} Q_{is} + (\chi/Q)_v^{\gamma} Q_{iv} + (\chi/Q)_g^{\gamma} Q_{ig} \right\} \quad (4\text{-}1)$$

The summation is over noble gas radionuclides **i**.

$\dot{D}_{TB}$ Total Body Dose Rate [mrem/yr]

Dose rate to the total body due to gamma radiation from noble gas radionuclides released in gaseous effluents.

Q_{is}, Q_{iv}, Q_{ig} Release Rate [µCi/sec]

Measured release rate of radionuclide i from a stack, vent or ground level release point, respectively.

K_i Gamma Total Body Dose Conversion Factor [(mrem/yr)/(uCi/m^3)]

Gamma total body dose factor due to gamma emissions for noble gas radionuclide i. K values are taken from Table 4-13.

$(\chi/Q)_s$
$(\chi/Q)_v$
$(\chi/Q)_g$

Relative Concentration Factor [sec/m^3]

Radioactivity concentration based on semi-infinite cloud methodology at a specified location per unit of radioactivity release rate for a stack, vent, or ground level release, respectively. See Table 4-4.

To comply with this specification, the effluent radiation monitor has a setpoint corresponding to an offsite total body dose rate at or below the limit (see Part II Section 2.2.3). In addition, compliance is assessed by calculating offsite total body dose rate based on periodic samples obtained per station procedures.

4.2.1.2 Noble Gas: Skin Dose Rate

RECS limits the skin dose rate due to noble gases in gaseous effluents released from a site to areas at and beyond the site boundary to less than or equal to a dose rate of 3000 mrem/yr at all times. (See Part I Section 12.4.1.)

The skin dose rate due to noble gases released in gaseous effluents is calculated by the following expression:

$$\dot{D}_{SK} = \sum_i \left\{ L_i \left[(\chi/Q)_s Q_{is} + (\chi/Q)_v Q_{iv} + (\chi/Q)_g Q_{ig} \right] + (1.11)\, M_i \left[(\chi/Q)_s^{\gamma} Q_{is} + (\chi/Q)_v^{\gamma} Q_{iv} + (\chi/Q)_g^{\gamma} Q_{ig} \right] \right\} \tag{4-2}$$

The summation is over noble gas radionuclides **i**.

$\dot{D}_{SK}$ Skin Dose Rate [mrem/yr]

Dose rate to skin due to beta and gamma radiation from noble gas radionuclides released in gaseous effluents.

L_i Beta Skin Dose Conversion Factor [(mrem/yr)/(uCi/m^3)]

Skin dose factor due to beta emissions for noble gas radionuclide i. L values are taken from Table 4-13.

1.11 Conversion Constant (rads in air to rem in tissue) [mrem/mrad]

M_i Gamma Air Dose Conversion Factor [(mrad/yr)/(μCi/m^3)]

Gamma air dose rate factor per unit of radioactivity release rate for radionuclide i. See Table 4-13 for Gamma Air Dose conversion factors (From Table B-1 of Regulatory Guide 1.109).

All other terms have been previously defined.

To comply with this specification, gaseous effluent radiation monitors have setpoints corresponding to an offsite skin dose rate at or below the limit (see Part II Section 2.2.3). In addition, compliance is assessed by calculating offsite skin dose rate based on periodic samples obtained per station procedures.

4.2.1.3 Non-Noble Gas Radionuclides: Organ Dose Rate

RECS limits the dose rate to any organ, due to radioactive materials in gaseous effluents released from a site to areas at and beyond the site boundary, to less than or equal to a dose rate of 1500 mrem/yr (See Part I Section 12.4.1).

Typically the child is considered to be the limiting receptor in calculating dose rate to organs due to inhalation of non-noble gas radionuclides in gaseous effluents.

The dose rate to any child organ due to inhalation is calculated by the following expression:

$$\dot{D}^{NNG}_{(Child)i(Inhal)j} = \sum_i R_{(Child)i(Inhal)j}\left\{(\chi/Q)_s Q_{is} + (\chi/Q)_v Q_{iv} + (\chi/Q)_g Q_{ig}\right\} \quad (4\text{-}3)$$

The summation is over non-noble gas radionuclides **i**.

$\dot{D}^{NNG}_{(Child)i(Inhal)j}$ Inhalation Dose Rate [mrem/yr]

Dose rate to the child age group from radionuclide **i**, via the inhalation pathway to organ **j** due to non-noble gas radionuclides.

$R_{(Child)i(Inhal)j}$ Inhalation Dose Factor [(mrem/yr)/(μCi/m^3)]

Inhalation dose factor for child age group for radionuclide **i**, and organ **j**.

All other terms have been previously defined.

RECS requires the dose rate due to non-noble gas radioactive materials in airborne effluents be determined to be within the above limit in accordance with a sampling and analysis program specified in Part I Table 12.4.1-1.

The child organ dose rate due to inhalation is calculated in each sector at the location of the highest offsite χ/Q (see Table 4-4). The result for the sector with the highest organ inhalation dose rate is compared to the limit.

4.2.2 Time Averaged Dose from Noble Gas

4.2.2.1 Gamma Air Dose

RECS limits the gamma air dose due to noble gas effluents released from each reactor unit to areas at and beyond the UNRESTRICTED AREA boundary to the following:

- Less than or equal to 5 mrad per calendar quarter.
- Less than or equal to 10 mrad per calendar year.

The gamma air dose due to noble gases released in gaseous effluents is calculated by the following expression:

$$\mathbf{D}_\gamma = (3.17E-8)\sum_i \mathbf{M}_i \left\{ (\chi/Q)_s^\gamma \mathbf{A}_{is} + (\chi/Q)_v^\gamma \mathbf{A}_{iv} + (\chi/Q)_g^\gamma \mathbf{A}_{ig} \right\} \quad (4\text{-}4)$$

The summation is over noble gas radionuclides **i**.

D_γ Gamma Air Dose [mrad]

Dose to air due to gamma radiation from noble gas radionuclides released in gaseous effluents.

3.17E-8 Conversion Constant (seconds to years) [yr/sec]

$(\chi/Q)_s^\gamma, (\chi/Q)_v^\gamma, (\chi/Q)_g^\gamma$ Gamma-χ/Q Factor [sec/m^3]

Radioactivity concentration based on finite cloud methodology at a specific location per unit of radioactivity release rate from a stack, vent or ground level release, respectively. See Table 4–3 for Gamma-χ/Q Factors.

A_{is}, A_{iv}, A_{ig} Cumulative Radionuclide Release [μCi]

Measured cumulative release of radionuclide **i** over the time period of interest from a stack, vent, or ground level release point, respectively.

All other terms have been previously defined.

RECS Section 12.4 requires determination of cumulative and projected gamma air dose contributions due to noble gases for the current calendar quarter and the current calendar year at least once per 31 days.

Gamma air dose is calculated for the sector with the highest offsite $(\chi/Q)^{\gamma}$ and is compared with the RECS limits on gamma air dose.

For a release attributable to a processing or effluent system shared by more than one reactor unit, the dose due to an individual unit is obtained by proportioning the effluents among the units sharing the system.

4.2.2.2 Beta Air Dose

RECS limits beta air dose due to noble gases in gaseous effluents released from each reactor unit to areas at and beyond the UNRESTRICTED AREA boundary to the following:

- Less than or equal to 10 mrad per calendar quarter.
- Less than or equal to 20 mrad per calendar year.

The beta air dose due to noble gases released in gaseous effluents is calculated by the following expression:

$$D_{\beta} = (3.17E-8)\sum_{i}\left\{N_i\left[(\chi/Q)_s A_{is} + (\chi/Q)_v A_{iv} + (\chi/Q)_g A_{ig}\right]\right\} \quad (4\text{-}5)$$

The summation is over noble gas radionuclides **i**.

D_{β} Beta Dose [mrad]

Dose to air due to beta radiation from noble gas radionuclides released in gaseous effluents.

N_i Beta Air Dose Conversion Factor [(mrad/yr)/(μCi/m^3)]

Beta air dose rate per unit of radioactivity concentration for radionuclide **i**. See Table 4-13 for Beta Air Dose conversion factors (From Table B-1 of Regulatory Guide 1.109).

All other terms have been previously defined.

RECS Section 12.4 requires determination of cumulative and projected beta air dose contributions due to noble gases for the current calendar quarter and the current calendar year at least once per 31 days.

Beta air dose is calculated for the sector with the highest offsite (χ/Q) and is compared with the RECS limit on beta air dose.

For a release attributable to a processing or effluent system shared by more than one reactor unit, the dose due to an individual unit is obtained by proportioning the effluents among the units sharing the system.

4.2.2.3 Total Body Dose

The total body dose, to any receiver is due, in part, to gamma radiation emitted from radioactivity in airborne effluents. This component is added to others to demonstrate compliance to the requirements of 40CFR190 and 10CFR20.

The total body dose component due to gamma radiation from noble gases released in gaseous effluents is calculated by the following expression:

$$D_{TB} = (3.17E-8)\sum_i K_i \left\{ (\chi/Q)_s^{\gamma} A_{is} + (\chi/Q)_v^{\gamma} A_{iv} + (\chi/Q)_g^{\gamma} A_{ig} \right\} \qquad (4\text{-}6)$$

The summation is over noble gas radionuclides **i**.

D_{TB} Total Body Dose [mrem]

Dose to the total body due to gamma radiation from noble gas radionuclides released in gaseous effluents.

K_i Gamma Total Body Dose Conversion Factor [(mrem/yr)/(uCi/m^3)]

Gamma total body dose factor due to gamma emissions for noble gas radionuclide **i** released from a stack, vent or ground level release point, respectively. See Table 4-13 for Gamma total body dose conversion factors. (From Table B-1 of Regulatory Guide 1.109)

All other terms have been previously defined.

The total body dose is also calculated for the 40CFR190 and 10CFR20 compliance assessments. In some cases, the total body dose may be required in 10CFR50 Appendix I assessments (See Part II Table 1-1).

4.2.2.4 Skin Dose

There is no regulatory requirement to evaluate skin dose. However, this component is evaluated for reference as there is skin dose design objective contained in 10CFR50 Appendix I. Note that in the unlikely event that if beta air dose guideline is exceeded, then the skin dose will require evaluation.

The part of skin dose due to noble gases released in gaseous effluents is calculated by the following expression:

$$D_{SK} = (3.17E-8)\sum_i \Big\{ L_i \big[(\chi/Q)_s A_{is} + (\chi/Q)_v A_{iv} + (\chi/Q)_g A_{ig} \big] + (1.11) M_i \big[(\chi/Q)_s^{\gamma} A_{is} + (\chi/Q)_v^{\gamma} A_{iv} + (\chi/Q)_g^{\gamma} A_{ig} \big] \Big\} \tag{4-7}$$

The summation is over noble gas radionuclides **i**.

D_{SK} Skin Dose [mrem]

Dose to the skin due to beta and gamma radiation from noble gas radionuclides released in gaseous effluents.

All other terms have been previously defined.

The skin dose is calculated for reference only.

4.2.3 Time Averaged Dose from Non-Noble Gas Radionuclides

RECS provides the following limits, based on 10CFR50 Appendix I, on the dose to a member of the public from specified non-noble gas radionuclides in gaseous effluents released from each reactor unit to areas at and beyond the UNRESTRICTED AREA boundary:

- Less than or equal to 7.5 mrem to any organ during any calendar quarter
- Less than or equal to 15 mrem to any organ during any calendar year

The individual dose components are also required as part of the 40CFR190 assessments and combined as part of the 10CFR20 assessment (Part II Table 1-1). The dose due to radionuclides deposited on the ground is considered to be a component of the deep dose equivalent for 10CFR20 compliance and an organ (and total body) dose component for 10CFR50 Appendix I and 40CFR190 compliance.

The dose is calculated for releases in the time period under consideration.

Specifically, the dose is calculated as follows:

$$D_{aj}^{NNG} = (3.17E-8)\sum_{p}\sum_{i}\left[W_s R_{aipj} A_{is} + W_v R_{aipj} A_{iv} + W_g R_{aipj} A_{ig}\right] \quad (4\text{-}8)$$

The summation is over pathways **p** and non-noble gas radionuclides **i**.

D_{aj}^{NNG} Dose Due to Non-Noble Gas Radionuclides [mrem]

Dose due to non-noble gases (radioiodines, tritium and particulates) to age group **a**, and to organ **j**.

W_s, W_v, W_g Relative Concentration Factor

Radioactive concentration at a specific location per unit of radioactivity release rate or concentration for stack, vent or ground level release, respectively.

W_s, W_v, or W_g = $(\chi/Q)_s$, $(\chi/Q)_v$ or $(\chi/Q)_g$ for immersion, inhalation and all tritium pathways.

W_s, W_v, or W_g = $(D/Q)_s$, $(D/Q)_v$ or $(D/Q)_g$ for ground plain and all ingestion pathways.

$(D/Q)_s$, $(D/Q)_v$, $(D/Q)_g$ Relative Deposition Factor [$1/m^2$]

Radioactivity concentration at a specified location per unit of radioactivity release concentration for a stack, vent, or ground level release, respectively. See Table 4-4 through Table 4-6. Deposition factors for cow milk, cow meat and nearest resident are in site specific procedures.

R_{aipj} Site-Specific Dose Factor [$(m^2$ mrem/yr)/(μCi/sec)] or [(mrem/yr)/(μCi/m^3)]

Site-specific dose factor for age group **a**, nuclide **i**, pathway **p** and organ **j**. Pathways included are ground plane exposure, inhalation, vegetation ingestion, milk ingestion and meat ingestion.

A_{is}, A_{iv}, A_{ig} Cumulative Radionuclide Release [μCi]

Measured cumulative release of radionuclide i over the time period of interest from a stack, vent, or ground level release point, respectively.

All other terms have been previously defined.

RECS Section 12.4 require cumulative and PROJECTED DOSE contributions for the current calendar quarter and the current calendar year for the specified non-noble gas radionuclides in airborne effluents to be determined at least once per 31 days.

To comply with this specification, Quad Cities Station obtains and analyzes samples in accordance with the radioactive gaseous waste or gaseous effluent sampling and analysis program (RECS Table 12.4.1-1). In accordance with NUREG 0133 (Reference 14), dose due to non-noble gases is assessed at the location in the UNRESTRICTED AREA where the combination of existing pathways and receptor age groups indicates the maximum potential exposure. The inhalation and ground plane exposure pathways are considered to exist at all locations. The food ingestion pathways at a specific location are considered based on their existence as determined by land use census. The values used for (χ/Q) and (D/Q) are shown in Table 4-4 through Table 4-6 and correspond to the applicable pathway location. χ/Q and D/Q values for cow milk, cow meat and nearest resident are in site specific procedures.

For a release attributable to a processing or effluent system shared by more than one reactor, the dose due to an individual unit is obtained by proportioning the effluents among the units sharing the system.

The dose evaluated is also included as part of the 10CFR20 and 40CFR190 assessment (See Part II Section 5.0).

4.2.3.1 Ground Plane

The site-specific dose factor for ground deposition of radioactivity is considered to be a total body dose component and is calculated by the following expression:

$$R_{ai(GP)j}[D/Q] = K'K''(0.7)DFG_i\left[\frac{1-e^{-\lambda_i t_b}}{\lambda_i}\right] \quad (4\text{-}9)$$

$R_{ai(GP)j}[D/Q]$ Ground Plane Deposition Dose Factor [(m^2 mrem/yr)/(μCi/sec)]

Site-specific ground plane dose factor for age group **a**, nuclide **i** and organ **j**. The ground plane dose is calculated using (D/Q).

K' Conversion Constant (1E6 pCi per μCi) [pCi/μCi]

K" Conversion Constant (8760 hr/yr) [hr/yr]

0.7 Shielding Factor; a factor that accounts for dimensionless shielding due to occupancy of structures.

DFG_i Ground Plane Dose Conversion Factor [(mrem/hr)/(pCi/m^2)]

Dose rate to the total body per unit of surface radioactivity concentration due to standing on ground uniformly contaminated with radionuclide **i**. Ground Plane Dose Factors are shown in Table 4-14.

Note that ground plane dose factors are only given for the total body and no age group. Doses to other organs are assumed to be equal to the total body dose. All age groups are assumed to receive the same dose.

λ_i Radiological Decay Constant [hr^{-1}]

Radiological decay constant for radionuclide **i**.

t_b Time Period of Ground Deposition [hr]

Time period during which the radioactivity on the ground is assumed to have been deposited (see Part II Table 1-3).

All other terms have been previously defined.

The ground plane exposure pathway is considered to exist at all locations.

4.2.3.2 Inhalation

The site-specific dose factor for inhalation is calculated by the following expression:

$$R_{ai(Inhal)j}[\chi/Q] = K' BR_a DFA_{aij} \qquad (4\text{-}10)$$

$R_{ai(Inhal)j}[\chi/Q]$ Inhalation Pathway Dose Factor [(mrem/yr)/(μCi/m^3)]

Site-specific inhalation dose factor for age group **a**, nuclide **i** and organ **j**. The inhalation dose is calculated using (χ/Q).

BR_a Individual Air Inhalation Rate [m^3/yr]

The air intake rate for individuals in age group **a**. See Table E-5 of Reg. Guide 1.109.

DFA_{aij} Inhalation Dose Conversion Factor [mrem/pCi]

Dose commitment to an individual in age group **a** to organ **j** per unit of activity of radionuclide **i** inhaled. Taken from Tables E-7 through E-10 of Regulatory Guide 1.109. The value for H-3 is taken from NUREG 4013 (Reference 107).

All other terms have been previously defined.

The inhalation exposure pathway is considered to exist at all locations.

4.2.3.3 Ingestion: Vegetation

Food ingestion pathway doses are calculated at locations indicated by the land use census survey. If no real pathway exists within 5 miles of the station, the cow-milk pathway is assumed to be located at 5 miles. Food pathway calculations are not made for sectors in which the offsite regions near the station are over bodies of water.

The dose factor for consumption of vegetables is calculated by the following expression:

$$R_{ai(Veg)j}[D/Q] = K'\left[\frac{(r)}{Y_v(\lambda_i + \lambda_w)}\right](DFL_{aij})\left[U_a^L f_L e^{-\lambda_i t_L} + U_a^S f_g e^{-\lambda_i t_h}\right] \qquad (4\text{-}11)$$

$R_{ai(Veg)j}[D/Q]$ Vegetation Ingestion Pathway Dose Factor [(m^2 mrem/yr)/(μCi/sec)]

Site-specific vegetation ingestion dose factor for age group **a**, nuclide **i** and organ **j**. With the exception of H-3, the vegetation dose is calculated using (D/Q).

r Vegetation Retention Factor [dimensionless]

Y_v Agricultural Productivity Yield [kg/ m^2]

λ_w Weathering Decay Constant [1/sec]

Removal constant for physical loss of activity by weathering. See ODCM Part II Table 1-3.

DFL_{aij} Ingestion Dose Conversion Factor [mrem/pCi]

Ingestion dose conversion factor for age group **a**, nuclide **i** and organ **j**. Converts pCi ingested to mrem. Taken from Tables E-11 though E-14 of Regulatory Guide 1.109. The value for H-3 is taken from NUREG 4013 (Reference 107).

U_a^L Consumption Rate for Fresh Leafy Vegetation [kg/yr]

Consumption rate for fresh leafy vegetation for age group **a**.

U_a^S Consumption Rate for Stored Vegetation [kg/yr]

Consumption rate for stored vegetation for age group **a**.

f_L Local Leafy Vegetation Fraction [dimensionless]

Fraction of the annual intake of fresh leafy vegetation that is grown locally.

f_g Local Stored Vegetation Fraction [dimensionless]

Fraction of the annual intake of stored vegetation that is grown locally.

t_L Environmental Transport Time - Fresh Vegetation [sec]

Average time between harvest of leafy vegetation and its consumption.

t_h Environmental Transport Time - Stored Vegetation [sec]

Average time between harvest of stored vegetation and its consumption.

All other terms have been previously defined.

The tritium dose from the vegetation pathway must be considered separately as the transport mechanism is based on airborne concentration rather than ground deposition. The dose factor for the tritium vegetation pathway is:

$$R_{a(H-3)(Veg))j}[\chi/Q] = K'K'''\left(U_a^L f_L + U_a^S f_g\right) DFL_{a(H-3))j}[0.75(0.5/H)] \tag{4-12}$$

$R_{a(H-3)(Veg))j}[\chi/Q]$ Tritium Vegetation Ingestion Pathway Dose Factor [(mrem/yr)/(μCi/m$^{3)}$]

Site-specific tritium vegetation ingestion dose factor for age group **a** and organ **j**. The tritium vegetation dose is calculated using χ/Q.

K'''	Conversion Constant (1E3 gm per Kg)	[gm/Kg]
H	Absolute Atmospheric Humidity	[gm/m^3]
0.75	Water Fraction The fraction of total vegetation that is water.	[dimensionless]
0.5	Specific Activity Ratio	[dimensionless]

All other terms have been previously defined.

4.2.3.4 Ingestion: Milk

The dose factor for consumption of milk is calculated by the following expressions:

$$R_{ai(Milk))j}[D/Q] = K'\frac{Q_F(U_{am})}{\lambda_i + \lambda_w} F_m(r)\left(DFL_{aij}\right)\left[\frac{f_p f_s}{Y_p} + \frac{\left(1 - f_p f_s\right)e^{-\lambda_i t_h}}{Y_s}\right]e^{-\lambda_i t_f} \tag{4-13}$$

$R_{ai(Milk))j}[D/Q]$ Milk Ingestion Pathway Dose Factor [(m^2 mrem/yr)/(μCi/sec)]

Site-specific milk ingestion dose factor for age group **a**, nuclide **i** and organ **j**. With the exception of H-3, the milk dose factor is calculated using (D/Q).

Q_F Feed Consumption [Kg/da]

Amount of feed consumed by milk animal each day. See ODCM Part II Table 1-3.

U_{am} Milk Consumption Rate [l/yr]

Milk consumption rate for age group **a**.

F_m Stable Element Transfer Coefficient for Milk [da/l]

Fraction of animal's daily intake of a particular chemical element that appears in each liter of milk (pCi/l in milk per pCi/da ingested by animal). See ODCM Part II Table 1-4.

f_p Pasture Time Fraction [dimensionless]

Fraction of year that animal is on pasture.

f_s Pasture Grass Fraction [dimensionless]

Fraction of animal feed that is pasture grass while animal is on pasture.

Y_P Agricultural Productivity Yield - Pasture Grass [kg/m^2]

The agricultural productivity by unit area of pasture feed grass.

Y_S Agricultural Productivity Yield - Stored Feed [kg/m^2]

The agricultural productivity by unit area of stored feed.

t_h Environmental Transport Time - Stored Feed [sec]

Average time between harvest to consumption of stored feed by milk animal.

t_f Environmental Transport Time - Pasture to Consumption [sec]

Average time from pasture, to milk animal, to milk, to consumption.

All other terms have been previously defined.

The tritium dose from the milk pathway must be considered separately as the transport mechanism is based on airborne concentration rather than ground deposition. The dose factor for the tritium milk pathway is:

$$R_{a(H-3)(Milk)j}[\chi/Q] = K'K''' F_m\, Q_F U_{am} DFL_{a(H-3)j}[0.75(0.5/H)] \qquad (4\text{-}14)$$

$R_{a(H-3)(Milk)j}[\chi/Q]$ — Tritium Milk Ingestion Pathway Dose Factor [(mrem/yr)/(μCi/m³)]

Site-specific tritium milk ingestion dose factor for age group **a** and organ **j**. The tritium milk dose is calculated using χ/Q.

H — Absolute Atmospheric Humidity [gm/m³]

All other terms have been previously defined.

4.2.3.5 Ingestion: Meat

The dose factor for consumption of meat is calculated by the following expression:

$$R_{ai(Meat)j}[D/Q] = K' \frac{Q_F(U_{af})}{\lambda_i + \lambda_w} F_f(r)(DFL_{aij})\left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s)e^{-\lambda_i t_h}}{Y_s}\right] e^{-\lambda_i t_f} \qquad (4\text{-}15)$$

$R_{ai(Meat)j}[D/Q]$ — Meat Ingestion Pathway Dose Factor [(m² mrem/yr)/(μCi/sec)]

Site-specific meat ingestion dose factor for age group **a**, nuclide **i** and organ **j**. With the exception of H-3, the meat dose factor is calculated using (D/Q).

U_{af} — Meat Consumption Rate [l/yr]

Meat consumption rate for age group **a**.

F_f — Stable Element Transfer Coefficient for Meat [da/Kg]

Fraction of animal's daily intake of a particular chemical element that appears in each liter of meat (pCi/Kg in meat per pCi/da ingested by animal). See ODCM Part II Table 1-4.

t_f — Environmental Transport Time - Pasture to Consumption [sec]

Average time from pasture, to meat animal, to meat, to consumption.

All other terms have been previously defined.

The tritium dose from the meat pathway must be considered separately as the transport mechanism is based on airborne concentration rather than ground deposition. The dose factor for the tritium meat pathway is:

$$R_{a(H-3)(Meat)j}[\chi/Q] = K'K'''F_f\, Q_F U_{af} DFL_{a(H-3)j}[0.75(0.5/H)] \quad (4\text{-}16)$$

$R_{a(H-3)(Meat)j}[\chi/Q]$ Tritium Meat Ingestion Pathway Dose Factor [(mrem/yr)/(μCi/m^3)]

Site-specific tritium meat ingestion dose factor for age group **a** and organ **j**. The tritium meat dose is calculated using χ/Q.

All other terms have been previously defined.

Table 4-1
Critical Ranges

Direction	UNRESTRICTED AREA Boundary[a] (m)	RESTRICTED AREA Boundary[b] (m)	Nearest Resident[c] (m)	Nearest Dairy Farm within 5 miles[d] (m)
N	864	219	800	note [d]
NNE	1029	224	note [d]	note [d]
NE	1212	265	note [d]	note [d]
ENE	1367	393	note [d]	note [d]
E	1170	867	note [d]	note [d]
ESE	1170	924	note [d]	note [d]
SE	1189	1010	note [d]	note [d]
SSE	1422	1059	note [d]	note [d]
S	1198	762	note [d]	note [d]
SSW	2140	335	note [d]	note [d]
SW	1372	232	note [d]	note [d]
WSW	823	189	note [d]	note [d]
W	713	189	note [d]	note [d]
WNW	713	183	note [d]	note [d]
NW	823	210	note [d]	note [d]
NNW	1481	224	note [d]	note [d]

a Nearest land in UNRESTRICTED AREA. Used in calculating the meteorological dose factors in Table 4–3 through Table 4-5 and Table 4-6.

b These values are to the edge of the Mississippi River, where applicable.

c The distances are rounded to the nearest conservative 100 meters.

d Current census data is contained in site specific procedures.

Table 4-2

Average Wind Speeds

Downwind Direction	Average Wind Speed (m/sec)[a]		
	Elevated	Mixed Mode	Ground Level
N	6.9	5.0	2.6
NNE	6.2	4.6	2.8
NE	5.3	3.7	2.4
ENE	6.0	4.4	2.8
E	6.9	5.0	3.2
ESE	7.1	5.2	3.7
SE	6.5	4.9	3.6
SSE	5.7	4.5	3.5
S	5.6	4.4	3.4
SSW	5.6	4.4	3.3
SW	5.8	4.6	3.0
WSW	6.0	4.7	3.4
W	6.1	4.8	3.1
WNW	6.0	4.5	2.6
NW	5.9	4.4	2.4
NNW	6.5	4.7	2.5

[a] Based on Quad Cities site meteorological data, January 1978 through December 1987 data for ground level and mixed mode release analysis and 1982-1987 data for elevated releases.

Table 4–3
Maximum Offsite Gamma-X/Q

Downwind Direction	Radius	Ground Gamma-X/Q	Stack Gamma-X/Q	Vent Gamma-X/Q
	(meters)	(sec/m^3)	(sec/m^3)	(sec/m^3)
N	864.	6.36E-07	8.54E-08	2.23E-07
NNE	1029.	5.02E-07	8.54E-08	2.02E-07
NE	1212.	3.72E-07	5.27E-08	1.20E-07
ENE	1367.	2.47E-07	3.47E-08	8.62E-08
E	1170.	4.32E-07	5.12E-08	1.48E-07
ESE	1170.	4.33E-07	6.75E-08	1.66E-07
SE	1189.	2.60E-07	5.75E-08	1.20E-07
SSE	1422.	1.34E-07	3.45E-08	6.43E-08
S	1198.	1.51E-07	3.47E-08	6.48E-08
SSW	2140.	6.23E-08	1.55E-08	2.83E-08
SW	1372.	1.97E-07	3.27E-08	7.17E-08
WSW	823.	5.27E-07	5.93E-08	1.66E-07
W	713.	8.56E-07	7.73E-08	2.22E-07
WNW	713.	1.14E-06	6.95E-08	2.30E-07
NW	823.	7.20E-07	6.64E-08	1.81E-07
NNW	1481.	2.66E-07	3.73E-08	9.59E-08

Table 4-4
X/Q and D/Q Maxima at or Beyond the UNRESTRICTED AREA Boundary

Downwind Direction	Elevated (Stack) Release				Mixed Mode (Vent) Release			Ground Level Release		
	Radius (meters)	X/Q (sec/m^3)	Radius (meters)	D/Q ($1/m^2$)	Radius (meters)	X/Q (sec/m^3)	D/Q ($1/m^2$)	Radius (meters)	X/Q (sec/m^3)	D/Q ($1/m^2$)
N	4400	1.344E-08	864	9.643E-10	864	3.427E-07	2.869E-09	864	3.817E-06	1.105E-08
NNE	4023	1.703E-08	1029	1.407E-09	1029	2.219E-07	3.049E-09	1029	2.597E-06	1.052E-08
NE	4828	1.287E-08	1212	7.019E-10	1212	1.321E-07	1.299E-09	1212	2.249E-06	6.701E-09
ENE	440	1.091E-08	1367	6.723E-10	1367	1.213E-07	1.319E-09	1367	1.446E-06	4.806E-09
E	3600	1.513E-08	1170	1.139E-09	1170	2.215E-07	2.811E-09	1170	2.212E-06	9.318E-09
ESE	3600	2.126E-08	1170	1.536E-09	1170	2.332E-07	3.437E-09	1170	2.094E-06	1.047E-08
SE	4023	1.758E-08	1189	1.082E-09	1189	1.439E-07	2.384E-09	1189	1.255E-06	6.450E-09
SSE	4023	1.259E-08	1422	6.915E-10	1422	8.279E-08	1.167E-09	1422	6.885E-07	3.222E-09
S	4400	1.005E-08	1500	4.437E-10	1198	6.887E-08	9.516E-10	1198	8.371E-07	3.350E-09
SSW	4400	8.621E-09	2140	3.110E-10	2140	5.104E-08	4.693E-10	2140	4.296E-07	1.380E-09
SW	4400	1.102E-08	1500	4.856E-10	1372	1.006E-07	1.116E-09	1372	1.224E-06	3.856E-09
WSW	4400	1.123E-08	1500	4.674E-10	823	2.158E-07	2.298E-09	823	2.968E-06	1.093E-08
W	4828	1.139E-08	1500	4.704E-10	713	3.445E-07	2.737E-09	713	5.271E-06	1.522E-08
WNW	4828	9.486E-09	1500	4.025E-10	713	5.025E-07	2.816E-09	713	7.554E-06	1.788E-08
NW	4828	9.752E-09	823	5.475E-10	823	2.981E-07	2.009E-09	823	4.739E-06	1.144E-08
NNW	4400	1.045E-08	1481	6.127E-10	1481	1.712E-07	1.202E-09	1481	1.928E-06	4.543E-09

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Based on Sargent & Lundy, Nuclear Safeguards and Licensing Division, Quad Cities calculation no. ATD-0139, "N-16 Skyshine Ground Level Doses from Quad Cities Turbine Systems & Piping, Revision 0.

Used for beta air, beta skin, and inhalation dose pathways. See ODCM part II sections 4.2.2.2, 4.2.2.4, and 4.2.3.2.

Used for produce and leafy vegetable pathways. See ODCM part II section 4.2.3.

