CHAPTER 11 - RADIOACTIVE WASTE MANAGEMENT

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CHAPTER 11 - RADIOACTIVE WASTE MANAGEMENT

11.1 SOURCE TERMS

The information provided in this section defines the radioactive material levels in the reactor water, steam and offgas for both design basis and normal operating conditions. The various radioisotopes listed have been grouped as fission, activation and corrosion products. The fission products, together with the activation products in the reactor coolant, are transported throughout much of the plant by the reactor coolant, and thus are the source of radioactivity for other systems.

In a typical Boiling Water Reactor (BWR), water is converted to steam by heat from the fuel elements in the reactor. The steam expands through a turbine and then is condensed and returned to the reactor. The principal mechanisms that affect the concentrations of radioactive materials in the reactor coolant are:

a. Fission product leakage to the coolant from defects in the fuel cladding and fission product generation in tramp uranium,

b. Corrosion products activated in the core,

c. Radioactivity removed by the reactor coolant cleanup system,

d. Radioactivity removed by the condensate demineralizers,

e. Radioactivity removed through the Steam Jet Air Ejectors, and

f. Radioactivity removed due to reactor coolant leakage.

g. Radioactivity removed by the condensate pre-filters.

The mechanisms will be described briefly later in the subsections.

11.1.1 Fuel Fission Product Inventory and Fuel Experience

11.1.1.1 Fuel Fission Product Inventory

The fission product inventory in the reactor core is presented in Chapter 15.

11.1.1.2 Fuel Experience

A discussion of fuel experience gained for BWR fuel, including failure experience, burnup experience, and thermal conditions under which the experience was gained, is available in two General Electric topical reports (References 1 and 2).

11.1.2 Activity in the Reactor Coolant System

11.1.2.1 Radioactive Noble Gases

The noble gas source terms in the Reactor Coolant System are shown in Table 11.1-1 for two plant conditions: design basis and normal operating conditions. The design basis source terms

are calculated by normalizing GE's noble gas source terms to the Oyster Creek Nuclear Generating Station current Technical Specification limit. The offgas release rate of 0.1-curies per second at 30 minutes decay was used as the basis of GE's noble gas source terms, and 0.3 curies per second at 30 minutes decay is the current Technical Specification maximum release rate of gross activity, except iodines and particulates with half lives longer than eight days. Therefore, the design basis source terms are calculated by multiplying the existing GE noble gas source terms by 3.0. The corresponding noble gas activities for normal operation are a factor of 10 lower than for the design case, as shown in Table 11.1-1.

11.1.2.2 Radioactive Gaseous Iodines

The gaseous iodine source terms to the Main Condenser Offgas Treatment System as shown in Table 11.1-2 for design basis and normal operating conditions. The normal operation source terms are a factor of 10 lower than the design basis source terms.

11.1.2.3 Reactor Coolant Activities

The source terms of liquid radioactive fission activation and corrosion products in the Reactor Coolant System are shown in Table 11.1-3A for normal operation. The corresponding fission product activities for the design case are a factor of 10 higher than for normal operation, as shown in the Table 11.1-3B. Activation and corrosion products, and a few isotopes such as NP-239, Na-24, P-32, Ag-110m and W-187 are formed by activation of impurities in the coolant or by corrosion of irradiated system materials. Therefore, design basis source terms are the same as those for normal operation.

11.1.3 Activities in the Process Stream

11.1.3.1 Source of Gaseous Leakage

The Radioactive Gaseous Waste System has been designed to process the gaseous wastes generated in the plant. This source of gaseous waste is treated principally by: delaying release to permit radioactive decay, and long term holdup using charcoal delay systems. Any effluent releases from the system are on a controlled basis. However, any leakage of reactor coolant or process stream either in the drywell or in the Reactor Building is collected in the building and vented through filtration systems to the environment. Any steam/water leakage in the Turbine Building is directly vented to the environment. The noncondensible gases are also discharged from the main condenser vacuum system exhaust, through the Augmented Offgas (AOG) System, if required, to the stack.

1. Gland Seal

   The Turbine Gland Sealing System uses a sidestream of primary steam flow through the turbine gland seal. The steam is condensed and returned to the condenser hotwell for reuse in the reactor. However, noble gases and radioiodines that remain in the gaseous phase are vented. Table 11.1-4 lists the expected gland seal isotopic release rates for normal operation.

2. Radwaste Buildings Exhaust

   The original Radwaste Building's ventilation system exhausts to the plant stack. Table 11.1-4 lists the expected isotopic release rates for normal operation. The New

Radwaste Building ventilation system exhausts the building atmosphere to the plant stack through a filter train equipped with HEPA filters preceded by a roughing filter.

3. Reactor Building Exhaust

Isotopic release rates from Reactor Building exhaust are also listed in Table 11.1-4 for normal plant operation.

4. Turbine Building Exhaust

The major sources of noble gas releases within the Turbine Building were determined (Reference 3) to originate from steam leaks in the heater bay and condenser area. Table 11.1-4 lists the noble gas and iodine release rates for normal plant operation.

In addition to the Turbine Building ventilation releases which are discharged from the plant stack, there are three ground level releases: the condensate/ feedwater pump room and the reheater protection room and RAGEMS II sample exhaust line. The condensate/feedwater pump room is ventilated by an independent system which discharges in the rear of the Turbine Building. The average annual release rates of I-131 and I-133 from this system are 7.88×10^{-3} Ci/yr (2.5×10^{-4} microcuries/sec) and 5.05×10^{-2} Ci/yr (1.6×10^{-3} microcuries/sec), respectively (Reference 4).

The reheater protection room is also ventilated by an independent system which discharges at ground level. The average annual release rate of I-131 from this system is 1.9×10^{-9} Ci/yr (6.2×10^{-11} microcuries/sec).

The third release point is the RAGEMS II Radiation Monitoring System. It samples the discharges from the condensate/feedwater pump room and the reheater protection room. These samples pass through radiation monitors that measure the source streams. The effluent is released outside the Turbine Building. The average annual release rates are contained within its source rates.

11.1.3.2 Sources of Liquid Leakage

The Liquid Radwaste System has been designed to process the liquid waste generated in the plant through valve stems, pump seals, flange connections, etc. All the liquid leakages are eventually collected in two separate process systems, namely the High Purity Waste Collection System (with two tanks) and Chemical Waste/Floor Drain Waste Collection System (with three tanks). Discussions on the operation of the components and associated input source terms for this system are presented in Section 11.2.

11.1.3.3 Mechanical Vacuum Pump Exhaust

Following plant shutdowns, a mechanical vacuum pump is used to reestablish the Main Condenser vacuum. In addition, the mechanical vacuum pump may be used during plant shutdown to maintain a slight condenser vacuum and thereby prevent outleakage of radioactive gases from the Main Condenser. If required to meet the design objectives of Appendix I of 10CFR50, the exhaust from the mechanical vacuum pump could be processed through charcoal adsorbers for removal of radioiodine prior to release to the environment.

11.1.3.4 Reactor Water Cleanup System

The Reactor Water Cleanup system draws reactor water (from the 'B' recirculation loop) through a filter and demineralizer and then returns the water to the reactor via the 'B' recirculation loop. The radioisotope inventories for this system would be the same as the reactor water inventories provided in Table 11.1-3A or 11.1-3B with a reduction due to decay, filtration, or demineralization.

11.1.3.5 Shutdown Cooling System (SCS)

Transport of radioactive materials by the SCS applies only when this system is operated in the reactor shutdown cooling mode. In this cooling mode, the system is placed in operation to recirculate reactor water to remove decay heat during a period of hours after reactor shutdown. During SCS operation, the primary source of radioactivity is from long lived radioactive fission products and noncoolant activation products.

11.1.3.6 Spent Fuel Pool and Fuel Pool Cooling and Cleanup System

The amount of radioactivity in the spent fuel pool is dependent upon the amount of stored spent fuel, the time since the fuel has been removed from the reactor, the amount of fission product leakage from the fuel, the amount of hardware temporarily stored in the pool, whether the reactor cavity is interconnected during an outage, and the radioactivity removal rate of the fuel pool cooling and cleanup system.

11.1.3.7 Control Rod Drive Hydraulic System

Portions of the Control Rod Drive Hydraulic System will also be in contact with reactor water. Activity in this system will be mainly due to long-lived activation products.

11.1.4 References

(1) Williamson and D.C. Ditamore, Current State of Knowledge of High Performance BWR Zircaloy Clad UO_2 Fuel, NEDO-10173, General Electric Co., May 1970.

(2) Williamson and D.C. Ditamore, Experience with BWR Fuel through September 1971, NEDO-10505, General Electric Co., May 1972.

(3) Helmholz, H.R., Gilbert, R.S., and Meek, M.E., NEDM-12340, "Noble Gas and Iodine Activity, in the Oyster Creek Ventilation and Off-Gas Systems," August 30, 1972.

(4) Nuclear Environmental Services, "Radionuclides Releases from Nuclear Power Stations for the Period November, 1974 to May, 1975. A Data Summary Prepared for the Electric Power Research Institute," May, 1975.

TABLE 11.1-1
(Sheet 1 of 1)

NOBLE GAS SOURCE TERMS FOR REACTOR COOLANT SYSTEM

		Design Bases		Normal Operation	
Isotope	Half Life	Source Term @ t = 0 (ûCi/Sec)	Source Term @ t = 30 min (ûCi/Sec)	Source Term @ t = 0 (ûCi/Sec)	Source Term @ t = 30 min (ûCi/Sec)
Kr-83m	1.86 hr	8.8 (3)	7.5 (3)	8.8 (2)	7.5 (2)
Kr-85m	4.4 hr	1.6 (4)	1.5 (4)	1.6 (3)	1.5 (3)
Kr-85	10.74 yr	26 to 52*	26 to 52*	2.6 to 52*	2.6 to 52*
Kr-87	76.0 min	5.2 (4)	3.9 (4)	5.2 (3)	3.9 (3)
Kr-88	2.79 hr	5.2 (4)	4.7 (4)	5.2 (3)	4.7 (3)
Kr-89	3.18 min	3.4 (5)	4.7 (2)	3.4 (4)	4.7 (1)
Kr-90	32.3 sec	7.3 (5)	- - -	7.3 (4)	- - -
Kr-91	8.6 sec	8.6 (5)	- - -	8.6 (4)	- - -
Kr-92	1.84 sec	8.6 (5)	- - -	8.6 (4)	- - -
Kr-93	1.29 sec	2.6 (5)	- - -	2.6 (4)	- - -
Kr-94	1.0 sec	6.0 (4)	- - -	6.0 (3)	- - -
Kr-95	0.5 sec	5.5 (3)	- - -	5.5 (2)	- - -
Kr-97	1.0 sec	3.6 (1)	- - -	3.6	- - -
Xe-131m	11.96 day	3.9 (1)	3.9 (1)	3.9	3.9
Xe-133m	2.26 day	7.5 (2)	7.3 (2)	7.5 (1)	7.3 (1)
Xe-133	5.27 day	2.1 (4)	2.1 (4)	2.1 (3)	2.1 (3)
Xe-135m	15.7 min	6.8 (4)	1.8 (4)	6.8 (3)	1.8 (3)
Xe-135	9.16 hr	5.7 (4)	5.7 (4)	5.7 (3)	5.7 (3)
Xe-137	3.82 min	3.9 (5)	1.7 (3)	3.9 (4)	1.7 (2)
Xe-138	14.2 min	2.3 (5)	5.5 (4)	2.3 (4)	5.5 (3)
Xe-139	40.0 sec	7.3 (5)	- - -	7.3 (4)	- - -
Xe-140	13.6 sec	7.8 (5)	- - -	7.8 (4)	- - -
Xe-141	1.72 sec	6.2 (5)	- - -	6.2 (4)	- - -
Xe-142	1.22 sec	1.9 (5)	- - -	1.9 (4)	- - -
Xe-143	0.96 sec	3.1 (4)	- - -	3.1 (3)	- - -
Xe-144	1.0 sec	1.5 (3)	- - -	1.5 (2)	- - -
TOTALS		6.5 (6)**	2.6 (5)	6.5 (5)	2.6 (4)

