11.3 GASEOUS WASTE MANAGEMENT SYSTEMS

Radioactive gases are collected and processed through the following systems depending upon their origin:

a) Gaseous Waste Management System (GWMS)

b) Vent Gas Collection Header (VGCH)

c) Main Condenser Evacuation System (MCES)

d) Turbine Gland Sealing System (TGSS)

e) Building Ventilation Systems

f) Atmospheric Dump Valves

A description of the MCES and the TGSS is contained in Subsection 10.4.2 and 10.4.3, respectively. The building ventilation systems are described in Section 9.4. These systems will be discussed in this section only where they interface with the Gaseous Waste Management Systems.

11.3.1 DESIGN BASES

The principal design objectives of the GWMS are as follows:

a) To protect the plant personnel, the general public and the environment by insuring that gaseous releases of potentially radioactive materials both in plant and to the environs are as low as practicable in accordance with 10CFR20 and 10CFR50 Appendix I.

→(DRN 03-2065, R14)

b) To provide a means to collect, store, sample, and monitor potentially radioactive gaseous wastes generated during plant operations as specified in 10CFR50, Appendix A, GDC 60. These wastes may contain noble gases, airborne halogens and radioactive material in particulate form.

→(EC-47424, R308)

Implementation of 10CFR50, Appendix A, GDC 64 is discussed in Section 11.5. The gaseous waste management system conforms to Regulatory Guide 1.143 as described in FSAR Section 1.8.1.143.

←(EC-47424, R308)

←(DRN 03-2065, R14)

The numerical design objectives for plant releases during normal operations, including anticipated operational occurrences, are based on 10CFR50 Appendix I. The design objectives are:

a) The calculated annual air dose due to gamma radiation at or beyond the site boundary is not to exceed 10 millirads.

b) The calculated annual air dose due to beta radiation at or beyond the site boundary is not to exceed 20 millirads.

→(DRN 99-2361, R11)

c) The calculated annual total quantity of all radioactive iodine and radioactive material in particulate form will not result in an annual dose or dose commitment to any organ of an individual in an unrestricted area from all pathways in excess of 15 mrem. Effluent release points are shown in Figure 2.1-4.

← (DRN 99-2361, R11)

→(DRN 99-2361, R11)
The expected annual quantities of radioactive materials released are shown in Tables 11.3-5 and 11.3-6. The expected doses to individuals at or beyond the site boundary are shown in Table 11.3-7.
←(DRN 99-2361, R11)

→(DRN 03-2065, R14)
Table 11.3-8 provides the airborne radioactivity concentrations at the maximum exposure point resulting from plant releases. These concentrations are based on the ANS-18.1 (Section 11.1.2). Increasing these concentrations by a factor of eight (accounting for operation with one percent failed fuel) demonstrates that the concentrations are well below the limits specified in 10CFR20, Appendix B, Table 2, Column 1.
←(DRN 03-2065, R14)

The GWMS is classified as non-seismic Category I and non-nuclear safety. The Gas Decay Tanks, interconnecting piping and components located between the upstream and downstream valves used to isolate the GDT from the rest of the system, however, are required by Regulatory Guide 1.143 to be designed to meet seismic criteria for an Operating Basis Earthquake (OBE). All major components and piping supports were designed to meet seismic Category I (SSE) criteria. Use of non-seismic supports may be considered on other than the GDT and associated equipment in accordance with plant procedures.

→(DRN 99-2361, R11)
The GWMS is designed to process maximum expected surges to the gas surge header with minimum impact on operations. There are two waste gas compressors to process the gas, one of which is in a standby mode to handle surges to the system that the on-line compressor cannot handle. The flow rates of the compressors are such that one compressor has sufficient capacity to process influents at their normal expected flow rates with sufficient reserve capacity in the standby compressor to handle surges. The GWMS has sufficient tank capacity for 60 days decay time. See Table 11.3-3 for influents to the gas surge header from the various components.
←(DRN 99-2361, R11)

Each compressor employs a double-diaphragm arrangement with an additional leak detection spacer diaphragm located between the two diaphragms. Failure of either the top or bottom diaphragm results in a pressure increase in the leak detection spacer. The rise in pressure triggers a pressure switch and initiates an alarm and automatically shuts the compressor down. The standby compressor would then come on line. As long as the second diaphragm remains intact, there is no possibility for gas to leak into or out of the system. Only in the unlikely event of simultaneous failure of both diaphragms, does the potential for leakage exist. Gaseous Waste Management System equipment, which requires shielding, is placed in separate cubicles. The separate cubicles allow operations to continue by using alternate process routes while performing maintenance on a particular piece of equipment. To reduce radioactive releases to the building atmosphere, globe valves with metal diaphragm seals are used where practical. In some cases, however, other types of valves which are designed and tested for zero leakage are employed. Welding of process piping and valves is also used to reduce potential radioactive gas release.

The maximum and average activity inventories and the bases for the values are given in Section 12.2. The geometry and layout of equipment, as required for shielding design calculations, is shown in Figure 1.2-11.