Table 4-5

X/Q and D/Q Maxima at or Beyond the RESTRICTED AREA Boundary

Downwind Direction	Elevated (Stack) Release				Mixed Mode (Vent) Release			Ground Level Release		
	Radius (meters)	X/Q (sec/m^3)	Radius (meters)	D/Q (1/m^2)	Radius (meters)	X/Q (sec/m^3)	D/Q (1/m^2)	Radius (meters)	X/Q (sec/m^3)	D/Q (1/m^2)
N	4400	1.344E-08	420	1.244E-09	219	3.171E-06	1.377E-08	219	3.908E-05	8.926E-08
NNE	480	2.173E-08	420	2.103E-09	224	2.086E-06	1.548E-08	224	3.155E-05	1.096E-07
NE	4828	1.287E-08	420	1.006E-09	265	1.070E-06	6.653E-09	265	2.583E-05	7.200E-08
ENE	4400	1.091E-08	420	1.010E-09	393	5.774E-07	5.329E-09	393	9.932E-06	3.539E-08
E	3600	1.513E-08	867	1.319E-09	867	3.073E-07	3.999E-09	867	3.485E-06	1.525E-08
ESE	3600	2.126E-08	924	1.688E-09	924	2.949E-07	4.507E-09	924	2.997E-06	1.544E-08
SE	4023	1.758E-08	1010	1.126E-09	1010	1.657E-07	2.875E-09	1010	1.611E-06	8.445E-09
SSE	4023	1.259E-08	1059	7.178E-10	1059	1.024E-07	1.611E-09	1059	1.080E-06	5.287E-09
S	4400	1.005E-08	1500	4.437E-10	762	1.070E-07	1.511E-09	762	1.672E-06	7.035E-09
SSW	4400	8.621E-09	420	4.004E-10	335	4.092E-07	3.719E-09	335	7.714E-06	2.774E-08
SW	4400	1.102E-08	1500	4.856E-10	232	1.173E-06	7.186E-09	232	2.231E-05	6.181E-08
WSW	4400	1.123E-08	1500	4.674E-10	189	2.260E-06	1.271E-08	189	3.588E-05	1.002E-07
W	4828	1.139E-08	1500	4.704E-10	189	3.196E-06	1.355E-08	189	5.242E-05	1.109E-07
WNW	4828	9.486E-09	420	4.079E-10	183	5.215E-06	1.491E-08	183	8.197E-05	1.362E-07
NW	4828	9.752E-09	420	6.595E-10	210	2.909E-06	1.002E-08	210	5.006E-05	9.064E-08
NNW	4400	1.045E-08	420	1.027E-09	224	3.092E-06	1.192E-08	224	4.464E-05	8.717E-08

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Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Kr-83m

Downwind Direction	UNRESTRICTED AREA Boundary (meters)	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)	SBAR (µCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (µCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (µCi/sec)
N	864	864	1.193E-06	8.998E-07	864	4.094E-05	3.087E-05	864	3.885E-04	2.929E-04
NNE	1029	1029	1.785E-06	1.346E-06	1029	2.796E-05	2.108E-05	1029	2.651E-04	1.999E-04
NE	1212	1212	9.747E-07	7.349E-07	1212	1.639E-05	1.236E-05	1212	2.162E-04	1.630E-04
ENE	1367	1367	9.035E-07	6.812E-07	1367	1.409E-05	1.063E-05	1367	1.373E-04	1.036E-04
E	1170	1170	1.378E-06	1.039E-06	1170	2.602E-05	1.962E-05	1170	2.220E-04	1.674E-04
ESE	1170	1170	1.775E-06	1.338E-06	1170	2.752E-05	2.075E-05	1170	2.113E-04	1.593E-04
SE	1189	1189	1.286E-06	9.695E-07	1189	1.748E-05	1.318E-05	1189	1.248E-04	9.407E-05
SSE	1422	1422	9.303E-07	7.014E-07	1422	9.663E-06	7.286E-06	1422	6.648E-05	5.012E-05
S	1198	1198	4.932E-07	3.719E-07	1198	8.591E-06	6.478E-06	1198	8.157E-05	6.150E-05
SSW	2140	2140	6.664E-07	5.025E-07	2140	5.469E-06	4.124E-06	2140	3.670E-05	2.767E-05
SW	1372	1372	6.134E-07	4.625E-07	1372	1.175E-05	8.862E-06	1372	1.164E-04	8.775E-05
WSW	823	823	4.376E-07	3.300E-07	823	2.665E-05	2.010E-05	823	3.016E-04	2.274E-04
W	713	713	4.936E0-7	3.722E-07	713	4.059E-05	3.060E-05	713	5.263E-04	3.968E-04
WNW	713	713	4.839E-07	3.648E-07	713	5.484E-05	4.135E-05	713	7.361E-04	5.550E-04
NW	823	823	8.023E-07	6.049E-07	823	3.493E-05	2.634E-05	823	4.707E-04	3.549E-04
NNW	1481	1481	9.575E-07	7.220E-07	1481	1.950E-05	1.470E-05	1481	1.814E-04	1.368E-04

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Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Kr-85m

Downwind Direction	UNRESTRICTED AREA Boundary	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
	(meters)	Radius (meters)	S (mrad/yr)	SBAR (μCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (μCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (μCi/sec)
N	864	864	1.266E-04	1.225E-04	864	4.908E-04	4.728E-04	864	2.089E-03	2.000E-03
NNE	1029	1029	1.322E-04	1.278E-04	1029	4.358E-04	4.204E-04	1029	1.591E-03	1.525E-03
NE	1212	1212	8.448E-05	8.172E-05	1212	2.793E-04	2.694E-04	1212	1.383E-03	1.326E-03
ENE	1367	1367	5.783E-05	5.593E-05	1367	2.056E-04	1.983E-04	1367	9.249E-04	8.872E-04
E	1170	1170	8.118E-05	7.850E-05	1170	3.308E-04	3.187E-04	1170	1.393E-03	1.336E-03
ESE	1170	1170	1.067E-04	1.032E-04	1170	3.662E-04	3.530E-04	1170	1.337E-03	1.282E-03
SE	1189	1189	9.118E-05	8.820E-05	1189	2.618E-04	2.525E-04	1189	8.091E-04	7.760E-04
SSE	1422	1422	5.797E-05	5.606E-05	1422	1.518E-04	1.464E-04	1422	4.523E-04	4.340E-04
S	1198	1198	5.611E-05	5.428E-05	1198	1.469E-04	1.417E-04	1198	5.192E-04	4.978E-04
SSW	2140	2140	3.024E-05	2.924E-05	2140	7.862E-05	7.579E-05	2140	2.775E-04	2.663E-04
SW	1372	1372	5.402E-05	5.226E-05	1372	1.697E-04	1.636E-04	1372	7.514E-04	7.204E-04
WSW	823	823	8.767E-05	8.484E-05	823	3.499E-04	3.372E-04	823	1.663E-03	1.564E-03
W	713	713	1.112E-04	1.076E-04	713	4.644E-04	4.473E-04	713	2.573E-03	2.461E-03
WNW	713	713	1.000E-04	9.678E-05	713	5.046E-04	4.854E-04	713	3.454E-03	3.302E-03
NW	823	823	9.794E-05	9.476E-05	823	3.993E-04	3.846E-04	823	2.406E-03	2.302E-03
NNW	1481	1481	6.223E-05	6.018E-05	1481	2.449E-04	2.360E-04	1481	1.147E-03	1.099E-03

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Table 4-6 (Page 3 of 15)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Kr-85

Downwind Direction	UNRESTRICTED AREA Boundary (meters)	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)	SBAR (µCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (µCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (µCi/sec)
N	864	864	1.753E-06	1.695E-06	864	5.814E-06	5.622E-06	864	2.347E-05	2.269E-05
NNE	1029	1029	1.834E-06	1.773E-06	1029	5.237E-06	5.064E-06	1029	1.792E-05	1.733E-05
NE	1212	1212	1.185E-06	1.146E-06	1212	3.399E-06	3.287E-06	1212	1.595E-05	1.542E-05
ENE	1367	1367	8.083E-07	7.817E-07	1367	2.473E-06	2.391E-06	1367	1.072E-05	1.037E-05
E	1170	1170	1.116E-06	1.079E-06	1170	3.908E-06	3.779E-06	1170	1.578E-05	1.525E-05
ESE	1170	1170	1.461E-06	1.413E-06	1170	4.335E-06	4.192E-06	1170	1.510E-05	1.460E-05
SE	1189	1189	1.259E-06	1.217E-06	1189	3.118E-06	3.015E-06	1189	9.186E-06	8.883E-06
SSE	1422	1422	8.057E-07	7.791E-07	1422	1.829E-06	1.769E-06	1422	5.211E-06	5.039E-06
S	1198	1198	7.916E-07	7.655E-07	1198	1.774E-06	1.716E-06	1198	5.956E-06	5.760E-06
SSW	2140	2140	4.230E-07	4.090E-07	2140	9.632E-07	9.314E-07	2140	3.375E-06	3.264E-06
SW	1372	1372	7.572E-07	7.322E-07	1372	2.039E-06	1.971E-06	1372	8.743E-06	8.454E-06
WSW	823	823	1.239E-06	1.198E-06	823	4.157E-06	4.020E-06	823	1.828E-05	1.768E-05
W	713	713	1.570E-06	1.519E-06	713	5.481E-06	5.300E-06	713	2.847E-05	2.753E-05
WNW	713	713	1.414E-06	1.367E-06	713	5.906E-06	5.711E-06	713	3.816E-05	3.690E-05
NW	823	823	1.372E-06	1.372E-06	823	4.734E-06	4.578E-06	823	2.700E-05	2.610E-05
NNW	1481	1481	8.575E-07	8.292E-07	1481	2.931E-06	2.834E-06	1481	1.350E-05	1.305E-05

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Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Kr-87

Downwind Direction	UNRESTRICTED AREA Boundary (meters)	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)	SBAR (μCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (μCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (μCi/sec)
N	864	864	6.162E-04	5.987E-04	864	1.698E-03	1.649E-03	864	5.808E-03	5.639E-03
NNE	1029	1029	6.389E-04	6.207E-04	1029	1.557E-03	1.512E-03	1029	4.508E-03	4.377E-03
NE	1212	1212	4.118E-04	4.001E-04	1212	9.907E-04	9.622E-04	1212	3.742E-03	3.633E-03
ENE	1367	1367	2.753E-04	2.675E-04	1367	7.128E-04	6.923E-04	1367	2.504E-03	2.432E-03
E	1170	1170	3.853E-04	3.743E-04	1170	1.146E-03	1.113E-03	1170	3.929E-03	3.815E-03
ESE	1170	1170	5.023E-04	4.880E-04	1170	1.270E-03	1.234E-03	1170	3.806E-03	3.695E-03
SE	1189	1189	4.324E-04	4.201E-04	1189	9.253E-04	8.986E-04	1189	2.291E-03	2.225E-03
SSE	1422	1422	2.723E-04	2.646E-04	1422	5.290E-04	5.137E-04	1422	1.256E-03	1.220E-03
S	1198	1198	2.704E-04	2.628E-04	1198	5.202E-04	5.052E-04	1198	1.424E-03	1.383E-03
SSW	2140	2140	1.354E-04	1.315E-04	2140	2.615E-04	2.540E-04	2140	7.068E-04	6.863E-04
SW	1372	1372	2.581E-04	2.507E-04	1372	5.872E-04	5.702E-04	1372	2.001E-03	1.943E-03
WSW	823	823	4.379E-04	4.255E-04	823	1.238E-03	1.202E-03	823	4.588E-03	4.454E-03
W	713	713	5.602E-04	5.443E-04	713	1.632E-03	1.585E-03	713	7.313E-03	7.101E-03
WNW	713	713	5.039E-04	4.896E-04	713	1.729E-03	1.679E-03	713	9.810E-03	9.525E-03
NW	823	823	4.859E-04	4.721E-04	823	1.388E-03	1.348E-03	823	6.654E-03	6.461E-03
NNW	1481	1481	2.903E-04	2.820E-04	1481	8.192E-04	7.955E-04	1481	2.955E-03	2.869E-03

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Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Kr-88

Downwind Direction	UNRESTRICTED AREA Boundary (meters)	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)	SBAR (µCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (µCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (µCi/sec)
N	864	864	1.594E-03	1.551E-03	864	4.220E-03	4.104E-03	864	1.481E-02	1.438E-02
NNE	1029	1029	1.665E-03	1.621E-03	1029	3.885E-03	3.779E-03	1029	1.143E-02	1.111E-02
NE	1212	1212	1.083E-03	1.054E-03	1212	2.515E-03	2.447E-03	1212	9.828E-03	9.548E-03
ENE	1367	1367	7.271E-04	7.078E-04	1367	1.805E-03	1.756E-03	1367	6.599E-03	6.411E-03
E	1170	1170	1.022E-03	9.755E-04	1170	2.853E-03	2.775E-03	1170	1.001E-02	9.728E-03
ESE	1170	1170	1.301E-03	1.266E-03	1170	3.165E-03	3.078E-03	1170	9.639E-03	9.364E-03
SE	1189	1189	1.124E-03	1.094E-03	1189	2.307E-03	2.244E-03	1189	5.837E-03	5.671E-03
SSE	1422	1422	7.148E-04	6.957E-04	1422	1.340E-03	1.303E-03	1422	3.258E-03	3.165E-03
S	1198	1198	7.126E-04	6.937E-04	1198	1.312E-03	1.276E-03	1198	3.701E-03	3.596E-03
SSW	2140	2140	3.636E-04	3.539E-04	2140	6.814E-04	6.628E-04	2140	1.963E-03	1.908E-03
SW	1372	1372	6.784E-04	6.604E-04	1372	1.485E-03	1.444E-03	1372	5.313E-03	5.161E-03
WSW	823	823	1.144E-03	1.114E-03	823	3.068E-03	2.984E-03	823	1.160E-02	1.127E-02
W	713	713	1.459E-03	1.420E-03	713	4.024E-03	3.913E-03	713	1.827E-02	1.774E-02
WNW	713	713	1.313E-03	1.278E-03	713	4.274E-03	4.156E-03	713	2.451E-02	2.379E-02
NW	823	823	1.265E-03	1.231E-03	823	3.452E-03	3.357E-03	823	1.699E-02	1.650E-02
NNW	1481	1481	7.588E-04	7.386E-04	1481	2.083E-03	2.026E-03	1481	8.020E-03	7.791E-03

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Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Kr-89

Downwind Direction	UNRESTRICTED AREA Boundary (meters)	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)	SBAR (µCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (µCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (µCi/sec)
N	864	864	7.380E-04	7.172E-04	864	1.425E-03	1.385E-03	864	2.034E-03	1.976E-03
NNE	1029	1029	6.261E-04	6.085E-04	1029	1.149E-03	1.116E-03	1029	1.603E-03	1.557E-03
NE	1212	1212	3.167E-04	3.078E-04	1212	5.081E-04	4.936E-04	1212	7.823E-04	7.598E-04
ENE	1367	1367	2.047E-04	1.989E-04	1367	3.701E-04	3.595E-04	1367	5.059E-04	4.914E-04
E	1170	1170	3.698E-04	3.594E-04	1170	8.126E-04	7.894E-04	1170	1.310E-03	1.273E-03
ESE	1170	1170	5.046E-04	4.904E-04	1170	9.740E-04	9.462E-04	1170	1.566E-03	1.522E-03
SE	1189	1189	4.116E-04	4.000E-04	1189	6.659E-04	6.469E-04	1189	9.264E-04	8.998E-04
SSE	1422	1422	2.003E-04	1.946E-04	1422	2.810E-04	2.730E-04	1422	3.822E-04	3.712E-04
S	1198	1198	2.189E-04	2.127E-04	1198	3.175E-04	3.084E-04	1198	4.622E-04	4.490E-04
SSW	2140	2140	5.751E-05	5.588E-05	2140	7.519E-05	7.304E-05	2140	8.761E-05	8.510E-05
SW	1372	1372	1.914E-04	1.860E-04	1372	3.241E-04	3.149E-04	1372	4.441E-04	4.313E-04
WSW	823	823	4.790E-04	4.655E-04	823	1.113E-03	1.081E-03	823	2.203E-03	2.140E-03
W	713	713	6.760E-04	6.569E-04	713	1.569E-03	1.524E-03	713	3.460E-03	3.361E-03
WNW	713	713	6.075E-04	5.904E-04	713	1.513E-03	1.470E-03	713	4.161E-03	4.041E-03
NW	823	823	5.447E-04	5.293E-04	823	1.114E-03	1.082E-03	823	2.198E-03	2.135E-03
NNW	1481	1481	2.270E-04	2.206E-04	1481	3.806E-04	3.697E-04	1481	3.958E-04	3.844E-04

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Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Kr-90

Downwind Direction	UNRESTRICTED AREA Boundary (meters)	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)	SBAR (μCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (μCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (μCi/sec)
N	864	864	1.025E-04	9.947E-05	864	1.001E-04	9.715E-05	864	3.226E-05	3.128E-05
NNE	1029	1029	4.953E-05	4.807E-05	1029	4.309E-05	4.181E-05	1029	1.549E-05	1.502E-05
NE	1212	1212	1.210E-05	1.174E-05	1212	7.167E-06	6.953E-06	1212	2.958E-06	2.869E-06
ENE	1367	1367	8.572E-06	8.320E-06	1367	7.121E-06	6.908E-06	1367	3.357E-06	3.255E-06
E	1170	1170	2.876E-05	2.792E-05	1170	3.061E-05	29.70E-05	1170	1.687E-05	1.636E-05
ESE	1170	1170	4.141E-05	4.019E-05	1170	3.846E-05	3.731E-05	1170	2.748E-05	2.665E-05
SE	1189	1189	2.685E-05	2.606E-05	1189	2.120E-05	2.056E-05	1189	1.306E-05	1.267E-05
SSE	1422	1422	5.661E-06	5.494E-06	1422	4.092E-06	3.970E-06	1422	2.460E-06	2.385E-06
S	1198	1198	9.811E-06	9.523E-06	1198	7.891E-06	7.656E-06	1198	6.776E-06	6.571E-06
SSW	2140	2140	5.194E-07	5.040E-07	2140	2.996E-07	2.907E-07	2140	1.827E-07	1.772E-07
SW	1372	1372	6.788E-06	6.588E-06	1372	6.147E-06	5.963E-06	1372	3.347E-06	3.246E-06
WSW	823	823	5.697E-05	5.530E-05	823	8.167E-0	7.923E-05	823	8.406E-05	8.151E-05
W	713	713	1.054E-04	1.023E-04	713	1.550E-04	1.504E-04	713	1.486E-04	1.441E-04
WNW	713	713	9.367E-05	9.092E-05	713	1.286E-04	1.211E-04	713	1.211E-04	1.174E-04
NW	823	823	6.316E-05	6.131E-05	823	6.467E-05	6.275E-05	823	3.606E-05	3.497E-05
NNW	1481	1481	8.234-06	7.992E-06	1481	6.106E-06	5.924E-06	1481	1.127E-06	1.093E-06

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Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Xe-131m

Downwind Direction	UNRESTRICTED AREA Boundary (meters)	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)	SBAR (µCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (µCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (µCi/sec)
N	864	864	3.647E-06	3.327E-06	864	4.407E-05	3.544E-05	864	3.834E-04	2.985E-04
NNE	1029	1029	4.237E-06	3.798E-06	1029	3.179E-05	2.595E-05	1029	2.633E-04	2.057E-04
NE	1212	1212	2.587E-06	2.338E-06	1212	1.947E-05	1.596E-05	1212	2.279E-04	1.782E-04
ENE	1367	1367	1.965E-06	1.747E-06	1367	1.602E-05	1.302E-05	1367	1.466E-04	1.149E-04
E	1170	1170	2.839E-06	2.511E-06	1170	2.808E-05	2.266E-05	1170	2.237E-04	1.750E-04
ESE	1170	1170	3.680E-06	3.262E-06	1170	2.997E-05	2.426E-05	1170	2.118E-04	1.657E-04
SE	1189	1189	2.967E-06	2.654E-06	1189	1.963E-05	1.599E-05	1189	1.267E-04	9.918E-05
SSE	1422	1422	1.993E-06	1.769E-06	1422	1.114E-05	9.905E-06	1422	6.993E-05	5.482E-05
S	1198	1198	1.599E-06	1.463E-06	1198	1.013E-05	8.309E-06	1198	8.492E-05	6.642E-05
SSW	2140	2140	1.206E-06	1.050E-06	2140	6.337E-06	5.144E-06	2140	4.359E-05	3.422E-05
SW	1372	1372	1.650E-06	1.493E-06	1372	1.332E-05	1.082E-05	1372	1.252E-04	9.792E-05
WSW	823	823	2.220E-06	2.075E-06	823	2.888E-05	2.335E-05	823	2.959E-04	2.304E-04
W	713	713	2.791E-06	2.589E-06	713	4.234E-05	3.407E-05	713	4.991E-04	3.877E-04
WNW	713	713	2.521E-06	2.357E-06	713	5.524E-05	4.391E-05	713	6.941E-04	5.386E-04
NW	823	823	2.737E-06	2.507E-06	823	3.710E-05	2.977E-05	823	4.622E-04	3.593E-04
NNW	1481	1481	2.099E-06	1.868E-06	1481	2.184E-05	1.759E-05	1481	1.999E-04	1.561E-04

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Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Xe-133m

Downwind Direction	UNRESTRICTED AREA Boundary (meters)	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)	SBAR (μCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (μCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (μCi/sec)
N	864	864	1.894E-05	1.812E-05	864	1.039E-04	9.305E-05	864	6.441E-04	5.482E-04
NNE	1029	1029	2.025E-05	1.928E-05	1029	8.483E-05	7.710E-05	1029	4.614E-04	3.957E-04
NE	1212	1212	1.285E-05	1.226E-05	1212	5.369E-05	4.897E-05	1212	4.033E-04	3.465E-04
ENE	1367	1367	9.011E-06	8.562E-06	1367	4.123E-05	3.733E-05	1367	2.642E-04	2.277E-04
E	1170	1170	1.267E-05	1.202E-05	1170	6.835E-05	6.147E-05	1170	3.977E-04	3.419E-04
ESE	1170	1170	1.660E-05	1.576E-05	1170	7.460E-05	6.727E-05	1170	3.783E-04	3.255E-04
SE	1189	1189	1.402E-05	1.334E-05	1189	5.149E-05	4.671E-05	1189	2.278E-04	1.962E-04
SSE	1422	1422	9.051E-06	8.594E-06	1422	2.975E-05	2.704E-05	1422	1.270E-04	1.096E-04
S	1198	1198	8.431E-06	8.074E-06	1198	2.808E-05	2.563E-05	1198	1.505E-05	1.293E-04
SSW	2140	2140	4.938E-06	4.658E-06	2140	1.613E-05	1.459E-05	2140	8.011E-05	6.932E-05
SW	1372	1372	8.224E-06	7.852E-06	1372	3.413E-05	3.088E-05	1372	2.212E-04	1.900E-04
WSW	823	823	1.283E-05	1.234E-05	823	7.137E-05	6.430E-05	823	4.990E-04	4.250E-04
W	713	713	1.619E-05	1.558E-05	713	9.876E-05	8.833E-05	713	8.170E-04	6.918E-04
WNW	713	713	1.461E-05	1.405E-05	713	1.166E-04	1.029E-04	713	1.121E-03	9.465E-04
NW	823	823	1.457E-05	13.95E-05	823	8.573E-05	7.661E-05	823	7.625E-04	6.468E-04
NNW	1481	1481	9.664E-06	9.184E-06	1481	5.202E-05	4.667E-05	1481	3.480E-04	2.982E-04

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Table 4-6 (Page 10 of 15)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Xe-133

Downwind Direction	UNRESTRICTED AREA Boundary (meters)	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)	SBAR (μCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (μCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (μCi/sec)
N	864	864	1.741E-05	1.678E-05	864	1.161E-04	1.068E-04	864	7.126E-04	6.308E-04
NNE	1029	1029	1.886E-05	1.810E-05	1029	9.493E-05	8.825E-05	1029	5.171E-04	4.609E-04
NE	1212	1212	1.186E-05	1.140E-05	1212	5.974E-05	5.567E-05	1212	4.451E-05	4.054E-04
ENE	1367	1367	8.561E-06	8.203E-06	1367	4.602E-05	4.266E-05	1367	2.989E-04	2.675E-04
E	1170	1170	1.214E-05	1.162E-05	1170	7.658E-05	7.065E-05	1170	4.478E-04	4.000E-04
ESE	1170	1170	1.606E-05	1.538E-05	1170	8.356E-05	7.724E-05	1170	4.264E-04	3.811E-04
SE	1189	1189	1.340E-05	1.286E-05	1189	5.575E-05	5.344E-05	1189	2.572E-04	2.301E-04
SSE	1422	1422	8.767E-06	8.399E-06	1422	3.309E-05	3.076E-05	1422	1.438E-04	1.289E-04
S	1198	1198	7.778E-06	7.503E-06	1198	3.131E-05	2.919E-05	1198	1.695E-04	1.513E-04
SSW	2140	2140	4.975E-06	4.743E-06	2140	1.790E-05	1.657E-05	2140	9.115E-05	8.184E-05
SW	1372	1372	7.778E-06	7.484E-06	1372	3.803E-05	3.523E-05	1372	2.491E-04	2.224E-04
WSW	823	823	1.135E-05	1.099E-05	823	7.956E-05	7.348E-05	823	5.527E-04	4.896E-04
W	713	713	1.419E-05	1.375E-05	713	1.096E-04	1.006E-04	713	8.936E-04	7.872E-04
WNW	713	713	1.281E-05	1.241E-05	713	1.283E-04	1.166E-04	713	1.218E-03	1.070E-03
NW	823	823	1.308E-05	1.232E-05	823	9.513E-05	8.731E-05	823	8.374E-04	7.389E-04
NNW	1481	1481	9.317E-06	8.932E-06	1481	5.833E-05	5.372E-05	1481	3.907E-04	3.480E-04

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Table 4-6 (Page 11 of 15)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Xe-135m

Downwind Direction	UNRESTRICTED AREA Boundary (meters)	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)	SBAR (µCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (µCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (µCi/sec)
N	864	864	2.899E-04	2.803E-04	864	8.530E-04	8.236E-04	864	2.453E-03	2.363E-03
NNE	1029	1029	2.877E-04	2.781E-04	1029	7.645E-04	7.384E-04	1029	1.941E-03	1.870E-03
NE	1212	1212	1.756E-04	1.697E-04	1212	4.447E-04	4.296E-04	1212	1.382E-03	1.332E-03
ENE	1367	1367	1.163E-04	1.125E-04	1367	3.217E-04	3.107E-04	1367	9.117E-04	8.789E-04
E	1170	1170	1.741E-04	1.683E-04	1170	5.632E-04	5.438E-04	1170	1.662E-03	1.602E-03
ESE	1170	1170	2.308E-04	2.231E-04	1170	6.317E-04	6.100E-04	1170	1.681E-03	1.620E-03
SE	1189	1189	1.959E-04	1.894E-04	1189	4.536E-04	4.381E-04	1189	1.003E-03	9.670E-04
SSE	1422	1422	1.166E-04	1.127E-04	1422	2.398E-04	2.316E-04	1422	5.084E-04	4.901E-04
S	1198	1198	1.163E-04	1.124E-04	1198	2.423E-04	2.340E-04	1198	5.714E-04	5.507E-04
SSW	2140	2140	5.156E-05	4.984E-05	2140	1.028E-04	9.925E-05	2140	2.160E-04	2.082E-04
SW	1372	1372	1.099E-04	1.063E-04	1372	2.682E-04	2.590E-04	1372	7.263E-04	7.000E-04
WSW	823	823	1.979E-04	1.914E-04	823	6.335E-04	6.118E-04	823	2.055E-03	1.979E-03
W	713	713	2.585E-04	2.499E-04	713	8.524E-04	8.229E-04	713	3.381E-03	3.255E-03
WNW	713	713	2.323E-04	2.246E-04	713	8.874E-04	8.56E-04	713	4.500E-03	4.332E-03
NW	823	823	2.227E-04	2.153E-04	823	6.913E-04	6.674E-04	823	2.772E-03	2.670E-03
NNW	1481	1481	1.264E-04	1.222E-04	1481	3.575E-04	3.452E-04	1481	9.461E-04	9.117E-04

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Table 4-6 (Page 12 of 15)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Xe-135

Downwind Direction	UNRESTRICTED AREA Boundary	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
	(meters)	Radius (meters)	S (mrad/yr)	SBAR (μCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (μCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (μCi/sec)
N	864	864	1.787E-04	1.729E-04	864	6.779E-04	6.555E-04	864	2.851E-03	2.753E-03
NNE	1029	1029	1.867E04	1.807E04	1029	6.045E04	5.847E04	1029	2.178E-03	2.753E-03
NE	1212	1212	1.196E-04	1.158E-04	1212	3.894E-04	3.766E-04	1212	1.917E-03	1.851E-03
ENE	1367	1367	8.192E-05	7.928E-05	1367	2.860E-04	2.766E-04	1367	1.285E-03	1.242E-03
E	1170	1170	1.145E-04	1.108E-04	1170	4.571E-04	4.420E-04	1170	1.913E-03	1.848E-03
ESE	1170	1170	1.504E-04	1.456E-04	1170	5.067E-04	4.900E-04	1170	1.833E-03	1.771E-03
SE	1189	1189	1.287E-04	1.246E-04	1189	3.627E-04	3.508E-04	1189	1.113E-03	1.075E-03
SSE	1422	1422	8.204E-05	7.939E-05	1422	2.113E-04	2.044E-04	1422	6.264E-04	6.052E-04
S	1198	1198	7.961E-05	7.705E-05	1198	2.044E-04	1.977E-04	1198	7.175E-04	6.931E-04
SSW	2140	2140	4.304E-05	4.165E-05	2140	1.103E-04	1.067E-04	2140	3.945E-04	3.812E-04
SW	1372	1372	7.655E-05	7.409E-05	1372	2.359E-04	2.282E-04	1372	1.046E-03	1.010E-03
WSW	823	823	1.242E-04	1.202E-04	823	4.833E-04	4.674E-04	823	2.225E-03	2.149E-03
W	713	713	1.573E-04	1.522E-04	713	6.395E-04	6.183E-04	713	3.478E-03	3.358E-03
WNW	713	713	1.415E-04	1.370E-04	713	6.923E-04	6.693E-04	713	4.660E-03	4.498E-03
NW	823	823	1.384E-04	1.340E-04	823	5.510E-04	5.328E-04	823	3.277E-03	3.164E-03
NNW	1481	1481	8.796E-05	8.512E-05	1481	3.406E-04	3.293E-04	1481	1.605E-03	1.550E-03

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Table 4-6 (Page 13 of 15)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Xe-137

Downwind Direction	UNRESTRICTED AREA Boundary (meters)	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)	SBAR (µCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (µCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (µCi/sec)
N	864	864	9.587E-05	9.280E-05	864	2.169E-04	2.100E-04	864	3.650E-04	3.532E-04
NNE	1029	1029	8.396E-05	9.280E-05	1029	1.789E-04	1.731E-04	1029	2.883E-04	2.789E-04
NE	1212	1212	4.406E-05	4.265E-05	1212	8.327E-05	8.059E-05	1212	1.506E-04	1.457E-04
ENE	1367	1367	2.876E-05	2.784E-05	1367	6.062E-05	5.866E-05	1367	9.706E-05	9.392E-05
E	1170	1170	5.014E-05	4.854E-05	1170	1.280E-04	1.238E-04	1170	2.375E-04	2.298E-04
ESE	1170	1170	6.821E-05	6.603E-05	1170	1.517E-04	1.468E-04	1170	2.747E-04	2.658E-04
SE	1189	1189	5.604E-05	5.425E-05	1189	1.044E-04	1.010E-04	1189	1.631E-04	1.578E-04
SSE	1422	1422	2.842E-05	2.751E-05	1422	4.591E-05	4.443E-05	1422	6.975E-05	6.749E-05
S	1198	1198	3.027E-05	2.930E-05	1198	5.064E-05	4.901E-05	1198	8.267E-05	7.999E-05
SSW	2140	2140	8.925E-06	8.639E-06	2140	1.344E-05	1.301E-05	2140	1.753E-05	1.696E-05
SW	1372	1372	2.697E-05	2.611E-05	1372	5.261E-05	5.091E-05	1372	8.334E-05	8.064E-05
WSW	823	823	6.236E-05	6.037E-05	823	1.682E-04	1.628E-04	823	3.760E-04	3.638E-04
W	713	713	8.655E-05	8.378E-05	713	2.349E-04	2.274E-04	713	5.968E-04	5.775E-04
WNW	713	713	7.777E-04	7.529E-04	713	2.298E-04	2.224E-04	713	7.354E-04	7.115E-04
NW	823	823	7.090E-05	6.863E-05	823	1.705E-04	1.650E-04	823	3.973E-04	3.845E-04
NNW	1481	1481	3.192E-05	3.090E-05	1481	6.298E-05	6.095E-05	1481	7.935E-05	7.678E-05

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Table 4-6 (Page 14 of 15)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Xe-138

Downwind Direction	UNRESTRICTED AREA Boundary (meters)	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)	SBAR (μCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (μCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (μCi/sec)
N	864	864	7.602E-04	9.388E-04	864	1.909E-03	1.854E-03	864	5.007E-03	4.860E-03
NNE	1029	1029	7.527E-04	7.315E-04	1029	1.728E-03	1.679E-03	1029	3.991E-03	3.874E-03
NE	1212	1212	4.600E-04	4.471E-04	1212	1.005E-03	9.759E-04	1212	2.814E-03	2.731E-03
ENE	1367	1367	3.014E-04	2.929E-04	1367	7.202E-04	6.995E-04	1367	1.859E-03	1.804E-03
E	1170	1170	4.505E-04	4.378E-04	1170	1.258E-03	1.222E-03	1170	3.418E-03	3.318E-03
ESE	1170	1170	5.943E-04	5.775E-04	1170	1.414E-03	1.373E-03	1170	3.473E-03	3.371E-03
SE	1189	1189	5.059E-04	4.916E-04	1189	1.022E-03	9.929E-04	1189	2.076E-03	2.015E-03
SSE	1422	1422	2.995E-04	2.910E-04	1422	5.384E-04	5.229E-04	1422	1.049E-03	1.018E-03
S	1198	1198	3.027E-04	2.941E-04	1198	5.469E-04	5.312E-04	1198	1.174E-03	1.139E-03
SSW	2140	2140	1.297E-04	1.260E-04	2140	2.269E-04	2.204E-04	2140	4.390E-04	4.262E-04
SW	1372	1372	2.843E-04	2.763E-04	1372	6.005E-04	5.832E-04	1372	1.480E-03	1.436E-03
WSW	823	823	5.252E-04	5.104E-04	823	1.428E-03	1.387E-03	823	4.220E-03	4.095E-03
W	713	713	6.885E-04	6.691E-04	713	1.914E-03	1.859E-03	713	6.917E-03	6.712E-03
WNW	713	713	6.188E-04	6.014E-04	713	1.974E-03	1.917E-03	713	9.182E-03	8.910E-03
NW	823	823	5.894E-03	5.728E-04	823	1.550E-03	1.505E-03	823	5.640E-03	5.474E-03
NNW	1481	1481	3.244E-04	3.152E-04	1481	7.909E-04	7.681E-04	1481	1.903E-03	1.847E-03

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Table 4-6 (Page 15 of 15)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the UNRESTRICTED AREA Boundary for Ar-41

Downwind Direction	UNRESTRICTED AREA Boundary (meters)	Elevated (Stack) Release			Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)	SBAR (μCi/sec)	Radius (meters)	V (mrad/yr)	VBAR (μCi/sec)	Radius (meters)	G (mrad/yr)	GBAR (μCi/sec)
N	864	864	9.169E-04	8.875E-04	864	2.639E-03	2.555E-03	864	9.453E-03	9.150E-03
NNE	1029	1029	9.534E-04	9.229E-04	1029	2.410E-03	2.333E-03	1029	7.295E-03	7.061E-03
NE	1212	1212	6.143E-04	5.947E-04	1212	1.545E-03	1.496E-03	1212	6.170E-03	5.973E-03
ENE	1367	1367	4.130E-04	3.998E-04	1367	1.116E-03	1.080E-03	1367	4.131E-03	3.999E-03
E	1170	1170	5.748E-04	5.564E-04	1170	1.782E-03	1.725E-03	1170	6.371E-03	6.167E-03
ESE	1170	1170	7.494E-04	7.254E-04	1170	1.976E-03	1.913E-03	1170	6.148E-03	5.951E-03
SE	1189	1189	6.447E-04	6.241E-04	1189	1.435E-03	1.389E-03	1189	3.710E-03	3.591E-03
SSE	1422	1422	4.090E-04	3.959E-04	1422	8.282E-04	8.017E-04	1422	2.052E-03	1.986E-03
S	1198	1198	4.040E-04	3.910E-04	1198	8.103E-04	7.843E-04	1198	2.334E-03	2.259E-03
SSW	2140	2140	2.070E-04	2.004E-04	2140	4.157E-04	4.024E-04	2140	1.195E-03	1.157E-03
SW	1372	1372	3.864E-04	3.740E-04	1372	9.192E-04	8.898E-04	1372	3.318E-03	3.212E-03
WSW	823	823	6.504E-04	6.296E-04	823	1.917E-03	1.856E-03	823	7.433E-03	7.196E-03
W	713	713	8.303E-04	2.525E-03	713	2.525E-03	2.445E-03	713	1.179E-02	1.141E-02
WNW	713	713	7.474E-04	7.235E-04	713	2.689E-03	2.603E-03	713	1.583E-02	1.532E-02
NW	823	823	7.219E-04	6.988E-04	823	2.157E-03	2.088E-03	823	1.085E-02	1.050E-02
NNW	1481	1481	4.362E-04	1.222E-04	1481	1.291E-03	1.249E-03	1481	4.963E-03	4.805E-03

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Table 4-7

Parameters for Calculations of N-16 Skyshine Radiation From Quad Cities

Location Number K	Activity	Occupancy Hours OH_k[a]	Occupancy Factor OF_k	Shielding Factor SF_k	Distance R_k (m)
1	Living at home (nearest resident)	8616	0.9836	0.7	800[b]
2	Fishing	36	0.00410	1.0	233[c]
3	Fishing	51	0.00586	1.0	344[c]
4	Fishing	31	0.00351	1.0	361[c]
5	Fishing	26	0.00293	1.0	680[c]

$M_h = 3$[e]

K = 3.80 E-5 mrem / (MWe-hr)

These parameters are used to obtain an initial estimate of skyshine dose to the maximally exposed member of the public using ODCM Part II, Section 5.0, Equation 5-1. If desired, more realistic parameters could be used in place of these to refine the estimate. For example, one could determine whether the nearest resident really fishes the specified number of hours at the specified location.