* Estimated from experimental observations
** 6.5 (6) = 6.5 x 10^6

TABLE 11.1-2
(Sheet 1 of 1)

GASEOUS IODINE SOURCE TERMS TO THE MAIN CONDENSER
OFFGAS TREATMENT SYSTEM

Isotope	Half Life	Design Bases Source Term @ t = 30 min (ûCi/Sec)	Normal Operation Source Term @ t = 30 min (ûCi/Sec)
I-131	8.06 day	0.86	0.09
I-133	20.8 hr.	2.57	0.26
I-135	6.68 hr.	5.06	0.51
TOTAL		8.49	0.86

TABLE 11.1-3A
(Sheet 1 of 1)

REACTOR COOLANT ACTIVITY CONCENTRATION*
(Normal Operation)

Isotope	ûCi/ml	Isotope	ûCi/ml
N-13	3.70(-2)	Cs-134	5.46(-5)
N-16	5.30(+1)	Cs-136	3.64(-5)
F-18	4.00(-3)	Cs-137	6.24(-5)
		Cs-138	7.54(-2)
Br-83	5.46(-3)	Ba-139	6.24(-2)
Br-84	1.04(-2)	Ba-140	3.12(-3)
Br-85	6.76(-3)	Ba-141	7.02(-2)
Sr-89	1.07(-3)	Ba-142	6.76(-2)
Sr-90	8.06(-5)	Ce-141	1.38(-5)
Sr-91	2.50(-2)	Ce-143	1.22(-5)
Sr-92	4.16(-2)	Ce-144	1.22(-5)
Zr-95	1.38(-2)	Pr-143	1.33(-5)
Zr-97	1.14(-5)	Nd-147	4.94(-6)
Nb-95	1.43(-5)		
Mo-99	7.80(-3)	Np-239	3.3(-1)
Tc-99m	1.04(-1)	Na-24	2.0(-3)
Tc-101	5.46(-2)	P-32	2.0(-5)
Ru-103	6.76(-6)	Cr-51	5.0(-4)
Ru-106	9.10(-7)	Mn-54	4.0(-5)
Te-129m	1.38(-5)	Mn-56	5.0(-2)
Te-132	1.69(-2)	Co-58	5.0(-3)
I-131	4.68(-3)	Co-60	5.0(-4)
I-132	4.42(-2)	Fe-59	8.0(-5)
I-133	3.12(-2)	Ni-65	3.0(-4)
I-134	9.10(-2)	Zn-65	2.0(-6)
I-135	4.68(-2)	Zn-69m	3.0(-5)
		Ag-110m	6.0(-5)
		W-187	3.0(-3)

* General Electric Document 22A2703E, Revision 3

TABLE 11.1-3B
(Sheet 1 of 1)

REACTOR COOLANT ACTIVITY CONCENTRATION*
(Design Basis)

Isotope	ûCi/ml	Isotope	ûCi/ml
N-13	3.70(-2)	Cs-134	5.46(-4)
N-16	5.30(+1)	Cs-136	3.64(-4)
F-18	4.00(-3)	Cs-137	6.24(-4)
		Cs-138	7.54(-1)
Br-83	5.46(-2)	Ba-139	6.24(-1)
Br-84	1.04(-1)	Ba-140	3.12(-2)
Br-85	6.76(-2)	Ba-141	7.02(-1)
Sr-89	1.07(-2)	Ba-142	6.76(-1)
Sr-90	8.06(-4)	Ce-141	1.38(-4)
Sr-91	2.50(-1)	Ce-143	1.22(-4)
Sr-92	4.16(-1)	Ce-144	1.22(-4)
Zr-95	1.38(-4)	Pr-143	1.33(-4)
Zr-97	1.14(-4)	Nd-147	4.94(-5)
Nb-95	1.43(-4)		
Mo-99	7.80(-2)	Np-239	3.3(-1)
Tc-99m	1.04(+0)	Na-24	2.0(-3)
Tc-101	5.46(-1)	P-32	2.0(-5)
Ru-103	6.76(-5)	Cr-51	5.0(-4)
Ru-106	9.10(-6)	Mn-54	4.0(-5)
Te-129m	1.38(-4)	Mn-56	5.0(-2)
Te-132	1.69(-1)	Co-58	5.0(-3)
I-131	4.68(-2)	Co-60	5.0(-4)
I-132	4.42(-1)	Fe-59	8.0(-5)
I-133	3.12(-1)	Ni-65	3.0(-4)
I-134	9.10(-1)	Zn-65	2.0(-6)
I-135	4.68(-1)	Zn-69m	3.0(-5)
		Ag-110M	6.0(-5)
		W-187	3.0(-3)

* General Electric Document 22A2703E, Revision 3

TABLE 11.1-4
(Sheet 1 of 1)

GASEOUS RADWASTE RELEASES

Normal Operation (Ci/yr)

Nuclide	Half-Life	Gland Seal	Reactor Bldg.	Old Radwaste Bldg.	Turbine Bldg.	Total
Kr 83m	1.86 h	28.3		1.57	13.7	43.57
Kr 85m	4.4 h	49.3	.057	3.14	34.5	87.00
Kr 85	10.74 y	.12	.321	.008	0.188	.64
Kr 87	76.0 m	158.6		8.48	70.84	237.9
Kr 88	2.97 h	165.2	.002	10.1	92.7	268.0
Kr 89	3.18 m	690.8		.1	19.3	710.2
Xe 131m	11.96 d	.123	.286	.009	.188	.61
Xe-133m	2.26 d	2.39	3.36	.160	3.39	9.3
Xe-133	5.27 d	67.2	133.8	4.57	100.5	306.1
Xe-135m	15.7 m	195.9		3.83	54.6	254.3
Xe-135	9.16 h	186.2	12.2	12.3	183.7	394.4
Xe-137	3.82 m	920.0		.374	41.5	961.8
Xe-138	14.2 m	681.4		11.6	178.0	871
Total		3145.4	150.0	56.2	793.1	4144.7
I-131	8.06 d	.003	.0139	.0002	.0237	.0408
I-133	20.8 h	.008	.0097	.0085	.0702	.0884
I-135	6.68 h	.016	.0006	.001	.1357	.1533
Total		.027	.0242	.0017	.2296	.2825

11.2 LIQUID WASTE MANAGEMENT SYSTEM

The Liquid Radwaste System is designed to collect, treat, store and process all potentially radioactive liquid wastes produced within the plant and in accordance with the requirements of Regulatory Guides 1.26 and 1.29. These wastes are collected in sumps and drain tanks at various locations throughout the plant and then transferred to the appropriate collection tanks in the New Radwaste Building for treatment, storage, and disposal. This system may be defined as a continuous collection, remote manual, batch type process. Processed wastes of condensate quality are recycled within the plant. Processed wastes exceeding the makeup requirements of the plant are discharged to the environment within the limits established by 10CFR20 and the guidelines prescribed by 10CFR50, Appendix I.

11.2.1 Design Basis

The Liquid Radwaste System is designed to limit offsite radiation exposures below the levels of 10CFR20 and 10CFR50, Appendix I. The Non-Nuclear Safety class (NNS), seismic Category I (foundations and retaining areas, see Figure 11.2-1) New Radwaste Building was designed to prevent liquid wastes from being released to the environment in the event of a Safe Shutdown Earthquake (SSE) without limiting station output or availability. Sufficient system capacity, redundancy and reliability exist to provide the treatment and holdup of wastes during normal operation including anticipated operational occurrences. This system is designed to: a) process 21000/105000 gpd of High Purity Waste and 8500/38000[*] gpd of Chemical Waste/Floor Drain, liquid (see Tables 11.2-1 and 11.2-2); and b) filter, concentrate or demineralize the soluble and insoluble radioactive liquid contaminants in the Chemical Waste/Floor Drain System, through filtration with a decontamination factor (D.F.) of 100 for insoluble contaminants, through evaporation with a minimum D.F.** of 10^4, or demineralization with D.F. of 100 for ionics.

11.2.2 System Descriptions

11.2.2.1 General

Waste input to the system originates from equipment leakage, drainage and process waste produced by plant operations. Due to the diverse nature of the waste liquids to be processed, limited segregation is employed to collect wastes with similar levels of chemical contaminants. This permits the most effective water treatment process to be utilized for treatment of each category of waste.

Processed wastes of condensate makeup quality are recycled for use within the plant. The potentially radioactive liquid wastes processed by the Liquid Radwaste System are broadly classified into one of the following categories:

a. High Purity Waste (Low Conductivity)
b. Chemical/Floor Drain Waste

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[*] These values represent normal and maximum volumes of liquid wastes, respectively.

** D.F. is defined for the radwaste concentrator as the Ratio of Specific Activity in the Bottoms to the specific activity in the Distillate.

Their respective flow diagrams are depicted in Drawing GE148F437. Each category of waste is collected and processed by a subsystem which utilizes waste processes compatible with the chemical concentrations and properties of that category of waste.

Adequate collection capacity and redundant process trains are provided for critical subsystems to ensure that plant operations are not limited by an inability to process design basis waste input. Collection tanks are sized to accommodate a minimum of one day's normal waste production.

Equipment drains, vents, overflows and leakages are routed through piping to the various collection sumps and tanks located throughout the plant. Inadvertent floor spills are directed to local sumps. These sumps and tanks automatically discharge their contents to the Liquid Radwaste System with the exception of the 1-1 and 1-5 sumps which are operated in the manual mode.

Waste collection tanks, valves, pipes and process components located in the New Radwaste Building are constructed of either stainless steel or Carpenter 20 material. The only exceptions are the Concentrator Distillate Demineralizers and the High Purity Demineralizers which are constructed of carbon steel and are rubber lined. Process piping systems up to and including instrument and sample root valves are of all welded construction except where flanges are used to ease maintenance operations and to join dissimilar materials or where Pyplok compression fittings are used to reduce radiation dose required to make piping change. All sumps are stainless steel lined for protection against corrosion and absorption of contaminated waste water.

All process piping is sloped for drainage and located within trenches, chases, cells and/or concrete buildings designed to provide shielding and secondary containment in the event of leaks and overflows. Indoor collection tanks, pumps, and major process components are located in individually shielded cubicles to isolate them from each other. This allows maintenance operations to be performed on individual components without personnel being exposed to radiation from other sources.

Process valves are located in shielded galleries to isolate them from pipe and operating galleries. Manual process valves which require frequent operation are provided with extension rods to permit remote operation from operating galleries. Where possible, valves from a single process train are segregated from valves in an adjacent train or valves from another system. This permits one process train to be isolated for maintenance while the other train or system operates without contributing to the exposure of maintenance personnel.