The GWMS provides a means to control the discharge of gaseous waste. The discharges are controlled by the operator in the main control room. The operator discharges the gas decay tanks through a flow meter and recorder, and a radiation monitor, which automatically terminates discharge flow on high activity. The release is controlled by a needle valve preceded by a pressure regulator to ensure constant flow rate. The procedure of sampling the gas decay tank prior to release and continuous monitoring of the release protects against operator error such as sampling one tank and lining up a different tank for discharge. The procedure for sampling and monitoring also protects against radiation monitor malfunction since the sample prior to discharge will be representative of tank contents. The process and effluent radiological monitoring systems are described in Section 11.5.

→(DRN 99-2361, R11; EC-37911, R307)
The GWMS is designed to prevent or preclude explosive mixtures rather than withstand an internal explosion. The gas analyzer package as shown on Figure 9.3-2 (Waste Gas Analyzer System) is provided to monitor hydrogen and 2 oxygen concentrations via various plant components where potentially explosive mixtures could develop. The gas analyzer has the capability of automatically sampling selected sample sources. The gas analyzer is also capable of monitoring a single sample source for as long as desired by manually overriding the sequence selector. Each sample source is purged, analyzed and recorded. Continuous recording of sample concentrations allows for the detection and observation of trends which may be developing. When the analysis indicates that the hydrogen or oxygen concentration of a sample exceeds a predetermined set point an alarm is annunciated.
←(DRN 99-2361, R11; EC-37911, R307)

If automatic analyzer operation is interrupted, samples can be obtained from the grab sample port on the analyzer, and from local sample ports at selected locations in the GWMS. The sample port on the analyzer will allow manual sample collection of a tank which has sufficient pressure to drive the gas to the analyzer, if the analyzer pump is inoperable. Local sample lines are also located on headers where samples can be taken manually. Samples taken can then be analyzed by a portable analyzer or taken to the radiochemistry lab. This will allow GWMS operation to continue until the analyzer is back in automatic operation.
→(EC-37911, R307)
In addition to the gas analyzer package, which can automatically analyze selected sequential sample points, a separate gas analyzer with alarm capabilities will be used to continuously monitor between the common discharge of the waste gas compressors and the gas decay tanks (i.e., a sample will be taken from line no. 3WM1-123A/B to the separate gas analyzer). The sequential analyzer will be used as the backup analyzer and serve the dual requirement of SRP 11.3 by monitoring the sequential points discussed previously.
←(EC-37911, R307)

→(DRN 00-696, R11-B)
The presence of oxygen in the GWMS would result from air infiltration into component gas spaces or air desorption into component gas spaces from water. Since the volume control tank and gas decay tanks operate under pressure air infiltration is not probable. Although air may be present in the volume control tank after maintenance it would not normally be vented to the gas decay tanks. Trace amounts of air may be present in the gases vented from the volume control tank due to desorption of air from reactor coolant in this component.
←(DRN 00-696, R11-B)

However, since the reactor coolant system oxygen concentration is maintained less than 0.1 ppm by the addition of hydrazine or hydrogen, it is not likely that more than trace amounts of oxygen would be desorbed.

Under the worst conditions of compressing air into a gas tank it would take 1-1/2 to 12 hrs. to reach an explosive mixture, depending on the hydrogen dilution volume in the tank. Under the more probable and realistic circumstances of trace oxygen, the time to reach an explosive mixture would be substantially greater.

A continuous backup oxygen analyzer has been installed on the high pressure side of the waste gas compressors in addition to the cyclic automatic gas analyzer already in place. This additional analyzer will give better indication of oxygen levels in the GWMS.

11.3.2 SYSTEM DESCRIPTION

The design of the Gaseous Waste Management System (GWMS) is presented in Figure 11.3-1. Principal flow paths (heavy lines) through the system as well as the release point (plant vent) are clearly indicated in the figure. Process data is presented in Table 11.3-10.

Waste gases which are routed to the Gas Surge Header (GSH) are mainly hydrogenated, radioactive or potentially radioactive gases from various sources throughout the plant. Gaseous wastes are generated from reactor coolant degassing operations, processing of radioactive liquid wastes and tank purgings. Waste gases enter the GWMS by way of three headers: the vent gas collection header, the containment vent header and the gas surge header.

11.3.2.1 Vent Gas Collection Header

→ (DRN 99-2361)

The VGCH collects gas primarily from aerated vents of process equipment in the waste and boron management systems, the Chemical and Volume Control System and the Fuel Pool System. Table 11.3-2 identifies each of the inputs to the VGCH. Because of the large volume of gas and the low activity level from the sources, the gases are routed directly to the plant stack. The radioactive releases from the VGCH will be negligible compared with other sources. As a further check to prevent unexpected activity release from this source, the radioactive release via plant stack is continuously monitored and the plant stack alarms on abnormal activity release.