Notes:

a The amount of time in a year that a maximally exposed fisherman would spend fishing near the site is estimates as 12 hours per week for 8 months per year. This yields an estimate of:

$$\left(12\frac{Hours}{Week}\right)\left[\frac{8\left(\frac{months}{year}\right)}{12\left(\frac{months}{year}\right)}\right]\left(52\frac{weeks}{year}\right) = 416\frac{hours}{year}$$

b Distance to nearest residence. (See Table 4-1)

c Estimated from drawings of the site.

d The OF_k is the quotient of the number of hours a location is occupied and the number of hours in a year. Thus, OH_k /8760 hours = OF_k rounded to the nearest 0.01 digit.

e Multiplication factor for hydrogen addition from Reference 6. Refer to equation 5-1.

Table 4-8 (page 1 of 2)
Mixed Mode Joint Frequency Distribution Table Summary 296 Foot Elevation Data

SUMMARY TABLE OF PERCENT BY DIRECTION AND CLASS

CLASS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
A	0.076	0.064	0.045	0.031	0.086	0.064	0.164	0.192	0.236	0.574	0.211	0.229	0.457	0.571	0.360	0.179	3.541
B	0.060	0.075	0.073	0.060	0.050	0.064	0.129	0.189	0.249	0.385	0.183	0.199	0.273	0.324	0.218	0.158	2.690
C	0.147	0.136	0.185	0.155	0.151	0.151	0.168	0.343	0.391	0.529	0.312	0.281	0.478	0.658	0.440	0.309	4.832
D	2.472	2.105	2.729	2.803	2.669	2.152	2.062	2.103	2.755	3.314	2.630	2.527	3.654	5.503	4.501	3.027	47.006
E	1.175	1.044	1.363	1.533	1.992	1.651	1.775	2.131	3.111	3.193	2.229	1.520	1.773	1.916	1.871	1.219	29.457
F	0.287	0.267	0.324	0.324	0.601	0.815	0.936	0.979	1.128	1.010	0.593	0.365	0.352	0.469	0.397	0.353	9.200
G	0.042	0.069	0.060	0.063	0.117	0.168	0.400	0.517	0.574	0.482	0.294	0.136	0.111	0.097	0.076	0.045	3.273
TOTAL	4.260	3.720	4.778	4.989	5.666	5.066	5.634	6.454	8.445	9.487	6.453	5.256	7.097	9.536	7.864	5.291	100.000

SUMMARY TABLE OF PERCENT BY DIRECTION AND SPEED

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.45	0.008	0.009	0.010	0.005	0.013	0.007	0.005	0.002	0.004	0.005	0.000	0.006	0.001	0.000	0.003	0.005	0.082
1.05	0.021	0.025	0.025	0.035	0.029	0.023	0.029	0.026	0.022	0.032	0.038	0.036	0.041	0.038	0.031	0.031	0.485
2.05	0.182	0.182	0.196	0.192	0.218	0.199	0.220	0.190	0.208	0.325	0.397	0.299	0.221	0.239	0.193	0.188	3.650
3.05	0.428	0.366	0.451	0.407	0.441	0.406	0.453	0.384	0.434	0.787	0.752	0.473	0.478	0.500	0.481	0.393	7.632
4.05	0.552	0.561	0.627	0.643	0.624	0.596	0.596	0.608	0.643	1.136	0.897	0.589	0.563	0.636	0.680	0.681	10.634
5.05	0.684	0.649	0.752	0.722	0.803	0.664	0.756	0.759	0.831	1.264	1.130	0.674	0.692	0.885	0.977	0.801	13.043
6.05	0.712	0.602	0.725	0.749	0.939	0.712	0.913	0.967	1.229	1.448	1.130	0.812	0.948	1.248	1.199	1.029	15.361
8.05	1.143	0.796	1.190	1.247	1.481	1.515	1.714	2.013	2.538	2.516	1.459	1.341	2.022	2.883	2.324	1.494	27.676
10.05	0.363	0.314	0.548	0.611	0.653	0.671	0.793	0.979	1.544	1.250	0.464	0.588	1.254	1.804	1.347	0.514	13.697
13.05	0.149	0.173	0.218	0.324	0.375	0.245	0.141	0.440	0.866	0.596	0.144	0.321	0.653	1.078	0.568	0.136	6.428
18.00	0.016	0.042	0.035	0.054	0.086	0.028	0.013	0.084	0.123	0.125	0.042	0.116	0.212	0.218	0.062	0.019	1.278
99.00	0.001	0.001	0.000	0.009	0.001	0.000	0.000	0.001	0.003	0.004	0.000	0.003	0.012	0.009	0.000	0.000	0.037
TOTAL	4.260	3.720	4.778	4.989	5.666	5.066	5.634	6.454	8.445	9.487	6.453	5.256	7.097	9.536	7.864	5.291	100.000

NOTE: WIND DIRECTIONS IN TABLES ARE PRESENTED IN “WIND FROM” AND NOT “WIND TO” DIRECTIONS

Table 4-8 (page 2 of 2)

Mixed Mode Joint Frequency Distribution Table Summary 296 Foot Elevation Data

Summary Table of Percent by Speed and Class							
Speed	Class						
	A	B	C	D	E	F	G
0.45	0.000	0.006	0.003	0.016	0.031	0.019	0.007
1.05	0.003	0.006	0.006	0.158	0.170	0.089	0.053
2.05	0.066	0.045	0.119	1.692	1.012	0.478	0.237
3.05	0.176	0.185	0.308	3.840	1.925	0.777	0.422
4.05	0.289	0.299	0.522	5.012	2.924	1.105	0.484
5.05	0.369	0.362	0.716	5.799	3.931	1.367	0.498
6.05	0.571	0.400	0.736	6.631	4.835	1.596	0.532
8.05	0.998	0.718	1.272	12.230	8.759	2.859	0.841
10.05	0.588	0.391	0.661	7.034	4.032	0.804	0.186
13.05	0.391	0.214	0.385	3.767	1.557	0.100	0.013
18.00	0.085	0.056	0.101	0.753	0.274	0.007	0.000
99.00	0.006	0.009	0.004	0.012	0.006	0.000	0.000

Table 4-9 (Page 1 of 2)
Mixed Mode Joint Frequency Distribution Table Summaries 196 Foot Elevation Data

SUMMARY TABLE OF PERCENT BY DIRECTION AND CLASS

CLASS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
A	0.158	0.151	0.168	0.127	0.107	0.161	0.192	0.324	0.365	0.741	0.187	0.212	0.416	0.453	0.539	0.252	4.552
B	0.049	0.044	0.070	0.046	0.043	0.087	0.073	0.068	0.100	0.212	0.080	0.060	0.117	0.177	1.156	0.078	1.459
C	0.130	0.135	0.172	0.194	0.185	0.164	0.170	0.211	0.283	0.494	0.269	0.242	0.395	0.421	0.350	0.247	4.063
D	1.397	1.290	1.866	2.073	1.889	1.508	1.388	1.441	1.735	2.308	1.967	1.899	2.881	3.767	2.712	1.908	32.028
E	1.025	0.905	1.323	1.778	2.029	1.551	1.643	1.947	2.558	3.048	2.280	1.841	2.437	2.656	2.102	1.157	30.281
F	0.342	0.319	0.433	0.501	0.726	0.863	0.776	0.936	1.291	1.051	0.506	0.337	0.415	0.475	0.374	0.311	9.655
G	0.125	0.127	0.167	0.203	0.380	0.598	0.843	0.980	0.955	0.767	0.306	0.174	0.203	0.148	0.102	0.118	6.196
TOTAL	3.225	2.970	4.200	4.922	5.359	4.932	5.086	5.907	7.287	8.620	5.596	4.765	6.865	8.097	6.334	4.071	88.234

SUMMARY TABLE OF PERCENT BY DIRECTION AND SPEED

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.45	0.006	0.015	0.006	0.006	0.006	0.006	0.008	0.010	0.012	0.008	0.018	0.009	0.002	0.015	0.000	0.006	0.131
1.05	0.046	0.035	0.064	0.050	0.048	0.062	0.058	0.079	0.060	0.075	0.097	0.064	0.054	0.064	0.052	0.050	0.959
2.05	0.305	0.265	0.255	0.356	0.348	0.342	0.367	0.391	0.385	0.621	0.719	0.499	0.445	0.383	0.362	0.331	6.372
3.05	0.520	0.477	0.702	0.680	0.787	0.767	0.699	0.711	0.744	1.289	1.295	0.769	0.790	0.792	0.810	0.607	12.440
4.05	0.761	0.665	0.769	0.981	0.975	0.886	1.081	1.172	1.228	1.725	1.389	1.000	1.217	1.191	1.132	0.809	16.983
5.05	0.607	0.611	0.848	0.963	1.069	1.014	1.116	1.138	1.376	1.673	0.991	0.912	1.308	1.603	1.240	0.796	17.265
6.05	0.426	0.372	0.645	0.684	0.801	0.760	0.850	0.899	1.266	1.303	0.563	0.631	1.099	1.435	1.024	0.656	13.415
8.05	0.412	0.399	0.650	0.832	0.821	0.782	0.721	0.953	1.406	1.337	0.453	0.603	1.272	1.745	1.208	0.643	14.237
10.05	0.113	0.086	0.226	0.302	0.389	0.249	0.147	0.417	0.661	0.520	0.056	0.220	0.509	0.702	0.412	0.156	5.165
13.05	0.028	0.045	0.034	0.068	0.111	0.064	0.036	0.133	0.144	0.068	0.014	0.053	0.160	0.163	0.094	0.016	1.232
18.00	0.000	0.000	0.002	0.001	0.003	0.000	0.000	0.004	0.004	0.001	0.001	0.005	0.008	0.004	0.000	0.001	0.034
99.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	3.225	2.970	4.200	4.922	5.359	4.932	5.086	5.907	7.287	8.620	5.596	4.765	6.865	8.097	6.334	4.071	88.234

NOTE: WIND DIRECTIONS IN TABLES ARE PRESENTED IN “WIND FROM” AND NOT “WIND TO” DIRECTIONS

Table 4-9 (Page 2 of 2)

Mid Elevation Joint Frequency Distribution Table Summaries 196 Foot Elevation Data

Summary Table of Percent by Speed and Class							
	Class						
Speed	**A**	**B**	**C**	**D**	**E**	**F**	**G**
0.45	0.000	0.000	0.000	0.023	0.056	0.014	0.039
1.05	0.002	0.002	0.008	0.249	0.307	0.166	0.224
2.05	0.089	0.050	0.184	2.680	1.748	0.785	0.837
3.05	0.358	0.180	0.684	4.451	3.666	1.724	1.378
4.05	0.794	0.331	0.869	5.305	5.832	2.387	1.466
5.05	0.885	0.309	0.724	5.544	6.119	2.367	1.317
6.05	0.850	0.190	0.640	4.731	4.847	1.458	0.699
8.05	1.026	0.281	0.610	5.969	5.482	0.655	0.216
10.05	0.459	0.102	0.267	2.423	1.798	0.096	0.020
13.05	0.089	0.014	0.077	0.636	0.411	0.004	0.000
18.00	0.001	0.000	0.000	0.018	0.015	0.000	0.000
99.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 4-10 (Page 1 of 2)
Mixed Mode Joint Frequency Distribution Table Summary 33 Foot Elevation Data

SUMMARY TABLE OF PERCENT BY DIRECTION AND CLASS

CLASS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
A	0.022	0.020	0.015	0.017	0.018	0.036	0.033	0.064	0.067	0.131	0.026	0.023	0.079	0.076	0.069	0.037	0.732
B	0.006	0.006	0.008	0.005	0.006	0.011	0.013	0.009	0.012	0.027	0.008	0.010	0.018	0.026	0.027	0.009	0.202
C	0.016	0.019	0.017	0.024	0.023	0.023	0.025	0.028	0.041	0.057	0.024	0.026	0.063	0.069	0.041	0.028	0.527
D	0.186	0.203	0.226	0.328	0.270	0.190	0.152	0.170	0.213	0.268	0.224	0.335	0.547	0.815	0.405	0.247	4.779
E	0.097	0.102	0.171	0.263	0.290	0.277	0.245	0.345	0.394	0.383	0.225	0.252	0.453	0.379	0.245	0.126	4.247
F	0.012	0.026	0.048	0.048	0.084	0.116	0.099	0.117	0.104	0.059	0.022	0.022	0.045	0.036	0.018	0.014	0.868
G	0.003	0.006	0.007	0.017	0.058	0.133	0.052	0.053	0.036	0.009	0.006	0.003	0.013	0.006	0.005	0.002	0.410
TOTAL	.341	0.382	0.493	0.702	0.749	0.786	0.619	0.787	0.868	0.934	0.535	0.672	1.218	1.408	0.810	0.463	11.766

SUMMARY TABLE OF PERCENT BY DIRECTION AND SPEED

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.45	0.000	0.000	0.000	0.001	0.000	0.001	0.001	0.001	.0003	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.010
1.05	0.004	0.005	0.008	0.012	0.020	0.036	0.030	0.036	0.031	0.009	0.012	0.010	0.009	0.005	0.005	0.005	0.239
2.05	0.029	0.031	0.056	0.058	0.107	0.167	0.131	0.163	0.160	0.091	0.077	0.078	0.092	0.072	0.038	0.032	1.381
3.05	0.047	0.058	0.090	0.121	0.126	0.153	0.149	0.173	0.206	0.245	0.173	0.139	0.231	0.159	0.097	0.066	2.234
4.05	0.066	0.078	0.106	0.151	0.123	0.137	0.132	0.159	0.175	0.283	0.144	0.137	0.247	0.275	0.176	0.114	2.503
5.05	0.068	0.069	0.089	0.115	0.101	0.096	0.073	0.094	0.121	0.163	0.075	0.105	0.214	0.291	0.174	0.111	1.961
6.05	0.044	0.055	0.056	0.084	0.091	0.090	0.050	0.077	0.091	0.068	0.024	0.063	0.136	0.244	0.140	0.076	1.390
8.05	0.051	0.040	0.056	0.109	0.116	0.074	0.040	0.076	0.071	0.064	0.014	0.047	0.156	0.240	0.145	0.046	1.343
10.05	0.025	0.040	0.032	0.049	0.042	0.028	0.009	0.008	0.009	0.011	0.014	0.080	0.093	0.110	0.035	0.010	0.594
13.05	0.006	0.006	0.000	0.002	0.022	0.003	0.004	0.000	0.000	0.000	0.000	0.014	0.034	0.011	0.000	0.003	0.105
18.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.006
99.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.341	0.382	0.493	0.702	0.749	0.786	0.619	0.787	0.868	0.934	0.535	0.672	1.218	1.408	0.810	0.463	11.766

NOTE: WIND DIRECTIONS IN TABLES ARE PRESENTED IN “WIND FROM” AND NOT “WIND TO” DIRECTIONS

Table 4-10 (Page 2 of 2)

Mixed Mode Joint Frequency Distribution Table Summary 33 Foot Elevation Data

Summary Table of Percent by Speed and Class							
Speed	**Class**						
	A	**B**	**C**	**D**	**E**	**F**	**G**
0.45	0.000	0.000	0.000	0.000	0.001	0.002	0.007
1.05	0.008	0.000	0.000	0.008	0.042	0.078	0.103
2.05	0.018	0.006	0.010	0.149	0.509	0.457	0.231
3.05	0.095	0.023	0.068	0.644	1.105	0.244	0.055
4.05	0.197	0.053	0.128	1.080	0.981	0..059	0.004
5.05	0.177	0.044	0.122	0.981	0.617	0.017	0.002
6.05	0.131	0.035	0.075	0.767	0.373	0.004	0.005
8.05	0.093	0.027	0.090	0.742	0.383	0.005	0.002
10.05	0.012	0.011	0.031	0.340	0.199	0.002	0.000
13.05	0.001	0.001	0.003	0.067	0.032	0.000	0.000
18.00	0.000	0.000	0.000	0.000	0.006	0.000	0.000
99.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 4-11 (Page 1 of 2)
Ground Level Joint Frequency Distribution Table Summary 33 Foot Elevation Data

SUMMARY TABLE OF PERCENT BY DIRECTION AND CLASS

CLASS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
A	0.180	0.185	0.133	0.155	0.133	0.224	0.243	0.352	0.363	0.856	0.294	0.247	0.556	0.539	0.516	0.303	5.280
B	0.058	0.058	0.071	0.048	0.044	0.095	0.093	0.079	0.087	0.222	0.122	0.063	0.164	0.180	0.168	0.085	1.658
C	0.151	0.189	0.195	0.201	0.187	0.195	0.211	0.220	0.267	0.527	.0350	0.313	0.454	0.527	0.342	0.253	4.582
D	1.614	1.666	1.966	2.403	2.014	1.814	1.588	1.537	1.562	2.410	2.476	2.451	3.540	4.726	2.898	2.124	36.788
E	0.946	1.011	1.561	2.128	2.275	2.129	1.985	2.335	2.585	3.085	2.739	2.277	3.197	3.168	1.953	1.169	34.543
F	0.255	0.383	0.631	0.574	0.863	1.222	1.085	1.175	1.016	0.718	0.491	0.403	0.619	0.564	0.296	0.227	10.523
G	0.088	0.151	0.205	0.279	0.886	1.841	0.863	0.691	0.457	0.212	0.241	0.126	0.265	0.175	0.082	0.068	6.628
TOTAL	3.291	3.644	4.763	5.788	6.402	7.519	6.065	6.389	6.337	8.030	6.712	5.900	8.795	9.879	6.255	4.229	100.000

SUMMARY TABLE OF PERCENT BY DIRECTION AND SPEED

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.45	0.047	0.055	0.086	0.089	0.083	0.095	0.132	0.146	0.115	0.070	0.123	0.083	0.073	0.068	0.054	0.039	1.358
1.05	0.214	0.257	0.417	0.419	0.723	0.991	0.860	0.898	0.730	0.593	0.782	0.583	0.504	0.394	0.214	0.172	8.753
2.05	0.612	0.713	1.138	1.108	1.629	2.537	1.901	1.965	1.826	1.789	2.096	1.700	1.967	1.611	0.987	0.663	24.241
3.05	0.713	0.825	1.061	1.281	1.341	1.609	1.443	1.476	1.601	2.434	2.038	1.534	2.336	2.005	1.285	0.935	23.916
4.05	0.624	0.701	0.875	1.103	0.983	0.881	0.925	0.985	1.051	1.814	1.041	0.974	1.629	1.905	1.395	0.974	17.860
5.05	0.489	0.473	0.576	0.719	0.607	0.595	0.429	0.481	0.576	0.881	0.452	0.493	1.088	1.617	1.034	0.751	11.259
6.05	0.265	0.323	0.317	0.471	0.454	0.446	0.257	0.278	0.305	0.299	0.124	0.296	0.632	1.188	0.717	0.437	6.808
8.05	0.263	0.205	0.238	0.504	0.481	0.296	0.102	0.153	0.124	0.133	0.037	0.133	0.413	0.910	0.504	0.228	4.723
10.05	0.056	0.085	0.056	0.091	0.073	0.064	0.012	0.008	0.010	0.015	0.019	0.091	0.114	0.170	0.066	0.027	0.956
13.05	0.008	0.008	0.000	0.002	0.029	0.006	0.004	0.000	0.000	0.000	0.000	0.014	0.035	0.012	0.000	0.004	0.120
18.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.006
99.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	3.291	3.644	4.763	5.788	6.402	7.519	6.065	6.389	6.337	8.030	6.712	5.900	8.795	9.879	6.255	4.229	100.000

NOTE: WIND DIRECTIONS IN TABLES ARE PRESENTED IN "WIND FROM" AND NOT "WIND TO" DIRECTIONS

Table 4-11 (Page 2 of 2)

Ground Level Joint Frequency Distribution Table Summary 33 Foot Elevation Data

Summary Table of Percent by Speed and Class							
	Class						
Speed	**A**	**B**	**C**	**D**	**E**	**F**	**G**
0.45	0.000	0.000	0.002	0.056	0.299	0.375	0.626
1.05	0.041	0.012	0.054	0.902	2.390	2.569	2.786
2.05	0.439	0.158	0.553	5.844	9.138	5.363	2.747
3.05	1.285	0.481	1.321	8.821	9.831	1.773	0.404
4.05	1.544	0.462	1.109	8.235	6.180	0.307	0.023
5.05	1.012	0.255	0.765	5.683	3.435	0.097	0.012
6.05	0.618	0.182	0.388	3.856	1.721	0.017	0.025
8.05	0.313	0.089	0.328	2.755	1.215	0.017	0.006
10.05	0.027	0.017	0.058	0.556	0.294	0.004	0.000
13.05	0.002	0.002	0.004	0.077	0.035	0.000	0.000
18.00	0.000	0.000	0.000	0.000	0.005	0.000	0.000
99.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 4-12

Station Characteristics

STATION: Quad Cities

LOCATION: Cordova, Illinois

CHARATERISTICS OF ELEVATED RELEASE POINT

1) Release Height = 94.49 m
2) Diameter = 3.35 m
3) Exit Speed = 16.0 m/s
4) Heat Content = 68 Kcal/s

CHARATERISTICS OF VENT STACK RELEASE POINT: NOT APPLICABLE

1) Release Height = 48.5 m[a]
Diameter = 2.74 m
3) Exit Speed = 14.8 m/s[a]

CHARATERISTICS OF GROUND LEVEL RELEASE

1) Release Height = 0 m
2) Building Factor (D) = 43.46 m[a]

METEOROLOGICAL DATA

A 296 foot tower is located 1623 meters SSE of elevated release point.

Release Point	Wind Speed & Direction	Differential Temperature
Elevated	296 ft	296 – 33 ft
Vent	196 ft	196 – 30 ft
Ground	33 ft	196 – 30 ft

[a] Used in calculating the meteorological and dose factors in Table 4–3 through Table 4-6. Also used in calculating dispersion and deposition factors for cow milk, cow meat, and nearest resident data in site specific procedures.

Table 4-13
Dose Factors for Noble Gases

Nuclide	Beta Air Dose Factor N_i (mrad/yr per uCi/m^3)	Beta Skin Dose Factor L_i (mrem/yr per uCi/m^3)	Gamma Air Dose Factor M_i (mrad/yr per uCi/m^3)	Gamma Total Body Dose Factor K_i (mrem/yr per uCi/m^3)
Kr-83m	2.88E+02	---	1.93E+01	7.56E-02
Kr-85m	1.97E+03	1.46E+03	1.23E+03	1.17E+03
Kr-85	1.95E+03	1.34E+03	1.72E+01	1.61E+01
Kr-87	1.03E+04	9.73E+03	6.17E+03	5.92E+03
Kr-88	2.93E+03	2.37E+03	1.52E+04	1.47E+04
Kr-89	1.06E+04	1.01E+04	1.73E+04	1.66E+04
Kr-90	7.83E+03	7.29E+03	1.63E+04	1.56E+04
Xe-131m	1.11E+03	4.76E+02	1.56E+02	9.15E+01
Xe-133m	1.48E+03	9.94E+02	3.27E+02	2.51E+02
Xe-133	1.05E+03	3.06E+02	3.53E+02	2.94E+02
Xe-135m	7.39E+02	7.11E+02	3.36E+03	3.12E+03
Xe-135	2.46E+03	1.86E+03	1.92E+03	1.81E+03
Xe-137	1.27E+04	1.22E+04	1.51E+03	1.42E+03
Xe-138	4.75E+03	4.13E+03	9.21E+03	8.83E+03
Ar-41	3.28E+03	2.69E+03	9.30E+03	8.84E+03

Source: Table B-1 of Reference 6.

Table 4-14 (Page 1 of 3)
External Dose Factors for Standing on Contaminated Ground
DFG_{ij} (mrem/hr per pCi/ m^2)

Element	Whole Body Dose Factor	Reference	Element	Dose Factor	Reference
H-3	0.00E+00	6	Be-7	5.95E-10	99
C-14	0.00E+00	6	F-18	1.19E-08	99
Na-22	2.42E-08	99	Na-24	2.50E-08	6
Mg-27	1.14E-08	99	Mg-28	1.48E-08	99
Al-26	2.95E-08	99	Al-28	2.00E-08	99
P-32	0.00E+00	6	Cl-38	1.70E-08	99
Ar-41	1.39E-08	99	K-40	2.22E-09	99
K-42	4.64E-09	99	K-43	1.19E-08	99
Ca-47	1.14E-08	99	Sc-44	2.50E-08	99
Sc-46m	1.21E-09	99	Sc-46	2.24E-08	99
Sc-47	1.46E-09	99	Ti-44	1.95E-09	99
V-48	3.21E-08	99	Cr-51	2.20E-10	6
Mn-52m	2.79E-08	99	Mn-52	3.80E-08	99
Mn-54	5.80E-09	6	Mn-56	1.10E-08	6
Fe-52	9.12E-09	99	Fe-55	0.00E+00	6
Fe-59	8.00E-09	6	Co-57	1.65E-09	99
Co-58	7.00E-09	6	Co-60	1.70E-08	6
Ni-63	0.00E+00	6	Ni-65	3.70E-09	6
Cu-64	1.50E-09	6	Cu-67	1.52E-09	99
Cu-68	8.60E-09[1]	--	Zn-65	4.00E-09	6
Zn-69m	5.06E-09	99	Zn-69	0.00E+00	6
Ga-66	2.70E-08	99	Ga-67	1.89E-09	99
Ga-68	1.24E-08	99	Ga-72	3.00E-08	99
Ge-77	1.34E-08	99	As-72	2.23E-08	99
As-73	1.16E-10	99	As-74	9.41E-09	99
As-76	6.46E-09	99	As-77	1.79E-10	99
Se-73	1.38E-08	99	Se-75	4.98E-09	99
Br-77	3.84E-09	99	Br-80	2.01E-09	99
Br-82	3.00E-08	99	Br-83	6.40E-11	6
Br-84	1.20E-08	6	Br-85	0.00E+00	6
Kr-79	3.07E-09	99	Kr-81	1.59E-10	99
Kr-83m	1.42E-11	99	Kr-85m	2.24E-09	99
Kr-85	1.35E-10	99	Kr-87	1.03E-08	99
Kr-88	2.07E-08	99	Kr-90	1.56E-08	99
Rb-84	1.07E-08	99	Rb-86	6.30E-10	6
Rb-87	0.00E+00	99	Rb-88	3.50E-09	6
Rb-89	1.50E-08	6	Sr-85	6.16E-09	99
Sr-87m	3.92E-09	99	Sr-89	5.60E-13	6
Sr-90	1.84E-11	99	Sr-91	7.10E-09	6
Sr-92	9.00E-09	6	Y-86	4.00E-08	99
Y-87	5.53E-09	99	Y-88	2.88E-08	99
Y-90	2.20E-12	6	Y-91m	3.80E-09	6
Y-91	2.40E-11	6	Y-92	1.60E-09	6
Y-93	5.70E-10	6	Zr-95	5.00E-09	6
Zr-97	5.50E-09	6	Nb-94	1.84E-08	99
Nb-95	5.10E-09	6	Nb-97m	8.57E-09	99
Nb-97	8.48E-09	99	Mo-99	1.90E-09	6
Tc-99m	9.60E-10	6	Tc-101	2.70E-09	6
Tc-104	1.83E-08[1]	--	Ru-97	2.99E-09	99
Ru-103	3.60E-09	6	Ru-105	4.50E-09	6
Ru/Rh-106	5.76E-09[3]	6, 99	Pc-109	3.80E-10	99
Cc-109	1.12E-10	99	In-111	5.11E-09	99
In-115m	2.01E-09	99	In-116	0.00E+00[2]	--
Sn-113	1.15E-09	99	Sn-117m	1.96E-08	99
Sn-119m	7.05E-11	99	Sb-117	0.00E+00[2]	--
Sb-122	2.71E-09[1]	--	Sb-124	1.16E-08[1]	--
Sb-125	4.56E-09	99	Sb-126	7.13E-10	99
Ag-108m	1.92E-08	99	Ag-108	1.14E-09	99
Ag-110m	1.80E-08	6	Ag-111	6.75E-10	99
Te-121m	2.65E-09	99	Te-121	6.75E-09	99

Table 4-14 (Page 2 of 3)
External Dose Factors for Standing on Contaminated Ground
DFG_{ij} (mrem/hr per pCi/ m^2)

Element	Whole Body Dose Factor	Reference	Element	Dose Factor	Reference
Te-123m	1.88E-09	99	Te-125m	3.50E-11	6
Te-125	0.00E+00[2]	--	Te-127m	1.10E-12	6
Te-127	1.00E-11	6	Te-129m	7.70E-10	6
Te-129	7.10E-10	6	Te-131m	8.40E-09	6
Te-131	2.20E-09	6	Te-I-132	3.40E-09[5]	6
Te-134	1.05E-08	99	I-123	2.12E-09	99
I-124	1.23E-08	99	I-125	2.89E-10	99
I-130	1.40E-08	6	I-131	2.80E-09	6
I-133	3.70E-09	6	I-134	1.60E-08	6
I-135	1.20E-08	6	Xe-127	3.44E-09	99
Xe-129m	5.57E-10	99	Xe-131m	2.13E-10	99
Xe-133m	4.81E-10	99	Xe-133	5.91E-10	99
Xe-135m	5.23E-09	99	Xe-135	3.36E-09	99
Xe-137	4.26E-09	99	Xe-138	1.30E-08	99
Cs-129	3.39E-09	99	Cs-132	8.40E-09	99
Cs-134	1.20E-08	6	Cs-136	1.50E-08	6
Cs-137/Ba-137m	1.14E-08[4]	6, 99	Cs-138	2.10E-08	6
Cs-139	5.15E-09	99	Ba-131	5.74E-09	99
Ba-133m	8.10E-10	99	Ba-133	4.85E-09	99
Ba-135m	7.26E-10	99	Ba-137m	7.17E-09	99
Ba-137	0.00E+00[2]	--	Ba-139	2.40E-09	6
Ba-La-140	1.71E-08[6]	6	Ba-141	4.30E-09	6
Ba-142	7.90E-09	6	La-142	1.50E-08	6
Ce-139	2.04E-09	99	Ce-141	5.50E-10	6
Ce-143	2.20E-09	6	Ce-Pr-144	5.20E-10[7]	6
Pr-142	1.84E-09	99	Pr-143	0.00E+00	6
Nc-147	1.00E-09	6	Nc-149	5.32E-09	99
Pm-145	3.38E-10	99	Pm-148m	2.35E-08	99
Pm-148	7.22E-09	99	Pm-149	5.32E-10	99
Sm-153	8.95E-10	99	Eu-152	1.30E-08	99
Eu-154	1.41E-08	99	Eu-155	8.27E-10	99
Gc-153	1.46E-09	99	Dy-157	4.39E-09	99
Er-169	6.12E-14	99	Er-171	5.11E-09	99
Tm-170	3.41E-10	99	Yb-169	4.12E-09	99
Yb-175	4.94E-10	99	Lu-177	4.60E-10	99
Hf-181	6.67E-09	99	Ta-182	1.42E-08	99
Ta-183	2.93E-09[1]	--	W-187	3.10E-09	6
Re-188	1.89E-09	99	Os-191	9.83E-10	99
Ir-194	2.31E-09	99	Pt-195m	9.79E-10	99
Pt-197	3.57E-10	99	Au-195m	2.54E-09	99
Au-195	1.14E-09	99	Au-198	5.19E-09	99
Au-199	1.18E-09	99	Hg-197	9.33E-10	99
Hg-203	2.89E-09	99	Tl-201	1.24E-09	99
Tl-206	0.00E+00[2]	--	Tl-208	3.58E-08	99
Pb-203	3.88E-09	99	Pb-210	3.57E-11	99
Pb-212	1.91E-09	99	Pb-214	3.18E-09	99
Bi-206	3.74E-08	99	Bi-207	1.77E-08	99
Bi-214	1.71E-08	99	Ra-226	8.78E-11	99
Th-232	8.14E-12	99	U-238	7.98E-12	99
Np-239	9.50E-10	6	Am-241	3.48E-10	99

1 *Valued derived by comparing the percentage and MeV of the nuclide's gammas and then comparing to Cesium-137, as a value was not available in the literature.*

2 0.0 due to low yield and short half-life. A value was not available in the literature.

Table 4-14 (Page 3 of 3)
External Dose Factors for Standing on Contaminated Ground
DFG_{ij} (mrem/hr per pCi/ m^2)

3 Value is the sum of Ru-106 (1.50E-9) and Rh-106 (4.26E-9). The Rh-106 value is from Reference 99 and the Ru-106 value is from Reference 6.

4 Value is the sum of Cs-137 (4.20E-9) and Ba-137m (7.17E-9). The values are from references 6 and 99, respectively.

5 Value is the sum of Te-132 (1.70E-9) and I-132 (1.70E-9).

6 Value is the sum of Ba-140 (2.10E-9) and La-140 (1.50E-8) from reference 6. In Reference 6, see Table E-6.

7 Value is the sum of Ce-144 (3.20E-10) and Pr-144 (2.00E-10) from reference 6.

Note: Dose assessments for 10CFR20 and 40CFR190 compliance are made for an adult only.

Dose assessments for 10CFR50 Appendix are made using dose factors of Regulatory Guide 1.109 (Reference 6) for all age groups.