Floor drains within indoor tank cubicles are valved (normally closed) to contain fluid within the cubicles in the unlikely event of failure of a tank or component. All process tanks are vented directly to their own cubicles. This arrangement prevents the tanks from breathing to and from areas potentially visited by maintenance personnel.

The waste sample tanks are located outdoors on the north and west sides of the Old Radwaste Building. These tanks contain low specific activity processed waste and therefore do not require shielding.

A detailed description of the various subsystems follows:

a. High Purity Liquid Waste System

The High Purity Liquid Waste System consists of two identical process trains, each consisting of a collection tank, feed pump, dewatering filter, demineralizer, resin trap and sample tank. This system collects and processes chemically clean radwaste characterized by low mineral content and relatively high radioactivity level. The mineral content is indicated by its conductivity which is normally in the order of 10 micromho per cm. High purity liquid waste consists typically of controlled micromhos/cm discharges from equipment. It is normally processed to meet condensate specifications to permit recycle within the plant.

Drawing GE148F437is a process flow diagram depicting the principal inputs to and flow paths within the High Purity Waste System.

Table 11.2-3 lists isotopic concentrations for normal operation including anticipated operational occurrence and design conditions. These activities are based on long term average flow rates. The Old Radwaste Treatment Systems are designed to meet the release limitations of 10CFR20. The New Radwaste Systems are designed to result in release of radioactivity which are as low as reasonably achievable and within the guidelines of Appendix I to 10CFR50.

Various equipment drain tanks and sumps distributed within the plant collect low conductivity liquid radioactive waste. The waste from each collector is then transferred to the high purity waste collector tanks in the Radwaste Building(s). The High Purity Waste Collector Tank is located at El. 23'-6" of the New Radwaste Building. This tank may receive high purity (low conductivity) waste from the following sources:

1. Chemical Waste Distillate Sample Tanks
2. Waste Sample Tanks (High Purity)
3. Drywell Equipment Drain Tank
4. Reactor Building Equipment Drain Tank
5. Old Radwaste Building Equipment Drain Sump
6. Regeneration System Waste Tank (low conductivity compartment)
7. Spent Resin Tanks

Should this tank be unavailable to receive these wastes due to maintenance operations, the backup tank, the old Waste Collector Tank would be available to receive the same. Two position, three way valves are used for such waste diversion in order to prevent an operator from inadvertently shutting off flow to both tanks. This latter tank and its associated pump, are located at El. 23'-6" of the Old Radwaste Building. With the exception of input from the Spent Resin Tanks, all normal High Purity Waste System inputs can be diverted to this tank. This tank also receives fuel pool drains and Reactor Water Cleanup System waste which are not diverted to the High Purity Waste Collector Tank. In the event of unanticipated waste surges in the High Purity Waste Collector Tank, excess water can be diverted to the Waste Collector Tank.

The High Purity Waste Collector Tank has mixing jets located above the bottom to suspend any settled solids. The High Purity Waste Collector Tank is equipped with an internal spray system to wash down the tank walls.

Two High Purity Waste Pumps are provided to serve the following functions:

1. Recycle the contents of the collection tanks to mix the tank contents and suspend settled solids.

2. Pump wastes through the process train(s) to the Waste Sample Tanks.

3. Pump wastes back to the Chemical Waste Tanks.

High Purity Waste Pump "A" serves the High Purity Waste Collector Tank, while High Purity Waste Pump "B" serves the Waste Collector Tank (HP-T-1B).

Each High Purity Waste Pump is a conventional centrifugal pump. The construction of this type of pump minimizes the system down time due to pump maintenance.

Two 150 gpm (100% capacity each) process trains consisting of two high purity waste filters, two high purity waste demineralizers, two high purity waste resin traps, and associated piping, valves and instrumentation constitute the major components of this system. The High Purity Waste Pump(s) provide the motive force to transfer waste through the process train(s) to the waste sample tanks. For normal operations, only one filter is used to remove suspended solids from the process fluid. Effluent from the filter(s) is then deionized by the waste demineralizers. These demineralizers are normally series- connected to provide back up protection in the event the first bed in series experiences breakthrough. At the option of the operator, the process trains may be operated in parallel with each filter supplying one demineralizer. Resin traps consisting of cartridge type filters are placed downstream of each demineralizer to remove any resin fines and resin beads which are not contained by the resin retention elements. Waste sample tanks are provided to receive filtered demineralized waste from the process train(s). Two tanks are provided to have one tank available for filling while the contents of the adjacent tank are being recirculated and sampled prior to discharge. All wastes satisfying the standards for condensate makeup water will be discharged to the condensate pump suction header and ultimately to condensate storage, where it will be available for continued use in the plant.

At the 150 gpm process rate, a typical day's wastes can be processed in about three hours. At this flow rate, the maximum design basis waste input can be processed within one shift, if it is assumed that the filter system and sample tank turnaround functions are proper. Even if it is assumed that the operations get delayed due to the filter failure, the system has sufficient waste storage capability to accumulate wastes up to two shift periods.

b. Chemical Waste/Floor Drain System

This system collects and processes liquid radwaste of relatively high mineral content and/or suspended matter and varying levels of radioactivity. This system consists of either an evaporator-based or a demineralizer based process train which are fed from three collection tanks (See Drawing GE148F437). Typically, chemical wastes are solutions from Condensate Pre-Filter cleaning, Condensate Demineralizer Air Bump and Rinse Operations, floor drain wastes from area washdowns, overflows and controlled drainage are collected in floor drain sumps and are pumped to this system.

The normal specific activity of wastes processed through this system is expected to be lower than that of the high purity system due to typically lower waste input concentrations and higher process decontamination factors.

Drawing GE148F437 is a flow diagram depicting the principal inputs to, and flow paths within, the Chemical Waste/Floor Drain System. Table 11.2-4 lists isotopic concentrations in terms of specific activity for normal operation and for the design conditions. These activities are based on long term average flow rates.

The Chemical Waste/Floor Drain System receives and processes waste from the following sources:

1. Laboratory Drain Tank
2. Regeneration System Waste Tank (high conductivity compartment)
3. High Purity Waste System (high conductivity waste diverted to this system)
4. Turbine Building Floor Drain Sumps
5. Old Radwaste Building Floor Drain Sumps
6. Drywell Floor Drain Sump
7. Reactor Building Floor Drain Sumps
8. Radwaste Building Floor Drain Sumps
9. Chemical Waste Distillate Sample Tanks
10. Stack Equipment Drain Sump
11. Laundry Drain Tank

Wastes from these sources are pumped into the Chemical Waste/Floor Drain Tanks. Each tank is vented directly to its cubicle through a mesh type filter. Each tank is provided with an overflow which drains directly to the cubicle floor drain.

Generally, the liquid wastes may be collected and prepared for processing as described herein. Plant Operations may alter this as required based on either chemistry or

volumes of the liquid waste inventory. Liquid wastes may be collected in the "A" Chem Waste Collection Tank. From there it may be transferred to the "C" tank for addition of coagulating agent and settling. The supernatant in the "C" tank may be transferred to the "B" tank. From there it can be directed to the appropriate components for processing as described in the following paragraphs.

Regeneration chemicals (acid and caustic) are no longer used because resin is no longer regenerated. As such, neutralization and pH corrections are not required. The neutralization system was ripped out except for the old acid day tank. See the discussion in Section 11.2.2.2.r for further details. The pH probes in the Chem Waste/Floor Drain Collection Pump suction header were removed and replaced with on-line conductivity monitoring. In addition, the Radwaste Sample Sink was renovated and all abandoned equipment was removed. All plugged lines were replaced and a turbidity monitor was installed to provide sampling capability at all key points throughout the radwaste process. Installation of the conductivity and turbidity instrumentation will provide Radwaste Operations with the data required to make informed decisions regarding radwaste processing alternatives.

The Chemical Waste/Dewatering Filters are used to remove suspended solids from the process fluids being fed to the radwaste concentrators or demineralization system depending on chemistry of the liquid waste. Solids removed from the process stream are discharged to the Solid Radwaste System. The radwaste concentrators or ion exchangers are used to process pretreated wastes. Concentrated liquid from the concentrator (evaporator) or spent resin from the ion exchangers is discharged to the Solid Radwaste system. Low conductivity distillate discharged from the concentrators may be polished by the concentrator distillate demineralizers or transferred to the High Purity System for final polishing. Y-type strainers placed downstream of the demineralizers serve as resin traps to prevent resin beads, not contained by the demineralizer retention screens, from entering the chemical waste distillate sample tanks. The filters, evaporators and demineralizers can be bypassed, if needed. Demineralization of the liquid waste (in lieu of evaporation) is accomplished by the existing Concentrator Distillate Demineralizers operated in series.

A water level detection system is provided in each tank cubicle with remote monitoring in the NRW Building Control Room to alert the operator of an inadvertent overflow. Additionally, dome type strainers are installed in the floor drains to preclude blockage of the drains due to debris.

Torus water volume can be adjusted during normal operation so that the upper limit of torus volume does not exceed the Technical Specification limit, by draining the torus water to the radwaste system. Drain valves at the torus water cleanup connection are used under administrative control. This connection provides area accessibility, and an alternate isolation capability exists through containment spray pump suction valve. For a discussion on draining of the torus for maintenance, repair and modification activities, refer to Subsection 9.3.3.2.8.

11.2.2.2 System's Components

The following sections provide a description of the major components of the Liquid Radwaste Treatment System including the capacity, size, design conditions, design code, quality group and seismic category of each unit, wherever applicable. The collection and storage tanks within

the Liquid Radwaste Treatment System operate at atmospheric pressure. Filters, concentrators, spent resin tanks and mixed bed demineralizers are pressure vessels. The Old Liquid Radwaste Treatment System is designed to conventional power plant codes. The Radwaste Building, to the extent shown on Figure 11.2-1, is designed to Seismic Category I standards. This provides the assurance that postulated failures of components within the building will not result in releases of radioactivity in liquid form to the environment. Therefore, system components which are based inside the building are classified non-seismic. The Old Liquid Radioactive Waste Storage Tanks located outside the building were not designed to seismic Category I requirements since this criteria did not exist at the time of plant design. However, the Technical Specifications have placed an allowable curie limit on the contents of these tanks to minimize the level of radioactivity released to the environment following a Safe Shutdown Earthquake.

The sample tanks are located in a curbed area which is not large enough to contain a full tank volume. Technical Specifications, however, ensure that instantaneous release levels are not exceeded in the event of a tank rupture. Samples are taken prior to release of any such water to the discharge canal. Separate shielded rooms are provided for individual tanks and process equipment. Shield walls are penetrated by piping as necessary to connect the vessels to the pumps located in separate cubicles. Exposure to operating personnel is limited by locating piping within shielded areas or in shielded pipe runs.

a. Drywell Equipment Drain Tank (DWEDT) and Pumps

   The DWEDT is discussed in Section 9.3.

   The DWEDT cooling system consists of an external, plate-type, heat exchanger on the discharge of the existing DWEDT pumps.

   The DWEDT Cooling Loop is designed to process the fluid normally through the heat exchanger before recirculation and/or discharge to the radwaste systems in order to keep the heat transfer surfaces wetted as much as possible and thus minimize the amount of fouling deposited on them. The heat exchanger can be bypassed manually at the discretion of the operator such that the DWEDT contents are transferred directly to the radwaste system. This local lineup allows for short term maintenance on the heat exchanger.