← (DRN 99-2361)

11.3.2.2 Containment Vent Header and Gas Surge Header

→ (DRN 99-2361)

Gases from the GSH, including the contribution of the Containment Vent Header flow into the gas surge tank where they are collected. The gases remain in the gas surge tank until the pressure builds to a point which actuates a single waste gas compressor. The waste gas compressor feeds a preselected gas decay tank until the pressure in the gas surge tank drops to a point where the waste gas compressor stops. A second waste gas compressor will start if the pressure in the gas surge tank builds due to a surge of the inputs. This automatic operation of the waste gas compressors will continue until a gas decay tank is observed to approach its upper operating pressure. At this point another gas decay tank will be manually lined up by means of a remote operated valve on the Waste Management System control panel to receive the waste gas compressor's discharge. The just filled tank is analyzed by the gas analyzer for hydrogen and oxygen content. Grab samples can also be taken for radioactivity analysis. The just filled tank is then isolated for decay and released via a batch release permit as specified in plant procedure.

← (DRN 99-2361)

The only process flow bypass line that exists in the GWMS leads from the gas surge tank directly to the gas discharge header and bypasses the waste gas compressor and gas decay tanks. This flow path is used mainly to purge air from components after maintenance operations, at which time the vented gas contains essentially no radioactivity. The valve on this bypass line is locked closed to facilitate administrative control. Moreover, the bypass flow passes through the radiation monitor in the gas discharge header.

Liquid seals are not used in this system.

11.3.2.3 Main Condenser Evacuation System

The operation and description of the MCES is discussed in Subsection 10.4.2.

11.3.2.4 Turbine Gland Sealing System

The operation and description of the TGSS is discussed in Subsection 10.4.3.

11.3.2.5 Building Ventilation Systems

Descriptions of the ventilation systems serving the Reactor Building, Reactor Auxiliary Building, Fuel Handling Building and Turbine Building with the potential for discharging radioactive gaseous waste are contained in Section 9.4. Radioactive sources for these areas are discussed in Section 12.2.

11.3.2.6 Atmospheric Dump Valves

→ (DRN 99-2361)

Steam release from valve operation will be considered less than one percent of release from Turbine Building due to steam leakage. This source is considered negligible, and as a result there is no dedicated radiation monitor for this pathway.

← (DRN 99-2361)

11.3.3 RADIOACTIVE RELEASES

→ (DRN 01-1285)

The source terms, atmospheric and hydrologic dispersion factors, and the dose calculation assumptions and methods are based on NUREG 0017 (April 1976), Regulatory Guide 1.109 (March 1976), and Regulatory Guide 1.111 (March 1976) as described in the FSAR. The analysis of record is based on receptors in existence at the time the FSAR was docketed for regulatory review in conformance with the standard of actual receptors as documented in 10 CFR 50, Appendix I, and Regulatory Guide 1.109, Table 1.

← (DRN 01-1285)

The expected gaseous releases during normal operations, including anticipated operations occurrences from plant sources (release points), per nuclide, are shown in Tables 11.3-5 and 11.3-6. The assumptions are presented in Table 11.2-12 and the values were calculated in accordance with NUREG 0017. Table 11.3-9a describes the release points.

The calculated average annual airborne radioactivity concentrations are compared with the limit of 10CFR20, Appendix B, Table 2, Column 1, in Table 11.3-8. The filtration of the various release points is contained in Table 11.3-9.

Waterford ventilation exhausts to the atmosphere fall into one of three possible categories. Each exhaust path is either a "principal effluent release pathway," a "non-potential release pathway," or a "secondary" release pathway.

First, Waterford technical specifications explicitly list and provide administrative controls over "principal effluent release pathways." Under accidents discussed in Chapter 15, these pathways are the largest contribution to site boundary dosage.

Second, some Waterford ventilation systems serve areas with small or nonexistent source terms, i.e., a "non-potential release pathway." Significant releases from these exhausts cannot occur. This ventilation system group has no source term in the served room(s). The ventilation systems are either (1) separate from others, or (2) multiple barriers separate them from any potential source term. Examples include HVAC for the administration building and the control room envelope.

Third, Waterford's design includes a ventilation system group that forms a "secondary" release pathway. A secondary pathway is not normally radioactive; however, a remote possibility exists that it can become radioactive during an unanticipated event. These pathways differ from the principle pathways listed on Table 11.3-9a. Any potential radioactive release from them results in insignificant (not discernible) dose consequences. Rooms served by these ventilation systems have transient radioactive sources isolated from the general area. Alternately, systems in this group have components which remove all but negligible amounts of radioactivity before discharge. Examples include the hot machine shop/decontamination shop and the auxiliary building switchgear area ventilation systems. Secondary pathways also exist in buildings which contain sources of radioactivity but do not have any ventilation system, e.g., a tank or sump containing processed liquid waste that may be degassing. All secondary release pathways have the potential to infrequently release insignificant amounts of radioactivity resulting in insignificant impact on off-site doses to the general public.

At this point the terms significant and insignificant need defining. These terms guide whether or not the Waterford design provides for monitoring radioactive releases from secondary pathways. Their definitions come from regulatory guidance as discussed below.