Table 4-15 (Page 1 of 2)

Ground Plane Dose Factors

(Same for all age groups)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.20E+07	1.20E+07	1.20E+07	1.20E+07	1.20E+07	1.20E+07	1.20E+07
Cr-51	4.65E+06	4.65E+06	4.65E+06	4.65E+06	4.65E+06	4.65E+06	4.65E+06
Mn-54	1.38E+09	1.38E+09	1.38E+09	1.38E+09	1.38E+09	1.38E+09	1.38E+09
Mn-56	9.03E+05	9.03E+05	9.03E+05	9.03E+05	9.03E+05	9.03E+05	9.03E+05
Fe-55	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-59	2.73E+08	2.73E+08	2.73E+08	2.73E+08	2.73E+08	2.73E+08	2.73E+08
Co-58	3.80E+08	3.80E+08	3.80E+08	3.80E+08	3.80E+08	3.80E+08	3.80E+08
Co-60	2.45E+10	2.45E+10	2.45E+10	2.45E+10	2.45E+10	2.45E+10	2.45E+10
Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-65	2.97E+05	2.97E+05	2.97E+05	2.97E+05	2.97E+05	2.97E+05	2.97E+05
Cu-64	6.05E+05	6.05E+05	6.05E+05	6.05E+05	6.05E+05	6.05E+05	6.05E+05
Zn-65	7.46E+08	7.46E+08	7.46E+08	7.46E+08	7.46E+08	7.46E+08	7.46E+08
Zn-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03
Br-84	2.03E+05	2.03E+05	2.03E+05	2.03E+05	2.03E+05	2.03E+05	2.03E+05
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	9.01E+06	9.01E+06	9.01E+06	9.01E+06	9.01E+06	9.01E+06	9.01E+06
Rb-88	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.31E+04
Rb-89	1.23E+05	1.23E+05	1.23E+05	1.23E+05	1.23E+05	1.23E+05	1.23E+05
Sr-89	2.16E+04	2.16E+04	2.16E+04	2.16E+04	2.16E+04	2.16E+04	2.16E+04
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-91	2.14E+06	2.14E+06	2.14E+06	2.14E+06	2.14E+06	2.14E+06	2.14E+06
Sr-92	7.76E+05	7.76E+05	7.76E+05	7.76E+05	7.76E+05	7.76E+05	7.76E+05
Y-90	4.50E+03	4.50E+03	4.50E+03	4.50E+03	4.50E+03	4.50E+03	4.50E+03
Y-91M	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05
Y-91	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06
Y-92	1.80E+05	1.80E+05	1.80E+05	1.80E+05	1.80E+05	1.80E+05	1.80E+05
Y-93	1.83E+05	1.83E+05	1.83E+05	1.83E+05	1.83E+05	1.83E+05	1.83E+05
Zr-95	2.45E+08	2.45E+08	2.45E+08	2.45E+08	2.45E+08	2.45E+08	2.45E+08
Zr-97	2.96E+06	2.96E+06	2.96E+06	2.96E+06	2.96E+06	2.96E+06	2.96E+06
Nb-95	1.37E+08	1.37E+08	1.37E+08	1.37E+08	1.37E+08	1.37E+08	1.37E+08
Mo-99	3.99E+06	3.99E+06	3.99E+06	3.99E+06	3.99E+06	3.99E+06	3.99E+06
Tc- 99M	1.84E+05	1.84E+05	1.84E+05	1.84E+05	1.84E+05	1.84E+05	1.84E+05
Tc-101	2.03E+04	2.03E+04	2.03E+04	2.03E+04	2.03E+04	2.03E+04	2.03E+04
Ru-103	1.08E+08	1.08E+08	1.08E+08	1.08E+08	1.08E+08	1.08E+08	1.08E+08
Ru-105	6.36E+05	6.36E+05	6.36E+05	6.36E+05	6.36E+05	6.36E+05	6.36E+05
Ru-106	4.22E+08	4.22E+08	4.22E+08	4.22E+08	4.22E+08	4.22E+08	4.22E+08
Ag-110M	3.45E+09	3.45E+09	3.45E+09	3.45E+09	3.45E+09	3.45E+09	3.45E+09

Table 4-15 (Page 2 of 2)

Ground Plane Dose Factors

(Same for all age groups)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	1.56E+06	1.56E+06	1.56E+06	1.56E+06	1.56E+06	1.56E+06	1.56E+06
Te-127M	9.16E+04	9.16E+04	9.16E+04	9.16E+04	9.16E+04	9.16E+04	9.16E+04
Te-127	2.99E+03	2.99E+03	2.99E+03	2.99E+03	2.99E+03	2.99E+03	2.99E+03
Te-129M	1.98E+07	1.98E+07	1.98E+07	1.98E+07	1.98E+07	1.98E+07	1.98E+07
Te-129	2.62E+04	2.62E+04	2.62E+04	2.62E+04	2.62E+04	2.62E+04	2.62E+04
Te-131M	8.02E+06	8.02E+06	8.02E+06	8.02E+06	8.02E+06	8.02E+06	8.02E+06
Te-131	2.92E+04	2.92E+04	2.92E+04	2.92E+04	2.92E+04	2.92E+04	2.92E+04
Te-132	4.22E+06	4.22E+06	4.22E+06	4.22E+06	4.22E+06	4.22E+06	4.22E+06
I-130	5.50E+06	5.50E+06	5.50E+06	5.50E+06	5.50E+06	5.50E+06	5.50E+06
I-131	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07
I-132	1.25E+06	1.25E+06	1.25E+06	1.25E+06	1.25E+06	1.25E+06	1.25E+06
I-133	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06
I-134	4.46E+05	4.46E+05	4.46E+05	4.46E+05	4.46E+05	4.46E+05	4.46E+05
I-135	2.53E+06	2.53E+06	2.53E+06	2.53E+06	2.53E+06	2.53E+06	2.53E+06
Cs-134	6.94E+09	6.94E+09	6.94E+09	6.94E+09	6.94E+09	6.94E+09	6.94E+09
Cs-136	1.50E+08	1.50E+08	1.50E+08	1.50E+08	1.50E+08	1.50E+08	1.50E+08
Cs-137	1.76E+10	1.76E+10	1.76E+10	1.76E+10	1.76E+10	1.76E+10	1.76E+10
Cs-138	3.59E+05	3.59E+05	3.59E+05	3.59E+05	3.59E+05	3.59E+05	3.59E+05
Ba-139	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05
Ba-140	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07
Ba-141	4.17E+04	4.17E+04	4.17E+04	4.17E+04	4.17E+04	4.17E+04	4.17E+04
Ba-142	4.44E+04	4.44E+04	4.44E+04	4.44E+04	4.44E+04	4.44E+04	4.44E+04
La-140	1.92E+07	1.92E+07	1.92E+07	1.92E+07	1.92E+07	1.92E+07	1.92E+07
La-142	7.60E+05	7.60E+05	7.60E+05	7.60E+05	7.60E+05	7.60E+05	7.60E+05
Ce-141	1.37E+07	1.37E+07	1.37E+07	1.37E+07	1.37E+07	1.37E+07	1.37E+07
Ce-143	2.31E+06	2.31E+06	2.31E+06	2.31E+06	2.31E+06	2.31E+06	2.31E+06
Ce-144	6.96E+07	6.96E+07	6.96E+07	6.96E+07	6.96E+07	6.96E+07	6.96E+07
Pr-143	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pr-144	1.84E+03	1.84E+03	1.84E+03	1.84E+03	1.84E+03	1.84E+03	1.84E+03
Nd-147	8.48E+06	8.48E+06	8.48E+06	8.48E+06	8.48E+06	8.48E+06	8.48E+06
W-187	2.35E+06	2.35E+06	2.35E+06	2.35E+06	2.35E+06	2.35E+06	2.35E+06
Np-239	1.71E+06	1.71E+06	1.71E+06	1.71E+06	1.71E+06	1.71E+06	1.71E+06

Notes:

1) Units are m^2 mrem/yr per μCi/sec.

2) All age groups are assumed to receive the same dose.

Table 4-16 (Page 1 of 8)

Inhalation Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	7.18E+02	7.18E+02	7.18E+02	7.18E+02	7.18E+02	7.18E+02
Na-24	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04
Cr-51	0.00E+00	0.00E+00	1.00E+02	5.95E+01	2.28E+01	1.44E+04	3.32E+03
Mn-54	0.00E+00	3.96E+04	6.30E+03	0.00E+00	9.84E+03	1.40E+06	7.74E+04
Mn-56	0.00E+00	1.24E+00	1.83E-01	0.00E+00	1.30E+00	9.44E+03	2.02E+04
Fe-55	2.46E+04	1.70E+04	3.94E+03	0.00E+00	0.00E+00	7.21E+04	6.03E+03
Fe-59	1.18E+04	2.78E+04	1.06E+04	0.00E+00	0.00E+00	1.02E+06	1.88E+05
Co-58	0.00E+00	1.58E+03	2.07E+03	0.00E+00	0.00E+00	9.28E+05	1.06E+05
Co-60	0.00E+00	1.15E+04	1.48E+04	0.00E+00	0.00E+00	5.97E+06	2.85E+05
Ni-63	4.32E+05	3.14E+04	1.45E+04	0.00E+00	0.00E+00	1.78E+05	1.34E+04
Ni-65	1.54E+00	2.10E-01	9.12E-02	0.00E+00	0.00E+00	5.60E+03	1.23E+04
Cu-64	0.00E+00	1.46E+00	6.15E-01	0.00E+00	4.62E+00	6.78E+03	4.90E+04
Zn-65	3.24E+04	1.03E+05	4.66E+04	0.00E+00	6.90E+04	8.64E+05	5.34E+04
Zn-69	3.38E-02	6.51E-02	4.52E-03	0.00E+00	4.22E-02	9.20E+02	1.63E+01
Br-83	0.00E+00	0.00E+00	2.41E+02	0.00E+00	0.00E+00	0.00E+00	2.32E+02
Br-84	0.00E+00	0.00E+00	3.13E+02	0.00E+00	0.00E+00	0.00E+00	1.64E-03
Br-85	0.00E+00	0.00E+00	1.28E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.35E+05	5.90E+04	0.00E+00	0.00E+00	0.00E+00	1.66E+04
Rb-88	0.00E+00	3.87E+02	1.93E+02	0.00E+00	0.00E+00	0.00E+00	3.34E-09
Rb-89	0.00E+00	2.56E+02	1.70E+02	0.00E+00	0.00E+00	0.00E+00	9.28E-12
Sr-89	3.04E+05	0.00E+00	8.72E+03	0.00E+00	0.00E+00	1.40E+06	3.50E+05
Sr-90	2.87E+07	0.00E+00	5.77E+05	0.00E+00	0.00E+00	9.60E+06	7.22E+05
Sr-91	6.19E+01	0.00E+00	2.50E+00	0.00E+00	0.00E+00	3.65E+04	1.91E+05
Sr-92	6.74E+00	0.00E+00	2.91E-01	0.00E+00	0.00E+00	1.65E+04	4.30E+04
Y-90	2.09E+03	0.00E+00	5.61E+01	0.00E+00	0.00E+00	1.70E+05	5.06E+05
Y-91M	2.61E-01	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.92E+03	1.33E+00
Y-91	4.62E+05	0.00E+00	1.24E+04	0.00E+00	0.00E+00	1.70E+06	3.85E+05
Y-92	1.03E+01	0.00E+00	3.02E-01	0.00E+00	0.00E+00	1.57E+04	7.35E+04
Y-93	9.44E+01	0.00E+00	2.61E+00	0.00E+00	0.00E+00	4.85E+04	4.22E+05
Zr-95	1.07E+05	3.44E+04	2.33E+04	0.00E+00	5.42E+04	1.77E+06	1.50E+05
Zr-97	9.68E+01	1.96E+01	9.04E+00	0.00E+00	2.97E+01	7.87E+04	5.23E+05
Nb-95	1.41E+04	7.82E+03	4.21E+03	0.00E+00	7.74E+03	5.05E+05	1.04E+05
Mo-99	0.00E+00	1.21E+02	2.30E+01	0.00E+00	2.91E+02	9.12E+04	2.48E+05
Tc- 99M	1.03E-03	2.91E-03	3.70E-02	0.00E+00	4.42E-02	7.64E+02	4.16E+03
Tc-101	4.18E-05	6.02E-05	5.90E-04	0.00E+00	1.08E-03	3.99E+02	1.09E-11
Ru-103	1.53E+03	0.00E+00	6.58E+02	0.00E+00	5.83E+03	5.05E+05	1.10E+05
Ru-105	7.90E-01	0.00E+00	3.11E-01	0.00E+00	1.02E+00	1.10E+04	4.82E+04
Ru-106	6.91E+04	0.00E+00	8.72E+03	0.00E+00	1.34E+05	9.36E+06	9.12E+05
Ag-110M	1.08E+04	1.00E+04	5.94E+03	0.00E+00	1.97E+04	4.63E+06	3.02E+05

Table 4-16 (Page 2 of 8)

Inhalation Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	3.42E+03	1.58E+03	4.67E+02	1.05E+03	1.24E+04	3.14E+05	7.06E+04
Te-127M	1.26E+04	5.77E+03	1.57E+03	3.29E+03	4.58E+04	9.60E+05	1.50E+05
Te-127	1.40E+00	6.42E-01	3.10E-01	1.06E+00	5.10E+00	6.51E+03	5.74E+04
Te-129M	9.76E+03	4.67E+03	1.58E+03	3.44E+03	3.66E+04	1.16E+06	3.83E+05
Te-129	4.98E-02	2.39E-02	1.24E-02	3.90E-02	1.87E-01	1.94E+03	1.57E+02
Te-131M	6.99E+01	4.36E+01	2.90E+01	5.50E+01	3.09E+02	1.46E+05	5.56E+05
Te-131	1.11E-02	5.95E-03	3.59E-03	9.36E-03	4.37E-02	1.39E+03	1.84E+01
Te-132	2.60E+02	2.15E+02	1.62E+02	1.90E+02	1.46E+03	2.88E+05	5.10E+05
I-130	4.58E+03	1.34E+04	5.28E+03	1.14E+06	2.09E+04	0.00E+00	7.69E+03
I-131	2.52E+04	3.58E+04	2.05E+04	1.19E+07	6.13E+04	0.00E+00	6.28E+03
I-132	1.16E+03	3.26E+03	1.16E+03	1.14E+05	5.18E+03	0.00E+00	4.06E+02
I-133	8.64E+03	1.48E+04	4.52E+03	2.15E+06	2.58E+04	0.00E+00	8.88E+03
I-134	6.44E+02	1.73E+03	6.15E+02	2.98E+04	2.75E+03	0.00E+00	1.01E+00
I-135	2.68E+03	6.98E+03	2.57E+03	4.48E+05	1.11E+04	0.00E+00	5.25E+03
Cs-134	3.73E+05	8.48E+05	7.28E+05	0.00E+00	2.87E+05	9.76E+04	1.04E+04
Cs-136	3.90E+04	1.46E+05	1.10E+05	0.00E+00	8.56E+04	1.20E+04	1.17E+04
Cs-137	4.78E+05	6.21E+05	4.28E+05	0.00E+00	2.22E+05	7.52E+04	8.40E+03
Cs-138	3.31E+02	6.21E+02	3.24E+02	0.00E+00	4.80E+02	4.86E+01	1.86E-03
Ba-139	9.36E-01	6.66E-04	2.74E-02	0.00E+00	6.22E-04	3.76E+03	8.96E+02
Ba-140	3.90E+04	4.90E+01	2.57E+03	0.00E+00	1.67E+01	1.27E+06	2.18E+05
Ba-141	1.00E-01	7.53E-05	3.36E-03	0.00E+00	7.00E-05	1.94E+03	1.16E-07
Ba-142	2.63E-02	2.70E-05	1.66E-03	0.00E+00	2.29E-05	1.19E+03	1.57E-16
La-140	3.44E+02	1.74E+02	4.58E+01	0.00E+00	0.00E+00	1.36E+05	4.58E+05
La-142	6.83E-01	3.10E-01	7.72E-02	0.00E+00	0.00E+00	6.33E+03	2.11E+03
Ce-141	1.99E+04	1.35E+04	1.53E+03	0.00E+00	6.26E+03	3.62E+05	1.20E+05
Ce-143	1.86E+02	1.38E+02	1.53E+01	0.00E+00	6.08E+01	7.98E+04	2.26E+05
Ce-144	3.43E+06	1.43E+06	1.84E+05	0.00E+00	8.48E+05	7.78E+06	8.16E+05
Pr-143	9.36E+03	3.75E+03	4.64E+02	0.00E+00	2.16E+03	2.81E+05	2.00E+05
Pr-144	3.01E-02	1.25E-02	1.53E-03	0.00E+00	7.05E-03	1.02E+03	2.15E-08
Nd-147	5.27E+03	6.10E+03	3.65E+02	0.00E+00	3.56E+03	2.21E+05	1.73E+05
W-187	8.48E+00	7.08E+00	2.48E+00	0.00E+00	0.00E+00	2.90E+04	1.55E+05
Np-239	2.30E+02	2.03E+02	1.24E+01	0.00E+00	7.00E+01	3.76E+04	1.19E+05

Notes:

1) Units are mrem/yr per $\mu Ci/m^3$.

Table 4-16 (Page 3 of 8)

Inhalation Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	7.25E+02	7.25E+02	7.25E+02	7.25E+02	7.25E+02	7.25E+02
Na-24	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04
Cr-51	0.00E+00	0.00E+00	1.35E+02	7.50E+01	3.07E+01	2.10E+04	3.00E+03
Mn-54	0.00E+00	5.11E+04	8.40E+03	0.00E+00	1.27E+04	1.98E+06	6.68E+04
Mn-56	0.00E+00	1.70E+00	2.52E-01	0.00E+00	1.79E+00	1.52E+04	5.74E+04
Fe-55	3.34E+04	2.38E+04	5.54E+03	0.00E+00	0.00E+00	1.24E+05	6.39E+03
Fe-59	1.59E+04	3.70E+04	1.43E+04	0.00E+00	0.00E+00	1.53E+06	1.78E+05
Co-58	0.00E+00	2.07E+03	2.78E+03	0.00E+00	0.00E+00	1.34E+06	9.52E+04
Co-60	0.00E+00	1.51E+04	1.98E+04	0.00E+00	0.00E+00	8.72E+06	2.59E+05
Ni-63	5.80E+05	4.34E+04	1.98E+04	0.00E+00	0.00E+00	3.07E+05	1.42E+04
Ni-65	2.18E+00	2.93E-01	1.27E-01	0.00E+00	0.00E+00	9.36E+03	3.67E+04
Cu-64	0.00E+00	2.03E+00	8.48E-01	0.00E+00	6.41E+00	1.11E+04	6.14E+04
Zn-65	3.86E+04	1.34E+05	6.24E+04	0.00E+00	8.64E+04	1.24E+06	4.66E+04
Zn-69	4.83E-02	9.20E-02	6.46E-03	0.00E+00	6.02E-02	1.58E+03	2.85E+02
Br-83	0.00E+00	0.00E+00	3.44E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.33E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.83E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.90E+05	8.40E+04	0.00E+00	0.00E+00	0.00E+00	1.77E+04
Rb-88	0.00E+00	5.46E+02	2.72E+02	0.00E+00	0.00E+00	0.00E+00	2.92E-05
Rb-89	0.00E+00	3.52E+02	2.33E+02	0.00E+00	0.00E+00	0.00E+00	3.38E-07
Sr-89	4.34E+05	0.00E+00	1.25E+04	0.00E+00	0.00E+00	2.42E+06	3.71E+05
Sr-90	3.31E+07	0.00E+00	6.66E+05	0.00E+00	0.00E+00	1.65E+07	7.65E+05
Sr-91	8.80E+01	0.00E+00	3.51E+00	0.00E+00	0.00E+00	6.07E+04	2.59E+05
Sr-92	9.52E+00	0.00E+00	4.06E-01	0.00E+00	0.00E+00	2.74E+04	1.19E+05
Y-90	2.98E+03	0.00E+00	8.00E+01	0.00E+00	0.00E+00	2.93E+05	5.59E+05
Y-91M	3.70E-01	0.00E+00	1.42E-02	0.00E+00	0.00E+00	3.20E+03	3.02E+01
Y-91	6.61E+05	0.00E+00	1.77E+04	0.00E+00	0.00E+00	2.94E+06	4.09E+05
Y-92	1.47E+01	0.00E+00	4.29E-01	0.00E+00	0.00E+00	2.68E+04	1.65E+05
Y-93	1.35E+02	0.00E+00	3.72E+00	0.00E+00	0.00E+00	8.32E+04	5.79E+05
Zr-95	1.46E+05	4.58E+04	3.15E+04	0.00E+00	6.74E+04	2.69E+06	1.49E+05
Zr-97	1.38E+02	2.72E+01	1.26E+01	0.00E+00	4.12E+01	1.30E+05	6.30E+05
Nb-95	1.86E+04	1.03E+04	5.66E+03	0.00E+00	1.00E+04	7.51E+05	9.68E+04
Mo-99	0.00E+00	1.69E+02	3.22E+01	0.00E+00	4.11E+02	1.54E+05	2.69E+05
Tc- 99M	1.38E-03	3.86E-03	4.99E-02	0.00E+00	5.76E-02	1.15E+03	6.13E+03
Tc-101	5.92E-05	8.40E-05	8.24E-04	0.00E+00	1.52E-03	6.67E+02	8.72E-07
Ru-103	2.10E+03	0.00E+00	8.96E+02	0.00E+00	7.43E+03	7.83E+05	1.09E+05
Ru-105	1.12E+00	0.00E+00	4.34E-01	0.00E+00	1.41E+00	1.82E+04	9.04E+04
Ru-106	9.84E+04	0.00E+00	1.24E+04	0.00E+00	1.90E+05	1.61E+07	9.60E+05
Ag-110M	1.38E+04	1.31E+04	7.99E+03	0.00E+00	2.50E+04	6.75E+06	2.73E+05

Table 4-16 (Page 4 of 8)

Inhalation Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	4.88E+03	2.24E+03	6.67E+02	1.40E+03	0.00E+00	5.36E+05	7.50E+04
Te-127M	1.80E+04	8.16E+03	2.18E+03	4.38E+03	6.54E+04	1.66E+06	1.59E+05
Te-127	2.01E+00	9.12E-01	4.42E-01	1.42E+00	7.28E+00	1.12E+04	8.08E+04
Te-129M	1.39E+04	6.58E+03	2.25E+03	4.58E+03	5.19E+04	1.98E+06	4.05E+05
Te-129	7.10E-02	3.38E-02	1.76E-02	5.18E-02	2.66E-01	3.30E+03	1.62E+03
Te-131M	9.84E+01	6.01E+01	4.02E+01	7.25E+01	4.39E+02	2.38E+05	6.21E+05
Te-131	1.58E-02	8.32E-03	5.04E-03	1.24E-02	6.18E-02	2.34E+03	1.51E+01
Te-132	3.60E+02	2.90E+02	2.19E+02	2.46E+02	1.95E+03	4.49E+05	4.63E+05
I-130	6.24E+03	1.79E+04	7.17E+03	1.49E+06	2.75E+04	0.00E+00	9.12E+03
I-131	3.54E+04	4.91E+04	2.64E+04	1.46E+07	8.40E+04	0.00E+00	6.49E+03
I-132	1.59E+03	4.38E+03	1.58E+03	1.51E+05	6.92E+03	0.00E+00	1.27E+03
I-133	1.22E+04	2.05E+04	6.22E+03	2.92E+06	3.59E+04	0.00E+00	1.03E+04
I-134	8.88E+02	2.32E+03	8.40E+02	3.95E+04	3.66E+03	0.00E+00	2.04E+01
I-135	3.70E+03	9.44E+03	3.49E+03	6.21E+05	1.49E+04	0.00E+00	6.95E+03
Cs-134	5.02E+05	1.13E+06	5.49E+05	0.00E+00	3.75E+05	1.46E+05	9.76E+03
Cs-136	5.15E+04	1.94E+05	1.37E+05	0.00E+00	1.10E+05	1.78E+04	1.09E+04
Cs-137	6.70E+05	8.48E+05	3.11E+05	0.00E+00	3.04E+05	1.21E+05	8.48E+03
Cs-138	4.66E+02	8.56E+02	4.46E+02	0.00E+00	6.62E+02	7.87E+01	2.70E-01
Ba-139	1.34E+00	9.44E-04	3.90E-02	0.00E+00	8.88E-04	6.46E+03	6.45E+03
Ba-140	5.47E+04	6.70E+01	3.52E+03	0.00E+00	2.28E+01	2.03E+06	2.29E+05
Ba-141	1.42E-01	1.06E-04	4.74E-03	0.00E+00	9.84E-05	3.29E+03	7.46E-04
Ba-142	3.70E-02	3.70E-05	2.27E-03	0.00E+00	3.14E-05	1.91E+03	4.79E-10
La-140	4.79E+02	2.36E+02	6.26E+01	0.00E+00	0.00E+00	2.14E+05	4.87E+05
La-142	9.60E-01	4.25E-01	1.06E-01	0.00E+00	0.00E+00	1.02E+04	1.20E+04
Ce-141	2.84E+04	1.90E+04	2.17E+03	0.00E+00	8.88E+03	6.14E+05	1.26E+05
Ce-143	2.66E+02	1.94E+02	2.16E+01	0.00E+00	8.64E+01	1.30E+05	2.55E+05
Ce-144	4.89E+06	2.02E+06	2.62E+05	0.00E+00	1.21E+06	1.34E+07	8.64E+05
Pr-143	1.34E+04	5.31E+03	6.62E+02	0.00E+00	3.09E+03	4.83E+05	2.14E+05
Pr-144	4.30E-02	1.76E-02	2.18E-03	0.00E+00	1.01E-02	1.75E+03	2.35E-04
Nd-147	7.86E+03	8.56E+03	5.13E+02	0.00E+00	5.02E+03	3.72E+05	1.82E+05
W-187	1.20E+01	9.76E+00	3.43E+00	0.00E+00	0.00E+00	4.74E+04	1.77E+05
Np-239	3.38E+02	2.88E+02	1.77E+01	0.00E+00	1.00E+02	6.49E+04	1.32E+05

Notes:

1) Units are mrem/yr per $\mu Ci/m^3$.

Table 4-16 (Page 5 of 8)

Inhalation Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	6.40E+02	6.40E+02	6.40E+02	6.40E+02	6.40E+02	6.40E+02
Na-24	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04
Cr-51	0.00E+00	0.00E+00	1.54E+02	8.55E+01	2.43E+01	1.70E+04	1.08E+03
Mn-54	0.00E+00	4.29E+04	9.51E+03	0.00E+00	1.00E+04	1.58E+06	2.29E+04
Mn-56	0.00E+00	1.66E+00	3.12E-01	0.00E+00	1.67E+00	1.31E+04	1.23E+05
Fe-55	4.74E+04	2.52E+04	7.77E+03	0.00E+00	0.00E+00	1.11E+05	2.87E+03
Fe-59	2.07E+04	3.34E+04	1.67E+04	0.00E+00	0.00E+00	1.27E+06	7.07E+04
Co-58	0.00E+00	1.77E+03	3.16E+03	0.00E+00	0.00E+00	1.11E+06	3.44E+04
Co-60	0.00E+00	1.31E+04	2.26E+04	0.00E+00	0.00E+00	7.07E+06	9.62E+04
Ni-63	8.21E+05	4.63E+04	2.80E+04	0.00E+00	0.00E+00	2.75E+05	6.33E+03
Ni-65	2.99E+00	2.96E-01	1.64E-01	0.00E+00	0.00E+00	8.18E+03	8.40E+04
Cu-64	0.00E+00	1.99E+00	1.07E+00	0.00E+00	6.03E+00	9.58E+03	3.67E+04
Zn-65	4.26E+04	1.13E+05	7.03E+04	0.00E+00	7.14E+04	9.95E+05	1.63E+04
Zn-69	6.70E-02	9.66E-02	8.92E-03	0.00E+00	5.85E-02	1.42E+03	1.02E+04
Br-83	0.00E+00	0.00E+00	4.74E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	5.48E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.53E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.98E+05	1.14E+05	0.00E+00	0.00E+00	0.00E+00	7.99E+03
Rb-88	0.00E+00	5.62E+02	3.66E+02	0.00E+00	0.00E+00	0.00E+00	1.72E+01
Rb-89	0.00E+00	3.45E+02	2.90E+02	0.00E+00	0.00E+00	0.00E+00	1.89E+00
Sr-89	5.99E+05	0.00E+00	1.72E+04	0.00E+00	0.00E+00	2.16E+06	1.67E+05
Sr-90	3.85E+07	0.00E+00	7.66E+05	0.00E+00	0.00E+00	1.48E+07	3.43E+05
Sr-91	1.21E+02	0.00E+00	4.59E+00	0.00E+00	0.00E+00	5.33E+04	1.74E+05
Sr-92	1.31E+01	0.00E+00	5.25E-01	0.00E+00	0.00E+00	2.40E+04	2.42E+05
Y-90	4.11E+03	0.00E+00	1.11E+02	0.00E+00	0.00E+00	2.62E+05	2.68E+05
Y-91M	5.07E-01	0.00E+00	1.84E-02	0.00E+00	0.00E+00	2.81E+03	1.72E+03
Y-91	9.14E+05	0.00E+00	2.44E+04	0.00E+00	0.00E+00	2.63E+06	1.84E+05
Y-92	2.04E+01	0.00E+00	5.81E-01	0.00E+00	0.00E+00	2.39E+04	2.39E+05
Y-93	1.86E+02	0.00E+00	5.11E+00	0.00E+00	0.00E+00	7.44E+04	3.89E+05
Zr-95	1.90E+05	4.18E+04	3.70E+04	0.00E+00	5.96E+04	2.23E+06	6.11E+04
Zr-97	1.88E+02	2.72E+01	1.60E+01	0.00E+00	3.89E+01	1.13E+05	3.51E+05
Nb-95	2.35E+04	9.18E+03	6.55E+03	0.00E+00	8.62E+03	6.14E+05	3.70E+04
Mo-99	0.00E+00	1.72E+02	4.26E+01	0.00E+00	3.92E+02	1.35E+05	1.27E+05
Tc- 99M	1.78E-03	3.48E-03	5.77E-02	0.00E+00	5.07E-02	9.51E+02	4.81E+03
Tc-101	8.10E-05	8.51E-05	1.08E-03	0.00E+00	1.45E-03	5.85E+02	1.63E+01
Ru-103	2.79E+03	0.00E+00	1.07E+03	0.00E+00	7.03E+03	6.62E+05	4.48E+04
Ru-105	1.53E+00	0.00E+00	5.55E-01	0.00E+00	1.34E+00	1.59E+04	9.95E+04
Ru-106	1.36E+05	0.00E+00	1.69E+04	0.00E+00	1.84E+05	1.43E+07	4.29E+05
Ag-110M	1.69E+04	1.14E+04	9.14E+03	0.00E+00	2.12E+04	5.48E+06	1.00E+05

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Inhalation Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	6.73E+03	2.33E+03	9.14E+02	1.92E+03	0.00E+00	4.77E+05	3.38E+04
Te-127M	2.49E+04	8.55E+03	3.02E+03	6.07E+03	6.36E+04	1.48E+06	7.14E+04
Te-127	2.77E+00	9.51E-01	6.11E-01	1.96E+00	7.07E+00	1.00E+04	5.62E+04
Te-129M	1.92E+04	6.85E+03	3.04E+03	6.33E+03	5.03E+04	1.76E+06	1.82E+05
Te-129	9.77E-02	3.50E-02	2.38E-02	7.14E-02	2.57E-01	2.93E+03	2.55E+04
Te-131M	1.34E+02	5.92E+01	5.07E+01	9.77E+01	4.00E+02	2.06E+05	3.08E+05
Te-131	2.17E-02	8.44E-03	6.59E-03	1.70E-02	5.88E-02	2.05E+03	1.33E+03
Te-132	4.81E+02	2.72E+02	2.63E+02	3.17E+02	1.77E+03	3.77E+05	1.38E+05
I-130	8.18E+03	1.64E+04	8.44E+03	1.85E+06	2.45E+04	0.00E+00	5.11E+03
I-131	4.81E+04	4.81E+04	2.73E+04	1.62E+07	7.88E+04	0.00E+00	2.84E+03
I-132	2.12E+03	4.07E+03	1.88E+03	1.94E+05	6.25E+03	0.00E+00	3.20E+03
I-133	1.66E+04	2.03E+04	7.70E+03	3.85E+06	3.38E+04	0.00E+00	5.48E+03
I-134	1.17E+03	2.16E+03	9.95E+02	5.07E+04	3.30E+03	0.00E+00	9.55E+02
I-135	4.92E+03	8.73E+03	4.14E+03	7.92E+05	1.34E+04	0.00E+00	4.44E+03
Cs-134	6.51E+05	1.01E+06	2.25E+05	0.00E+00	3.30E+05	1.21E+05	3.85E+03
Cs-136	6.51E+04	1.71E+05	1.16E+05	0.00E+00	9.55E+04	1.45E+04	4.18E+03
Cs-137	9.07E+05	8.25E+05	1.28E+05	0.00E+00	2.82E+05	1.04E+05	3.62E+03
Cs-138	6.33E+02	8.40E+02	5.55E+02	0.00E+00	6.22E+02	6.81E+01	2.70E+02
Ba-139	1.84E+00	9.84E-04	5.37E-02	0.00E+00	8.62E-04	5.77E+03	5.77E+04
Ba-140	7.40E+04	6.48E+01	4.33E+03	0.00E+00	2.11E+01	1.74E+06	1.02E+05
Ba-141	1.96E-01	1.09E-04	6.36E-03	0.00E+00	9.47E-05	2.92E+03	2.75E+02
Ba-142	5.00E-02	3.60E-05	2.79E-03	0.00E+00	2.91E-05	1.64E+03	2.74E+00
La-140	6.44E+02	2.25E+02	7.55E+01	0.00E+00	0.00E+00	1.83E+05	2.26E+05
La-142	1.30E+00	4.11E-01	1.29E-01	0.00E+00	0.00E+00	8.70E+03	7.59E+04
Ce-141	3.92E+04	1.95E+04	2.90E+03	0.00E+00	8.55E+03	5.44E+05	5.66E+04
Ce-143	3.66E+02	1.99E+02	2.87E+01	0.00E+00	8.36E+01	1.15E+05	1.27E+05
Ce-144	6.77E+06	2.12E+06	3.61E+05	0.00E+00	1.17E+06	1.20E+07	3.89E+05
Pr-143	1.85E+04	5.55E+03	9.14E+02	0.00E+00	3.00E+03	4.33E+05	9.73E+04
Pr-144	5.96E-02	1.85E-02	3.00E-03	0.00E+00	9.77E-03	1.57E+03	1.97E+02
Nd-147	1.08E+04	8.73E+03	6.81E+02	0.00E+00	4.81E+03	3.28E+05	8.21E+04
W-187	1.63E+01	9.66E+00	4.33E+00	0.00E+00	0.00E+00	4.11E+04	9.10E+04
Np-239	4.66E+02	3.01E+02	2.35E+01	0.00E+00	9.73E+01	5.81E+04	6.40E+04

Notes:

1) Units are mrem/yr per $\mu Ci/m^3$.