   A throttling valve regulates, manually, the flow of the cool water recirculated to the DWEDT. Throttling this valve to split the flow evenly between the radwaste system and the DWEDT prevents pump runout. The heat exchanger is served by the Reactor Building Closed Cooling Water (RBCCW) system. A thermal relief valve is provided at the RBCCW outlet line to prevent overpressurization.

   The temperature of the DWEDT contents is indicated and high temperature alarm is annunciated in the new radwaste Control Room panel. The tank is equipped with duplex pumps. Pump suction strainers are located between three and six inches above the tank bottom. Liquid level switches are provided to start and stop the duty and standby pumps and annunciate high tank level.

   With the selector switch in the AUTO position, the duty pump is started by increasing tank level. If input to the tank is in excess of the pump-out capability of the duty, the standby pump is also started at a higher level. Both pumps are stopped as the level

decreases. The duty and standby assignments of the pumps are automatically altered by an auto-selecting device. When switched to OFF, both pumps are disabled. The drywell equipment drain tank discharge header has two air diaphragm operated isolation valves located just outside the drywell.

These valves are automatically closed by drywell high pressure, and by reactor low-low water level. They are spring loaded to fail closed on loss of air or electricity. Closing time is less than three seconds. The Drywell Equipment Drain Tank pumps are interlocked to trip when either of the isolation valves is closed. There is a flow integrator in the DWEDT discharge line for surveillance of equipment leaks within the drywell. Tank and pump data are listed in Table 11.2-5.

The new heat exchanger is designed to remove the heat resulting from 25 gpm of 212°F fluid being cooled to 170°F (approximately 525,000 Btu/hr) with an excess margin of approximately 225,000 Btu/hr. This will maintain the DEDT contents at a temperature well below the pump NPSH design limit of 200°F and will provide an allowance for the change in heat exchanger performance due to fouling of heat transfer surfaces. The heat exchanger is designed for a 70 gpm cooling flow.

The heat removed by the new external heat exchanger is rejected to the existing RBCCW system. The RBCCW is designed for a total heat duty of 116 x 10^6 Btu/hr. The maximum heat load on the RBCCW prior to this modification was 80 x 10^6 Btu/hr. The additional heat load contributed by this modification (less than 1 x 10^6 Btu/hr) will not degrade the present RBCCW system.

Table 11.2-27 provides the system limitations, set points, and precautions.

b. Reactor Building Equipment Drain Tank (RBEDT) and Pumps

The Reactor Building Equipment Drain Tank is provided with an internal cooling coil supplied with Reactor Building Closed Cooling Water. Cooling water flow is controlled remotely by a solenoid valve. Tank temperature is indicated and high temperature is annunciated both on the old radwaste Control Room panel and the new radwaste Control Room panel. Level switches are provided to start and stop the Reactor Building equipment drain tank pump. High tank level and pump starts are annunciated at the control panel. A local manual switch is provided at the pump. The RBEDT pumps and the DWEDT pumps share a common discharge line to the High Purity Waste Collector Tank. Tank and pump data are listed on Table 11.2-6.

c. Radwaste Equipment Drain Sump (REDS) and Pumps

The Radwaste Equipment Drain Sump is equipped with duplex pumps, arranged and controlled similar to those in the Drywell Equipment Drain Tank. REDS and pumps data are listed on Table 11.2-7.

d. High Purity Waste Collector Tanks (HPWCT) (HP-T-1A&B) and High Purity Waste Pumps (HPWP) (HP-P-1A&B)

Inputs to the High Purity Waste Collector Tanks are received from the drain tanks and sumps, and the reactor cleanup system.

HP-T-1A is fitted with internal cooling coils to limit the temperature of the tank contents to a maximum of 120°F. This protects the thermally sensitive anion resins in the high purity waste demineralizers from high temperature degradation. The cooling coils are not functional whenever the NRWCCW System is in a stand-by mode as described in Section 9.2.1.4.3. The tank is also fitted with internal mixing jets and spray nozzles. Instrumentation for both tanks includes continuous level readout and continuous temperature indication. Wastes are manually diverted to the recirculation mode upon receipt of a high temperature alarm. The 100% capacity high purity waste pumps provide the motive force to operate the process trains.

Only one pump is required to supply each 150 gpm train. The pumps serve each of the collector tanks, respectively. These pumps are used to recirculate the contents of each tank. The temporary construction strainer in the suction of HP-P-001A was removed following completion of preoperational and startup tests. The strainer in the suction of HP-P-001B has been re-installed following the relining of HP-T-001B to prevent foreign material and debris from this work from being introduced into the system. The high purity waste pumps can be aligned to either waste processing trains. The appropriate train is selected by opening the appropriate high purity waste filter inlet valve. The high purity waste pumps are manually controlled by remote switches located on the radwaste control panel. High Purity Waste Collector Tanks and pumps data are listed in Table 11.2-8.

e. Waste Surge Tank

The Waste Surge Tank (WST) which is located outdoors has been permanently abandoned. Blind flanges have been installed to isolate the WST from the Liquid Radwaste System.

The concrete pads, where the Waste and Concentrator Distillate Sample Tanks are located, are curbed to contain potential leakage and rainwater. The area under the sample tanks can be drained to either the Old Radwaste Building floor drain sump or the discharge canal. The normal drainage path is to the Old Radwaste Building Floor Drain Sump, however, if activity levels permit, discharge may be to the discharge canal.

f. High Purity Waste Filters (HPWF)

The High Purity Waste Filters use a dilute cellulose fiber/resin or diatomaceous earth precoat and bodyfeed slurry of powdered resin to effect removal of suspended solids. Removal efficiency is on the order of 95% for rigid 1 micron diameter particles and 99% for rigid 5 micron diameter particles. Solids accumulated on the filters are dewatered with air and discharged to the Solid Radwaste System on a batch-basis. The High Purity Waste Filter System consists of the following principal components and is located in the New Radwaste Building.

1. Filter assembly 2 of each
2. Precoat tank 1
3. Precoat pump 2 of each

4. Bodyfeed tank 1

5. Bodyfeed pump 2 of each

The filter vessels contain a nest assembly of vertically stacked horizontal filter leafs (elements) mounted on a hollow central shaft. Flow is introduced to the vessel shell, passes through the screened elements and exits through the hollow central shaft. To precoat the filter elements, a dilute resin/fiber or diatomaceous earth slurry is mixed in the precoat tank and recirculated through the filter. A turbidity meter is used to measure the clarity of the filtrate exiting the vessel. After a uniform precoat has formed wastes can be fed to the filter. High Purity Waste Filter data are listed in Table 11.2-10.

g. High Purity Waste Demineralizers (HPWD)

The High Purity Waste Demineralizers are provided to remove ionic impurities from the process stream and are located in the New Radwaste Building. The demineralizers are protected against short run life dueto high conductivity feed by divert valves and associated instrumentation located upstream of the filters and demineralizers. Should the conductivity of the feed stream exceed the set point of conductivity, flow is diverted to the Chemical Waste/Floor Drain System. Upon clearing, the flow path automatically returns to its normal pathway. The High Purity Waste Demineralizers are arranged in such a manner as to permit either series operation at 150 gpm or parallel operation at a total flow rate of 300 gpm (150 gpm each). Normal system operation is for series flow through the demineralizers. This permits the operator to run the lead demineralizer to exhaustion and still have the downstream demineralizer in good condition. Differential pressure indication is provided on the radwaste control panel for each demineralizer to allow the operator to determine if excessive pressure drop due to crud loading from filter deficiency or resin fines production is being experienced. Effluent conductivity is indicated and high conductivity alarmed on the radwaste control panel. Due to the inherent flexibility of the demineralizer system, it is also necessary to locate a conductivity element in the common demineralizer effluent line. These elements monitor and record the conductivity of the effluent from each train regardless of demineralizer lineup. High conductivity is alarmed and results in automatic closing of the inlet valve to the waste sample tanks and opening of the recycle valve to the collector tank. The operator must take the appropriate corrective action to remedy the poor quality effluent. When effluent quality improves and the alarm clears, the valves will return to their normal position.

High purity resins are new or partially exhausted condensate demineralizer resins that are slurried in the Condensate Demineralizer Regeneration System and transferred to the HPWDs. Therefore, the resin type, volume and mix ratios for both the Radwaste and Condensate Demineralizer Systems must be identical. The exhausted resins from this system are transferred to the Spent Resin Storage Tanks. Oyster Creek no longer regenerates resins.

The High Purity Waste Demineralizers have a header and lateral type underdrain system to retain the resin beads. The lateral retention screens will withstand full system differential pressure. Resin transfer, backwash, rinse and mixing operations are controlled by manual valves located in the valve gallery in the general vicinity of the demineralizers.

High Purity Waste Demineralizers data are listed in Table 11.2-11.

h. High Purity Waste Resin Traps (HPWRT)

The High Purity Waste Resin Traps located downstream of the high purity waste demineralizers, are design to retain resin fines and resin beads which break through the retention elements of the high purity waste demineralizers. These resin traps are actually cartridge type filters. Differential pressure across the filters is used to determine the need for a cartridge change. Pressure differential across each filter is indicated locally. Manual valving is provided to isolate any one resin trap to permit cartridge changeout without affecting normal system processing capability. High Purity Resin Trap data are listed in Table 11.2-12.

i. Waste Sample Tanks (WST) (HP-T-2A&B) and High Purity Waste Sample Pumps (HPWSP) (HP-P-2A&B)

The two Waste Sample Tanks are used to collect and hold processed waste for sampling prior to recycle within the plant and/or discharge to the environment. Each of the two tanks is sized to contain a full batch from the high purity waste collection tank, thus making one tank available for filling while the remaining tank is being recirculated, sampled and emptied. Processed waste not suitable for recycle to the plant or discharge to the environment can be directed to the high purity waste collection tank for reprocessing.

The High Purity Waste Sample Tanks are located outdoors adjacent to the old Radwaste Building. These tanks are provided with a heating system. Tank level is indicated and high and low level is alarmed on the radwaste control panel. The concrete pad, where the Waste Sample Tanks are located, is curbed to prevent potential leakage and accumulation of rainwater. This area is drained to either the ORW floor drain sump or to the discharge canal, depending on the activity level of the contained water.

Two High Purity Waste Sample Pumps (HP-P-2A&B) are located in the new pumphouse which adjoins the Waste Sample Tank and the Old Radwaste Building, and are provided to recirculate and transfer sample tank contents. The pump suctions are interconnected to enable one pump to substitute for the other in the event of a malfunction. The pumps can discharge the tank contents to the condensate pump suction header for recycle to the plant.

In order to prevent air or other non-condensable gas inleakge to the condenser, both pumps are interlocked to their corresponding tanks levels to trip on low level. Provisions are made to divert the discharge to the Chemical Waste/Floor Drain Collection tanks, if desired. These pumps are also used to provide backwash water for the fuel pool filter. These pumps are controlled by remote switches located on the radwaste control panel. With the remote switch in the "Local" position, the pumps can be controlled locally from the Old Radwaste Building. Pressure switch(es) in the pump suction line(s) are interlocked with the pump controls to prevent the pump(s) from running dry.