There is some Regulatory precedence to indicate that not all releases are "significant." NUREG 0017 provides guidelines for calculating design basis source terms for routine releases from PWRs and BWRS. Specifically, designers used NUREG 0017 to develop the source terms for Waterford effluent releases. NUREG 0017, section 1.3, acknowledges that not all effluent releases are significant. It considers, for example, steam from the atmospheric dumps and exhaust air from buildings other than the auxiliary and turbine building negligible. Regulatory Guide 1.21 also recognizes a difference between significant and insignificant. However, it does not explicitly define what fraction of the annual dose limits is significant.

Secondary pathways have the following characteristics. There is only a remote possibility for attaining ten percent of the concentration limits in 10CFR20, Appendix B, Table 2, Column 1 either at or beyond the site boundary. Technical specifications define the site boundary.

When considering all hypothetical "worst case" unanticipated occurrences, the potential activity released corresponds to less than or equal to one percent of the annual air and organ dose limits from an equivalent single release pathway. Last, all of the estimated "worst cast" scenarios for all secondary release pathways combined do not exceed ten percent of the design basis annual air and organ dose limits.

The following lists the release pathways that cannot be radioactive.

- Control room HVAC exhausts
- Fuel Handling Building emergency HVAC room exhaust
- HVAC equipment room on the RAB +69MSL exhaust
- RAB air conditioning system serving offices and work areas on the RAB +7MSL
- The elevator shaft serving the non-radiological portion of the RAB
- Turbine building ventilation system (not condenser vacuum)

The following lists the secondary pathways.

- Emergency diesel generator ventilation system (fan E-28)
- Battery rooms exhaust (fans E-29, E-30, E-31)
- Computer battery room exhaust
- Switchgear area smoke purge
- Electrical penetration and cable vault and relay room smoke purge (fan E-49)
- Electrical penetration area smoke purge (fan E-50)
- Hot machine shop and decontamination shop ventilation system
- Radwaste Solidification Building air (no ventilation system)
- Radwaste Compactor Building air (no ventilation system)
- While having an open containment equipment hatch

Waterford 3 has analyzed the consequences of the above secondary release pathways using "worst case" source terms. Radioactive releases from these secondary pathways are not routinely anticipated. The hypothetical source terms used in the analyses were assumed to result from a breach in a barrier of a system, component, or room anticipated to have airborne radioactivity at some time during plant operations. Source terms may come from leakage from either (1) an adjoining room that may contain radioactivity, or (2) from a radioactive ventilation duct.

→ (DRN 99-2361)

Waterford 3 considers a release from a secondary pathway insignificant by satisfying the characteristics listed above. The analyses determined the effluent concentration necessary to exceed ten percent of the allowable limits. The potential for that concentration was weighed by comparing it to anticipated in-plant airborne levels discussed in Chapter 12. If the calculated concentrations for these analyses were significantly above what Chapter 12 anticipates, Waterford 3 considered the likelihood to attain the needed concentrations remote because of a lack of a substantial source term. As long as the likelihood of ever exceeding the ten percent limit is remote, releases from the secondary pathway are deemed insignificant and do not require continuous effluent monitoring.

After examining the potential sources in the area serviced by the ventilation systems for each secondary pathway, Waterford 3 concludes that enough radioactivity could not gather to affect off-site receptors. During times when a potential exists for generating airborne activity, e.g., a barrier between a principal release path and secondary release path opens due to maintenance; routine health physics coverage can provide adequate monitoring. Routine coverage typically entails continuous air sampling and possibly a continuous air monitor to alert personnel working in the area about changing conditions. None of the secondary pathways needs continuous effluent monitoring. Annual release activities from these pathways are calculated and submitted to the NRC in an Annual Effluent Release Report.

← (DRN 99-2361)

Waterford 3 Problem Evaluation Information Request (PEIR) 71098 concludes that the secondary pathways examined meet the established criteria for being insignificant. Therefore, no dedicated radiation monitoring equipment exists for the secondary pathways.

→(DRN 01-1285)

SECTION 11.3 REFERENCES

1. Louisiana Power and Light Letter to NRC, "Waterford Steam Electric Station Unit 3, Docket No. 50-382, Compliance With Appendix I to 10 CFR 50, LPL 5258, dated June 4, 1976.

←(DRN 01-1285)

Table 11.3-1 Revision 309 (06/16)

GWMS EQUIPMENT DESCRIPTION

Tanks	Gas Decay Tanks	Gas Surge Tank
Quantity	3	1
Type (cylindrical)	vertical	vertical
→(DRN 99-2361, R11)		
Internal Volume, $ft.^3$	600 each	20
Design Pressure, psig	380	60
←(DRN 99-2361, R11)		
Normal Operating Pressure, psig	0-345	5
Design Temperature, °F	200	200
Normal Operating Temperature °F	110	100
Code	ASME VIII, Division 1 (Built to ASME III-3, 1971 Edition, Summer 1972 Addenda)	ASME VIII, Division 1 (Built to ASME III-3, 1971 Edition, Summer 1972 Addenda)
Material	Carbon Steel	Carbon Steel

Waste Gas Compressor and Cooler

→(LBDCR 15-045, R309)