Table 4-16 (Page 7 of 8)

Inhalation Dose Factors

Infant Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02
Na-24	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04
Cr-51	0.00E+00	0.00E+00	8.95E+01	5.75E+01	1.32E+01	1.28E+04	3.57E+02
Mn-54	0.00E+00	2.53E+04	4.98E+03	0.00E+00	4.98E+03	1.00E+06	7.06E+03
Mn-56	0.00E+00	1.54E+00	2.21E-01	0.00E+00	1.10E+00	1.25E+04	7.17E+04
Fe-55	1.97E+04	1.17E+04	3.33E+03	0.00E+00	0.00E+00	8.69E+04	1.09E+03
Fe-59	1.36E+04	2.35E+04	9.48E+03	0.00E+00	0.00E+00	1.02E+06	2.48E+04
Co-58	0.00E+00	1.22E+03	1.82E+03	0.00E+00	0.00E+00	7.77E+05	1.11E+04
Co-60	0.00E+00	8.02E+03	1.18E+04	0.00E+00	0.00E+00	4.51E+06	3.19E+04
Ni-63	3.39E+05	2.04E+04	1.16E+04	0.00E+00	0.00E+00	2.09E+05	2.42E+03
Ni-65	2.39E+00	2.84E-01	1.23E-01	0.00E+00	0.00E+00	8.12E+03	5.01E+04
Cu-64	0.00E+00	1.88E+00	7.74E-01	0.00E+00	3.98E+00	9.30E+03	1.50E+04
Zn-65	1.93E+04	6.26E+04	3.11E+04	0.00E+00	3.25E+04	6.47E+05	5.14E+04
Zn-69	5.39E-02	9.67E-02	7.18E-03	0.00E+00	4.02E-02	1.47E+03	1.32E+04
Br-83	0.00E+00	0.00E+00	3.81E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.04E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.90E+05	8.82E+04	0.00E+00	0.00E+00	0.00E+00	3.04E+03
Rb-88	0.00E+00	5.57E+02	2.87E+02	0.00E+00	0.00E+00	0.00E+00	3.39E+02
Rb-89	0.00E+00	3.21E+02	2.06E+02	0.00E+00	0.00E+00	0.00E+00	6.82E+01
Sr-89	3.98E+05	0.00E+00	1.14E+04	0.00E+00	0.00E+00	2.03E+06	6.40E+04
Sr-90	1.55E+07	0.00E+00	3.12E+05	0.00E+00	0.00E+00	1.12E+07	1.31E+05
Sr-91	9.56E+01	0.00E+00	3.46E+00	0.00E+00	0.00E+00	5.26E+04	7.34E+04
Sr-92	1.05E+01	0.00E+00	3.91E-01	0.00E+00	0.00E+00	2.38E+04	1.40E+05
Y-90	3.29E+03	0.00E+00	8.82E+01	0.00E+00	0.00E+00	2.69E+05	1.04E+05
Y-91M	4.07E-01	0.00E+00	1.39E-02	0.00E+00	0.00E+00	2.79E+03	2.35E+03
Y-91	5.88E+05	0.00E+00	1.57E+04	0.00E+00	0.00E+00	2.45E+06	7.03E+04
Y-92	1.64E+01	0.00E+00	4.61E-01	0.00E+00	0.00E+00	2.45E+04	1.27E+05
Y-93	1.50E+02	0.00E+00	4.07E+00	0.00E+00	0.00E+00	7.64E+04	1.67E+05
Zr-95	1.15E+05	2.79E+04	2.03E+04	0.00E+00	3.11E+04	1.75E+06	2.17E+04
Zr-97	1.50E+02	2.56E+01	1.17E+01	0.00E+00	2.59E+01	1.10E+05	1.40E+05
Nb-95	1.57E+04	6.43E+03	3.78E+03	0.00E+00	4.72E+03	4.79E+05	1.27E+04
Mo-99	0.00E+00	1.65E+02	3.23E+01	0.00E+00	2.65E+02	1.35E+05	4.87E+04
Tc- 99M	1.40E-03	2.88E-03	3.72E-02	0.00E+00	3.11E-02	8.11E+02	2.03E+03
Tc-101	6.51E-05	8.23E-05	8.12E-04	0.00E+00	9.79E-04	5.84E+02	8.44E+02
Ru-103	2.02E+03	0.00E+00	6.79E+02	0.00E+00	4.24E+03	5.52E+05	1.61E+04
Ru-105	1.22E+00	0.00E+00	4.10E-01	0.00E+00	8.99E-01	1.57E+04	4.84E+04
Ru-106	8.68E+04	0.00E+00	1.09E+04	0.00E+00	1.07E+05	1.16E+07	1.64E+05
Ag-110M	9.98E+03	7.22E+03	5.00E+03	0.00E+00	1.09E+04	3.67E+06	3.30E+04

Table 4-16 (Page 8 of 8)

Inhalation Dose Factors

Infant Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	4.76E+03	1.99E+03	6.58E+02	1.62E+03	0.00E+00	4.47E+05	1.29E+04
Te-127M	1.67E+04	6.90E+03	2.07E+03	4.87E+03	3.75E+04	1.31E+06	2.73E+04
Te-127	2.23E+00	9.53E-01	4.89E-01	1.85E+00	4.86E+00	1.03E+04	2.44E+04
Te-129M	1.41E+04	6.09E+03	2.23E+03	5.47E+03	3.18E+04	1.68E+06	6.90E+04
Te-129	7.88E-02	3.47E-02	1.88E-02	6.75E-02	1.75E-01	3.00E+03	2.63E+04
Te-131M	1.07E+02	5.50E+01	3.63E+01	8.93E+01	2.65E+02	1.99E+05	1.19E+05
Te-131	1.74E-02	8.22E-03	5.00E-03	1.58E-02	3.99E-02	2.06E+03	8.22E+03
Te-132	3.72E+02	2.37E+02	1.76E+02	2.79E+02	1.03E+03	3.40E+05	4.41E+04
I-130	6.36E+03	1.39E+04	5.57E+03	1.60E+06	1.53E+04	0.00E+00	1.99E+03
I-131	3.79E+04	4.44E+04	1.96E+04	1.48E+07	5.18E+04	0.00E+00	1.06E+03
I-132	1.69E+03	3.54E+03	1.26E+03	1.69E+05	3.95E+03	0.00E+00	1.90E+03
I-133	1.32E+04	1.92E+04	5.60E+03	3.56E+06	2.24E+04	0.00E+00	2.16E+03
I-134	9.21E+02	1.88E+03	6.65E+02	4.45E+04	2.09E+03	0.00E+00	1.29E+03
I-135	3.86E+03	7.60E+03	2.77E+03	6.96E+05	8.47E+03	0.00E+00	1.83E+03
Cs-134	3.96E+05	7.03E+05	7.45E+04	0.00E+00	1.90E+05	7.97E+04	1.33E+03
Cs-136	4.83E+04	1.35E+05	5.29E+04	0.00E+00	5.64E+04	1.18E+04	1.43E+03
Cs-137	5.49E+05	6.12E+05	4.55E+04	0.00E+00	1.72E+05	7.13E+04	1.33E+03
Cs-138	5.05E+02	7.81E+02	3.98E+02	0.00E+00	4.10E+02	6.54E+01	8.76E+02
Ba-139	1.48E+00	9.84E-04	4.30E-02	0.00E+00	5.92E-04	5.95E+03	5.10E+04
Ba-140	5.60E+04	5.60E+01	2.90E+03	0.00E+00	1.34E+01	1.60E+06	3.84E+04
Ba-141	1.57E-01	1.08E-04	4.97E-03	0.00E+00	6.50E-05	2.97E+03	4.75E+03
Ba-142	3.98E-02	3.30E-05	1.96E-03	0.00E+00	1.90E-05	1.55E+03	6.93E+02
La-140	5.05E+02	2.00E+02	5.15E+01	0.00E+00	0.00E+00	1.68E+05	8.48E+04
La-142	1.03E+00	3.77E-01	9.04E-02	0.00E+00	0.00E+00	8.22E+03	5.95E+04
Ce-141	2.77E+04	1.67E+04	1.99E+03	0.00E+00	5.25E+03	5.17E+05	2.16E+04
Ce-143	2.93E+02	1.93E+02	2.21E+01	0.00E+00	5.64E+01	1.16E+05	4.97E+04
Ce-144	3.19E+06	1.21E+06	1.76E+05	0.00E+00	5.38E+05	9.84E+06	1.48E+05
Pr-143	1.40E+04	5.24E+03	6.99E+02	0.00E+00	1.97E+03	4.33E+05	3.72E+04
Pr-144	4.79E-02	1.85E-02	2.41E-03	0.00E+00	6.72E-03	1.61E+03	4.28E+03
Nd-147	7.94E+03	8.13E+03	5.00E+02	0.00E+00	3.15E+03	3.22E+05	3.12E+04
W-187	1.30E+01	9.02E+00	3.12E+00	0.00E+00	0.00E+00	3.96E+04	3.56E+04
Np-239	3.71E+02	2.98E+02	1.88E+01	0.00E+00	6.62E+01	5.95E+04	2.49E+04

Notes:

1) Units are mrem/yr per $\mu Ci/m^3$.

Table 4-17 (Page 1 of 6)

Vegetation Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.29E+03	1.29E+03	1.29E+03	1.29E+03	1.29E+03	1.29E+03
Na-24	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05
Cr-51	0.00E+00	0.00E+00	4.64E+04	2.77E+04	1.02E+04	6.15E+04	1.17E+07
Mn-54	0.00E+00	3.13E+08	5.97E+07	0.00E+00	9.31E+07	0.00E+00	9.58E+08
Mn-56	0.00E+00	1.54E+01	2.73E+00	0.00E+00	1.95E+01	0.00E+00	4.91E+02
Fe-55	2.10E+08	1.45E+08	3.38E+07	0.00E+00	0.00E+00	8.08E+07	8.31E+07
Fe-59	1.26E+08	2.96E+08	1.13E+08	0.00E+00	0.00E+00	8.27E+07	9.87E+08
Co-58	0.00E+00	3.08E+07	6.90E+07	0.00E+00	0.00E+00	0.00E+00	6.24E+08
Co-60	0.00E+00	1.67E+08	3.69E+08	0.00E+00	0.00E+00	0.00E+00	3.14E+09
Ni-63	1.04E+10	7.21E+08	3.49E+08	0.00E+00	0.00E+00	0.00E+00	1.50E+08
Ni-65	5.97E+01	7.75E+00	3.54E+00	0.00E+00	0.00E+00	0.00E+00	1.97E+02
Cu-64	0.00E+00	9.09E+03	4.27E+03	0.00E+00	2.29E+04	0.00E+00	7.75E+05
Zn-65	3.17E+08	1.01E+09	4.56E+08	0.00E+00	6.75E+08	0.00E+00	6.36E+08
Zn-69	4.95E-06	9.48E-06	6.59E-07	0.00E+00	6.16E-06	0.00E+00	1.42E-06
Br-83	0.00E+00	0.00E+00	3.00E+00	0.00E+00	0.00E+00	0.00E+00	4.32E+00
Br-84	0.00E+00	0.00E+00	2.20E-11	0.00E+00	0.00E+00	0.00E+00	1.72E-16
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.20E+08	1.03E+08	0.00E+00	0.00E+00	0.00E+00	4.34E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	9.95E+09	0.00E+00	2.86E+08	0.00E+00	0.00E+00	0.00E+00	1.60E+09
Sr-90	6.95E+11	0.00E+00	1.40E+10	0.00E+00	0.00E+00	0.00E+00	1.75E+10
Sr-91	3.01E+05	0.00E+00	1.22E+04	0.00E+00	0.00E+00	0.00E+00	1.43E+06
Sr-92	4.12E+02	0.00E+00	1.78E+01	0.00E+00	0.00E+00	0.00E+00	8.17E+03
Y-90	1.33E+04	0.00E+00	3.57E+02	0.00E+00	0.00E+00	0.00E+00	1.41E+08
Y-91M	4.93E-09	0.00E+00	1.91E-10	0.00E+00	0.00E+00	0.00E+00	1.45E-08
Y-91	5.12E+06	0.00E+00	1.37E+05	0.00E+00	0.00E+00	0.00E+00	2.82E+09
Y-92	8.95E-01	0.00E+00	2.62E-02	0.00E+00	0.00E+00	0.00E+00	1.57E+04
Y-93	1.67E+02	0.00E+00	4.62E+00	0.00E+00	0.00E+00	0.00E+00	5.31E+06
Zr-95	1.18E+06	3.77E+05	2.55E+05	0.00E+00	5.92E+05	0.00E+00	1.20E+09
Zr-97	3.35E+02	6.77E+01	3.09E+01	0.00E+00	1.02E+02	0.00E+00	2.10E+07
Nb-95	1.43E+05	7.95E+04	4.27E+04	0.00E+00	7.86E+04	0.00E+00	4.83E+08
Mo-99	0.00E+00	6.14E+06	1.17E+06	0.00E+00	1.39E+07	0.00E+00	1.42E+07
Tc- 99M	3.06E+00	8.64E+00	1.10E+02	0.00E+00	1.31E+02	4.23E+00	5.11E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	4.77E+06	0.00E+00	2.05E+06	0.00E+00	1.82E+07	0.00E+00	5.57E+08
Ru-105	5.27E+01	0.00E+00	2.08E+01	0.00E+00	6.81E+02	0.00E+00	3.23E+04
Ru-106	1.93E+08	0.00E+00	2.44E+07	0.00E+00	3.72E+08	0.00E+00	1.25E+10
Ag-110M	1.05E+07	9.75E+06	5.79E+06	0.00E+00	1.92E+07	0.00E+00	3.98E+09

Table 4-17 (Page 2 of 6)

Vegetation Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	9.67E+07	3.50E+07	1.30E+07	2.91E+07	3.93E+08	0.00E+00	3.86E+08
Te-127M	3.49E+08	1.25E+08	4.26E+07	8.92E+07	1.42E+09	0.00E+00	1.17E+09
Te-127	5.68E+03	2.04E+03	1.23E+03	4.21E+03	2.31E+04	0.00E+00	4.48E+05
Te-129M	2.51E+08	9.37E+07	3.97E+07	8.62E+07	1.05E+09	0.00E+00	1.26E+09
Te-129	7.14E-04	2.68E-04	1.74E-04	5.48E-04	3.00E-03	0.00E+00	5.39E-04
Te-131M	9.09E+05	4.45E+05	3.71E+05	7.04E+05	4.50E+06	0.00E+00	4.41E+07
Te-131	1.26E-15	5.26E-16	3.97E-16	1.03E-15	5.51E-15	0.00E+00	1.78E-16
Te-132	4.28E+06	2.77E+06	2.60E+06	3.06E+06	2.67E+07	0.00E+00	1.31E+08
I-130	3.89E+05	1.15E+06	4.52E+05	9.72E+07	1.79E+06	0.00E+00	9.87E+05
I-131	8.07E+07	1.15E+08	6.62E+07	3.78E+10	1.98E+08	0.00E+00	3.05E+07
I-132	5.58E+01	1.49E+02	5.22E+01	5.22E+03	2.38E+02	0.00E+00	2.80E+01
I-133	2.08E+06	3.62E+06	1.10E+06	5.32E+08	6.31E+06	0.00E+00	3.25E+06
I-134	8.55E-05	2.32E-04	8.31E-05	4.02E-03	3.69E-04	0.00E+00	2.02E-07
I-135	3.87E+04	1.01E+05	3.74E+04	6.68E+06	1.62E+05	0.00E+00	1.14E+05
Cs-134	4.67E+09	1.11E+10	9.08E+09	0.00E+00	3.59E+09	1.19E+09	1.94E+08
Cs-136	4.25E+07	1.68E+08	1.21E+08	0.00E+00	9.33E+07	1.28E+07	1.90E+07
Cs-137	6.36E+09	8.70E+09	5.70E+09	0.00E+00	2.95E+09	9.81E+08	1.68E+08
Cs-138	3.32E-11	6.56E-11	3.25E-11	0.00E+00	4.82E-11	4.76E-12	2.80E-16
Ba-139	2.71E-02	1.93E-05	7.92E-04	0.00E+00	1.80E-05	1.09E-05	4.80E-02
Ba-140	1.29E+08	1.61E+05	8.42E+06	0.00E+00	5.49E+04	9.24E+04	2.65E+08
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	1.98E+03	9.97E+02	2.63E+02	0.00E+00	0.00E+00	0.00E+00	7.32E+07
La-142	1.94E-04	8.83E-05	2.20E-05	0.00E+00	0.00E+00	0.00E+00	6.45E-01
Ce-141	1.97E+05	1.33E+05	1.51E+04	0.00E+00	6.19E+04	0.00E+00	5.09E+08
Ce-143	9.94E+02	7.35E+05	8.13E+01	0.00E+00	3.24E+02	0.00E+00	2.75E+07
Ce-144	3.29E+07	1.38E+07	1.77E+06	0.00E+00	8.16E+06	0.00E+00	1.11E+10
Pr-143	6.27E+04	2.51E+04	3.11E+03	0.00E+00	1.45E+04	0.00E+00	2.75E+08
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	3.37E+04	3.90E+04	2.33E+03	0.00E+00	2.28E+04	0.00E+00	1.87E+08
W-187	3.79E+04	3.17E+04	1.11E+04	0.00E+00	0.00E+00	0.00E+00	1.04E+07
Np-239	1.42E+03	1.40E+02	7.72E+01	0.00E+00	4.37E+02	0.00E+00	2.87E+07

Notes:

1) Units are m^2 mrem/yr per μCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-17 (Page 3 of 6)

Vegetation Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.47E+03	1.47E+03	1.47E+03	1.47E+03	1.47E+03	1.47E+03
Na-24	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05
Cr-51	0.00E+00	0.00E+00	6.16E+04	3.42E+04	1.35E+04	8.79E+04	1.03E+07
Mn-54	0.00E+00	4.54E+08	9.01E+07	0.00E+00	1.36E+08	0.00E+00	9.32E+08
Mn-56	0.00E+00	1.39E+01	2.47E+00	0.00E+00	1.76E+01	0.00E+00	9.13E+02
Fe-55	3.26E+08	2.31E+08	5.39E+07	0.00E+00	0.00E+00	1.47E+08	1.00E+08
Fe-59	1.79E+08	4.18E+08	1.61E+08	0.00E+00	0.00E+00	1.32E+08	9.89E+08
Co-58	0.00E+00	4.37E+07	1.01E+08	0.00E+00	0.00E+00	0.00E+00	6.02E+08
Co-60	0.00E+00	2.49E+08	5.60E+08	0.00E+00	0.00E+00	0.00E+00	3.24E+09
Ni-63	1.61E+10	1.13E+09	5.45E+08	0.00E+00	0.00E+00	0.00E+00	1.81E+08
Ni-65	5.55E+01	7.10E+00	3.23E+00	0.00E+00	0.00E+00	0.00E+00	3.85E+02
Cu-64	0.00E+00	8.24E+03	3.87E+03	0.00E+00	2.08E+04	0.00E+00	6.39E+05
Zn-65	4.24E+08	1.47E+09	6.86E+08	0.00E+00	9.41E+08	0.00E+00	6.23E+08
Zn-69	4.64E-06	8.84E-06	6.19E-07	0.00E+00	5.78E-06	0.00E+00	1.63E-05
Br-83	0.00E+00	0.00E+00	2.81E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	2.00E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.75E+08	1.29E+08	0.00E+00	0.00E+00	0.00E+00	4.06E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.51E+10	0.00E+00	4.33E+08	0.00E+00	0.00E+00	0.00E+00	1.80E+09
Sr-90	9.22E+11	0.00E+00	1.84E+10	0.00E+00	0.00E+00	0.00E+00	2.11E+10
Sr-91	2.81E+05	0.00E+00	1.12E+04	0.00E+00	0.00E+00	0.00E+00	1.27E+06
Sr-92	3.84E+02	0.00E+00	1.64E+01	0.00E+00	0.00E+00	0.00E+00	9.78E+03
Y-90	1.24E+04	0.00E+00	3.35E+02	0.00E+00	0.00E+00	0.00E+00	1.02E+08
Y-91M	4.59E-09	0.00E+00	1.75E-10	0.00E+00	0.00E+00	0.00E+00	2.17E-07
Y-91	7.84E+06	0.00E+00	2.10E+05	0.00E+00	0.00E+00	0.00E+00	3.21E+09
Y-92	8.41E-01	0.00E+00	2.43E-02	0.00E+00	0.00E+00	0.00E+00	2.31E+04
Y-93	1.57E+02	0.00E+00	4.30E+00	0.00E+00	0.00E+00	0.00E+00	4.80E+06
Zr-95	1.72E+06	5.44E+05	3.74E+05	0.00E+00	7.99E+05	0.00E+00	1.26E+09
Zr-97	3.10E+02	6.14E+01	2.83E+01	0.00E+00	9.31E+01	0.00E+00	1.66E+07
Nb-95	1.93E+05	1.07E+05	5.90E+04	0.00E+00	1.04E+05	0.00E+00	4.58E+08
Mo-99	0.00E+00	5.63E+06	1.07E+06	0.00E+00	1.29E+07	0.00E+00	1.01E+07
Tc- 99M	2.70E+00	7.52E+00	9.75E+01	0.00E+00	1.12E+02	4.17E+00	4.94E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	6.82E+06	0.00E+00	2.91E+06	0.00E+00	2.40E+07	0.00E+00	5.69E+08
Ru-105	4.90E+01	0.00E+00	1.90E+01	0.00E+00	6.18E+02	0.00E+00	3.95E+04
Ru-106	3.09E+08	0.00E+00	3.90E+07	0.00E+00	5.97E+08	0.00E+00	1.48E+10
Ag-110M	1.52E+07	1.44E+07	8.73E+06	0.00E+00	2.74E+07	0.00E+00	4.03E+09

Table 4-17 (Page 4 of 6)

Vegetation Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	1.49E+08	5.35E+07	1.99E+07	4.15E+07	0.00E+00	0.00E+00	4.38E+08
Te-127M	5.51E+08	1.96E+08	6.56E+07	1.31E+08	2.24E+09	0.00E+00	1.37E+09
Te-127	5.36E+03	1.90E+03	1.15E+03	3.70E+03	2.17E+04	0.00E+00	4.14E+05
Te-129M	3.61E+08	1.34E+08	5.72E+07	1.17E+08	1.51E+09	0.00E+00	1.36E+09
Te-129	6.68E-04	2.49E-04	1.63E-04	4.77E-04	2.80E-03	0.00E+00	3.65E-03
Te-131M	8.42E+05	4.04E+05	3.37E+05	6.07E+05	4.21E+06	0.00E+00	3.24E+07
Te-131	1.17E-15	4.82E-16	3.66E-16	9.01E-16	5.11E-15	0.00E+00	9.60E-17
Te-132	3.89E+06	2.46E+06	2.32E+06	2.60E+06	2.36E+07	0.00E+00	7.81E+07
I-130	3.47E+05	1.01E+06	4.01E+05	8.20E+07	1.55E+06	0.00E+00	7.73E+05
I-131	7.68E+07	1.08E+08	5.78E+07	3.14E+10	1.85E+08	0.00E+00	2.13E+07
I-132	5.03E+01	1.32E+02	4.72E+01	4.43E+03	2.07E+02	0.00E+00	5.73E+01
I-133	1.93E+06	3.28E+06	1.00E+06	4.58E+08	5.75E+06	0.00E+00	2.48E+06
I-134	7.73E-05	2.05E-04	7.36E-05	3.41E-03	3.23E-04	0.00E+00	2.70E-06
I-135	3.49E+04	8.99E+04	3.33E+04	5.78E+06	1.42E+05	0.00E+00	9.97E+04
Cs-134	7.10E+09	1.67E+10	7.75E+09	0.00E+00	5.31E+09	2.03E+09	2.08E+08
Cs-136	4.35E+07	1.71E+08	1.15E+08	0.00E+00	9.31E+07	1.47E+07	1.38E+07
Cs-137	1.01E+10	1.35E+10	4.69E+09	0.00E+00	4.59E+09	1.78E+09	1.92E+08
Cs-138	3.07E-11	5.89E-11	2.94E-11	0.00E+00	4.35E-11	5.06E-12	2.67E-14
Ba-139	2.55E-02	1.79E-05	7.42E-04	0.00E+00	1.69E-05	1.23E-05	2.27E-01
Ba-140	1.38E+08	1.69E+05	8.90E+06	0.00E+00	5.74E+04	1.14E+05	2.13E+08
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	1.81E+03	8.88E+02	2.36E+02	0.00E+00	0.00E+00	0.00E+00	5.10E+07
La-142	1.78E-04	7.92E-05	1.97E-05	0.00E+00	0.00E+00	0.00E+00	2.41E+00
Ce-141	2.83E+05	1.89E+05	2.17E+04	0.00E+00	8.89E+04	0.00E+00	5.40E+08
Ce-143	9.29E+02	6.76E+05	7.55E+01	0.00E+00	3.03E+02	0.00E+00	2.03E+07
Ce-144	5.27E+07	2.18E+07	2.83E+06	0.00E+00	1.30E+07	0.00E+00	1.33E+10
Pr-143	7.01E+04	2.80E+04	3.49E+03	0.00E+00	1.63E+04	0.00E+00	2.31E+08
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	3.67E+04	4.00E+04	2.39E+03	0.00E+00	2.35E+04	0.00E+00	1.44E+08
W-187	3.53E+04	2.87E+04	1.01E+04	0.00E+00	0.00E+00	0.00E+00	7.78E+06
Np-239	1.38E+03	1.30E+02	7.24E+01	0.00E+00	4.09E+02	0.00E+00	2.10E+07

Notes:

1) Units are m^2 mrem/yr per μCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per μCi/m^3.

Table 4-17 (Page 5 of 6)

Vegetation Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	2.29E+03	2.29E+03	2.29E+03	2.29E+03	2.29E+03	2.29E+03
Na-24	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05
Cr-51	0.00E+00	0.00E+00	1.17E+05	6.49E+04	1.77E+04	1.18E+05	6.20E+06
Mn-54	0.00E+00	6.65E+08	1.77E+08	0.00E+00	1.86E+08	0.00E+00	5.58E+08
Mn-56	0.00E+00	1.82E+01	4.10E+00	0.00E+00	2.20E+01	0.00E+00	2.63E+03
Fe-55	8.01E+08	4.25E+08	1.32E+08	0.00E+00	0.00E+00	2.40E+08	7.87E+07
Fe-59	3.97E+08	6.42E+08	3.20E+08	0.00E+00	0.00E+00	1.86E+08	6.69E+08
Co-58	0.00E+00	6.45E+07	1.97E+08	0.00E+00	0.00E+00	0.00E+00	3.76E+08
Co-60	0.00E+00	3.78E+08	1.12E+09	0.00E+00	0.00E+00	0.00E+00	2.10E+09
Ni-63	3.95E+10	2.11E+09	1.34E+09	0.00E+00	0.00E+00	0.00E+00	1.42E+08
Ni-65	1.02E+02	9.59E+00	5.60E+00	0.00E+00	0.00E+00	0.00E+00	1.18E+03
Cu-64	0.00E+00	1.09E+04	6.56E+03	0.00E+00	2.62E+04	0.00E+00	5.10E+05
Zn-65	8.12E+08	2.16E+09	1.35E+09	0.00E+00	1.36E+09	0.00E+00	3.80E+08
Zn-69	8.56E-06	1.24E-05	1.14E-06	0.00E+00	7.50E-06	0.00E+00	7.80E-04
Br-83	0.00E+00	0.00E+00	5.18E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	3.39E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.54E+08	2.79E+08	0.00E+00	0.00E+00	0.00E+00	2.92E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	3.59E+10	0.00E+00	1.03E+09	0.00E+00	0.00E+00	0.00E+00	1.39E+09
Sr-90	1.87E+12	0.00E+00	3.77E+10	0.00E+00	0.00E+00	0.00E+00	1.67E+10
Sr-91	5.17E+05	0.00E+00	1.95E+04	0.00E+00	0.00E+00	0.00E+00	1.14E+06
Sr-92	7.04E+02	0.00E+00	2.82E+01	0.00E+00	0.00E+00	0.00E+00	1.33E+04
Y-90	2.31E+04	0.00E+00	6.18E+02	0.00E+00	0.00E+00	0.00E+00	6.57E+07
Y-91M	8.42E-09	0.00E+00	3.06E-10	0.00E+00	0.00E+00	0.00E+00	1.65E-05
Y-91	1.87E+07	0.00E+00	4.99E+05	0.00E+00	0.00E+00	0.00E+00	2.49E+09
Y-92	1.55E+00	0.00E+00	4.43E-02	0.00E+00	0.00E+00	0.00E+00	4.47E+04
Y-93	2.89E+02	0.00E+00	7.94E+00	0.00E+00	0.00E+00	0.00E+00	4.31E+06
Zr-95	3.86E+06	8.50E+05	7.56E+05	0.00E+00	1.22E+06	0.00E+00	8.86E+08
Zr-97	5.67E+02	8.19E+01	4.83E+01	0.00E+00	1.18E+02	0.00E+00	1.24E+07
Nb-95	4.12E+05	1.61E+05	1.15E+05	0.00E+00	1.51E+05	0.00E+00	2.97E+08
Mo-99	0.00E+00	7.69E+06	1.90E+06	0.00E+00	1.64E+07	0.00E+00	6.36E+06
Tc- 99M	4.64E+00	9.10E+00	1.51E+02	0.00E+00	1.32E+02	4.62E+00	5.18E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.53E+07	0.00E+00	5.89E+06	0.00E+00	3.86E+07	0.00E+00	3.96E+08
Ru-105	8.97E+01	0.00E+00	3.25E+01	0.00E+00	7.89E+02	0.00E+00	5.86E+04
Ru-106	7.45E+08	0.00E+00	9.30E+07	0.00E+00	1.01E+09	0.00E+00	1.16E+10
Ag-110M	3.21E+07	2.17E+07	1.74E+07	0.00E+00	4.04E+07	0.00E+00	2.58E+09

Table 4-17 (Page 6 of 6)

Vegetation Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	3.51E+08	9.52E+07	4.68E+07	9.86E+07	0.00E+00	0.00E+00	3.39E+08
Te-127M	1.32E+09	3.56E+08	1.57E+08	3.16E+08	3.77E+09	0.00E+00	1.07E+09
Te-127	9.89E+03	2.67E+03	2.12E+03	6.84E+03	2.81E+04	0.00E+00	3.86E+05
Te-129M	8.40E+08	2.35E+08	1.30E+08	2.71E+08	2.47E+09	0.00E+00	1.02E+09
Te-129	1.24E-03	3.45E-04	2.94E-04	8.83E-04	3.62E-03	0.00E+00	7.70E-02
Te-131M	1.54E+06	5.32E+05	5.66E+05	1.09E+06	5.15E+06	0.00E+00	2.16E+07
Te-131	2.15E-15	6.57E-16	6.41E-16	1.65E-15	6.51E-15	0.00E+00	1.13E-14
Te-132	6.97E+06	3.09E+06	3.73E+06	4.49E+06	2.86E+07	0.00E+00	3.11E+07
I-130	6.10E+05	1.23E+06	6.35E+05	1.36E+08	1.84E+06	0.00E+00	5.76E+05
I-131	1.43E+08	1.44E+08	8.17E+07	4.75E+10	2.36E+08	0.00E+00	1.28E+07
I-132	8.93E+01	1.64E+02	7.54E+01	7.61E+03	2.51E+02	0.00E+00	1.93E+02
I-133	3.52E+06	4.36E+06	1.65E+06	8.09E+08	7.26E+06	0.00E+00	1.76E+06
I-134	1.37E-04	2.55E-04	1.17E-04	5.86E-03	3.90E-04	0.00E+00	1.69E-04
I-135	6.20E+04	1.12E+05	5.28E+04	9.89E+06	1.71E+05	0.00E+00	8.51E+04
Cs-134	1.60E+10	2.63E+10	5.55E+09	0.00E+00	8.16E+09	2.93E+09	1.42E+08
Cs-136	8.18E+07	2.25E+08	1.46E+08	0.00E+00	1.20E+08	1.79E+07	7.90E+06
Cs-137	2.39E+10	2.29E+10	3.38E+09	0.00E+00	7.46E+09	2.68E+09	1.43E+08
Cs-138	5.58E-11	7.75E-11	4.92E-11	0.00E+00	5.45E-11	5.87E-12	3.57E-11
Ba-139	4.69E-02	2.51E-05	1.36E-03	0.00E+00	2.19E-05	1.47E-05	2.71E+00
Ba-140	2.77E+08	2.43E+05	1.62E+07	0.00E+00	7.90E+04	1.45E+05	1.40E+08
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	3.25E+03	1.13E+03	3.82E+02	0.00E+00	0.00E+00	0.00E+00	3.16E+07
La-142	3.23E-04	1.03E-04	3.22E-05	0.00E+00	0.00E+00	0.00E+00	2.04E+01
Ce-141	6.55E+05	3.27E+05	4.85E+04	0.00E+00	1.43E+05	0.00E+00	4.08E+08
Ce-143	1.71E+03	9.28E+05	1.34E+02	0.00E+00	3.89E+02	0.00E+00	1.36E+07
Ce-144	1.27E+08	3.98E+07	6.78E+06	0.00E+00	2.21E+07	0.00E+00	1.04E+10
Pr-143	1.46E+05	4.38E+04	7.24E+03	0.00E+00	2.37E+04	0.00E+00	1.57E+08
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	7.27E+04	5.89E+04	4.56E+03	0.00E+00	3.23E+04	0.00E+00	9.33E+07
W-187	6.41E+04	3.80E+04	1.70E+04	0.00E+00	0.00E+00	0.00E+00	5.34E+06
Np-239	2.55E+03	1.83E+02	1.29E+02	0.00E+00	5.30E+02	0.00E+00	1.36E+07

Notes:

1) Units are m^2 mrem/yr per μCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

3) The infant age group is assumed to receive no due through the vegetation ingestion pathway therefore no dose factors are supplied.