Flow elements are located in the recycle and overboard discharge lines. The flow rate (and duration) of all processed waste discharges to the environment is indicated and recorded. A radiation monitor in the discharge line is able to record the activity of all wastes discharged to the environment. A high radiation level alarm is provided to

annunciate and trip closed the discharge valve in the event of exceeding the alarm's set point. This air operated valve is also available to prevent unauthorized or inadvertent discharges to the environment from the High Purity Waste System, by locking the valve in the closed position. Waste Sample Tank and High Purity Waste Sample Pump data are listed in Table 11.2-13. If the monitor is not available, a sample procedure can be used to assure the release is within limits. The current configuration of the discharge path is as follows: the discharge piping downstream of the radiation monitors and valve V-22-803 is cut and blank flanged; the piping that bypasses the radiation monitors downstream of the valve V-22-804 is cut and blank flanged; the piping upstream of the overboard discharge isolation valve V-22-807 is also cut and flanged.

j. Drywell Floor Drain Sump (DFDS) and Pumps

The Drywell Floor Drain Sump is fitted with two submersible pumps. Liquid level switches are provided to start and stop the duty and standby pumps and annunciate high liquid level in the sump.

With the selector switch in the AUTO position, the duty pump is started by increasing sump level. If input to the sump is in excess of the pumpout capability of the duty pump, the standby pump is automatically started at a higher level. Both pumps are stopped as the level decreases. The duty and standby assignments of the pumps are automatically changed by an autoselecting device. When switch is to OFF, both pumps are disabled.

The DFDS pump discharge header has two air operated, containment isolation valves located just outside the drywell. These valves are automatically closed by drywell high pressure, and by reactor low-low water level. There is a flow integrator in the DFDS discharge line, for surveillance of unidentified leakage within the drywell. Drywell floor drain sump and pump data are listed in Table 11.2-14.

k. Reactor Building Floor Drain Sumps (RBFDS) and Pumps

Reactor Building Floor Drain Sumps 1-6 and 1-7 are interconnected by an 8 inch pipe, with the pumps mounted only on the 1-7 sump. The sump is fitted with one cover mounted pump and one submersible pump, arranged and controlled with high level instrumentation logic similar to that described for the DFDS. Reactor Building Floor Sumps and pump data are listed in Table 11.2-15.

l. Radwaste Floor Drain Sumps (RFDS) and Pumps

Floor Drain sump tops within the Old Radwaste Building are fitted with a grating to collect floor washdown in the area and with two submersible pumps, arranged and controlled with level instrumentation logic similar to that described for the DFDS. Radwaste Floor Drain Sumps and pump data are listed in Table 11.2-16.

Three floor drain sumps serve the New Radwaste Building. Each sump contains two pumps (one preferred and one standby) which start and stop by means of liquid level switches. New Radwaste Floor Drain Sumps and pump data are listed in Table 11.2-16.

m. Stack Equipment Drain Sump (SEDS) and Pumps

The Stack Equipment Drain Sump collects Offgas System delay line drains and one Boiler House floor drain. Offgas Building sump contents are also pumped into this sump. The sump is fitted with two submersible pumps arranged and controlled with level instrumentation logic similar to that described for the DFDS. Stack Equipment Drain Sumps and pump data are listed in Table 11.2-17.

n. Regeneration System Waste Tank (RSWT) and Pump

The Regeneration System Waste Tank is a two compartment receiver for liquid waste from Condensate Pre-Filter cleaning evolutions and condensate demineralizer ABRO solutions discharged during the resin backwash cycle. Both of these waste streams are directed to the Hi Conductivity Compartment of this tank.

Only the high conductivity compartment of this tank discharges to the Chemical Waste/Floor Drain System. The low conductivity compartment discharges to the High Purity Waste System. Instrumentation and pump control logic is similar to that described for the DFDS. Regeneration System Waste Tank and pump data are listed in Table 11.2-18.

o. Laboratory Drain Tank (LDT) and Pumps

Pump out of the Laboratory Drain Tank is remote-manual operation. High tank level is annunciated in the radwaste Control Room. Upon receiving such a high level signal, the pump is manually started. Low tank level automatically stops the pump. Laboratory Drain Tank and pump data are listed in Table 11.2-19.

p. Turbine Building Floor Drain Sumps and Pumps

Floor and equipment drains are collected in five sumps in the Turbine Building basement. Four are pumped to one of the Radwaste Chemical Waste/Floor Drain Collection Tanks (RWCW/FDCT). The other (1-5 sump) can be pumped either to the RWCW/FDCT or, as long as it is monitored, overboard to the canal through the 30" discharge header.

The sump pumps are 100 percent capacity pumps arranged for intermittent, alternate operation except for the sump 1-1 and 1-5 pumps which are controlled manually. Sump pumps are vertical, wet-pit type with integral steel cover plate and submersible type.

q. Augmented Offgas Building Floor Drain Sumps and Pumps

Two sumps serve the Augmented Offgas Building. One is located at elevation 23' - 6", and the second is located in the pipechase tunnel at elevation 17' - 6". Sump and pump data are listed in Table 11.2-28.

r. Chemical Waste/Floor Drain Collection Tanks and Pumps

Chemical wastes, floor drains and Radwaste Building equipment drains are collected locally within the receivers and sumps and discharged to the two header collection system which drains to the Chemical Waste/ Floor Drain Collection Tanks. As was previously described, chemical wastes and floor drains may be collected together or segregated at the option of the operator.

The original sparger system in the Chem Waste Collection Tanks never functioned as originally anticipated. They plugged rapidly after cleaning and proved to be completely ineffective. The spargers were removed from all three tanks, each was modified as follows:

- The "A" tank was left with just the recirculation line. While this does not provide optimum mixing, it is far better than the original condition of a plugged sparger. The motive force for mixing is provided by the Chem Waste Collection Pump.

- The "B" tank was fitted with a mechanical mixer. This mixer is the equivalent of a 16,000 gpm pump. It can recirculate one tank volume in less than one minute. Radiation levels at the bottom of the tank have reduced from approximately 1.2 REM to approximately 10 mRem, thus demonstrating the mixer's effectiveness.

- The "C" tank was fitted with a full flow eductor. The Chem Waste Collection Pump provides the motive force for mixing. Results of its effectiveness are not known at this writing.

  Two Chem Waste Collection Pumps are supplied to provide the motive force for mixing as described above and to feed the process trains. Each pump can be aligned for both suction and discharge to any of the three collection tanks.

The "C" tank was further modified as follows:

- It was fitted with an additional side suction line. This line, which is approximately two feet above the original suction line, will permit solids to settle out and be used to draw off the supernatant for processing. The cleaner supernatant will yield longer filter run times and thus significantly reduce the volume of wet waste generated.

- An air driven diaphragm pump will be used to transfer the sludge at the bottom of the collection tank, via the original suction and drain line, directly to the Batch Tank (SL-T-008) or to a high integrity container for dewatering and disposal.

- The neutralization system has been removed. Since resins are no longer regenerated, there is no need for pH corrections. The original acid day tank (NA-T-001) was changed to the Coagulant Addition Tank (WC-T-010). It will be used to add coagulating agents to the "C" tank via a dedicated drain line. The coagulating agent will enhance settling by causing the extremely fine particles to combine into larger, heavier particles which will settle out. The eductor installed in this tank will provide the necessary mixing for the coagulating agent.

  The chemical waste/floor drain pumps are manually controlled by remote switches located on the radwaste control panel.

  Data for the chemical waste/floor drain collection tanks and pumps are listed in Table 11.2-20.

s. <u>Chemical Waste/Dewatering Filters (CWDF)</u>

Refer to item f., "High Purity Waste Filters." With the exception of line sizes and equipment capacities, the High Purity Waste Filter System and Chemical Waste/Dewatering Filter System are identical. Chemical Waste/Dewatering Filters data is listed in Table 11.2-21.

t. Radwaste Concentrators

The two (2) Radwaste Concentrators are skid mounted submerged tube evaporator packages designed to degas and distill radioactive feed solutions consisting of treated chemical and floor drain wastes. Concentrated bottoms (liquor) accumulated during operation of the units are pumped out as a batch to the solid radwaste system. Subcooled distillate is continuously discharged during operation.

Each concentrator consists of the following principal components:

1. Feed preheater
2. Gas stripper
3. Evaporator
4. Absorption tower
5. Condenser
6. Distillate cooler
7. Vent condenser
8. Distillate pump
9. Concentrate pump

The concentrator functions in the following manner: Pretreated feed solutions are introduced to the unit through the steam heated feed preheater where the temperature of the feed is raised close to the saturation point. The near saturated feed is then degassed in the gas stripper by both mechanical detrainment and additional heating from a counter current process steam flow. Condensibles from this condenser are recycled back to the stripping column.

Degassed feed solutions are next introduced to the steam evaporator section. Process vapor and entrained moisture rising from the evaporator are separated and scrubbed within the absorption tower. Scrubbing, to remove semivolatiles is accomplished by passing the rising process stream through bubble trays flooded with process distillate. High quality vapor exiting the absorption tower is condensed in the evaporator condenser. Saturated distillate from the evaporator condenser is subcooled by the distillate cooler prior to being pumped, by the distillate pump, from the evaporator package to the concentrator distillate demineralizers. Concentrated waste within the evaporator is constantly recirculated and mixed with the feed solutions until the endpoint concentration is reached. At this point, concentrator operation is terminated and the

accumulated batch of concentrated waste is pumped to the solid radwaste system (Concentrated Liquid Waste Tanks).

The radwaste concentrator vent condenser releases are routed through a charcoal filter prior to mixing them with the exhaust ventilation system flow. The filter will remove noncondensible radioactive gases. The "prime" mover for the gas flow will be the concentrator vent condenser process pressure reinforced by the negative pressure created at the point of connection to the exhaust ventilation system. Low point drains are provided to remove condensate from the associated piping.

The evaporator concentrates pumps serve two 30 gpm Westinghouse skid mounted evaporators by recirculating/transferring concentrated solutions from the evaporator shell to the Concentrated Liquid Waste Storage Tanks. During normal operation, the evaporator concentrates pump operates in a continuous recirculation mode. Each pump is interlocked with its corresponding suction valve to enable pump operation only in the full open valve position. Radwaste concentrator and pump data are listed in Table 11.2-22.

u. Concentrator Distillate Demineralizers (CDD)

The Concentrator Distillate Demineralizers polish high purity distillate produced by the Radwaste Concentrators. They can also be used in series to purify the Chem Waste/Dewatering Filters outlet flow, and bypass the concentrators. Each demineralizer has a resin capacity of 30 cubic feet. Spent resins from these units are not regenerated, rather, they are sluiced to the Solid Radwaste System (Spent Resin Storage Tank). Fresh resins are manually loaded into the demineralizers through fill ports located in the floor slab at El. 48'-0".