Design	Compressor A	Compressor B
Type	Positive Displacement	Positive Displacement
Design Inlet Temperature (°F)	200	200
Design Inlet Pressure (psig)	150	150
Design Discharge Pressure (psig)	380	380
Maximum Operating Discharge Pressure (psig)	345	345
Maximum After Cooler Outlet Temperature (°F)	110	110
Minimum Flow (SCFM)	2	2
Code	Manufacturer Standards (Built to ASME Section VIII, 1971 Edition)	Manufacturer Standards (Built to ASME III-3, 1971 Edition, Winder 1971 Addenda)

←(LBDCR 15-045, R309)

Gas Analyzer

Quantity		1
Type		Automatic hydrogen/ oxygen analyzer
Measurement Range:	hydrogen	0-5%, 0-50%, 0-100%, by volume
	oxygen	0-5%, 0-10%, 0-25%, by volume
Sample Inlet Pressure, psig		1 to 50
Sample Discharge Pressure, psig		5-15 psig
Code		none

Table 11.3-2

SOURCES TO THE VENT GAS COLLECTION HEADER

Source	Volume (SCFY)
Waste Condensate Ion Exchanger	64
Boric Acid Condensate Tank	102,000
Boric Acid Condensate Ion Exchanger	128
Pre Concentrator Ion Exchanger	128
Holdup Tank	102,000
Purification Ion Exchanger	96
Boric Acid Makeup Tanks	2,000
Waste Tanks	375,000
Waste Condensate Tanks	375,000
Miscellaneous	100,00
→	
Gas Analyzer	38,000
←	
Total	1.1 (+6)

( ) Denotes power of 10

Table 11.3-3 Revision 11-B (06/02)

SOURCES AND VOLUMES TO THE GAS SURGE TANK

Component	Volume (SCFY)
Gas Surge Header:	
→(DRN 00-696)	
Flash Tank[(1)]	21,767
Volume Control Tank	1,325
←(DRN 00-696)	
→(DRN 00-1045)	
←(DRN 00-1045)	
Containment Vent Header:	
Reactor Drain Tank	7,800
Quench Tank	0
→ (DRN 99-2361)	
Gas Analyzer	38,000
Total	70,307
← (DRN 99-2361)	

→ (DRN 00-696)

(1) This is historical data. The Flash Tank path is inactive per ER-W3-00-0225-00-00. Effluent now flows directly to the Holdup Tanks.

← (DRN 00-696)

TABLE 11.3-4 Revision 14 (12/05)

ACTIVITIES OF SOURCES TO THE GSH DURING NORMAL OPERATIONS INCLUDING ANTICIPATED OPERATIONAL OCCURENCES
(Ci/yr)

→(DRN 00-1045, R11-A; 03-2065, R14)

	FT	VCT	RDT	TOTAL
Kr-85m	3.20E+02	1.20E+01	4.40E+01	3.76E+02
Kr-85	2.20E+02	8.40E+00	3.10E+01	2.59E+02
Kr-87	8.70E+01	6.90E+00	1.20E+01	1.06E+02
Kr-88	2.90E+02	2.44E+01	4.00E+01	3.54E+02
Xe-131m	1.60E+02	6.00E+00	2.28E+01	1.89E+02
Xe-133	2.60E+04	7.46E+02	3.50E+03	3.02E+04
Xe-135	5.00E+02	7.36E+01	7.10E+01	6.45E+02
Xe-135m	1.90E+01	1.89E+00	2.70E+00	2.36E+01
Xe-138	6.30E+01	1.47E+00	8.80E+00	7.33E+01
1-131	2.20E-01	2.60E-04	1.00E-01	3.20E-01
1-132	5.20E-02	6.20E-05	2.40E-02	7.61E-02
1-133	2.60E-01	3.00E-04	1.20E-01	3.80E-01
1-134	2.30E-02	2.70E-05	1.10E-02	3.40E-02
1-135	1.10E-01	1.30E-04	5.10E-02	1.61E-01

←(DRN 00-1045, R11-A)

→(DRN 00-696, R11-B)

←(DRN 03-2065, R14)

FT = Flash Tank (BMS)[1]

VCT = Volume Control Tank (CVCS)

←(DRN 00-696, R11-B)

→(DRN 00-1045, R11-A)

←(DRN 00-1045, R11-A)

RDT = Reactor Drain Tank (BMS)

→(DRN 00-696, R11-B)

(1) This is historical data. The Flash Tank path is inactive per ER-W3-00-0225-00-00. Effluent now flows directly to the Holdup Tanks.