Table 4-18 (Page 1 of 8)

Grass-Cow-Milk Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	4.35E+02	4.35E+02	4.35E+02	4.35E+02	4.35E+02	4.35E+02
Na-24	2.46E+06	2.46E+06	2.46E+06	2.46E+06	2.46E+06	2.46E+06	2.46E+06
Cr-51	0.00E+00	0.00E+00	2.86E+04	1.71E+04	6.29E+03	3.79E+04	7.18E+06
Mn-54	0.00E+00	8.41E+06	1.61E+06	0.00E+00	2.50E+06	0.00E+00	2.58E+07
Mn-56	0.00E+00	4.13E-03	7.32E-04	0.00E+00	5.24E-03	0.00E+00	1.32E-01
Fe-55	2.51E+07	1.74E+07	4.05E+06	0.00E+00	0.00E+00	9.68E+06	9.95E+06
Fe-59	2.97E+07	6.98E+07	2.67E+07	0.00E+00	0.00E+00	1.95E+07	2.33E+08
Co-58	0.00E+00	4.72E+06	1.06E+07	0.00E+00	0.00E+00	0.00E+00	9.56E+07
Co-60	0.00E+00	1.64E+07	3.62E+07	0.00E+00	0.00E+00	0.00E+00	3.08E+08
Ni-63	6.73E+09	4.66E+08	2.26E+08	0.00E+00	0.00E+00	0.00E+00	9.73E+07
Ni-65	3.70E-01	4.81E-02	2.19E-02	0.00E+00	0.00E+00	0.00E+00	1.22E+00
Cu-64	0.00E+00	2.36E+04	1.11E+04	0.00E+00	5.95E+04	0.00E+00	2.01E+06
Zn-65	1.37E+09	4.36E+09	1.97E+09	0.00E+00	2.92E+09	0.00E+00	2.75E+09
Zn-69	2.01E-12	3.84E-12	2.67E-13	0.00E+00	2.50E-12	0.00E+00	5.78E-13
Br-83	0.00E+00	0.00E+00	9.65E-02	0.00E+00	0.00E+00	0.00E+00	1.39E-01
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.60E+09	1.21E+09	0.00E+00	0.00E+00	0.00E+00	5.12E+08
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.45E+09	0.00E+00	4.16E+07	0.00E+00	0.00E+00	0.00E+00	2.33E+08
Sr-90	5.38E+10	0.00E+00	1.08E+09	0.00E+00	0.00E+00	0.00E+00	1.35E+09
Sr-91	2.87E+04	0.00E+00	1.16E+03	0.00E+00	0.00E+00	0.00E+00	1.37E+05
Sr-92	4.84E-01	0.00E+00	2.09E-02	0.00E+00	0.00E+00	0.00E+00	9.58E+00
Y-90	7.10E+01	0.00E+00	1.90E+00	0.00E+00	0.00E+00	0.00E+00	7.52E+05
Y-91M	6.42E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E-19
Y-91	8.59E+03	0.00E+00	2.30E+02	0.00E+00	0.00E+00	0.00E+00	4.73E+06
Y-92	5.57E-05	0.00E+00	1.63E-06	0.00E+00	0.00E+00	0.00E+00	9.75E-01
Y-93	2.22E-01	0.00E+00	6.12E-03	0.00E+00	0.00E+00	0.00E+00	7.03E+03
Zr-95	9.44E+02	3.03E+02	2.05E+02	0.00E+00	4.75E+02	0.00E+00	9.59E+05
Zr-97	4.32E-01	8.72E-02	3.99E-02	0.00E+00	1.32E-01	0.00E+00	2.70E+04
Nb-95	8.26E+04	4.60E+04	2.47E+04	0.00E+00	4.54E+04	0.00E+00	2.79E+08
Mo-99	0.00E+00	2.47E+07	4.70E+06	0.00E+00	5.60E+07	0.00E+00	5.73E+07
Tc- 99M	3.31E+00	9.35E+00	1.19E+02	0.00E+00	1.42E+02	4.58E+00	5.53E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.02E+03	0.00E+00	4.39E+02	0.00E+00	3.88E+03	0.00E+00	1.19E+05
Ru-105	8.51E-04	0.00E+00	3.36E-04	0.00E+00	1.10E-02	0.00E+00	5.20E-01
Ru-106	2.04E+04	0.00E+00	2.58E+03	0.00E+00	3.94E+04	0.00E+00	1.32E+06
Ag-110M	5.82E+07	5.39E+07	3.20E+07	0.00E+00	1.06E+08	0.00E+00	2.20E+10

Table 4-18 (Page 2 of 8)

Grass-Cow-Milk Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	1.63E+07	5.91E+06	2.18E+06	4.90E+06	6.63E+07	0.00E+00	6.51E+07
Te-127M	4.58E+07	1.64E+07	5.58E+06	1.17E+07	1.86E+08	0.00E+00	1.54E+08
Te-127	6.66E+02	2.39E+02	1.44E+02	4.94E+02	2.71E+03	0.00E+00	5.26E+04
Te-129M	6.02E+07	2.24E+07	9.52E+06	2.07E+07	2.51E+08	0.00E+00	3.03E+08
Te-129	2.83E-10	1.06E-10	6.88E-11	2.17E-10	1.19E-09	0.00E+00	2.13E-10
Te-131M	3.61E+05	1.76E+05	1.47E+05	2.79E+05	1.79E+06	0.00E+00	1.75E+07
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	2.39E+06	1.55E+06	1.45E+06	1.71E+06	1.49E+07	0.00E+00	7.32E+07
I-130	4.18E+05	1.23E+06	4.86E+05	1.04E+08	1.92E+06	0.00E+00	1.06E+06
I-131	2.96E+08	4.23E+08	2.43E+08	1.39E+11	7.26E+08	0.00E+00	1.12E+08
I-132	1.65E-01	4.40E-01	1.54E-01	1.54E+01	7.02E-01	0.00E+00	8.27E-02
I-133	3.88E+06	6.74E+06	2.06E+06	9.91E+08	1.18E+07	0.00E+00	6.06E+06
I-134	1.89E-12	5.13E-12	1.83E-12	8.89E-11	8.16E-12	0.00E+00	4.47E-15
I-135	1.29E+04	3.38E+04	1.25E+04	2.23E+06	5.42E+04	0.00E+00	3.82E+04
Cs-134	5.65E+09	1.35E+10	1.10E+10	0.00E+00	4.35E+09	1.45E+09	2.35E+08
Cs-136	2.63E+08	1.04E+09	7.46E+08	0.00E+00	5.77E+08	7.91E+07	1.18E+08
Cs-137	7.38E+09	1.01E+10	6.61E+09	0.00E+00	3.43E+09	1.14E+09	1.95E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	4.43E-08	3.16E-11	1.30E-09	0.00E+00	2.95E-11	1.79E-11	7.86E-08
Ba-140	2.69E+07	3.38E+04	1.76E+06	0.00E+00	1.15E+04	1.93E+04	5.54E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	4.52E+00	2.28E+00	6.02E-01	0.00E+00	0.00E+00	0.00E+00	1.67E+05
La-142	1.89E-11	8.59E-12	2.14E-12	0.00E+00	0.00E+00	0.00E+00	6.28E-08
Ce-141	4.84E+03	3.28E+03	3.72E+02	0.00E+00	1.52E+03	0.00E+00	1.25E+07
Ce-143	4.15E+01	3.07E+04	3.39E+00	0.00E+00	1.35E+01	0.00E+00	1.15E+06
Ce-144	3.58E+05	1.50E+05	1.92E+04	0.00E+00	8.87E+04	0.00E+00	1.21E+08
Pr-143	1.58E+02	6.34E+01	7.83E+00	0.00E+00	3.66E+01	0.00E+00	6.92E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	9.48E+01	1.10E+02	6.56E+00	0.00E+00	6.41E+01	0.00E+00	5.26E+05
W-187	6.51E+03	5.44E+03	1.90E+03	0.00E+00	0.00E+00	0.00E+00	1.78E+06
Np-239	3.67E+00	3.61E-01	1.99E-01	0.00E+00	1.12E+00	0.00E+00	7.40E+04

Notes:

1) Units are m^2 mrem/yr per μCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-18 (Page 3 of 8)

Grass-Cow-Milk Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	5.66E+02	5.66E+02	5.66E+02	5.66E+02	5.66E+02	5.66E+02
Na-24	4.29E+06	4.29E+06	4.29E+06	4.29E+06	4.29E+06	4.29E+06	4.29E+06
Cr-51	0.00E+00	0.00E+00	4.99E+04	2.77E+04	1.09E+04	7.12E+04	8.38E+06
Mn-54	0.00E+00	1.40E+07	2.78E+06	0.00E+00	4.18E+06	0.00E+00	2.87E+07
Mn-56	0.00E+00	7.32E-03	1.30E-03	0.00E+00	9.27E-03	0.00E+00	4.82E-01
Fe-55	4.45E+07	3.16E+07	7.36E+06	0.00E+00	0.00E+00	2.00E+07	1.37E+07
Fe-59	5.18E+07	1.21E+08	4.67E+07	0.00E+00	0.00E+00	3.81E+07	2.86E+08
Co-58	0.00E+00	7.94E+06	1.83E+07	0.00E+00	0.00E+00	0.00E+00	1.09E+08
Co-60	0.00E+00	2.78E+07	6.26E+07	0.00E+00	0.00E+00	0.00E+00	3.62E+08
Ni-63	1.18E+10	8.35E+08	4.01E+08	0.00E+00	0.00E+00	0.00E+00	1.33E+08
Ni-65	6.78E-01	8.66E-02	3.94E-02	0.00E+00	0.00E+00	0.00E+00	4.70E+00
Cu-64	0.00E+00	4.21E+04	1.98E+04	0.00E+00	1.06E+05	0.00E+00	3.26E+06
Zn-65	2.11E+09	7.31E+09	3.41E+09	0.00E+00	4.68E+09	0.00E+00	3.10E+09
Zn-69	3.70E-12	7.05E-12	4.94E-13	0.00E+00	4.61E-12	0.00E+00	1.30E-11
Br-83	0.00E+00	0.00E+00	1.78E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.73E+09	2.22E+09	0.00E+00	0.00E+00	0.00E+00	7.01E+08
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	2.67E+09	0.00E+00	7.66E+07	0.00E+00	0.00E+00	0.00E+00	3.18E+08
Sr-90	8.13E+10	0.00E+00	1.63E+09	0.00E+00	0.00E+00	0.00E+00	1.86E+09
Sr-91	5.27E+04	0.00E+00	2.10E+03	0.00E+00	0.00E+00	0.00E+00	2.39E+05
Sr-92	8.85E-01	0.00E+00	3.77E-02	0.00E+00	0.00E+00	0.00E+00	2.26E+01
Y-90	1.30E+02	0.00E+00	3.51E+00	0.00E+00	0.00E+00	0.00E+00	1.08E+06
Y-91M	1.18E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.55E-18
Y-91	1.58E+04	0.00E+00	4.24E+02	0.00E+00	0.00E+00	0.00E+00	6.48E+06
Y-92	1.03E-04	0.00E+00	2.98E-06	0.00E+00	0.00E+00	0.00E+00	2.82E+00
Y-93	4.09E-01	0.00E+00	1.12E-02	0.00E+00	0.00E+00	0.00E+00	1.25E+04
Zr-95	1.65E+03	5.21E+02	3.58E+02	0.00E+00	7.65E+02	0.00E+00	1.20E+06
Zr-97	7.87E-01	1.56E-01	7.17E-02	0.00E+00	2.36E-01	0.00E+00	4.22E+04
Nb-95	1.41E+05	7.82E+04	4.30E+04	0.00E+00	7.58E+04	0.00E+00	3.34E+08
Mo-99	0.00E+00	4.46E+07	8.51E+06	0.00E+00	1.02E+08	0.00E+00	8.00E+07
Tc- 99M	5.74E+00	1.60E+01	2.07E+02	0.00E+00	2.39E+02	8.89E+00	1.05E+04
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.81E+03	0.00E+00	7.74E+02	0.00E+00	6.38E+03	0.00E+00	1.51E+05
Ru-105	1.55E-03	0.00E+00	6.03E-04	0.00E+00	1.96E-02	0.00E+00	1.25E+00
Ru-106	3.75E+04	0.00E+00	4.73E+03	0.00E+00	7.24E+04	0.00E+00	1.80E+06
Ag-110M	9.63E+07	9.11E+07	5.54E+07	0.00E+00	1.74E+08	0.00E+00	2.56E+10

Table 4-18 (Page 4 of 8)

Grass-Cow-Milk Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	3.01E+07	1.08E+07	4.02E+06	8.40E+06	0.00E+00	0.00E+00	8.87E+07
Te-127M	8.44E+07	2.99E+07	1.00E+07	2.01E+07	3.42E+08	0.00E+00	2.10E+08
Te-127	1.24E+03	4.38E+02	2.66E+02	8.52E+02	5.00E+03	0.00E+00	9.54E+04
Te-129M	1.10E+08	4.09E+07	1.74E+07	3.55E+07	4.61E+08	0.00E+00	4.13E+08
Te-129	5.20E-10	1.94E-10	1.27E-10	3.72E-10	2.18E-09	0.00E+00	2.84E-09
Te-131M	6.57E+05	3.15E+05	2.63E+05	4.74E+05	3.28E+06	0.00E+00	2.53E+07
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	4.27E+06	2.71E+06	2.55E+06	2.85E+06	2.60E+07	0.00E+00	8.57E+07
I-130	7.35E+05	2.13E+06	8.49E+05	1.73E+08	3.27E+06	0.00E+00	1.63E+06
I-131	5.37E+08	7.52E+08	4.04E+08	2.19E+11	1.29E+09	0.00E+00	1.49E+08
I-132	2.92E-01	7.64E-01	2.74E-01	2.57E+01	1.20E+00	0.00E+00	3.33E-01
I-133	7.08E+06	1.20E+07	3.66E+06	1.68E+09	2.11E+07	0.00E+00	9.09E+06
I-134	3.35E-12	8.89E-12	3.19E-12	1.48E-10	1.40E-11	0.00E+00	1.17E-13
I-135	2.29E+04	5.91E+04	2.19E+04	3.80E+06	9.33E+04	0.00E+00	6.54E+04
Cs-134	9.82E+09	2.31E+10	1.07E+10	0.00E+00	7.34E+09	2.80E+09	2.87E+08
Cs-136	4.47E+08	1.76E+09	1.18E+09	0.00E+00	9.58E+08	1.51E+08	1.42E+08
Cs-137	1.34E+10	1.78E+10	6.20E+09	0.00E+00	6.06E+09	2.35E+09	2.53E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	8.20E-08	5.77E-11	2.39E-09	0.00E+00	5.44E-11	3.98E-11	7.31E-07
Ba-140	4.85E+07	5.95E+04	3.13E+06	0.00E+00	2.02E+04	4.00E+04	7.49E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	8.12E+00	3.99E+00	1.06E+00	0.00E+00	0.00E+00	0.00E+00	2.29E+05
La-142	3.41E-11	1.51E-11	3.77E-12	0.00E+00	0.00E+00	0.00E+00	4.61E-07
Ce-141	8.88E+03	5.93E+03	6.81E+02	0.00E+00	2.79E+03	0.00E+00	1.70E+07
Ce-143	7.62E+01	5.55E+04	6.20E+00	0.00E+00	2.49E+01	0.00E+00	1.67E+06
Ce-144	6.58E+05	2.72E+05	3.54E+04	0.00E+00	1.63E+05	0.00E+00	1.66E+08
Pr-143	2.90E+02	1.16E+02	1.44E+01	0.00E+00	6.74E+01	0.00E+00	9.55E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	1.82E+02	1.98E+02	1.19E+01	0.00E+00	1.17E+02	0.00E+00	7.16E+05
W-187	1.19E+04	9.71E+03	3.40E+03	0.00E+00	0.00E+00	0.00E+00	2.63E+06
Np-239	7.00E+00	6.60E-01	3.67E-01	0.00E+00	2.07E+00	0.00E+00	1.06E+05

Notes:

1) Units are m^2 mrem/yr per μCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-18 (Page 5 of 8)

Grass-Cow-Milk Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	8.97E+02	8.97E+02	8.97E+02	8.97E+02	8.97E+02	8.97E+02
Na-24	8.93E+06	8.93E+06	8.93E+06	8.93E+06	8.93E+06	8.93E+06	8.93E+06
Cr-51	0.00E+00	0.00E+00	1.02E+05	5.65E+04	1.54E+04	1.03E+05	5.39E+06
Mn-54	0.00E+00	2.10E+07	5.59E+06	0.00E+00	5.88E+06	0.00E+00	1.76E+07
Mn-56	0.00E+00	1.28E-02	2.88E-03	0.00E+00	1.54E-02	0.00E+00	1.85E+00
Fe-55	1.12E+08	5.93E+07	1.84E+07	0.00E+00	0.00E+00	3.35E+07	1.10E+07
Fe-59	1.20E+08	1.94E+08	9.69E+07	0.00E+00	0.00E+00	5.64E+07	2.02E+08
Co-58	0.00E+00	1.21E+07	3.71E+07	0.00E+00	0.00E+00	0.00E+00	7.08E+07
Co-60	0.00E+00	4.32E+07	1.27E+08	0.00E+00	0.00E+00	0.00E+00	2.39E+08
Ni-63	2.96E+10	1.59E+09	1.01E+09	0.00E+00	0.00E+00	0.00E+00	1.07E+08
Ni-65	1.66E+00	1.56E-01	9.11E-02	0.00E+00	0.00E+00	0.00E+00	1.91E+01
Cu-64	0.00E+00	7.39E+04	4.47E+04	0.00E+00	1.79E+05	0.00E+00	3.47E+06
Zn-65	4.13E+09	1.10E+10	6.85E+09	0.00E+00	6.94E+09	0.00E+00	1.93E+09
Zn-69	9.10E-12	1.32E-11	1.22E-12	0.00E+00	7.98E-12	0.00E+00	8.29E-10
Br-83	0.00E+00	0.00E+00	4.37E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	8.78E+09	5.40E+09	0.00E+00	0.00E+00	0.00E+00	5.65E+08
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	6.62E+09	0.00E+00	1.89E+08	0.00E+00	0.00E+00	0.00E+00	2.56E+08
Sr-90	1.68E+11	0.00E+00	3.38E+09	0.00E+00	0.00E+00	0.00E+00	1.51E+09
Sr-91	1.29E+05	0.00E+00	4.88E+03	0.00E+00	0.00E+00	0.00E+00	2.86E+05
Sr-92	2.16E+00	0.00E+00	8.67E-02	0.00E+00	0.00E+00	0.00E+00	4.09E+01
Y-90	3.23E+02	0.00E+00	8.64E+00	0.00E+00	0.00E+00	0.00E+00	9.19E+05
Y-91M	2.87E-19	0.00E+00	1.04E-20	0.00E+00	0.00E+00	0.00E+00	5.62E-16
Y-91	3.90E+04	0.00E+00	1.04E+03	0.00E+00	0.00E+00	0.00E+00	5.20E+06
Y-92	2.53E-04	0.00E+00	7.23E-06	0.00E+00	0.00E+00	0.00E+00	7.30E+00
Y-93	1.00E+00	0.00E+00	2.75E-02	0.00E+00	0.00E+00	0.00E+00	1.50E+04
Zr-95	3.83E+03	8.43E+02	7.50E+02	0.00E+00	1.21E+03	0.00E+00	8.79E+05
Zr-97	1.91E+00	2.77E-01	1.63E-01	0.00E+00	3.97E-01	0.00E+00	4.19E+04
Nb-95	3.18E+05	1.24E+05	8.85E+04	0.00E+00	1.16E+05	0.00E+00	2.29E+08
Mo-99	0.00E+00	8.12E+07	2.01E+07	0.00E+00	1.73E+08	0.00E+00	6.72E+07
Tc- 99M	1.32E+01	2.58E+01	4.28E+02	0.00E+00	3.75E+02	1.31E+01	1.47E+04
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	4.28E+03	0.00E+00	1.65E+03	0.00E+00	1.08E+04	0.00E+00	1.11E+05
Ru-105	3.79E-03	0.00E+00	1.38E-03	0.00E+00	3.33E-02	0.00E+00	2.48E+00
Ru-106	9.24E+04	0.00E+00	1.15E+04	0.00E+00	1.25E+05	0.00E+00	1.44E+06
Ag-110M	2.09E+08	1.41E+08	1.13E+08	0.00E+00	2.63E+08	0.00E+00	1.68E+10

Table 4-18 (Page 6 of 8)

Grass-Cow-Milk Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	7.38E+07	2.00E+07	9.84E+06	2.07E+07	0.00E+00	0.00E+00	7.12E+07
Te-127M	2.08E+08	5.60E+07	2.47E+07	4.97E+07	5.93E+08	0.00E+00	1.68E+08
Te-127	3.04E+03	8.19E+02	6.51E+02	2.10E+03	8.64E+03	0.00E+00	1.19E+05
Te-129M	2.71E+08	7.58E+07	4.21E+07	8.75E+07	7.97E+08	0.00E+00	3.31E+08
Te-129	1.28E-09	3.58E-10	3.05E-10	9.16E-10	3.75E-09	0.00E+00	7.99E-08
Te-131M	1.60E+06	5.53E+05	5.88E+05	1.14E+06	5.35E+06	0.00E+00	2.24E+07
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	1.02E+07	4.52E+06	5.46E+06	6.58E+06	4.19E+07	0.00E+00	4.55E+07
I-130	1.72E+06	3.47E+06	1.79E+06	3.82E+08	5.19E+06	0.00E+00	1.62E+06
I-131	1.30E+09	1.31E+09	7.45E+08	4.33E+11	2.15E+09	0.00E+00	1.17E+08
I-132	6.91E-01	1.27E+00	5.84E-01	5.89E+01	1.94E+00	0.00E+00	1.49E+00
I-133	1.72E+07	2.13E+07	8.05E+06	3.95E+09	3.55E+07	0.00E+00	8.57E+06
I-134	7.94E-12	1.47E-11	6.79E-12	3.39E-10	2.26E-11	0.00E+00	9.78E-12
I-135	5.43E+04	9.78E+04	4.62E+04	8.66E+06	1.50E+05	0.00E+00	7.45E+04
Cs-134	2.26E+10	3.72E+10	7.84E+09	0.00E+00	1.15E+10	4.13E+09	2.00E+08
Cs-136	1.01E+09	2.77E+09	1.80E+09	0.00E+00	1.48E+09	2.20E+08	9.75E+07
Cs-137	3.22E+10	3.09E+10	4.55E+09	0.00E+00	1.01E+10	3.62E+09	1.93E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	2.01E-07	1.08E-10	5.84E-09	0.00E+00	9.39E-11	6.33E-11	1.16E-05
Ba-140	1.17E+08	1.03E+05	6.84E+06	0.00E+00	3.34E+04	6.12E+04	5.94E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	1.95E+01	6.80E+00	2.29E+00	0.00E+00	0.00E+00	0.00E+00	1.90E+05
La-142	8.24E-11	2.63E-11	8.22E-12	0.00E+00	0.00E+00	0.00E+00	5.20E-06
Ce-141	2.19E+04	1.09E+04	1.62E+03	0.00E+00	4.78E+03	0.00E+00	1.36E+07
Ce-143	1.87E+02	1.01E+05	1.47E+01	0.00E+00	4.26E+01	0.00E+00	1.49E+06
Ce-144	1.62E+06	5.09E+05	8.66E+04	0.00E+00	2.82E+05	0.00E+00	1.33E+08
Pr-143	7.18E+02	2.16E+02	3.57E+01	0.00E+00	1.17E+02	0.00E+00	7.75E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	4.48E+02	3.63E+02	2.81E+01	0.00E+00	1.99E+02	0.00E+00	5.75E+05
W-187	2.89E+04	1.71E+04	7.67E+03	0.00E+00	0.00E+00	0.00E+00	2.40E+06
Np-239	1.72E+01	1.24E+00	8.69E-01	0.00E+00	3.58E+00	0.00E+00	9.15E+04

Notes:

1) Units are m^2 mrem/yr per μCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-18 (Page 7 of 8)

Grass-Cow-Milk Dose Factors

Infant Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.36E+03	1.36E+03	1.36E+03	1.36E+03	1.36E+03	1.36E+03
Na-24	1.56E+07	1.56E+07	1.56E+07	1.56E+07	1.56E+07	1.56E+07	1.56E+07
Cr-51	0.00E+00	0.00E+00	1.61E+05	1.05E+05	2.30E+04	2.05E+05	4.70E+06
Mn-54	0.00E+00	3.90E+07	8.84E+06	0.00E+00	8.64E+06	0.00E+00	1.43E+07
Mn-56	0.00E+00	3.13E-02	5.39E-03	0.00E+00	2.69E-02	0.00E+00	2.84E+00
Fe-55	1.35E+08	8.73E+07	2.33E+07	0.00E+00	0.00E+00	4.27E+07	1.11E+07
Fe-59	2.24E+08	3.92E+08	1.54E+08	0.00E+00	0.00E+00	1.16E+08	1.87E+08
Co-58	0.00E+00	2.43E+07	6.05E+07	0.00E+00	0.00E+00	0.00E+00	6.04E+07
Co-60	0.00E+00	8.82E+07	2.08E+08	0.00E+00	0.00E+00	0.00E+00	2.10E+08
Ni-63	3.49E+10	2.16E+09	1.21E+09	0.00E+00	0.00E+00	0.00E+00	1.07E+08
Ni-65	3.51E+00	3.97E-01	1.81E-01	0.00E+00	0.00E+00	0.00E+00	3.02E+01
Cu-64	0.00E+00	1.84E+05	8.51E+04	0.00E+00	3.11E+05	0.00E+00	3.77E+06
Zn-65	5.55E+09	1.90E+10	8.78E+09	0.00E+00	9.23E+09	0.00E+00	1.61E+10
Zn-69	1.94E-11	3.49E-11	2.60E-12	0.00E+00	1.45E-11	0.00E+00	2.85E-09
Br-83	0.00E+00	0.00E+00	9.27E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.23E+10	1.10E+10	0.00E+00	0.00E+00	0.00E+00	5.70E+08
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.26E+10	0.00E+00	3.61E+08	0.00E+00	0.00E+00	0.00E+00	2.59E+08
Sr-90	1.86E+11	0.00E+00	3.77E+09	0.00E+00	0.00E+00	0.00E+00	1.52E+09
Sr-91	2.70E+05	0.00E+00	9.76E+03	0.00E+00	0.00E+00	0.00E+00	3.19E+05
Sr-92	4.60E+00	0.00E+00	1.71E-01	0.00E+00	0.00E+00	0.00E+00	4.96E+01
Y-90	6.82E+02	0.00E+00	1.83E+01	0.00E+00	0.00E+00	0.00E+00	9.42E+05
Y-91M	6.09E-19	0.00E+00	2.07E-20	0.00E+00	0.00E+00	0.00E+00	2.03E-15
Y-91	7.33E+04	0.00E+00	1.95E+03	0.00E+00	0.00E+00	0.00E+00	5.25E+06
Y-92	5.37E-04	0.00E+00	1.51E-05	0.00E+00	0.00E+00	0.00E+00	1.02E+01
Y-93	2.14E+00	0.00E+00	5.83E-02	0.00E+00	0.00E+00	0.00E+00	1.69E+04
Zr-95	6.81E+03	1.66E+03	1.18E+03	0.00E+00	1.79E+03	0.00E+00	8.26E+05
Zr-97	4.05E+00	6.96E-01	3.18E-01	0.00E+00	7.01E-01	0.00E+00	4.44E+04
Nb-95	5.94E+05	2.45E+05	1.41E+05	0.00E+00	1.75E+05	0.00E+00	2.07E+08
Mo-99	0.00E+00	2.08E+08	4.05E+07	0.00E+00	3.10E+08	0.00E+00	6.84E+07
Tc- 99M	2.74E+01	5.65E+01	7.27E+02	0.00E+00	6.08E+02	2.95E+01	1.64E+04
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	8.67E+03	0.00E+00	2.90E+03	0.00E+00	1.80E+04	0.00E+00	1.05E+05
Ru-105	8.00E-03	0.00E+00	2.69E-03	0.00E+00	5.88E-02	0.00E+00	3.18E+00
Ru-106	1.90E+05	0.00E+00	2.38E+04	0.00E+00	2.25E+05	0.00E+00	1.44E+06
Ag-110M	3.86E+08	2.82E+08	1.86E+08	0.00E+00	4.03E+08	0.00E+00	1.46E+10

Table 4-18 (Page 8 of 8)

Grass-Cow-Milk Dose Factors

Infant Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	1.51E+08	5.04E+07	2.04E+07	5.08E+07	0.00E+00	0.00E+00	7.19E+07
Te-127M	4.21E+08	1.40E+08	5.10E+07	1.22E+08	1.04E+09	0.00E+00	1.70E+08
Te-127	6.45E+03	2.16E+03	1.39E+03	5.25E+03	1.57E+04	0.00E+00	1.35E+05
Te-129M	5.57E+08	1.91E+08	8.58E+07	2.14E+08	1.39E+09	0.00E+00	3.33E+08
Te-129	2.72E-09	9.38E-10	6.35E-10	2.28E-09	6.77E-09	0.00E+00	2.17E-07
Te-131M	3.37E+06	1.36E+06	1.12E+06	2.75E+06	9.35E+06	0.00E+00	2.29E+07
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	2.10E+07	1.04E+07	9.71E+06	1.54E+07	6.51E+07	0.00E+00	3.85E+07
I-130	3.53E+06	7.77E+06	3.12E+06	8.71E+08	8.53E+06	0.00E+00	1.67E+06
I-131	2.72E+09	3.20E+09	1.41E+09	1.05E+12	3.74E+09	0.00E+00	1.14E+08
I-132	1.43E+00	2.91E+00	1.04E+00	1.36E+02	3.25E+00	0.00E+00	2.36E+00
I-133	3.63E+07	5.29E+07	1.55E+07	9.62E+09	6.22E+07	0.00E+00	8.95E+06
I-134	1.65E-11	3.37E-11	1.20E-11	7.87E-10	3.77E-11	0.00E+00	3.49E-11
I-135	1.13E+05	2.25E+05	8.19E+04	2.01E+07	2.50E+05	0.00E+00	8.13E+04
Cs-134	3.65E+10	6.80E+10	6.87E+09	0.00E+00	1.75E+10	7.18E+09	1.85E+08
Cs-136	1.97E+09	5.80E+09	2.16E+09	0.00E+00	2.31E+09	4.72E+08	8.80E+07
Cs-137	5.15E+10	6.02E+10	4.27E+09	0.00E+00	1.62E+10	6.55E+09	1.88E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	4.29E-07	2.84E-10	1.24E-08	0.00E+00	1.71E-10	1.72E-10	2.72E-05
Ba-140	2.41E+08	2.41E+05	1.24E+07	0.00E+00	5.72E+04	1.48E+05	5.92E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	4.06E+01	1.60E+01	4.12E+00	0.00E+00	0.00E+00	0.00E+00	1.88E+05
La-142	1.73E-10	6.35E-11	1.52E-11	0.00E+00	0.00E+00	0.00E+00	1.08E-05
Ce-141	4.34E+04	2.64E+04	3.11E+03	0.00E+00	8.15E+03	0.00E+00	1.37E+07
Ce-143	3.96E+02	2.63E+05	3.00E+01	0.00E+00	7.65E+01	0.00E+00	1.53E+06
Ce-144	2.33E+06	9.52E+05	1.30E+05	0.00E+00	3.85E+05	0.00E+00	1.33E+08
Pr-143	1.49E+03	5.56E+02	7.37E+01	0.00E+00	2.07E+02	0.00E+00	7.84E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	8.88E+02	9.12E+02	5.59E+01	0.00E+00	3.51E+02	0.00E+00	5.78E+05
W-187	6.08E+04	4.23E+04	1.46E+04	0.00E+00	0.00E+00	0.00E+00	2.48E+06
Np-239	3.64E+01	3.26E+00	1.84E+00	0.00E+00	6.50E+00	0.00E+00	9.42E+04

Notes:

1) Units are m^2 mrem/yr per μCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-19 (Page 1 of 8)

Grass-Goat-Milk Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	8.88E+02	8.88E+02	8.88E+02	8.88E+02	8.88E+02	8.88E+02
Na-24	2.95E+05	2.95E+05	2.95E+05	2.95E+05	2.95E+05	2.95E+05	2.95E+05
Cr-51	0.00E+00	0.00E+00	3.43E+03	2.05E+03	7.55E+02	4.55E+03	8.62E+05
Mn-54	0.00E+00	1.01E+06	1.93E+05	0.00E+00	3.00E+05	0.00E+00	3.09E+06
Mn-56	0.00E+00	4.95E-04	8.79E-05	0.00E+00	6.29E-04	0.00E+00	1.58E-02
Fe-55	3.26E+05	2.26E+05	5.26E+04	0.00E+00	0.00E+00	1.26E+05	1.29E+05
Fe-59	3.86E+05	9.07E+05	3.48E+05	0.00E+00	0.00E+00	2.53E+05	3.02E+06
Co-58	0.00E+00	5.66E+05	1.27E+06	0.00E+00	0.00E+00	0.00E+00	1.15E+07
Co-60	0.00E+00	1.97E+06	4.34E+06	0.00E+00	0.00E+00	0.00E+00	3.70E+07
Ni-63	8.07E+08	5.60E+07	2.71E+07	0.00E+00	0.00E+00	0.00E+00	1.17E+07
Ni-65	4.44E-02	5.77E-03	2.63E-03	0.00E+00	0.00E+00	0.00E+00	1.46E-01
Cu-64	0.00E+00	2.63E+03	1.23E+03	0.00E+00	6.63E+03	0.00E+00	2.24E+05
Zn-65	1.65E+08	5.24E+08	2.37E+08	0.00E+00	3.50E+08	0.00E+00	3.30E+08
Zn-69	2.41E-13	4.61E-13	3.21E-14	0.00E+00	3.00E-13	0.00E+00	6.93E-14
Br-83	0.00E+00	0.00E+00	1.16E-02	0.00E+00	0.00E+00	0.00E+00	1.67E-02
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	3.12E+08	1.45E+08	0.00E+00	0.00E+00	0.00E+00	6.15E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	3.05E+09	0.00E+00	8.74E+07	0.00E+00	0.00E+00	0.00E+00	4.88E+08
Sr-90	1.13E+11	0.00E+00	2.27E+09	0.00E+00	0.00E+00	0.00E+00	2.84E+09
Sr-91	6.03E+04	0.00E+00	2.44E+03	0.00E+00	0.00E+00	0.00E+00	2.87E+05
Sr-92	1.02E+00	0.00E+00	4.39E-02	0.00E+00	0.00E+00	0.00E+00	2.01E+01
Y-90	8.52E+00	0.00E+00	2.28E-01	0.00E+00	0.00E+00	0.00E+00	9.03E+04
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.26E-20
Y-91	1.03E+03	0.00E+00	2.76E+01	0.00E+00	0.00E+00	0.00E+00	5.67E+05
Y-92	6.68E-06	0.00E+00	1.95E-07	0.00E+00	0.00E+00	0.00E+00	1.17E-01
Y-93	2.66E-02	0.00E+00	7.34E-04	0.00E+00	0.00E+00	0.00E+00	8.43E+02
Zr-95	1.13E+02	3.63E+01	2.46E+01	0.00E+00	5.70E+01	0.00E+00	1.15E+05
Zr-97	5.19E-02	1.05E-02	4.79E-03	0.00E+00	1.58E-02	0.00E+00	3.24E+03
Nb-95	9.92E+03	5.52E+03	2.97E+03	0.00E+00	5.45E+03	0.00E+00	3.35E+07
Mo-99	0.00E+00	2.97E+06	5.65E+05	0.00E+00	6.72E+06	0.00E+00	6.88E+06
Tc- 99M	3.97E-01	1.12E+00	1.43E+01	0.00E+00	1.70E+01	5.50E-01	6.64E+02
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.22E+02	0.00E+00	5.26E+01	0.00E+00	4.66E+02	0.00E+00	1.43E+04
Ru-105	1.02E-04	0.00E+00	4.03E-05	0.00E+00	1.32E-03	0.00E+00	6.25E-02
Ru-106	2.45E+03	0.00E+00	3.10E+02	0.00E+00	4.73E+03	0.00E+00	1.58E+05
Ag-110M	6.99E+06	6.46E+06	3.84E+06	0.00E+00	1.27E+07	0.00E+00	2.64E+09

Table 4-19 (Page 2 of 8)

Grass-Goat-Milk Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	1.96E+06	7.09E+05	2.62E+05	5.88E+05	7.95E+06	0.00E+00	7.81E+06
Te-127M	5.49E+06	1.96E+06	6.69E+05	1.40E+06	2.23E+07	0.00E+00	1.84E+07
Te-127	8.00E+01	2.87E+01	1.73E+01	5.92E+01	3.26E+02	0.00E+00	6.31E+03
Te-129M	7.22E+06	2.69E+06	1.14E+06	2.48E+06	3.01E+07	0.00E+00	3.64E+07
Te-129	3.39E-11	1.27E-11	8.26E-12	2.60E-11	1.43E-10	0.00E+00	2.56E-11
Te-131M	4.33E+04	2.12E+04	1.76E+04	3.35E+04	2.14E+05	0.00E+00	2.10E+06
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	2.87E+05	1.86E+05	1.74E+05	2.05E+05	1.79E+06	0.00E+00	8.78E+06
I-130	5.01E+05	1.48E+06	5.84E+05	1.25E+08	2.31E+06	0.00E+00	1.27E+06
I-131	3.55E+08	5.08E+08	2.91E+08	1.67E+11	8.71E+08	0.00E+00	1.34E+08
I-132	1.98E-01	5.29E-01	1.85E-01	1.85E+01	8.42E-01	0.00E+00	9.93E-02
I-133	4.65E+06	8.09E+06	2.47E+06	1.19E+09	1.41E+07	0.00E+00	7.27E+06
I-134	2.27E-12	6.15E-12	2.20E-12	1.07E-10	9.79E-12	0.00E+00	5.36E-15
I-135	1.55E+04	4.06E+04	1.50E+04	2.68E+06	6.51E+04	0.00E+00	4.58E+04
Cs-134	1.70E+10	4.04E+10	3.30E+10	0.00E+00	1.31E+10	4.34E+09	7.06E+08
Cs-136	7.88E+08	3.11E+09	2.24E+09	0.00E+00	1.73E+09	2.37E+08	3.53E+08
Cs-137	2.21E+10	3.03E+10	1.98E+10	0.00E+00	1.03E+10	3.42E+09	5.86E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	5.32E-09	3.79E-12	1.56E-10	0.00E+00	3.54E-12	2.15E-12	9.44E-09
Ba-140	3.23E+06	4.05E+03	2.11E+05	0.00E+00	1.38E+03	2.32E+03	6.64E+06
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	5.43E-01	2.74E-01	7.23E-02	0.00E+00	0.00E+00	0.00E+00	2.01E+04
La-142	2.27E-12	1.03E-12	2.57E-13	0.00E+00	0.00E+00	0.00E+00	7.53E-09
Ce-141	5.81E+02	3.93E+02	4.46E+01	0.00E+00	1.83E+02	0.00E+00	1.50E+06
Ce-143	4.98E+00	3.68E+03	4.07E-01	0.00E+00	1.62E+00	0.00E+00	1.38E+05
Ce-144	4.29E+04	1.79E+04	2.30E+03	0.00E+00	1.06E+04	0.00E+00	1.45E+07
Pr-143	1.90E+01	7.60E+00	9.40E-01	0.00E+00	4.39E+00	0.00E+00	8.31E+04
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	1.14E+01	1.32E+01	7.87E-01	0.00E+00	7.69E+00	0.00E+00	6.31E+04
W-187	7.82E+02	6.53E+02	2.28E+02	0.00E+00	0.00E+00	0.00E+00	2.14E+05
Np-239	4.40E-01	4.33E-02	2.39E-02	0.00E+00	1.35E-01	0.00E+00	8.88E+03

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per µCi/m^3.