Instrumentation for the demineralizers consists of differential pressure gauges between the influent and effluent lines to measure differential pressure across the beds and conductivity elements on the effluent line to measure product conductivity. A high conductivity alarm is provided to alert the operator of demineralizer breakthrough and allow him to take corrective action before contaminating a batch of processed waste. Concentrator distillate demineralizer data are listed in Table 11.2-23.

v. Chemical Waste Distillate Sample Tanks (CWDST) and Pump

The Chemical Waste Distillate Sample Tanks are used to collect and hold processed waste for sampling prior to recycle within the plant and/or discharge to the environment. The new Liquid Radwaste Treatment System utilizes the original Floor Drain Sample tanks for this purpose. Two tanks are provided so that one tank is available for filling while the remaining tank is being recirculated, sampled and emptied. Process waste, not suitable for recycle to the plant or discharge to the environment, can be directed to the high purity waste collection tank or a chemical waste/floor drain collection tank for reprocessing. Chemical waste distillate sample tank and pump data are listed in Table 11.2-24.

w. Contractor Supplied Portable Liquid Processing System

If liquid waste chemistry or volumes mandate, a contractor supplied portable liquid processing system can be used to treat liquid radwaste streams in lieu of evaporation or

existing demineralizers. All appropriate design bases and criteria will be established if this processing alternative is necessary.

X. Portable Drum Evaporators

Portable drum evaporators are approved for use in selected areas of the plant for evaporation of water with low isotopic concentration. These units are operated in accordance with approved site procedures.

11.2.3 Radioactive Liquid Releases

11.2.3.1 Normal Operation Releases

The sources of radioactive wastes that are to be released are as follows:

a. High Purity Waste

b. Chemical Waste/Floor Drain

The design basis for the normal sources of the High Purity Waste System are 8600 gpd from the Drywell Equipment Drain Tank, 1000 gpd from the Reactor Building Equipment Drain Tank, 3500 gpd from Radwaste Building Equipment Drain Sump, and 8000 gpd from the Turbine Building Equipment Drains and Regeneration Station. For the Chemical Waste/Floor Drain System the sources are 1400 gpd from the Drywell Floor Drain Sump, 1000 gpd from the Radwaste Building Floor Drain Sump, 1500 gpd from the Turbine Building Floor Drain Sump, 1400 gpd from the Stack Equipment Drain Sump, 200 gpd from the Laboratory Drain Tank, and 3000 gpd from the Regeneration System. These values along with maximum daily inputs (design basis) for High Purity Waste and Chemical Waste/Floor Drain Systems are presented in Tables 11.2-1 and 11.2-2, respectively.

The estimated radioisotopic releases from the High Purity Waste and Chemical Waste/Floor Drain Systems are listed in Table 11.2-25. The design total annual release under normal operating conditions was 2.20 curies. This estimated figure was based on the assumption that during normal operating conditions the discharge from the High Purity Waste System is 10% of the total waste processed by this system as most of the liquid will be recycled for continued use in the plant. The discharge from the Chemical Waste/Floor Drain System is conservatively assumed to be 100% of the distillate processed by the system. Even though the isotopic concentrations indicated in Table 11.2-25 are below the maximum permissible concentrations in water for an unrestricted area Appendix B, Table II, of 10CFR20), Oyster Creek operating policy is "zero release overboard."

11.2.3.2 Release Points

The release route of the radioactive liquid waste generated in the Liquid Radioactive Waste Processing System is shown in Drawing GE148F437. Liquid processed for recycle and/or discharge from High Purity Waste System ultimately accumulates in the High Purity Waste Sampling Tanks. Each of the two tanks are sized to contain a full batch from the High Purity Waste Collection Tank, thus making one tank available for filling while the remaining tank is being recirculated, sampled and emptied.

Liquid processed for discharge from Chemical Waste/Floor Drain System ultimately accumulates in the Chemical Waste Distillate Sample Tanks. Processed liquid waste suitable for discharge to the environment is routed to a monitored release point which is the termination point of the service water piping of the intake canal.

11.2.3.3 Dilution Factor

Dilution of liquid wastes released to the environment is accomplished by introducing these wastes to the Service Water System Discharge. Wastes being discharged are sampled and analyzed per chemistry procedure which establishes the maximum overboard discharge rate to be in accordance with the Offsite Dose Calculation Manual (ODCM). This flow is diluted by the normal Circulating Water System flow of approximately 460,000 gpm. This apparent dilution must be corrected by a recirculation factor of 3.76 to account for recirculation of Barnegat Bay water into the canal. No credit is assumed for additional dilution provided by the thermal dilution pumps installed in the canal.

11.2.3.4 Estimated Doses

Critical pathway exposures to individuals have been calculated for effluent discharges from the New Liquid Radwaste System at Oyster Creek. Expected annual isotopic releases from the radwaste facility are presented in Table 11.2-25. The isotopes other than the noble gases are concentrated in marine organisms and result in a source of exposure to man from the ingestion of seafood. Calculations show that this is the most critical pathway. Maximum doses to an individual from the liquid releases are presented in Table 11.2-26.

TABLE 11.2-1
(Sheet 1 of 1)

HIGH PURITY LIQUID WASTE SYSTEM DESIGN BASIS –
NORMAL AND MAXIMUM DAILY INPUTS FROM PRINCIPAL SOURCES

Source	Volume, gpd	
	Normal	Maximum
1. Drywell Equipment Drain Tank	8600	36,000
2. Reactor Building Equipment Drain Tank	1000	NC*
3. Radwaste Building Equipment Drain Sump	3500	NC*
4. Resin Regeneration System - Low Conductivity	8000	92,400
Total	21,100*	105,500**

* NC: Not critical to total volume

** Maximum inputs do not occur simultaneously, this value is the sum of normal values for items 1 through 3 and maximum value for item 4.

TABLE 11.2-2
(Sheet 1 of 1)

CHEMICAL WASTE/FLOOR DRAIN SYSTEM DESIGN BASIS –
NORMAL AND MAXIMUM DAILY INPUTS FROM PRINCIPAL SOURCES

	Volume, gpd	
Source	Normal	Maximum
1. Drywell Floor Drain Sump	1400	2250
	--	
	--	
2. Reactor Building Floor Drain Sumps	NC*	2000
3. Radwaste Building Floor Drain Sump	1000	-
4. Turbine Building Floor Drain Sump	1500	2000
5. Stack Equipment Drain Sump	1400	10
6. Laboratory Drains	200	
7. Regeneration System	3000	31600
Totals	8500**	37860**

* NC: Not critical to total volume
** Maximum inputs do not occur simultaneously, this value is the sum of normal values for items 1 through 6 and maximum value for item 7.

TABLE 11.2-3
(Sheet 1 of 3)

HIGH PURITY WASTE SYSTEM SOURCE TERMS

		DESIGN Isotopic Concentration (0Ci/ml)					NORMAL OPERATION Isotopic Concentration (0Ci/ml)				
NODE POINT		1	2	3	4	5	1	2	3	4	5
FLOW (gpm)		27.8	150.	150.	150.	2.78	27.8	150.	150.	150.	2.78
Isotope	Half-Life										
N-13	9.96 min.	7.40(-3)	9.85(-5)	9.85(-5)	9.88(-8)	1.79(-35)	7.40(-3)	9.85(-5)	9.85(-5)	9.88(-8)	1.79(-35)
F-18	1.83 hr.	8.00(-4)	1.17(-4)	1.l7(-4)	1.17(-7)	2.56(-10)	8.00(-4)	1.17(-4)	1.17(-4)	1.17(-7)	2.56(-10)
Br-83	2.41 hr.	1.09(-2)	2.10(-3)	2.10(-3)	2.10(-6)	1.99(-8)	1.09(-3)	2.10(-4)	2.10(-4)	2.10(-7)	1.99(-9)
Br-84	31.8 min.	2.08(-2)	8.84(-4)	8.84(-4)	8.86(-7)	9.15(-16)	2.08(-3)	8.84(-5)	8.84(-5)	8.86(-8)	9.35(-17)
Br-85	3.00 min.	1.35(-2)	5.42(-5)	5.42(-5)	5.44(-8)	0.0	1.35(-3)	5.42(-6)	5.42(-6)	5.44(-9)	0.0
Kr-83m	1.86 hr.		2.07(-3)	2.07(-3)	2.07(-6)	2.28(-8)		2.07(-4)	2.07(-4)	2.07(-7)	2.28(-9)
Kr-85	10.7 yr.		4.78(-9)	4.78(-9)	4.80(-12)	2.58(-13)		4.78(-10)	4.78(-10)	4.80(-13)	2.58(-14)
Kr-85m	4.4 hr		5.10(-5)	5.10(-5)	5.11(-8)	2.75(-9)		5.10(-6)	5.10(-6)	5.11(-9)	2.75(-10)
Sr-89	50.0 d.	2.13(-3)	2.12(-3)	2.12(-3)	2.12(-6)	2.10(-6)	2.13(-4)	2.12(-4)	2.12(-4)	2.12(-7)	2.10(-7)
Sr-90	28.0 yr.	1.61(-4)	1.62(-4)	1.62(-4)	1.63(-7)	1.67(-7)	1.61(-5)	1.62(-5)	1.62(-5)	1.63(-8)	1.67(-8)
Sr-91	9.70 hr.	4.99(-2)	3.93(-2)	3.93(-2)	3.95(-5)	1.72(-5)	4.99(-3)	3.93(-3)	3.93(-3)	3.95(-6)	1.72(-6)
Sr-92	2.60 hr.	8.32(-2)	1.72(-2)	1.72(-2)	1.72(-5)	2.28(-7)	8.32(-3)	1.72(-3)	1.72(-3)	1.72(-6)	2.28(-8)
Y-90	64.0 hr.		1.50(-5)	1.50(-5)	1.50(-8)	4.29(-8)		1.50(-6)	1.50(-6)	1.50(-9)	4.29(-9)
Y-91	59.0 d.		1.93(-4)	1.93(-4)	1.94(-7)	4.58(-7)		1.93(-5)	1.93(-5)	1.94(-8)	4.58(-8)
Y-91m	50.0 min.		2.71(-2)	2.17(-2)	2.72(-5)	1.34(-5)		2.71(-3)	2.17(-3)	2.72(-6)	1.34(-6)
Y-92	3.53 hr.		1.58(-2)	1.58(-2)	1.59(-5)	1.99(-6)		1.58(-3)	1.58(-3)	1.59(-6)	1.99(-7)
Zr-95	64.0 d.	2.76(-5)	2.75(-5)	2.75(-6)	2.75(-6)	1.04(-6)	2.76(-6)	2.75(-6)	2.75(-7)	2.75(-7)	1.04(-7)
Zr-97	17.0 hr.	2.29(-5)	2.27(-6)	2.27(-7)	2.27(-7)	1.04(-11)	2.29(-6)	2.27(-7)	2.27(-8)	2.27(-8)	1.04(-12)
Nb-95	35.2 d.	2.86(-5)	2.87(-6)	2.87(-6)	2.87(-6)	1.10(-6)	2.86(-6)	2.87(-6)	2.87(-7)	2.87(-7)	1.10(-7)
Mo-99	67.0 hr.	1.56(-2)	1.43(-2)	1.43(-3)	1.43(-3)	4.64(-4)	1.56(-3)	1.43(-3)	1.43(-4)	1.43(-4)	4.64(-5)
Tc-99m	6.0 hr.	2.08(-1)	9.29(-2)	9.29(-2)	9.36(-5)	5.16(-4)	2.08(-2)	9.29(-3)	9.29(-3)	9.36(-6)	5.16(-5)
Tc-101	14.0 min.	1.09(-1)	2.04(-3)	2.02(-3)	2.03(-6)	2.44(-26)	1.09(-2)	2.04(-4)	2.02(-4)	2.03(-7)	2.44(-27)
Ru-103	40.0 d.	1.35(-5)	1.35(-5)	1.35(-6)	1.35(-6)	5.12(-7)	1.35(-6)	1.35(-6)	1.35(-7)	1.35(-7)	5.12(-8)
Ru-106	1.0 yr.	1.82(-6)	1.82(-6)	1.82(-7)	1.82(-7)	6.99(-8)	1.82(-7)	1.82(-7)	1.82(-8)	1.82(-8)	6.99(-9)
Te-129m	33.0 d.	2.76(-5)	2.73(-5)	2.73(-5)	2.74(-8)	2.70(-8)	2.76(-6)	2.73(-6)	2.73(-6)	2.74(-9)	2.70(-9)