←(DRN 00-696, R11-B)

TABLE 11.3-5 Revision 14 (12/05)

SOURCE TERMS (NO CONTINUOUS GAS STRIPPING OF VOLUME CONTROL TANK)
NOBLE GASES AND IODINES

GASEOUS RELEASE RATE - CURIES PER YEAR

	PRIMARY COOLANT (MICROCI/GM)	SECONDARY COOLANT (MICROCI/GM)	GAS STRIPPING*		BUILDING VENTIALTION REACTOR			STEAM** BLOWDOWN VENT OFFGAS	MCES EXHAUST	TOTAL
			SHUTDOWN	CONTINUOUS	REACTOR	AUXILIARY	TURBINE			
→(DRN 03-2065, R14)										
KR-85M	2.113E-01	4.058E-08	0.00E+00	0.00E+00	8.0E+00	4.0E+00	0.00E+00	0.00E+00	2.0E+00	1.4E+01
KR-85	8.571E-01	1.603E-07	3.5E+02	7.7E+02	1.6E+03	1.8E+01	0.00E+00	0.00E+00	8.0E+00	2.7E+03
KR-87	1.979E-01	3.567E-08	0.00E+00	0.00E+00	2.0E+00	4.0E+00	0.00E+00	0.00E+00	2.0E+00	8.0E+00
KR-88	3.696E-01	7.037E-08	0.00E+00	0.00E+00	9.0E+00	8.0E+00	0.00E+00	0.00E+00	4.0E+00	2.1E+01
XE131M	1.060E+00	1.967E-07	1.3E+01	8.0E+00	1.4E+03	2.2E+01	0.00E+00	0.00E+00	1.0E+01	1.5E+03
XE133M	9.440E-02	1.828E-08	0.00E+00	0.00E+00	4.5E+01	2.0E+00	0.00E+00	0.00E+00	0.00E+00	4.7E+01
XE133	3.601E+00	6.759E-07	0.00E+00	0.00E+00	3.3E+03	7.6E+01	0.00E+00	0.00E+00	3.6E+01	3.4E+03
XE135M	1.714E-01	3.217E-08	0.00E+00	0.00E+00	0.00E+00	4.0E+00	0.00E+00	0.00E+00	2.0E+00	6.0E+00
XE135	1.125E+00	2.153E-07	0.00E+00	0.00E+00	9.3E+01	2.4E+01	0.00E+00	0.00E+00	1.1E+01	1.3E+02
XE137	4.483E-02	8.458E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
XE138	1.582E-01	2.979E-08	0.00E+00	0.00E+00	0.00E+00	3.0E+00	0.00E+00	0.00E+00	2.0E+00	5.0E+00
TOTAL NOBLE GASES										7.8E+03

	PRIMARY COOLANT (MICROCI/GM)	SECONDARY COOLANT (MICROCI/GM)	BUILDING VENTILATION				STEAM** BLOWDOWN VENT OFFGAS	MCES EXHAUST	TOTAL
			FUEL HANDLING	REACTOR	AUXILIARY	TURBINE			
I131	8.897E-02	8.967E-06	1.2E-03	3.8E-03	2.8E-02	3.8E-04	0.00E+00	0.00E+00	3.3E-02
I133	2.413E-01	1.886E-05	3.2E-03	8.2E-04	7.7E-02	8.0E-04	0.00E+00	0.00E+00	8.9E-02

TOTAL H-3 RELEASED VIA GASEOUS PATHWAY = 1100 CI/YR

C-14 RELEASED VIA GASEOUS PATHWAY = 7.3 CI/YR

AR-41 RELEASED VIA CONTAINMENT VENT = 34 CI/YR

0.00E+00 APPEARING IN THE TABLE INDICATES RELEASE IS LESS THAN 1.0 CI/YR FOR NOBLE GAS, 0.0001 CI/YR FOR IODINE

*RELEASE FROM GAS DECAY TANKS

**THE STEAM BLOWDOWN SYSTEM GASES ARE VENTED TO THE CONDENSER

←(DRN 03-2065, R14)

TABLE 11.3-6 Revision 14 (12/05)

SOURCE TERMS (NO CONTINUOUS GAS STRIPPING OF VOLUME TANK)
PARTICULATES

AIRBORNE PARTICULATE RELEASE RATE-CURIES PER YEAR

→(DRN 03-2065, R14)

NUCLIDE	WASTE GAS SYSTEM	REACTOR	BUILDING VENTILATION REACTOR AUXILIARY	FUEL HANDLING	TOTAL
Cr-51	1.4E-05	9.5E-05	3.2E-06	1.8E-06	1.1E-04
Mn-54	2.1E-06	5.5E-05	7.8E-07	3.0E-06	6.1E-05
Co-57	0.0E+00	8.5E-06	0.0E+00	0.0E+00	8.5E-06
Co-58	8.7E-06	2.6E-04	1.9E-05	2.1E-04	5.0E-04
Co-60	1.4E-05	2.7E-05	5.1E-06	8.2E-05	1.3E-04
Fe-59	1.8E-06	2.8E-05	5.0E-07	0.0E+00	3.0E-05
Sr-89	4.4E-05	1.3E-04	7.5E-06	2.1E-05	2.0E-04
Sr-90	1.7E-05	5.4E-05	2.9E-06	8.0E-06	8.2E-05
Zr-95	4.8E-06	0.0E+00	1.0E-05	3.6E-08	1.5E-05
Nb-95	3.7E-06	1.9E-07	3.0E-07	2.4E-05	4.7E-05
Ru-103	3.2E-06	1.7E-05	2.3E-07	3.8E-07	2.1E-05
Ru-106	2.7E-06	0.0E+00	6.0E-08	6.9E-07	3.5E-06
Sb-125	0.0E+00	0.0E+00	3.9E-08	5.7E-07	6.1E-07
Cs-134	3.3E-05	2.6E-05	5.4E-06	1.7E-05	8.1E-05
Cs-136	5.3E-06	3.3E-05	4.8E-07	0.0E+00	3.9E-05
Cs-137	7.7E-05	5.7E-05	7.2E-06	2.7E-05	1.7E-04
Ba-140	2.3E-05	0.0E+00	4.0E-06	0.0E+00	2.7E-05
Ce-141	2.2E-06	1.3E-05	2.6E-07	4.4E-09	1.5E-05