Table 4-19 (Page 3 of 8)

Grass-Goat-Milk Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.16E+03	1.16E+03	1.16E+03	1.16E+03	1.16E+03	1.16E+03
Na-24	5.15E+05	5.15E+05	5.15E+05	5.15E+05	5.15E+05	5.15E+05	5.15E+05
Cr-51	0.00E+00	0.00E+00	5.99E+03	3.33E+03	1.31E+03	8.55E+03	1.01E+06
Mn-54	0.00E+00	1.68E+06	3.34E+05	0.00E+00	5.02E+05	0.00E+00	3.45E+06
Mn-56	0.00E+00	8.78E-04	1.56E-04	0.00E+00	1.11E-03	0.00E+00	5.78E-02
Fe-55	5.79E+05	4.11E+05	9.57E+04	0.00E+00	0.00E+00	2.60E+05	1.78E+05
Fe-59	6.74E+05	1.57E+06	6.07E+05	0.00E+00	0.00E+00	4.96E+05	3.72E+06
Co-58	0.00E+00	9.53E+05	2.20E+06	0.00E+00	0.00E+00	0.00E+00	1.31E+07
Co-60	0.00E+00	3.34E+06	7.52E+06	0.00E+00	0.00E+00	0.00E+00	4.35E+07
Ni-63	1.42E+09	1.00E+08	4.81E+07	0.00E+00	0.00E+00	0.00E+00	1.59E+07
Ni-65	8.13E-02	1.04E-02	4.73E-03	0.00E+00	0.00E+00	0.00E+00	5.63E-01
Cu-64	0.00E+00	4.69E+03	2.20E+03	0.00E+00	1.19E+04	0.00E+00	3.64E+05
Zn-65	2.53E+08	8.78E+08	4.09E+08	0.00E+00	5.62E+08	0.00E+00	3.72E+08
Zn-69	4.44E-13	8.46E-13	5.92E-14	0.00E+00	5.53E-13	0.00E+00	1.56E-12
Br-83	0.00E+00	0.00E+00	2.13E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	5.68E+08	2.67E+08	0.00E+00	0.00E+00	0.00E+00	8.41E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	5.61E+09	0.00E+00	1.61E+08	0.00E+00	0.00E+00	0.00E+00	6.69E+08
Sr-90	1.71E+11	0.00E+00	3.41E+09	0.00E+00	0.00E+00	0.00E+00	3.90E+09
Sr-91	1.11E+05	0.00E+00	4.41E+03	0.00E+00	0.00E+00	0.00E+00	5.02E+05
Sr-92	1.86E+00	0.00E+00	7.92E-02	0.00E+00	0.00E+00	0.00E+00	4.74E+01
Y-90	1.56E+01	0.00E+00	4.21E-01	0.00E+00	0.00E+00	0.00E+00	1.29E+05
Y-91M	1.41E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.66E-19
Y-91	1.90E+03	0.00E+00	5.08E+01	0.00E+00	0.00E+00	0.00E+00	7.77E+05
Y-92	1.23E-05	0.00E+00	3.57E-07	0.00E+00	0.00E+00	0.00E+00	3.39E-01
Y-93	4.90E-02	0.00E+00	1.34E-03	0.00E+00	0.00E+00	0.00E+00	1.50E+03
Zr-95	1.98E+02	6.25E+01	4.30E+01	0.00E+00	9.18E+01	0.00E+00	1.44E+05
Zr-97	9.44E-02	1.87E-02	8.61E-03	0.00E+00	2.83E-02	0.00E+00	5.06E+03
Nb-95	1.69E+04	9.38E+03	5.16E+03	0.00E+00	9.09E+03	0.00E+00	4.01E+07
Mo-99	0.00E+00	5.36E+06	1.02E+06	0.00E+00	1.23E+07	0.00E+00	9.59E+06
Tc- 99M	6.89E-01	1.92E+00	2.49E+01	0.00E+00	2.86E+01	1.07E+00	1.26E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	2.17E+02	0.00E+00	9.29E+01	0.00E+00	7.66E+02	0.00E+00	1.81E+04
Ru-105	1.86E-04	0.00E+00	7.24E-05	0.00E+00	2.35E-03	0.00E+00	1.51E-01
Ru-106	4.50E+03	0.00E+00	5.67E+02	0.00E+00	8.68E+03	0.00E+00	2.16E+05
Ag-110M	1.16E+07	1.09E+07	6.65E+06	0.00E+00	2.09E+07	0.00E+00	3.07E+09

Table 4-19 (Page 4 of 8)

Grass-Goat-Milk Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	3.61E+06	1.30E+06	4.82E+05	1.01E+06	0.00E+00	0.00E+00	1.06E+07
Te-127M	1.01E+07	3.59E+06	1.20E+06	2.41E+06	4.10E+07	0.00E+00	2.52E+07
Te-127	1.48E+02	5.25E+01	3.19E+01	1.02E+02	6.00E+02	0.00E+00	1.14E+04
Te-129M	1.32E+07	4.90E+06	2.09E+06	4.26E+06	5.53E+07	0.00E+00	4.96E+07
Te-129	6.24E-11	2.33E-11	1.52E-11	4.46E-11	2.62E-10	0.00E+00	3.41E-10
Te-131M	7.88E+04	3.78E+04	3.15E+04	5.68E+04	3.94E+05	0.00E+00	3.03E+06
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	5.13E+05	3.25E+05	3.06E+05	3.42E+05	3.12E+06	0.00E+00	1.03E+07
I-130	8.82E+05	2.55E+06	1.02E+06	2.08E+08	3.93E+06	0.00E+00	1.96E+06
I-131	6.45E+08	9.02E+08	4.85E+08	2.63E+11	1.55E+09	0.00E+00	1.78E+08
I-132	3.50E-01	9.17E-01	3.29E-01	3.09E+01	1.44E+00	0.00E+00	3.99E-01
I-133	8.50E+06	1.44E+07	4.40E+06	2.01E+09	2.53E+07	0.00E+00	1.09E+07
I-134	4.03E-12	1.07E-11	3.83E-12	1.78E-10	1.68E-11	0.00E+00	1.41E-13
I-135	2.75E+04	7.09E+04	2.63E+04	4.56E+06	1.12E+05	0.00E+00	7.85E+04
Cs-134	2.94E+10	6.93E+10	3.22E+10	0.00E+00	2.20E+10	8.41E+09	8.62E+08
Cs-136	1.34E+09	5.28E+09	3.54E+09	0.00E+00	2.87E+09	4.53E+08	4.25E+08
Cs-137	4.02E+10	5.34E+10	1.86E+10	0.00E+00	1.82E+10	7.06E+09	7.60E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	9.84E-09	6.92E-12	2.87E-10	0.00E+00	6.53E-12	4.77E-12	8.78E-08
Ba-140	5.82E+06	7.14E+03	3.75E+05	0.00E+00	2.42E+03	4.80E+03	8.98E+06
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	9.75E-01	4.79E-01	1.27E-01	0.00E+00	0.00E+00	0.00E+00	2.75E+04
La-142	4.09E-12	1.82E-12	4.53E-13	0.00E+00	0.00E+00	0.00E+00	5.53E-08
Ce-141	1.07E+03	7.12E+02	8.17E+01	0.00E+00	3.35E+02	0.00E+00	2.04E+06
Ce-143	9.15E+00	6.66E+03	7.44E-01	0.00E+00	2.99E+00	0.00E+00	2.00E+05
Ce-144	7.90E+04	3.27E+04	4.24E+03	0.00E+00	1.95E+04	0.00E+00	1.99E+07
Pr-143	3.48E+01	1.39E+01	1.73E+00	0.00E+00	8.08E+00	0.00E+00	1.15E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	2.19E+01	2.38E+01	1.43E+00	0.00E+00	1.40E+01	0.00E+00	8.59E+04
W-187	1.43E+03	1.17E+03	4.08E+02	0.00E+00	0.00E+00	0.00E+00	3.15E+05
Np-239	8.40E-01	7.92E-02	4.40E-02	0.00E+00	2.49E-01	0.00E+00	1.27E+04

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-19 (Page 5 of 8)

Grass-Goat-Milk Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.83E+03	1.83E+03	1.83E+03	1.83E+03	1.83E+03	1.83E+03
Na-24	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06
Cr-51	0.00E+00	0.00E+00	1.22E+04	6.78E+03	1.85E+03	1.24E+04	6.47E+05
Mn-54	0.00E+00	2.52E+06	6.70E+05	0.00E+00	7.06E+05	0.00E+00	2.11E+06
Mn-56	0.00E+00	1.53E-03	3.46E-04	0.00E+00	1.85E-03	0.00E+00	2.22E-01
Fe-55	1.45E+06	7.71E+05	2.39E+05	0.00E+00	0.00E+00	4.36E+05	1.43E+05
Fe-59	1.56E+06	2.53E+06	1.26E+06	0.00E+00	0.00E+00	7.33E+05	2.63E+06
Co-58	0.00E+00	1.46E+06	4.46E+06	0.00E+00	0.00E+00	0.00E+00	8.49E+06
Co-60	0.00E+00	5.18E+06	1.53E+07	0.00E+00	0.00E+00	0.00E+00	2.87E+07
Ni-63	3.56E+09	1.90E+08	1.21E+08	0.00E+00	0.00E+00	0.00E+00	1.28E+07
Ni-65	1.99E-01	1.87E-02	1.09E-02	0.00E+00	0.00E+00	0.00E+00	2.29E+00
Cu-64	0.00E+00	8.24E+03	4.98E+03	0.00E+00	1.99E+04	0.00E+00	3.87E+05
Zn-65	4.96E+08	1.32E+09	8.22E+08	0.00E+00	8.33E+08	0.00E+00	2.32E+08
Zn-69	1.09E-12	1.58E-12	1.46E-13	0.00E+00	9.57E-13	0.00E+00	9.95E-11
Br-83	0.00E+00	0.00E+00	5.24E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.05E+09	6.48E+08	0.00E+00	0.00E+00	0.00E+00	6.78E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.39E+10	0.00E+00	3.97E+08	0.00E+00	0.00E+00	0.00E+00	5.38E+08
Sr-90	3.53E+11	0.00E+00	7.11E+09	0.00E+00	0.00E+00	0.00E+00	3.16E+09
Sr-91	2.72E+05	0.00E+00	1.03E+04	0.00E+00	0.00E+00	0.00E+00	6.00E+05
Sr-92	4.54E+00	0.00E+00	1.82E-01	0.00E+00	0.00E+00	0.00E+00	8.60E+01
Y-90	3.87E+01	0.00E+00	1.04E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+05
Y-91M	3.45E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.75E-17
Y-91	4.68E+03	0.00E+00	1.25E+02	0.00E+00	0.00E+00	0.00E+00	6.24E+05
Y-92	3.03E-05	0.00E+00	8.67E-07	0.00E+00	0.00E+00	0.00E+00	8.75E-01
Y-93	1.20E-01	0.00E+00	3.31E-03	0.00E+00	0.00E+00	0.00E+00	1.80E+03
Zr-95	4.60E+02	1.01E+02	9.00E+01	0.00E+00	1.45E+02	0.00E+00	1.05E+05
Zr-97	2.30E-01	3.32E-02	1.96E-02	0.00E+00	4.77E-02	0.00E+00	5.03E+03
Nb-95	3.82E+04	1.49E+04	1.06E+04	0.00E+00	1.40E+04	0.00E+00	2.75E+07
Mo-99	0.00E+00	9.75E+06	2.41E+06	0.00E+00	2.08E+07	0.00E+00	8.06E+06
Tc- 99M	1.58E+00	3.10E+00	5.14E+01	0.00E+00	4.50E+01	1.57E+00	1.76E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	5.14E+02	0.00E+00	1.97E+02	0.00E+00	1.29E+03	0.00E+00	1.33E+04
Ru-105	4.55E-04	0.00E+00	1.65E-04	0.00E+00	4.00E-03	0.00E+00	2.97E-01
Ru-106	1.11E+04	0.00E+00	1.38E+03	0.00E+00	1.50E+04	0.00E+00	1.72E+05
Ag-110M	2.51E+07	1.69E+07	1.35E+07	0.00E+00	3.15E+07	0.00E+00	2.01E+09

Table 4-19 (Page 6 of 8)

Grass-Goat-Milk Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	8.86E+06	2.40E+06	1.18E+06	2.49E+06	0.00E+00	0.00E+00	8.55E+06
Te-127M	2.50E+07	6.72E+06	2.96E+06	5.97E+06	7.12E+07	0.00E+00	2.02E+07
Te-127	3.64E+02	9.83E+01	7.82E+01	2.52E+02	1.04E+03	0.00E+00	1.42E+04
Te-129M	3.26E+07	9.09E+06	5.05E+06	1.05E+07	9.56E+07	0.00E+00	3.97E+07
Te-129	1.54E-10	4.30E-11	3.66E-11	1.10E-10	4.51E-10	0.00E+00	9.59E-09
Te-131M	1.92E+05	6.63E+04	7.06E+04	1.36E+05	6.42E+05	0.00E+00	2.69E+06
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	1.22E+06	5.42E+05	6.55E+05	7.89E+05	5.03E+06	0.00E+00	5.46E+06
I-130	2.06E+06	4.17E+06	2.15E+06	4.59E+08	6.23E+06	0.00E+00	1.95E+06
I-131	1.56E+09	1.57E+09	8.94E+08	5.20E+11	2.58E+09	0.00E+00	1.40E+08
I-132	8.29E-01	1.52E+00	7.00E-01	7.07E+01	2.33E+00	0.00E+00	1.79E+00
I-133	2.06E+07	2.55E+07	9.66E+06	4.74E+09	4.25E+07	0.00E+00	1.03E+07
I-134	9.53E-12	1.77E-11	8.14E-12	4.07E-10	2.71E-11	0.00E+00	1.17E-11
I-135	6.52E+04	1.17E+05	5.55E+04	1.04E+07	1.80E+05	0.00E+00	8.94E+04
Cs-134	6.79E+10	1.11E+11	2.35E+10	0.00E+00	3.45E+10	1.24E+10	6.01E+08
Cs-136	3.03E+09	8.32E+09	5.39E+09	0.00E+00	4.43E+09	6.61E+08	2.92E+08
Cs-137	9.67E+10	9.26E+10	1.37E+10	0.00E+00	3.02E+10	1.09E+10	5.80E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	2.42E-08	1.29E-11	7.01E-10	0.00E+00	1.13E-11	7.59E-12	1.40E-06
Ba-140	1.41E+07	1.23E+04	8.21E+05	0.00E+00	4.01E+03	7.34E+03	7.12E+06
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	2.33E+00	8.16E-01	2.75E-01	0.00E+00	0.00E+00	0.00E+00	2.27E+04
La-142	9.88E-12	3.15E-12	9.87E-13	0.00E+00	0.00E+00	0.00E+00	6.24E-07
Ce-141	2.62E+03	1.31E+03	1.94E+02	0.00E+00	5.74E+02	0.00E+00	1.63E+06
Ce-143	2.25E+01	1.22E+04	1.76E+00	0.00E+00	5.11E+00	0.00E+00	1.78E+05
Ce-144	1.95E+05	6.11E+04	1.04E+04	0.00E+00	3.38E+04	0.00E+00	1.59E+07
Pr-143	8.62E+01	2.59E+01	4.28E+00	0.00E+00	1.40E+01	0.00E+00	9.30E+04
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	5.37E+01	4.35E+01	3.37E+00	0.00E+00	2.39E+01	0.00E+00	6.89E+04
W-187	3.47E+03	2.05E+03	9.21E+02	0.00E+00	0.00E+00	0.00E+00	2.88E+05
Np-239	2.07E+00	1.48E-01	1.04E-01	0.00E+00	4.29E-01	0.00E+00	1.10E+04

Notes:

1) Units are m^2 mrem/yr per μCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-19 (Page 7 of 8)

Grass-Goat-Milk Dose Factors

Infant Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	2.78E+03	2.78E+03	2.78E+03	2.78E+03	2.78E+03	2.78E+03
Na-24	1.87E+06	1.87E+06	1.87E+06	1.87E+06	1.87E+06	1.87E+06	1.87E+06
Cr-51	0.00E+00	0.00E+00	1.93E+04	1.26E+04	2.76E+03	2.46E+04	5.64E+05
Mn-54	0.00E+00	4.68E+06	1.06E+06	0.00E+00	1.04E+06	0.00E+00	1.72E+06
Mn-56	0.00E+00	3.75E-03	6.47E-04	0.00E+00	3.22E-03	0.00E+00	3.41E-01
Fe-55	1.76E+06	1.13E+06	3.03E+05	0.00E+00	0.00E+00	5.55E+05	1.44E+05
Fe-59	2.92E+06	5.09E+06	2.01E+06	0.00E+00	0.00E+00	1.51E+06	2.43E+06
Co-58	0.00E+00	2.91E+06	7.26E+06	0.00E+00	0.00E+00	0.00E+00	7.25E+06
Co-60	0.00E+00	1.06E+07	2.50E+07	0.00E+00	0.00E+00	0.00E+00	2.52E+07
Ni-63	4.19E+09	2.59E+08	1.45E+08	0.00E+00	0.00E+00	0.00E+00	1.29E+07
Ni-65	4.21E-01	4.77E-02	2.17E-02	0.00E+00	0.00E+00	0.00E+00	3.63E+00
Cu-64	0.00E+00	2.05E+04	9.48E+03	0.00E+00	3.46E+04	0.00E+00	4.20E+05
Zn-65	6.66E+08	2.28E+09	1.05E+09	0.00E+00	1.11E+09	0.00E+00	1.93E+09
Zn-69	2.33E-12	4.19E-12	3.12E-13	0.00E+00	1.74E-12	0.00E+00	3.42E-10
Br-83	0.00E+00	0.00E+00	1.11E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.67E+09	1.32E+09	0.00E+00	0.00E+00	0.00E+00	6.84E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	2.64E+10	0.00E+00	7.58E+08	0.00E+00	0.00E+00	0.00E+00	5.43E+08
Sr-90	3.91E+11	0.00E+00	7.92E+09	0.00E+00	0.00E+00	0.00E+00	3.19E+09
Sr-91	5.66E+05	0.00E+00	2.05E+04	0.00E+00	0.00E+00	0.00E+00	6.70E+05
Sr-92	9.65E+00	0.00E+00	3.59E-01	0.00E+00	0.00E+00	0.00E+00	1.04E+02
Y-90	8.19E+01	0.00E+00	2.20E+00	0.00E+00	0.00E+00	0.00E+00	1.13E+05
Y-91M	7.31E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.44E-16
Y-91	8.79E+03	0.00E+00	2.34E+02	0.00E+00	0.00E+00	0.00E+00	6.30E+05
Y-92	6.44E-05	0.00E+00	1.81E-06	0.00E+00	0.00E+00	0.00E+00	1.23E+00
Y-93	2.57E-01	0.00E+00	6.99E-03	0.00E+00	0.00E+00	0.00E+00	2.03E+03
Zr-95	8.17E+02	1.99E+02	1.41E+02	0.00E+00	2.15E+02	0.00E+00	9.91E+04
Zr-97	4.87E-01	8.35E-02	3.81E-02	0.00E+00	8.42E-02	0.00E+00	5.33E+03
Nb-95	7.13E+04	2.94E+04	1.70E+04	0.00E+00	2.10E+04	0.00E+00	2.48E+07
Mo-99	0.00E+00	2.49E+07	4.86E+06	0.00E+00	3.72E+07	0.00E+00	8.21E+06
Tc- 99M	3.29E+00	6.78E+00	8.73E+01	0.00E+00	7.29E+01	3.54E+00	1.97E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.04E+03	0.00E+00	3.48E+02	0.00E+00	2.16E+03	0.00E+00	1.27E+04
Ru-105	9.60E-04	0.00E+00	3.23E-04	0.00E+00	7.06E-03	0.00E+00	3.82E-01
Ru-106	2.28E+04	0.00E+00	2.85E+03	0.00E+00	2.70E+04	0.00E+00	1.73E+05
Ag-110M	4.63E+07	3.38E+07	2.24E+07	0.00E+00	4.84E+07	0.00E+00	1.75E+09

Table 4-19 (Page 8 of 8)

Grass-Goat-Milk Dose Factors

Infant Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	1.81E+07	6.05E+06	2.45E+06	6.09E+06	0.00E+00	0.00E+00	8.62E+06
Te-127M	5.05E+07	1.68E+07	6.12E+06	1.46E+07	1.24E+08	0.00E+00	2.04E+07
Te-127	7.74E+02	2.59E+02	1.66E+02	6.30E+02	1.89E+03	0.00E+00	1.63E+04
Te-129M	6.68E+07	2.29E+07	1.03E+07	2.57E+07	1.67E+08	0.00E+00	3.99E+07
Te-129	3.26E-10	1.13E-10	7.62E-11	2.74E-10	8.13E-10	0.00E+00	2.61E-08
Te-131M	4.05E+05	1.63E+05	1.35E+05	3.30E+05	1.12E+06	0.00E+00	2.74E+06
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	2.52E+06	1.25E+06	1.17E+06	1.84E+06	7.81E+06	0.00E+00	4.62E+06
I-130	4.24E+06	9.32E+06	3.74E+06	1.04E+09	1.02E+07	0.00E+00	2.00E+06
I-131	3.26E+09	3.85E+09	1.69E+09	1.26E+12	4.49E+09	0.00E+00	1.37E+08
I-132	1.72E+00	3.49E+00	1.24E+00	1.64E+02	3.90E+00	0.00E+00	2.83E+00
I-133	4.36E+07	6.35E+07	1.86E+07	1.15E+10	7.46E+07	0.00E+00	1.07E+07
I-134	1.98E-11	4.05E-11	1.44E-11	9.44E-10	4.53E-11	0.00E+00	4.19E-11
I-135	1.36E+05	2.70E+05	9.83E+04	2.42E+07	3.01E+05	0.00E+00	9.76E+04
Cs-134	1.09E+11	2.04E+11	2.06E+10	0.00E+00	5.25E+10	2.15E+10	5.54E+08
Cs-136	5.91E+09	1.74E+10	6.49E+09	0.00E+00	6.93E+09	1.42E+09	2.64E+08
Cs-137	1.54E+11	1.81E+11	1.28E+10	0.00E+00	4.85E+10	1.96E+10	5.65E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	5.14E-08	3.41E-11	1.49E-09	0.00E+00	2.05E-11	2.07E-11	3.26E-06
Ba-140	2.89E+07	2.89E+04	1.49E+06	0.00E+00	6.87E+03	1.78E+04	7.11E+06
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	4.88E+00	1.92E+00	4.95E-01	0.00E+00	0.00E+00	0.00E+00	2.26E+04
La-142	2.08E-11	7.62E-12	1.82E-12	0.00E+00	0.00E+00	0.00E+00	1.29E-06
Ce-141	5.20E+03	3.17E+03	3.73E+02	0.00E+00	9.78E+02	0.00E+00	1.64E+06
Ce-143	4.75E+01	3.15E+04	3.60E+00	0.00E+00	9.19E+00	0.00E+00	1.84E+05
Ce-144	2.79E+05	1.14E+05	1.56E+04	0.00E+00	4.62E+04	0.00E+00	1.60E+07
Pr-143	1.78E+02	6.67E+01	8.84E+00	0.00E+00	2.48E+01	0.00E+00	9.41E+04
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	1.07E+02	1.09E+02	6.70E+00	0.00E+00	4.22E+01	0.00E+00	6.93E+04
W-187	7.29E+03	5.07E+03	1.75E+03	0.00E+00	0.00E+00	0.00E+00	2.98E+05
Np-239	4.37E+00	3.91E-01	2.21E-01	0.00E+00	7.80E-01	0.00E+00	1.13E+04

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-20 (Page 1 of 6)

Grass-Cow-Meat Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.85E+02	1.85E+02	1.85E+02	1.85E+02	1.85E+02	1.85E+02
Na-24	1.45E-03	1.45E-03	1.45E-03	1.45E-03	1.45E-03	1.45E-03	1.45E-03
Cr-51	0.00E+00	0.00E+00	7.04E+03	4.21E+03	1.55E+03	9.34E+03	1.77E+06
Mn-54	0.00E+00	9.18E+06	1.75E+06	0.00E+00	2.73E+06	0.00E+00	2.81E+07
Mn-56	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-55	2.93E+08	2.03E+08	4.72E+07	0.00E+00	0.00E+00	1.13E+08	1.16E+08
Fe-59	2.65E+08	6.24E+08	2.39E+08	0.00E+00	0.00E+00	1.74E+08	2.08E+09
Co-58	0.00E+00	1.82E+07	4.09E+07	0.00E+00	0.00E+00	0.00E+00	3.70E+08
Co-60	0.00E+00	7.52E+07	1.66E+08	0.00E+00	0.00E+00	0.00E+00	1.41E+09
Ni-63	1.89E+10	1.31E+09	6.33E+08	0.00E+00	0.00E+00	0.00E+00	2.73E+08
Ni-65	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cu-64	0.00E+00	2.52E-07	1.18E-07	0.00E+00	6.36E-07	0.00E+00	2.15E-05
Zn-65	3.56E+08	1.13E+09	5.12E+08	0.00E+00	7.57E+08	0.00E+00	7.13E+08
Zn-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.88E+08	2.28E+08	0.00E+00	0.00E+00	0.00E+00	9.63E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	3.01E+08	0.00E+00	8.65E+06	0.00E+00	0.00E+00	0.00E+00	4.83E+07
Sr-90	1.43E+10	0.00E+00	2.87E+08	0.00E+00	0.00E+00	0.00E+00	3.59E+08
Sr-91	1.43E-10	0.00E+00	5.79E-12	0.00E+00	0.00E+00	0.00E+00	6.83E-10
Sr-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	1.08E+02	0.00E+00	2.91E+00	0.00E+00	0.00E+00	0.00E+00	1.15E+06
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	1.13E+06	0.00E+00	3.03E+04	0.00E+00	0.00E+00	0.00E+00	6.23E+08
Y-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-93	4.39E-12	0.00E+00	1.21E-13	0.00E+00	0.00E+00	0.00E+00	1.39E-07
Zr-95	1.87E+06	6.01E+05	4.07E+05	0.00E+00	9.43E+05	0.00E+00	1.91E+09
Zr-97	2.04E-05	4.12E-06	1.88E-06	0.00E+00	6.22E-06	0.00E+00	1.28E+00
Nb-95	2.30E+06	1.28E+06	6.89E+05	0.00E+00	1.27E+06	0.00E+00	7.78E+09
Mo-99	0.00E+00	9.93E+04	1.89E+04	0.00E+00	2.25E+05	0.00E+00	2.30E+05
Tc- 99M	0.00E+00	1.22E-20	1.56E-19	0.00E+00	1.85E-19	0.00E+00	7.23E-18
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.05E+08	0.00E+00	4.53E+07	0.00E+00	4.01E+08	0.00E+00	1.23E+10
Ru-105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-106	2.80E+09	0.00E+00	3.54E+08	0.00E+00	5.40E+09	0.00E+00	1.81E+11
Ag-110M	6.68E+06	6.18E+06	3.67E+06	0.00E+00	1.22E+07	0.00E+00	2.52E+09

Table 4-20 (Page 2 of 6)

Grass-Cow-Meat Dose Factors

Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	3.59E+08	1.30E+08	4.81E+07	1.08E+08	1.46E+09	0.00E+00	1.43E+09
Te-127M	1.12E+09	3.99E+08	1.36E+08	2.85E+08	4.53E+09	0.00E+00	3.74E+09
Te-127	2.50E-10	8.98E-11	5.41E-11	1.85E-10	1.02E-09	0.00E+00	1.97E-08
Te-129M	1.13E+09	4.23E+08	1.79E+08	3.89E+08	4.73E+09	0.00E+00	5.71E+09
Te-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-131M	4.49E+02	2.20E+02	1.83E+02	3.48E+02	2.23E+03	0.00E+00	2.18E+04
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	1.40E+06	9.03E+05	8.48E+05	9.98E+05	8.70E+06	0.00E+00	4.27E+07
I-130	2.03E-06	5.98E-06	2.36E-06	5.07E-04	9.33E-06	0.00E+00	5.15E-06
I-131	1.07E+07	1.54E+07	8.80E+06	5.03E+09	2.63E+07	0.00E+00	4.05E+06
I-132	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-133	3.70E-01	6.43E-01	1.96E-01	9.45E+01	1.12E+00	0.00E+00	5.78E-01
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	4.66E-17	1.22E-16	4.50E-17	8.04E-15	1.95E-16	0.00E+00	1.38E-16
Cs-134	6.58E+08	1.57E+09	1.28E+09	0.00E+00	5.07E+08	1.68E+08	2.74E+07
Cs-136	1.20E+07	4.73E+07	3.40E+07	0.00E+00	2.63E+07	3.61E+06	5.37E+06
Cs-137	8.72E+08	1.19E+09	7.81E+08	0.00E+00	4.05E+08	1.35E+08	2.31E+07
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-140	2.88E+07	3.61E+04	1.88E+06	0.00E+00	1.23E+04	2.07E+04	5.92E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	3.76E-02	1.90E-02	5.01E-03	0.00E+00	0.00E+00	0.00E+00	1.39E+03
La-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ce-141	1.40E+04	9.49E+03	1.08E+03	0.00E+00	4.41E+03	0.00E+00	3.63E+07
Ce-143	1.99E-02	1.47E+01	1.63E-03	0.00E+00	6.47E-03	0.00E+00	5.49E+02
Ce-144	1.46E+06	6.09E+05	7.83E+04	0.00E+00	3.61E+05	0.00E+00	4.93E+08
Pr-143	2.10E+04	8.42E+03	1.04E+03	0.00E+00	4.86E+03	0.00E+00	9.20E+07
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	7.21E+03	8.33E+03	4.98E+02	0.00E+00	4.87E+03	0.00E+00	4.00E+07
W-187	2.07E-02	1.73E-02	6.04E-03	0.00E+00	0.00E+00	0.00E+00	5.66E+00
Np-239	2.57E-01	2.53E-02	1.40E-02	0.00E+00	7.90E-02	0.00E+00	5.19E+03

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per µCi/m^3.

Table 4-20 (Page 3 of 6)

Grass-Cow-Meat Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.10E+02	1.10E+02	1.10E+02	1.10E+02	1.10E+02	1.10E+02
Na-24	1.16E-03	1.16E-03	1.16E-03	1.16E-03	1.16E-03	1.16E-03	1.16E-03
Cr-51	0.00E+00	0.00E+00	5.63E+03	3.13E+03	1.23E+03	8.04E+03	9.46E+05
Mn-54	0.00E+00	7.00E+06	1.39E+06	0.00E+00	2.09E+06	0.00E+00	1.44E+07
Mn-56	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-55	2.38E+08	1.69E+08	3.94E+07	0.00E+00	0.00E+00	1.07E+08	7.31E+07
Fe-59	2.12E+08	4.95E+08	1.91E+08	0.00E+00	0.00E+00	1.56E+08	1.17E+09
Co-58	0.00E+00	1.41E+07	3.24E+07	0.00E+00	0.00E+00	0.00E+00	1.94E+08
Co-60	0.00E+00	5.83E+07	1.31E+08	0.00E+00	0.00E+00	0.00E+00	7.60E+08
Ni-63	1.52E+10	1.07E+09	5.15E+08	0.00E+00	0.00E+00	0.00E+00	1.71E+08
Ni-65	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cu-64	0.00E+00	2.06E-07	9.68E-08	0.00E+00	5.21E-07	0.00E+00	1.60E-05
Zn-65	2.50E+08	8.69E+08	4.05E+08	0.00E+00	5.56E+08	0.00E+00	3.68E+08
Zn-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.08E+08	1.91E+08	0.00E+00	0.00E+00	0.00E+00	6.03E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	2.54E+08	0.00E+00	7.28E+06	0.00E+00	0.00E+00	0.00E+00	3.03E+07
Sr-90	9.89E+09	0.00E+00	1.98E+08	0.00E+00	0.00E+00	0.00E+00	2.26E+08
Sr-91	1.21E-10	0.00E+00	4.80E-12	0.00E+00	0.00E+00	0.00E+00	5.47E-10
Sr-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	9.13E+01	0.00E+00	2.46E+00	0.00E+00	0.00E+00	0.00E+00	7.53E+05
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	9.54E+05	0.00E+00	2.56E+04	0.00E+00	0.00E+00	0.00E+00	3.91E+08
Y-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-93	3.71E-12	0.00E+00	1.02E-13	0.00E+00	0.00E+00	0.00E+00	1.13E-07
Zr-95	1.50E+06	4.74E+05	3.26E+05	0.00E+00	6.96E+05	0.00E+00	1.09E+09
Zr-97	1.70E-05	3.37E-06	1.55E-06	0.00E+00	5.10E-06	0.00E+00	9.11E-01
Nb-95	1.80E+06	9.98E+05	5.49E+05	0.00E+00	9.67E+05	0.00E+00	4.27E+09
Mo-99	0.00E+00	8.21E+04	1.57E+04	0.00E+00	1.88E+05	0.00E+00	1.47E+05
Tc- 99M	0.00E+00	0.00E+00	1.24E-19	0.00E+00	1.43E-19	0.00E+00	6.29E-18
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	8.56E+07	0.00E+00	3.66E+07	0.00E+00	3.02E+08	0.00E+00	7.15E+09
Ru-105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-106	2.36E+09	0.00E+00	2.97E+08	0.00E+00	4.55E+09	0.00E+00	1.13E+11
Ag-110M	5.06E+06	4.79E+06	2.91E+06	0.00E+00	9.13E+06	0.00E+00	1.35E+09

Table 4-20 (Page 4 of 6)

Grass-Cow-Meat Dose Factors

Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	3.03E+08	1.09E+08	4.06E+07	8.47E+07	0.00E+00	0.00E+00	8.95E+08
Te-127M	9.41E+08	3.34E+08	1.12E+08	2.24E+08	3.82E+09	0.00E+00	2.35E+09
Te-127	2.12E-10	7.53E-11	4.57E-11	1.46E-10	8.60E-10	0.00E+00	1.64E-08
Te-129M	9.49E+08	3.52E+08	1.50E+08	3.06E+08	3.97E+09	0.00E+00	3.56E+09
Te-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-131M	3.75E+02	1.80E+02	1.50E+02	2.70E+02	1.87E+03	0.00E+00	1.44E+04
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	1.14E+06	7.24E+05	6.81E+05	7.63E+05	6.94E+06	0.00E+00	2.29E+07
I-130	1.63E-06	4.72E-06	1.88E-06	3.85E-04	7.27E-06	0.00E+00	3.63E-06
I-131	8.92E+06	1.25E+07	6.71E+06	3.64E+09	2.15E+07	0.00E+00	2.47E+06
I-132	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-133	3.09E-01	5.25E-01	1.60E-01	7.32E+01	9.20E-01	0.00E+00	3.97E-01
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	3.79E-17	9.75E-17	3.61E-17	6.27E-15	1.54E-16	0.00E+00	1.08E-16
Cs-134	5.23E+08	1.23E+09	5.71E+08	0.00E+00	3.91E+08	1.49E+08	1.53E+07
Cs-136	9.34E+06	3.68E+07	2.47E+07	0.00E+00	2.00E+07	3.15E+06	2.96E+06
Cs-137	7.24E+08	9.63E+08	3.36E+08	0.00E+00	3.28E+08	1.27E+08	1.37E+07
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-140	2.38E+07	2.91E+04	1.53E+06	0.00E+00	9.88E+03	1.96E+04	3.67E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	3.09E-02	1.52E-02	4.04E-03	0.00E+00	0.00E+00	0.00E+00	8.73E+02
La-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ce-141	1.18E+04	7.87E+03	9.04E+02	0.00E+00	3.70E+03	0.00E+00	2.25E+07
Ce-143	1.67E-02	1.22E+01	1.36E-03	0.00E+00	5.46E-03	0.00E+00	3.66E+02
Ce-144	1.23E+06	5.08E+05	6.60E+04	0.00E+00	3.04E+05	0.00E+00	3.09E+08
Pr-143	1.77E+04	7.05E+03	8.79E+02	0.00E+00	4.10E+03	0.00E+00	5.81E+07
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	6.35E+03	6.90E+03	4.14E+02	0.00E+00	4.05E+03	0.00E+00	2.49E+07
W-187	1.73E-02	1.41E-02	4.94E-03	0.00E+00	0.00E+00	0.00E+00	3.82E+00
Np-239	2.25E-01	2.12E-02	1.18E-02	0.00E+00	6.66E-02	0.00E+00	3.41E+03