TABLE 11.2-3
(Sheet 2 of 3)

HIGH PURITY WASTE SYSTEM SOURCE TERMS

		DESIGN Isotopic Concentration (0Ci/ml)					NORMAL OPERATION Isotopic Concentration (0Ci/ml)				
NODE POINT		1	2	3	4	5	1	2	3	4	5
FLOW (gpm)		27.8	150.	150.	150.	2.78	27.8	150.	150.	150.	2.78
Isotope	Half-Life										
Te-129	1.14 hr.		1.58(-5)	1.58(-5)	1.59(-8)	1.72(-8)		1.58(-6)	1.58(-6)	1.59(-9)	1.72(-9)
Te-132	3.25 d.	3.38(-2)	3.12(-2)	3.12(-2)	3.13(-5)	2.70(-5)	3.38(-3)	3.12(-3)	3.12(-3)	3.13(-6)	2.70(-6)
I-129	1.57×10^{7} yr.		1.16(-8)	1.16(-8)	1.17(-11)	4.12(-11)		1.16(-9)	1.16(-9)	1.17(-12)	4.12(-12)
I-131	8.06 d.	9.36(-3)	9.07(-3)	9.07(-3)	9.10(-6)	8.55(-6)	9.36(-4)	9.07(-4)	9.07(-4)	9.10(-7)	8.55(-7)
I-132	2.30 hr.	8.84(-2)	4.20(-2)	4.20(-2)	4.22(-5)	2.79(-5)	8.84(-3)	4.20(-3)	4.20(-3)	4.22(-6)	2.79(-6)
I-133	20.8 hr.	6.24(-2)	4.70(-2)	4.70(-2)	4.27(-5)	2.76(-5)	6.24(-3)	4.70(-3)	4.70(-3)	4.72(-6)	2.75(-6)
I-134	53.0 min.	1.82(-1)	1.29(-2)	1.29(-2)	1.29(-5)	4.58(-11)	1.82(-2)	1.29(-3)	1.29(-3)	1.29(-6)	4.58(-12)
I-135	6.88 hr.	9.36(-2)	4.25(-2)	4.25(-2)	4.26(-5)	7.87(-5)	9.36(-3)	4.25(-3)	4.25(-3)	4.26(-6)	7.87(-7)
Xe-133	5.30 d	2.40(-3)	2.40(-3)	2.40(-6)	8.61(-6)		2.40(-4)	2.40(-4)	2.40(-7)	8.61(-7)	
Xe-133m	1.66 d.		1.30(-4)	1.30(-4)	1.30(-7)	4.15(-7)		1.30(-5)	1.30(-5)	1.30(-8)	4.15(-8)
Xe-135	9.16 hr.		2.35(-2)	2.35(-2)	2.36(-5)	2.72(-5)		2.35(-3)	2.35(-3)	2.36(-6)	2.72(-6)
Xe-135m	16.0 min.		1.14(-2)	1.14(-2)	1.14(-5)	1.19(-7)		1.14(-3)	1.14(-3)	1.14(-6)	1.19(-8)
Cs-134	2.20 yr.	1.09(-4)	1.09(-4)	1.09(-4)	1.10(-7)	1.09(-7)	1.09(-5)	1.09(-5)	1.09(-5)	1.10(-8)	1.09(-8)
Cs-135	3×10^{6} yr.		1.86(-5)	1.86(-5)	1.87(-8)	6.33(-6)		1.86(-6)	1.86(-6)	1.87(-9)	6.33(-7)
Cs-136	13.0 d.	7.28(-5)	7.14(-5)	7.14(-5)	7.16(-8)	6.88(-8)	7.28(-6)	7.14(-6)	7.14(-6)	7.16(-9)	6.88(-9)
Cs-137	29.9 yr.	1.25(-4)	1.25(-4)	1.25(-4)	1.25(-7)	1.34(-7)	1.25(-5)	1.25(-5)	1.25(-5)	1.25(-8)	1.34(-8)
Cs-138	32.0 min.	1.51(-1)	6.45(-3)	6.45(-3)	6.47(-6)	7.74(-15)	1.51(-2)	6.45(-4)	6.45(-4)	6.47(-6)	7.74(-15)
Ba-137m	2.55 min.		1.16(-4)	1.16(-4)	1.17(-7)	1.25(-7)		1.16(-5)	1.16(-5)	1.17(-8)	1.25(-8)
Ba-139	85.0 min.	1.25(-1)	1.42(-2)	1.42(-2)	1.42(-5)	5.34(-9)	1.25(-2)	1.42(-3)	1.42(-3)	1.42(-6)	5.34(-10)
Ba-140	13.0 d.	6.24(-3)	6.12(-3)	6.12(-3)	6.14(-6)	5.90(-6)	6.24(-4)	6.12(-4)	6.12(-4)	6.14(-7)	5.90(-7)
Ba-141	18.0 min.	1.40(-1)	3.38(-3)	3.38(-3)	3.39(-6)	8.41(-22)	1.40(-2)	3.38(-4)	3.38(-4)	3.39(-7)	8.41(-23)
Ba-142	11.0 min.	1.35(-1)	1.99(-3)	1.99(-3)	1.99(-6)	1.30(-31)	1.35(-2)	1.99(-4)	1.99(-4)	1.99(-7)	1.30(-32)
Ce-141	33.0 d.	2.76(-5)	6.36(-5)	6.36(-6)	6.36(-6)	2.42(-6)	2.76(-6)	6.36(-6)	6.36(-7)	6.36(-7)	2.42(-7)
Ce-143	33.0 hr.	2.44(-5)	2.04(-5)	2.04(-6)	2.04(-6)	5.59(-7)	2.44(-6)	2.04(-6)	2.04(-7)	2.04(-7)	5.59(-8)
Ce-144	284. d.	2.44(-5)	2.45(-5)	2.45(-6)	2.45(-6)	9.41(-7)	2.44(-6)	2.45(-6)	2.45(-7)	2.45(-7)	9.41-(8)

TABLE 11.2-3
(Sheet 3 of 3)

HIGH PURITY WASTE SYSTEM SOURCE TERMS

		DESIGN Isotopic Concentration (ûCi/ml)					NORMAL OPERATION Isotopic Concentrations (ûCi/ml)				
NODE POINT		1	2	3	4	5	1	2	3	4	5
FLOW (gpm)		27.8	150.	150.	150.	2.78	27.8	150.	150.	150.	2.78
Isotope	Half-Life										
La-140	40.0 hr.		8.67(-4)	8.70(-4)	8.70(-7)	2.13(-6)		8.67(-5)	8.70(-5)	8.70(-8)	2.13(-7)
La-141	3.8 hr.		3.24(-3)	3.24(-3)	3.25(-6)	1.82(-7)		3.24(-4)	3.24(-4)	3.25(-7)	1.82(-8)
La-142	92.5 min.		1.99(-3)	1.99(-3)	1.99(-6)	1.54(-9)		1.99(-4)	1.99(-4)	1.99(-7)	1.54(-10)
Pr-143	13.6 d.	2.65(-5)	2.66(-5)	2.66(-6)	2.66(-6)	1.02(-6)	2.65(-6)	2.66(-6)	2.66(-7)	2.66(-7)	1.02(-7)
Pr-144	17.3 min.		2.39(-5)	2.39(-6)	2.39(-6)	9.41(-7)		2.39(-6)	2.39(-7)	2.39(-7)	9.41(-8)
Nd-147	11.1 d.	9.88(-6)	9.68(-6)	9.68(-7)	9.68(-7)	3.73(-6)	9.88(-7)	9.68(-7)	9.68(-8)	9.68(-8)	3.73(-7)
Np-239	2.33 d.	6.60(-2)	5.92(-2)	5.92(-2)	5.94(-5)	4.93(-5)	6.60(-2)	5.92(-2)	5.92(-2)	5.94(-5)	4.83(-5)
Na-24	15.0 hr.	4.00(-4)	2.72(-4)	2.72(-4)	2.72(-7)	1.28(-7)	4.00(-4)	2.72(-4)	2.72(-4)	2.72(-7)	1.28(-7)
P-32	14.3 d.	4.00(-6)	3.93(-6)	3.93(-6)	3.94(-9)	3.91(-9)	4.00(-6)	3.93(-6)	3.93(-6)	3.94(-9)	3.81(-9)
Cr-51	27.0 d.	1.00(-4)	9.93(-5)	9.93(-5)	9.93(-6)	3.76(-6)	1.00(-4)	9.93(-5)	9.93(-6)	9.93(-6)	3.76(-6)
Mn-54	310. d.	8.000(-6)	8.01(-6)	8.01(-7)	8.01(-7)	3.08(-7)	8.00(-6)	8.01(-6)	8.01(-7)	8.01(-7)	3.08(-7)
Mn-56	2.59 hr.	1.00(-2)	2.06(-3)	2.06(-4)	2.06(-4)	1.04(-6)	1.00(-2)	2.06(-3)	2.06(-4)	2.06(-4)	1.04(-6)
Co-58	70.0 d .	1.00(-3)	9.99(-4)	9.99(-5)	9.99(-5)	3.82(-5)	1.00(-3)	9.99(-4)	9.99(-5)	9.99(-5)	3.82(-5)
Co-60	5.21 yr.	1.00(-4)	1.00(-4)	1.00(-5)	1.00(-5)	3.86(-6)	1.00(-4)	1.00(-4)	1.00(-5)	1.00(-5)	3.86(-6)
Fe-59	45.0 d.	1.60(-5)	1.59(-5)	1.59(-6)	1.59(-6)	6.08(-7)	1.60(-5)	1.59(-5)	1.59(-6)	1.59(-6)	6.08(-7)
Ni-65	2.56 hr.	6.00(-5)	1.22(-5)	1.22(-6)	1.22(-6)	5.86(-9)	6.00(-5)	1.22(-5)	1.22(-6)	1.22(-6)	5.86(-9)
Zn-65	229. d.	4.00(-7)	4.00(-7)	4.00(-7)	4.01(-10)	3.99(-10)	4.00(-7)	4.00(-7)	4.00(-7)	4.01(-10)	3.99(-10)
Zn-69m	14.0 hr.	6.00(-6)	3.97(-6)	3.97(-6)	3.98(-9)	1.77(-9)	6.00(-6)	3.97(-6)	3.97(-6)	3.98(-8)	1.77(-8)
Ag-110m	270. d.	1.20(-5)	1.20(-5)	1.20(-6)	1.20(-6)	4.63(-7)	1.20(-5)	1.20(-5)	1.20(-6)	1.20(-6)	4.63(-7)
W-187	1.00 d.	6.00(-4)	4.70(-4)	4.69(-5)	4.69(-5)	1.12(-5)	6.00(-4)	4.70(4)	4.69(-5)	4.69(-5)	1.12(-5)