←(DRN 03-2065, R14)

TABLE 11.3-7 (Sheet 1 of 2) Revision 14 (12/05)

→ (DRN 99-2361, R11)

MAXIMUM INDIVIDUAL DOSES FROM GASEOUS EFFLUENT PATHWAYS
(NO CONTINUOUS GAS STRIPPING OF VOLUME CONTROL TANK)(1)

← (DRN 99-2361, R11)

Pathway	Air Dose (mrad/yr.)	Whole Body (mrem/yr.)	Thyroid (mrem/yr.)	Skin (mrem/yr.)
All Age Groups:				
→(DRN 03-2065, R14)				
Gamma Air Dose At Site Boundary	1.29E+00			
Beta Air Dose At Site Boundary	3.82E+00			
Tissue Dose From External Exposure		5.8E-01	5.8E-01	1.7E+00
Ground Shine Dose		2.4E-01	2.4E-01	2.9E-01
Adults:				
Inhalation Dose		3.7E-01	4.4E-01	3.7E-01
Ingestion Doses				
Leafy Vegetables		1.2E+00	1.4E+00	1.1E+00
Cow Milk		4.6E-01	1.4E+00	3.9E-01
Goat Milk		3.3E-02	5.4E-02	3.0E-02
Beef		4.4E-01	4.7E-01	4.3E-01
Teen:				
Inhalation Dose		3.7E-01	4.6E-01	3.7E-01
Ingestion Doses				
Leafy Vegetables		1.5E+00	1.7E+00	1.4E+00
Cow Milk		6.7E-01	2.3E+00	6.0E-01
Goat Milk		4.6E-02	8.2E-02	4.3E-02
Beef		3.2E-01	3.6E-01	3.2E-01
Child:				
Inhalation Dose		3.2E-01	4.3E-01	3.2E-01
Ingestion Doses				
Leafy Vegetables		2.9E+00	3.2E+00	2.8E+00

→(DRN 00-1045, R11-A)

(1) The Location of each pathway of exposure and the atmospheric dispersion and deposition factors used to obtain these values are presented in Table A-3 of Calculation RAC-087, Revision 0.

←(DRN 00-1045, R11-A)

←(DRN 03-2065, R14)

TABLE 11.3-7 (Sheet 2 of 2) Revision 14 (12/05)

→ (DRN 99-2361, R11)

MAXIMUM INDIVIDUAL DOSES FROM GASEOUS EFFLUENT PATHWAYS
(NO CONTINUOUS GAS STRIPPING OF VOLUME CONTROL TANK)(1)

← (DRN 99-2361, R11)

→(DRN 03-2065, R14)

Pathway	Air Dose (mrad/yr.)	Whole Body (mrem/yr.)	Thyroid (mrem/yr.)	Skin (mrem/yr.)
Cow Milk		1.3E+00	4.5E+00	1.3E+00
Goat Milk		8.3E-02	1.6E-01	8.1E-02
Beef		5.4E-01	5.9E-01	5.3E-01
Infant:				
Inhalation Dose		1.8E-01	2.9E-01	1.8E-01
Ingestion Doses				
Cow Milk		2.4E+00	1.0E+01	3.3E+00
Goat Milk		1.5E-01	3.3E-01	1.4E-01
Beef		N/A	N/A	N/A

←(DRN 03-2065, R14)

TABLE 11.3-8 Revision 14 (12/05)

AVERAGE ANNUAL AIRBORNE RADIONUCLIDE CONCENTRATIONS

→(DRN 03-2065, R14)