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-20 (Page 5 of 6)

Grass-Cow-Meat Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.34E+02	1.34E+02	1.34E+02	1.34E+02	1.34E+02	1.34E+02
Na-24	1.84E-03	1.84E-03	1.84E-03	1.84E-03	1.84E-03	1.84E-03	1.84E-03
Cr-51	0.00E+00	0.00E+00	8.78E+03	4.87E+03	1.33E+03	8.90E+03	4.66E+05
Mn-54	0.00E+00	8.01E+06	2.13E+06	0.00E+00	2.25E+06	0.00E+00	6.72E+06
Mn-56	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-55	4.57E+08	2.42E+08	7.51E+07	0.00E+00	0.00E+00	1.37E+08	4.49E+07
Fe-59	3.76E+08	6.08E+08	3.03E+08	0.00E+00	0.00E+00	1.76E+08	6.34E+08
Co-58	0.00E+00	1.64E+07	5.03E+07	0.00E+00	0.00E+00	0.00E+00	9.59E+07
Co-60	0.00E+00	6.93E+07	2.04E+08	0.00E+00	0.00E+00	0.00E+00	3.84E+08
Ni-63	2.91E+10	1.56E+09	9.91E+08	0.00E+00	0.00E+00	0.00E+00	1.05E+08
Ni-65	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cu-64	0.00E+00	2.77E-07	1.67E-07	0.00E+00	6.68E-07	0.00E+00	1.30E-05
Zn-65	3.75E+08	1.00E+09	6.22E+08	0.00E+00	6.30E+08	0.00E+00	1.76E+08
Zn-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	5.78E+08	3.55E+08	0.00E+00	0.00E+00	0.00E+00	3.72E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	4.81E+08	0.00E+00	1.37E+07	0.00E+00	0.00E+00	0.00E+00	1.86E+07
Sr-90	1.57E+10	0.00E+00	3.15E+08	0.00E+00	0.00E+00	0.00E+00	1.40E+08
Sr-91	2.26E-10	0.00E+00	8.54E-12	0.00E+00	0.00E+00	0.00E+00	5.00E-10
Sr-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	1.73E+02	0.00E+00	4.62E+00	0.00E+00	0.00E+00	0.00E+00	4.92E+05
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	1.80E+06	0.00E+00	4.82E+04	0.00E+00	0.00E+00	0.00E+00	2.40E+08
Y-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-93	6.97E-12	0.00E+00	1.91E-13	0.00E+00	0.00E+00	0.00E+00	1.04E-07
Zr-95	2.67E+06	5.86E+05	5.22E+05	0.00E+00	8.39E+05	0.00E+00	6.11E+08
Zr-97	3.16E-05	4.57E-06	2.70E-06	0.00E+00	6.56E-06	0.00E+00	6.93E-01
Nb-95	3.11E+06	1.21E+06	8.64E+05	0.00E+00	1.14E+06	0.00E+00	2.24E+09
Mo-99	0.00E+00	1.14E+05	2.82E+04	0.00E+00	2.44E+05	0.00E+00	9.44E+04
Tc- 99M	0.00E+00	1.18E-20	1.96E-19	0.00E+00	1.72E-19	0.00E+00	6.72E-18
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.55E+08	0.00E+00	5.95E+07	0.00E+00	3.90E+08	0.00E+00	4.00E+09
Ru-105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-106	4.44E+09	0.00E+00	5.54E+08	0.00E+00	5.99E+09	0.00E+00	6.90E+10
Ag-110M	8.39E+06	5.67E+06	4.53E+06	0.00E+00	1.06E+07	0.00E+00	6.74E+08

Table 4-20 (Page 6 of 6)

Grass-Cow-Meat Dose Factors

Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	5.70E+08	1.54E+08	7.59E+07	1.60E+08	0.00E+00	0.00E+00	5.50E+08
Te-127M	1.77E+09	4.78E+08	2.11E+08	4.24E+08	5.06E+09	0.00E+00	1.44E+09
Te-127	3.99E-10	1.08E-10	8.56E-11	2.76E-10	1.14E-09	0.00E+00	1.56E-08
Te-129M	1.79E+09	5.00E+08	2.78E+08	5.77E+08	5.25E+09	0.00E+00	2.18E+09
Te-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-131M	6.97E+02	2.41E+02	2.57E+02	4.96E+02	2.33E+03	0.00E+00	9.78E+03
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	2.09E+06	9.23E+05	1.12E+06	1.34E+06	8.57E+06	0.00E+00	9.30E+06
I-130	2.92E-06	5.89E-06	3.04E-06	6.49E-04	8.81E-06	0.00E+00	2.76E-06
I-131	1.65E+07	1.66E+07	9.45E+06	5.50E+09	2.73E+07	0.00E+00	1.48E+06
I-132	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-133	5.75E-01	7.10E-01	2.69E-01	1.32E+02	1.18E+00	0.00E+00	2.86E-01
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	6.86E-17	1.23E-16	5.84E-17	1.09E-14	1.89E-16	0.00E+00	9.40E-17
Cs-134	9.22E+08	1.51E+09	3.19E+08	0.00E+00	4.69E+08	1.68E+08	8.16E+06
Cs-136	1.61E+07	4.43E+07	2.87E+07	0.00E+00	2.36E+07	3.52E+06	1.56E+06
Cs-137	1.33E+09	1.28E+09	1.88E+08	0.00E+00	4.16E+08	1.50E+08	7.99E+06
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-140	4.39E+07	3.84E+04	2.56E+06	0.00E+00	1.25E+04	2.29E+04	2.22E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	5.66E-02	1.98E-02	6.67E-03	0.00E+00	0.00E+00	0.00E+00	5.52E+02
La-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ce-141	2.22E+04	1.11E+04	1.64E+03	0.00E+00	4.85E+03	0.00E+00	1.38E+07
Ce-143	3.14E-02	1.70E+01	2.46E-03	0.00E+00	7.14E-03	0.00E+00	2.49E+02
Ce-144	2.32E+06	7.26E+05	1.24E+05	0.00E+00	4.02E+05	0.00E+00	1.89E+08
Pr-143	3.34E+04	1.00E+04	1.66E+03	0.00E+00	5.44E+03	0.00E+00	3.61E+07
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	1.19E+04	9.65E+03	7.47E+02	0.00E+00	5.29E+03	0.00E+00	1.53E+07
W-187	3.21E-02	1.90E-02	8.52E-03	0.00E+00	0.00E+00	0.00E+00	2.67E+00
Np-239	4.23E-01	3.04E-02	2.14E-02	0.00E+00	8.79E-02	0.00E+00	2.25E+03

Notes:

1) Units are m^2 mrem/yr per μCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per μCi/m^3.

3) The infant age group is assumed to receive no dose through the meat ingestion pathway therefore no dose factors are supplied.

5.0 TOTAL DOSE

Radioactivity contained within tanks, pipes or other systems and contained radioactive material or waste stored on site can produce radiation at offsite locations. Annual offsite radiation doses near the stations due to such sources were judged to be negligible in comparison with applicable limits except for doses due to BWR turbine skyshine and potential doses due to radioactive waste storage facilities (excludes radioactive material storage). Changes or modifications to the power station that may impact the offsite dose through increases to the direct radiation levels need to be evaluated on a case-by-case basis and added to the Radiological Effluent Controls (RECS) to the ODCM when applicable.

5.1 Total Dose Calculation Requirements

5.1.1 Total Effective Dose Equivalent Limits; 10CFR20, 40CFR190, and 10CFR72

The Quad Cities Station is required to determine the total dose to a member of the public due to all uranium fuel cycle sources in order to assess compliance with 40CFR190 as part of demonstrating compliance with 10CFR20.

The total dose for the uranium fuel cycle is the sum of doses due to radioactivity in airborne and liquid effluents and the doses due to direct radiation from contained sources at the nuclear power station. When evaluation of total dose is required for a station, the following contributions are summed:

- Doses due to airborne and liquid effluents from the station.
- Doses due to liquid effluents from nuclear power stations upstream.
- Doses due to any onsite radioactive waste storage facilities, if applicable.
- Doses due to N-16 skyshine.

10CFR20 requires compliance to dose limits expressed as "Total Effective Dose Equivalent" (TEDE). Although annual dose limits in 10CFR20 are now expressed in terms of TEDEs, 40CFR190 limits remain stated as organ dose. The NRC continues to require 10CFR50 Appendix I and 40CFR190 doses to be reported in terms of organ dose and not TEDE. Due to the fact that organ dose limits set forth in 40CFR190 are substantially lower than those of 10CFR20 (25 mrem/yr vs. 100 mrem/yr), the NRC has stated that demonstration of compliance with the dose limits in 40CFR190 will be deemed as demonstration of compliance with the dose limits of 10CFR20 for most facilities (Reference 104). In addition to compliance with 40CFR190, it may be necessary for a nuclear power plant to address dose from on-site activity by members of the public.

5.1.2 ISFSI

10CFR72.104 dose limits are the same as those specified by 40CFR190.

Even a fully loaded ISFSI is not expected to become the prominent contributor to the limits in this section. ISFSI dose contribution is in the form of direct radiation as no liquid or gas releases are expected to occur. The 10CFR72.212 report prepared in accordance with ISFSI requirements assumes a certain array of casks exists on the pad. The dose contribution from this array of casks in combination with historical uranium fuel cycle operations (e.g. QCNPS 1 & 2) prior to ISFSI operations was analyzed to be within the 40CFR190 and 10CFR72.104 limits.

If the dose limits of 40CFR190 or 10CFR72.104 are exceeded, a special report to the NRC as well as an appropriate request for exemption/variance is required to be submitted to the NRC.

The requirement that the dose limits of 10CFR72.104 apply to "any real individual" is controlled for ISFSI activities in the ISFSI 72.212 report. Therefore, for the purposes of analyzing dose in the south end of the site, the member of the public as defined in 40CFR190 at this area is the same as the "real individual" identified in the 72.212 report. However, the location for the real individual identified in the ISFSI 72.212 report is not the limiting individual for calculating dose. The real individual that lives 800 meters north of QCNPS will remain the limiting individual, even with a fully loaded ISFSI.

5.1.3 Total Dose Calculation Methodology

There are presently two types of contained sources of radioactivity that are of concern in Quad Cities Station's offsite radiological dose assessments. The first source is that due to gamma rays from nitrogen-16 (^{16}N) carried over to the turbine in BWR (boiling water reactor) steam. The second source is that due to gamma rays associated with radioactive material resident in onsite radwaste storage facilities.

Gamma radiation from these sources contributes to the whole total body dose (deep dose equivalent). In addition to the total body, skin and single organ dose assessments previously described, an additional assessment is required. The additional assessment addresses radiation dose due to radioactivity contained within the nuclear power station and its structures.

5.1.4 BWR Skyshine

The most significant dose component to members of the public produced by "contained sources" is nitrogen-16 (^{16}N) within the turbine building of BWRs. Although primary side shielding is around the turbine and its piping, ^{16}N gamma rays scattered by air molecules in the overhead air space above the turbine and piping cause a measurable "skyshine" radiation dose in the local power plant environs.

Equation 5-1 is used to evaluate skyshine dose. Quad Cities adds hydrogen to reactor coolant to improve coolant chemistry. The addition of hydrogen can increase the dose rate due to skyshine up to a factor of 10 times expected levels depending on injection rates and power levels (Reference 39). Increasing the hydrogen injection rate will increase the dose rates even further. (See Reference 102) The skyshine dose determined by Equation 5-1 depends on the following factors:

- The distance of the dose recipient location from the turbine.
- The number of hours per year that the location is occupied by a dose recipient.
- The total energy [MWe-hr] generated by the nuclear power station with hydrogen addition.
- The total energy [MWe-hr] generated by the nuclear power station without hydrogen addition.

5.2 BWR Skyshine Calculation

The contained onsite radioactivity source that results in the most significant offsite radiation levels at Quad Cities Station is skyshine resulting from ^{16}N decay inside turbines and steam piping.

The ^{16}N that produces the skyshine effect is formulated through neutron activation of the oxygen atoms (oxygen-16, or ^{16}O) in reactor coolant as the coolant passes through the operating reactor core. The ^{16}N travels with the steam produced in the reactor to the steam driven turbine. While the ^{16}N is in transport, it radioactively decays with a half-life of about 7 seconds and produces 6 to 7 MeV gamma rays. Typically, offsite dose points are shielded from a direct view of components containing ^{16}N, but there can be skyshine radiation at offsite locations due to scattering of gamma rays off the mass of air above the steamlines and turbine.

The offsite dose rate due to skyshine has been found to have the following dependencies:

- The dose rate decreases as distance from the station increases.

- The dose rate increases non-linearly as the power production level increases.
- The dose rate increases when hydrogen is added to the reactor coolant, an action taken to improve reactor coolant chemistry characteristics (see Reference 39).

To calculate offsite dose due to skyshine in a given time period due to skyshine, Quad Cities Station must track the following parameters:

- The total gross energy E_h produced with hydrogen being added.
- The total gross energy E_o produced without hydrogen being added.

The turbines at the site are sufficiently close to each other that energy generated by the two operating units at may be summed.

An initial estimate of skyshine dose is calculated per the following equation:

$$D^{Sky} = (K)(E_o + M_h E_h)\sum_k \left\{ OF_k \; SF_k \; e^{-0.007R_k} \right\} \qquad (5\text{-}1)$$

The summation is over all locations "**k**" occupied by a hypothetical maximally exposed member of the public characterized by the parameters specified in ODCM Part II Table 4-7. The parameters in Equation 5-1 are defined as follows:

D^{Ssky}	Dose Due to N-16 Skyshine	[mrem]
	Gamma External direct gamma dose (deep dose equivalent) due to BWR N-16 skyshine for the time period of interest.	
K	Empirical Constant	[mrem/(MWe-hr)]
	A constant determined by fitting data measured at the each station.	
E_o	Electrical Energy Generated Without Hydrogen Addition	[MWe-hr]
	Total gross electrical energy generated without hydrogen addition in the time period of interest.	
E_h	Electrical Energy Generated with Hydrogen Addition	[MWe-hr]
	Total gross electrical energy generated with hydrogen addition in the period of interest.	

M_h Multiplication Factor for Hydrogen Addition [dimensionless]

Factor applied to offsite dose rate when skyshine is present. Hydrogen addition increases main steam line radiation levels typically up to a factor of approximately 5 (see Page 8-1 of Reference 39). M_h is station specific and is given in ODCM, Part II Table 4-7.

OF_k Occupancy Factor [dimensionless]

The fraction of time that the dose recipient spends at location "**k**" during the period of interest. See ODCM Part II Table 4-7.

SF_k Shielding Factor [dimensionless]

A dimensionless factor that accounts for shielding due to occupancy of structures.

SF_k = 0.7 if there is a structure at location "**k**"

SF_k = 1.0 otherwise. See ODCM Part II, Table 4-7.

0.007 Empirical Constant [m^{-1}]

A constant determined by fitting data measured at the Quad Cities station (see Reference 45).

R_k Distance [m]

Distance from the turbine to location "**k**". See ODCM Part II, Table 4-7.

5.3 Onsite Radwaste and Rad Material Storage Facilities

A 10CFR50.59 analysis is required for radwaste storage facilities.

5.3.1 Process Waste Storage Facilities

- Interim Radwaste Storage Facility (IRSF) structure
- Concrete vaults containing radwaste liners

5.3.2 DAW Storage Facilities

- Dry Active Waste (DAW) facilities (may include Butler buildings/warehouses)
- Seavans or other temporary warehouses

5.3.3 ISFSI Facilities

- Independent spent fuel storage installation facilities.

5.4 Methodology

The external total body dose is comprised of the following parts:

5.4.1 Total body dose due to noble gas radionuclides in gaseous effluents (Section 4.2.2),

5.4.2 Dose due to ^{16}N skyshine (section 5.2) and other contained sources (section 5.3) and

5.4.3 Total body dose due to radioactivity deposited on the ground (Section 4.2.3.1).

The external total body dose due to radioactivity deposited on the ground is accounted for in the determination of the non-noble gas dose and is considered in section 4.2.3 and 4.2.3.1.

The total external total body dose, D^{Ex}, is given by:

$$D^{Ex} = D^{TB}{}_{wb} + D^{Sky} + D^{OSF} \qquad (5\text{-}2)$$

D^{Ex} Total External Total Body Dose [mrem]

Total external total body dose due to irradiation by external sources at the location of interest.

D^{TB} Noble Gas Total Body Dose [mrem]

External total body dose due to gamma radiation from noble gas radionuclides released in gaseous effluents at the location of interest. See Section 4.2.2.3.

D^{Sky} Dose Due to N-16 Skyshine Total Body Dose [mrem]

External total body dose due to N-16 skyshine for the period and location of interest. See Equation 5-1.

D^{OSF} Dose From On-Site Storage Facilities [mrem]

External total body dose due to gamma radiation from on-site storage facilities at the location of interest. See Section 5.3.

5.5 Total Dose

The total dose, D^{Tot}, in the UNRESTRICTED AREA to a member of the public due to plant operations is given by:

$$D^{Tot} = D^{Ex} + D_{aj}^{Liq} + D_{aj}^{NNG} \quad (5\text{-}3)$$

where:

D^{Tot} Total Dose To Member of Public *[mrem]*

Total off-site dose to a member of public due to plant operations.

D^{Ex} Total External Total Body Dose [mrem]

Total body dose due to external exposure to noble gases, N-16 skyshine and on-site storage facilities.

D_{aj}^{Liq} Liquid Effluent Dose [mrem]

Dose due to liquid effluents to age group "**a**" and organ "**j**". The age group and organ with the highest dose from liquid effluents is used.

D_{aj}^{NNG} Non-Noble Gaseous Effluent Dose [mrem]

Dose due to non-noble gaseous effluents to age group "**a**" and organ "**j**". The age group and organ with the highest dose from non-noble gas effluents is used.

5.6 Compliance to Total Dose Limits

5.6.1 Total Effective Dose Equivalent Limit - 10CFR20 Compliance

Quad Cities' RECS limits the Total Effective Dose Equivalent (TEDE) to an annual limit of 100 mrem, as required by 10CFR20.1301 (a)(1). Demonstration of compliance with the limits of 40CFR190 (per Section 5.1.1) will be considered to demonstrate compliance with the 100 mrem/year limit.

5.6.2 Dose to a MEMBER OF THE PUBLIC in the UNRESTRICTED AREA

The NRC has stated that demonstration of compliance with the limits of 40CFR190 or with the design objectives of Appendix I to 10CFR50 will be deemed to demonstrate compliance with the limits of 10CFR20.1301(a)(1). Power reactors that comply with Appendix I may also have to demonstrate that they are within the 25 mrem limit of 40CFR190 (See Reference 104).

5.6.3 Dose to a MEMBER OF THE PUBLIC in the RESTRICTED AREA

In August of 1995, a revision to 10CFR20 was implemented that changed the definition of a member of the public. As a result, estimated doses were calculated for a member of the public who enters the site boundary, but is not authorized for unescorted access to the protected area of the site and does not enter any radiologically posted areas on the site. Realistic assumptions were made for occupancy times and locations visited while within the site boundary.

These evaluations indicate that the doses estimated for these members of the public are well within the 10CFR20 limits. These dose evaluations will be performed annually and if necessary, a model will be developed and included in the ODCM.

Evaluation of the 40CFR190 dose is used to demonstrate compliance to 10CFR20 and satisfy station RECS and Technical Specifications (see ODCM Part I).

5.6.4 Total Dose Due to the Uranium Fuel Cycle (40CFR190)

RECS, 40CFR190, and 10CFR72 limit the annual (calendar year) dose or dose commitment to any member of the public due to releases of radioactivity and to radiation from uranium fuel cycle sources to the following:

- Less than or equal to 25 mrem to the total body.
- Less than or equal to 25 mrem to any organ except the thyroid.
- Less than or equal to 75 mrem to the thyroid.

Total Dose Components

This requirement includes the total dose from operations at the nuclear power station. This includes doses due to radioactive effluents (airborne and liquid) and dose due to direct radiation from non-effluent sources (e.g., sources contained in systems on site). It also includes dose due to plants under consideration, neighboring plants and dose due to other facilities in the uranium fuel cycle.

The operations comprising the uranium fuel cycle are specified in 40CFR190.02(b). The following are included to the extent that they directly support the production of electrical power for public use utilizing nuclear energy:

- Milling of uranium ore.
- Chemical conversion of uranium.
- Isotopic enrichment of uranium.
- Fabrication of uranium fuel.
- Generation of electricity by a light-watered-cooled nuclear power plant using uranium fuel.
- Reprocessing of spent uranium fuel.

Excluded are:

- Mining operations.
- Operations at waste disposal sites.
- Transportation of any radioactive material in support of these operations.
- The re-use of recovered non-uranium special nuclear and by-product materials from the cycle.

5.7 When Compliance Assessment is Required

Compliance with the 40CFR190 regulations is required as part of demonstration of compliance to 10CFR20 regulations per 10CFR20.1301(d).

The dose due to the uranium fuel cycle is determined by equation 5-3.

6.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

6.1 General Information

6.1.1 The Radiological Environmental Monitoring Program (REMP) supplements the results of station radiological effluent monitoring by verifying that the measurable concentration of radioactive material and levels of radiation present in the surrounding environment are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways.

6.1.2 The REMP program consists of the following components:

- Monitoring direct radiation and radionuclides in the environment surrounding the site.
- Performing a Land Use Census annually during the growing season to identify changes in land use. Changes in land use may require changing the monitoring program.
- Participation in an Interlaboratory Comparison Program to ensure independent checks on the precision and accuracy of radioactive material measurement in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring.

6.2 Monitoring

6.2.1 The REMP program monitors the following exposure pathways:

- Airborne
- Direct radiation
- Waterborne
- Ingestion

6.2.2 Specific sampling and analysis requirements of the REMP program are described in ODCM Part II Table 6-1 and ODCM Part I Section 12.6. ODCM Part II Figure 6-1 and Figure 6-2 shows the specific location of each monitoring locations.

6.2.3 In addition to the monitoring locations described in ODCM Part II Table 6-1 and ODCM Part I Section 12.6, additional direct radiation monitoring is performed. These monitoring locations are described in station procedures and may vary. Reporting dose received from these monitoring locations in the Radiological Environmental Operating Report is not required.

6.2.4 Deviations from the sampling requirements of the REMP program are permitted. Refer to ODCM Part I Section 12.6.1 for requirements when required samples are not obtained.

6.3 Land Use Census

6.3.1 A Land Use Census is performed annually to identify changes in land use surrounding the site. Specific requirements of the Land Use Census are described in Table 6-1 and ODCM Part I Section 12.6.2. The results of the Land Use Census are reviewed and the monitoring program modified as necessary.

6.4 Interlaboratory Comparison Program

6.4.1 The laboratory performing the REMP analyses shall participate in an Interlaboratory Comparison Program as described in ODCM Part I Section 12.6.3.

Table 6-1 (Page 1 of 7)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sample or Monitoring Location	Sampling or Collection Frequency	Type and Frequency of Analysis
1. Airborne Radioiodine and Particulates	a. Indicators-Near Field Q-01 Onsite No. 1 0.5 mi N (0.8 km) Q-02 Onsite No. 2 0.4 mi ENE (0.7 km) Q-03 Onsite No. 3 0.6 mi S (1.0 km) Q-04 Nitrin 1.7 mi NE (2.7 km)	Sampler Operation Continuous	Radioiodine Canister: I-131 analysis on each sample.
	b. Indicators-Far Field Q-37 Meredosia Road 4.4 mi ENE (7.1 km) Q-38 Fuller Road 4.7 mi E (7.6 km) Q-13 Princeton 4.7 mi SW (7.6 km) Q-16 Low Moor 5.7 mi NNW (9.2 km) c. Control Q-7 Clinton 8.8 mi NE (14.1 km)	Filter change 7 days or more frequently as required due to dust loading.	Particulate Sample: Gross beta analysis on each sample. Gamma isotopic analysis[3] once per 92 days on composite filters by location.

Table 6-1 (Page 2 of 7)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sample or Monitoring Location	Sampling or Collection Frequency	Type and Frequency of Analysis
2. Direct Radiation	a. Indicators-Inner Ring* Q-101-1, 0.6 mi N (0.9 km) Q-101-2, 0.9 mi N (1.4 km) Q-102-1, 1.3 mi NNE (2.2 km) Q-102-3, 1.4 mi NNE (2.3 km) Q-103-1, 1.2 mi NE (1.9 km) Q-103-2, 1.2 mi NE (1.9 km) Q-104-1, 1.1 mi ENE (1.9 km) Q-104-2, 0.9 mi ENE (1.4 km) Q-105-1, 0.8 mi E (1.2 km) Q-105-2, 0.8 mi E (1.2 km) Q-106-2, 0.7 mi ESE (1.1 km) Q-106-3, 0.7 mi ESE (1.2 km) Q-107-2, 0.7 mi SE (1.2 km) Q-107-3, 0.8 mi SE (1.2 km) Q-108-1, 1.0 mi SSE (1.5 km) Q-108-2, 0.9 mi SSE (1.4 km) Q-109-1, 0.9 mi S (1.4 km) Q-109-2, 1.2 mi S (1.9 km) Q-111-1, 2.6 mi SW (4.2 km) Q-111-2, 2.5 mi SW (4.0 km) Q-112-1, 2.5 mi WSW (4.0 km) Q-112-2, 2.2 mi WSW (3.6 km) Q-113-1, 2.5 mi W (4.1 km) Q-113-2, 2.5 mi W (4.1 km) Q-114-1, 2.1 mi WNW (3.5 km) Q-114-2, 2.5 mi WNW (4.0 km) Q-115-1, 2.6 mi NW (4.2 km) Q-115-2, 2.3 mi NW (3.6 km) Q-116-1, 2.3 mi NNW (3.7 km) Q-116-3, 2.4 mi N (3.9 km) * = Inner Ring TLDs are not placed within SSW sector because of the river at this range.	92 days	Gamma dose on each TLD once per 92 days

Table 6-1 (Page 3 of 7)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sample or Monitoring Location	Sampling or Collection Frequency	Type and Frequency of Analysis
2. Direct Radiation (Cont'd)	b. Indicators-Outer Ring Q-201-1, 4.2 mi N (6.7 km) Q-201-2, 4.2 mi N (6.7 km) Q-202-1, 4.4 mi NNE (7.0 km) Q-202-2, 4.8 mi NNE (7.7 km) Q-203-1, 4.7 mi NE (7.5 km) Q-203-2, 5.0 mi NE (8.0 km) Q-204-1, 4.7 mi ENE (7.5 km) Q-204-2, 4.5 mi ENE (7.2 km) Q-205-1, 4.7 mi E (7.5 km) Q-205-4, 4.8 mi E (7.7 km) Q-206-1, 4.8 mi ESE (7.7 km) Q-206-2, 4.8 mi ESE (7.7 km) Q-207-1, 4.7 mi SE (7.6 km) Q-207-4, 4.7 mi SE (7.6 km) Q-208-1, 4.3 mi SSE (6.8 km) Q-208-2, 4.9 mi SSE (7.9 km) Q-209-1, 4.7 mi S (7.6 km) Q-209-4, 4.7 mi S (7.6 km) Q-210-1, 4.1 mi SSW (6.5 km) Q-210-5, 3.3 mi SSW (5.3 km) Q-211-1, 4.5 mi SW (7.3 km) Q-211-2, 4.5 mi SW (7.3 km) Q-212-1, 5.4 mi WSW (8.7 km) Q-212-2, 4.4 mi WSW (7.2 km) Q-213-1, 4.3 mi W (6.9 km) Q-213-2, 4.8 mi W (7.8 km) Q-214-1, 4.7 mi WNW (7.5 km) Q-214-2, 4.4 mi WNW (7.1 km) Q-215-1, 5.0 mi NW (8.0 km) Q-215-2, 4.2 mi NW (6.7 km) Q-216-1, 4.6 mi NNW (7.4 km) Q-216-2, 4.3 mi NNW (7.0 km)		

Table 6-1 (Page 4 of 7)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sample or Monitoring Location	Sampling or Collection Frequency	Type and Frequency of Analysis
2. Direct Radiation (Cont'd)	c. Other Indicators One at each of the airborne location given in part 1.a and 1.b. d. Controls One at airborne control location given in part 1.c.		
3. Waterborne a. Ground/Well	a. Indicators Q-35, McMillan Well 1.5 mi S (2.4 km) Q-36, Cordova Well 3.3 mi SSW (5.3 km)	92 days	Gamma isotopic(3) and tritium analysis on each sample.
b. Drinking Water	a. Indicator There are no drinking water pathways within 5.0 mi downstream of Station.	Grab samples once per 7 days.	Gross beta and gamma isotopic analyses(3) on 31-day composite; tritium analysis on 92-day composite. I-131(4) on 14-day composite when calculated dose > 1 mrem/year.

Table 6-1 (Page 5 of 7)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sample or Monitoring Location	Sampling or Collection Frequency	Type and Frequency of Analysis
3. Waterborne (Con't)			
c. Surface Water	a. Indicator Q-33 Cordova, 3.1 mi SSW (5.0 km) b. Control Q-34 Camanche 4.4 NNE (7.1 km)	Grab samples once per 7 days.	Gross beta and gamma isotopic analyses(3) on 31-day composite; tritium analysis on 92-day composite.
d. Sediments	a. Indicators Q-39 Cordova, Downstream on Mississippi River 0.8 mi SSW (1.3 km)	184 days	Gamma isotopic analysis(3) on each sample.
4. Ingestion			
a. Milk	a. Indicators Q-26 Bill Stanley Dairy, 3.5 mi ESE (4.8 km) There are no other participating dairies within 5.0 miles. b. Controls There are no participating control dairies within 9.3 to 18.6 miles.	Once per 14 days when animals are on pasture (May through October), 31 days at other times (November through April).	Gamma isotopic(3) and I-131(9) analysis on each sample.

Table 6-1 (Page 6 of 7)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sample or Monitoring Location	Sampling or Collection Frequency	Type and Frequency of Analysis
4. Ingestion (Cont'd)			
b. Fish	a. Indicator Q-24 Pool #14 of Mississippi River, 0.5 mi SW (0.8 km) b. Control Q-29 Mississippi River-Upstream 1.0 mi N (1.6 km)	184 days	Gamma isotopic analysis(3) on edible portions of each sample.
c. Food Products	a. Indicators Two sample locations from each of the four major quadrants within 5.0 mi. Sample locations for food products may vary based on availability and therefore are not required to be identified here but shall be taken. b. Controls Two samples grown within 9.3 to 18.6 mi.	12 months	Gamma isotopic(3) analysis on each sample.

Table 6-1 (Page 7 of 7)
Radiological Environmental Monitoring Program

1 Deleted.

2 Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

3 Gamma isotopic analysis means the identification and quantification of gamma emitting radionuclides that may be attributable to the effluents from the station.

4 I-131 analysis means the analytical separation and counting procedure are specific for this radionuclide.

Figure 6-1 REMP Sample Locations – 2-Mile Radius

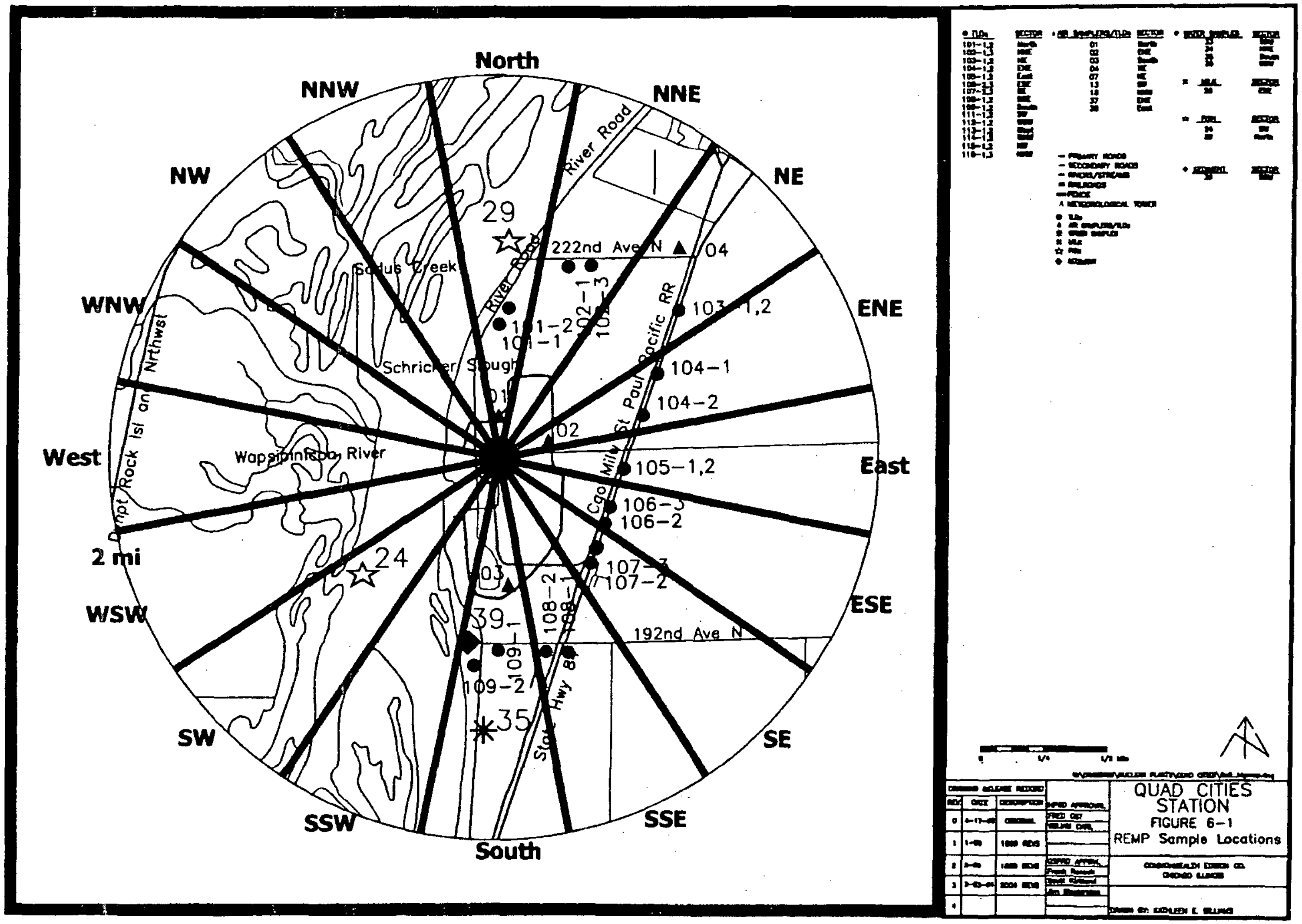

Figure 6-2 REMP Sample Locations – 9.3-Mile Radius