Nuclide	Concentration Ci* (μCi/cc)	Effluent Concentration ECi** (uCi/cc)	Ci/ECi***
Kr-85m	5.11E-12	1.00E-07	5.11E-05
Kr-85	9.85E-10	7.00E-07	1.41E-03
KR-87	2.92E-12	2.00E-08	1.46E-04
Kr-88	7.66E-12	9.00E-09	8.51E-04
Xe-131m	5.47E-10	2.00E-06	2.73E-04
Xe-133m	1.71E-11	6.00E-07	2.86E-05
Xe-133	1.24E-09	5.00E-07	2.48E-03
Xe-135m	2.19E-12	4.00E-08	5.47E-05
Xe-135	4.74E-11	7.00E-08	6.77E-04
Xe-138	1.82E-12	2.00E-08	9.12E-05
I-131	1.20E-14	2.00E-10	6.02E-05
I-133	3.25E-14	2.00E-08	1.62E-06
Cr-51	4.01E-17	6.00E-08	6.69E-10
Mn-54	2.22E-17	1.00E-09	2.22E-08
Co-57	3.10E-18	4.00E-09	7.75E-10
Co-58	1.82E-16	1.00E-09	1.82E-07
Co-60	4.74E-17	5.00E-11	9.48E-07
Fe-59	1.09E-17	7.00E-10	1.56E-08
Sr-89	7.29E-17	2.00E-10	3.65E-07
Sr-90	2.99E-17	6.00E-12	4.98E-06
Zr-95	5.47E-18	4.00E-10	1.37E-08
Nb-95	1.71E-17	2.00E-09	8.57E-09
Ru-103	7.66E-18	2.00E-09	3.83E-09
Ru-106	1.28E-18	1.00E-10	1.28E-08
Sb-125	2.22E-19	3.00E-09	7.41E-11
Cs-134	2.95E-17	2.00E-10	1.48E-07
Cs-136	1.42E-17	9.00E-10	1.58E-08
Cs-137	6.20E-17	2.00E-10	3.10E-07
Ba-140	9.85E-18	2.00E-09	4.92E-09
Ce-141	5.47E-18	1.00E-09	5.47E-09
Ar-41	1.24E-11	1.00E-08	1.24E-03
C-14	2.66E-12	3.00E-09	8.87E-04

* Based on Total Releases in Tables 11.3-5 and 11.3-6 and atmospheric dispersion factor of 1.15E-05 sec/m^3 from RAC87 revision 0.

** Effluent Concentration in 10CFR20, Appendix B, Table 2, Column 1.

*** Fraction of Effluent Concentration allowed by 10CFR20.

←(DRN 03-2065, R14)

TABLE 11.3-9

FILTRATION PROVISION

	Source	Filtration System	HEPA	Charcoal
(1)	Containment			
		Recirculation		
		Airborne Radio-activity Removal System (ARRS)	Yes	Yes - 4 in. bed depth
		Purge		
		Routed via Reactor Auxiliary Building Normal Ventilation System		
(2)	Reactor Auxiliary Building	Reactor Auxiliary Building Normal Ventilation System	Yes	Yes - 4 in. bed depth
(3)	Gaseous Waste Man-agement System	N.A.	N.A.	N.A.
(4)	Mechanical Vacuum Pump Discharge	Routed via Reactor Auxiliary Building Normal Ventilation System	Yes	Yes - 4 in. bed depth
(5)	Gland Steam Con-denser Discharge	Routed via Reactor Auxiliary Building Normal Ventilation System	Yes	Yes - 4 in. bed depth
(6)	Turbine Building	N.A.	N.A.	N.A.
(7)	Steam Generator Blowdown Tank Vent	Routed via condenser which is vented to Reactor Auxiliary Building Normal Ventilation System	Yes	Yes - 4 in. bed depth

TABLE 11.3-9a

HVAC RADIOACTIVE RELEASE POINT DATA

Source	Release Point	Height Above MSL (ft.)	Height Above and Relationship to Adjacent Structure	Discharge Temperature (F)	Release Point Flow Rate (scfm)	Velocity (fpm)	Size and Shape of Orifice
(1) Containment Building	Plant Stack	200	131 ft. above Reactor[(1)] Auxiliary Building roof and adjacent to Containment Building	107 max 50 min	98,580	2,561	Diameter 7 ft. - circular
(2) Auxiliary Building	Plant Stack	200	131 ft. above Reactor Auxiliary Building roof and adjacent to Containment Building	104 max 50 min	83,580	2,172	Diameter 7 ft. - circular
(3) Gaseous Waste Management System	Plant Stack	200	131 ft. above Reactor Auxiliary Building roof and adjacent to Containment Building	104 max 50 min	83,580	2,172	Diameter 7 ft. - circular
(4) Mechanical Vacuum Pump	Plant Stack	200	131 ft. above Reactor Auxiliary Building roof and adjacent to Containment Building	104 max 50 min	83,580	2,172	Diameter 7 ft. - circular
(5) Gland Steam Condenser	Plant Stack	200	131 ft. above Reactor Auxiliary Building roof and adjacent to Containment Building	104 max 50 min	83,580	2,172	Diameter 7 ft. - circular
(6) Turbine Building	Ground Level	-	-	-	-	-	-
(7) Steam Generator Blowdown Vent	Plant Stack	200	131 ft. above Reactor Auxiliary Building roof and adjacent to Containment Building	104 max 50 min	83,580	2,172	Diameter 7 ft. - circular

(1) Reactor Auxiliary Building Elevation 69 ft.

TABLE 11.3-10

GASEOUS WASTE MANAGEMENT SYSTEM
PROCESS DATA

(See Figure 11.3-1 for location of data points)

GSH Processing

GWMS Location Point	1	2	3	4
Flow, scfm	1.0	2.0	0	0-50
Pressure, psig	1.5-7.0	5-345	5-345	10
Temperature, F	120	110	110	110