TABLE 11.2-4
(Sheet 1 of 3)

CHEMICAL WASTE/FLOOR DRAIN SYSTEM SOURCE TERMS

		DESIGN Isotopic Concentration (ûCi/ml)						NORMAL OPERATION Isotopic Concentrations (ûCi/ml)					
NODE POINT		1	2	3	4	5	6	1	2	3	4	5	6
FLOW (gpm)		10.4	30.	30.	30.	30.	10.4	10.4	30.	30.	30.	30.	10.4
Isotope	Half-Life												
N-13	9.16 min.	1.11(-2)	1.11(-4)	1.11(-4)	1.11(-8)	1.11(-10)	1.70(-45)	1.11(-2)	1.11(-4)	1.11(-4)	1.11(-8)	1.11(-10)	1.70(-45)
F-18	1.83 hr.	1.20(-3)	1.32(-4)	1.32(-4)	1.32(-7)	1.32(-9)	5.05(-13)	1.20(-3)	1.32(-4)	1.32(-4)	1.32(-7)	1.32(-9)	5.05(-13)
Br-83	2.41 hr.	1.64(-2)	2.37(-3)	2.37(-3)	2.37(-6)	2.37(-8)	5.87(-11)	1.64(-3)	2.37(-4)	2.37(-3)	2.37(-7)	2.37(-9)	5.87(-12)
Br-84	31.8 min.	3.12(-2)	9.93(-4)	9.93(-4)	9.93(-7)	9.93(-9)	4.56(-20)	3.12(-3)	9.93(-5)	9.93(-5)	9.93(-8)	9.93(-10)	4.56(-21)
Br-85	3.00 min.	2.03(-2)	6.09(-5)	6.09(-5)	6.09(-8)	6.09(-10)	0.0	2.03(-3)	6.09(-6)	6.09(-6)	6.09(-9)	6.09(-11)	0.0
Kr-83m	1.86 hr.	2.36(-3)	2.36(-3)	2.36(-6)	2.36(-8)	1.24(-9)	2.36(-4)	2.36(-4)	2.36(-7)	2.36(-9)	1.24(-10)		
Kr-85	10.7 yr.	7.97(-9)	7.97(-9)	7.97(-12)	7.97(-14)	1.07(-11)		7.97(-10)	7.97(-10)	7.97(-13)	7.97(-15)	1.07(-12)	
Kr-85m	4.4 hr		5.95(-5)	5.95(-5)	5.95(-8)	5.95(-10)	2.17(-9)		5.95(-6)	5.95(-6)	5.95(-9)	5.95(-11)	2.17(-10)
Sr-89	50.0 d.	3.20(-3)	3.18(-3)	3.18(-3)	3.18(-7)	3.18(-9)	3.14(-9)	3.20(-4)	3.18(-4)	3.18(-4)	3.18(-8)	3.18(-10)	3.14(-10)
Sr-90	28.0 yr.	2.42(-4)	2.42(-4)	2.42(-4)	2.42(-8)	2.42(-10)	2.45(-10)	2.42(-5)	2.42(-5)	2.42(-5)	2.42(-9)	2.42(-11)	2.45(-11)
Sr-91	9.70 hr.	7.49(-2)	5.01(-2)	5.01(-2)	5.01(-6)	5.01(-8)	1.55(-8)	7.49(-3)	5.01(-3)	5.01(-3)	5.01(-7)	5.01(-9)	1.55(-9)
Sr-92	2.60 hr.	1.25(-1)	1.95(-2)	1.95(-2)	1.95(-6)	1.95(-8)	7.43(-11)	1.25(-2)	1.95(-3)	1.95(-3)	1.95(-7)	1.95(-9)	7.43(-12)
Y-90	64.0 hr.		3.03(-5)	3.03(-5)	3.03(-9)	3.03(-11)	7.51(-11)		3.03(-6)	3.03(-6)	3.03(-10)	3.03(-12)	7.51(-12)
Y-91	59.0 d.		3.53(-4)	3.53(-4)	3.53(-8)	3.53(-10)	7.34(-10)		3.53(-5)	3.53(-5)	3.53(-9)	3.53(-11)	7.34(-11)
Y-91m	50.0 min.		3.51(-2)	3.51(-2)	3.51(-6)	5.05(-8)	1.21(-8)		3.51(-3)	3.51(-3)	3.51(-7)	5.05(-9)	1.21(-9)
Y-92	3.53 hr.		1.89(-2)	1.89(-2)	1.89(-6)	1.89(-8)	9.86(-10)		1.89(-3)	1.89(-3)	1.89(-7)	1.89(-9)	9.86(-11)
Zr-95	64.0 d.	4.13(-5)	4.12(-5)	4.12(-6)	4.12(-10)	4.12(-10)	4.09(-10)	4.13(-6)	4.12(-7)	4.12(-7)	4.12(-11)	4.12(-11)	4.09(-11)
Zr-97	17.0 hr.	3.43(-5)	2.55(-6)	2.55(-7)	2.55(-11)	2.55(-11)	2.46(-16)	3.43(-6)	2.55(-8)	2.55(-8)	2.55(-12)	2.55(-12)	2.46(-17)
Nb-95	35.2 d.	4.29(-5)	4.30(-5)	4.30(-6)	4.30(-10)	4.30(-10)	4.29(-10)	4.29(-6)	4.30(-7)	4.30(-7)	4.30(-11)	4.30(-11)	4.29(-11)
Mo-99	67.0 hr.	2.34(-2)	2.08(-2)	2.08(-3)	2.08(-7)	2.08(-7)	1.67(-7)	2.34(-3)	2.08(-4)	2.08(-4)	2.08(-8)	2.08(-8)	1.67(-8)
Tc-99m	6.0 hr.	3.12(-1)	1.14(-1)	1.14(-1)	1.14(-5)	1.14(-7)	1.16(-7)	3.12(-2)	1.14(-2)	1.14(-2)	1.14(-6)	1.14(-8)	1.16(-8)
Tc-101	14.0 min.	1.64(-1)	2.30(-3)	2.30(-3)	2.30(-7)	2.30(-9)	2.23(-34)	1.64(-2)	2.30(-4)	2.30(-4)	2.30(-8)	2.30(-10)	2.23(-35)
Ru-103	40.0 d.	2.03(-5)	2.02(-5)	2.02(-6)	2.02(-10)	2.02(-10)	1.99(-10)	2.03(-6)	2.02(-7)	2.02(-7)	2.02(-11)	2.02(-11)	1.99(-11)
Ru-106	1.0 yr.	2.73(-6)	2.73(-6)	2.73(-7)	2.73(-11)	2.74(-11)	2.73(-11)	2.73(-7)	2.73(-7)	2.73(-8)	2.73(-12)	2.74(-12)	2.73(-12)
Te-129m	33.0 d.	4.13(-5)	4.09(-5)	4.09(-5)	4.09(-9)	4.09(-11)	4.02(-11)	4.13(-6)	4.09(-6)	4.09(-6)	4.09(-10)	4.09(-12)	4.02(-12)

TABLE 11.2-4
(Sheet 2 of 3)

CHEMICAL WASTE/FLOOR DRAIN SYSTEM SOURCE TERMS

		DESIGN Isotopic Concentration (ûCi/ml)						NORMAL OPERATION Isotopic Concentrations (ûCi/ml)					
NODE POINT		1	2	3	4	5	6	1	2	3	4	5	6
FLOW (gpm)		10.4	30.	30.	30.	30.	10.4	10.4	30.	30.	30.	30.	10.4
Isotope	Half-Life												
Te-129	1.14 hr.		2.42(-5)	2.42(-5)	2.42(-9)	2.42(-11)	2.56(-11)		2.42(-6)	2.42(-6)	2.42(-10)	2.42(-12)	2.56(-12)
Te-132	3.25 d.	5.07(-2)	4.57(-2)	4.57(-2)	4.57(-6)	4.57(-8)	3.78(-8)	5.07(-3)	4.57(-3)	4.57(-3)	4.57(-7)	4.57(-9)	3.78(-9)
I-129	$1.57x10^7$yr.	2.46(-8)	2.46(-8)	2.46(-11)	2.46(-13)	2.91(-13)		2.46(-9)	2.46(-9)	2.46(-12)	2.46(-14)	2.91(-14)	
I-131	8.10 d.	1.40(-2)	1.35(-2)	1.35(-2)	1.35(-5)	1.35(-7)	1.25(-7)	1.40(-3)	1.35(-3)	1.35(-3)	1.35(-6)	1.35(-8)	1.25(-8)
I-132	2.30 hr.	1.33(-1)	5.81(-2)	5.81(-2)	5.81(-5)	5.81(-7)	4.00(-8)	1.33(-2)	5.81(-3)	5.81(-3)	5.81(-6)	5.81(-8)	4.00(-9)
I-133	20.8 hr.	9.36(-2)	6.46(-2)	6.46(-2)	6.46(-5)	6.46(-7)	3.21(-7)	9.36(-3)	6.46(-3)	6.46(-3)	6.46(-6)	6.46(-8)	3.21(-8)
I-134	53.0 min.	2.73(-1)	1.45(-2)	1.45(-2)	1.45(-5)	1.45(-7)	1.70(-14)	2.73(-2)	1.45(-3)	1.45(-3)	1.45(-6)	1.45(-8)	1.70(-15)
I-135	6.88 hr.	1.40(-1)	5.18(-2)	5.18(-2)	5.18(-5)	5.18(-7)	5.84(-8)	1.40(-2)	5.18(-3)	5.18(-3)	5.18(-6)	5.18(-8)	5.84(-9)
Xe-133	5.30 d.		4.47(-3)	4.47(-3)	4.47(-6)	4.47(-8)	4.05(-6)		4.47(-4)	4.47(-4)	4.47(-7)	4.47(-9)	4.05(-7)
Xe-133m	1.66 d.		2.38(-4)	2.38(-4)	2.38(-7)	2.38(-9)	1.85(-7)		2.38(-5)	2.38(-5)	2.38(-8)	2.38(-10)	1.85(-8)
Xe-135	9.10 hr.		3.51(-2)	3.51(-2)	3.51(-5)	3.51(-7)	7.24(-6)		3.51(-3)	3.51(-3)	3.51(-6)	3.51(-8)	7.24(-7)
Xe-135m	16.0 min.		1.39(-2)	1.39(-2)	1.39(-5)	1.39(-7)	1.64(-8)		1.39(-3)	1.39(-3)	1.39(-6)	1.39(-8)	1.64(-9)
Cs-134	2.20 yr.	1.64(-4)	1.64(-4)	1.64(-4)	1.64(-8)	1.64(-10)	1.64(-10)	1.64(-5)	1.64(-5)	1.64(-5)	1.64(-9)	1.64(-11)	1.64(-11)
Cs-135	$3x10^6$ yr.		4.05(-5)	4.05(-5)	4.05(-9)	4.05(-11)	1.47)-7)		4.05(-6)	4.05(-6)	4.05(-10)	4.05(-12)	1.47(-8)
Cs-136	13.0 d.	1.09(-4)	1.06(-4)	1.06(-4)	1.06(-8)	1.06(-10)	1.01(-10)	1.09(-5)	1.06(-5)	1.06(-5)	1.06(-9)	1.06(-11)	1.01(-11)
Cs-137	29.9 yr.	1.87(-1)	1.87(-4)	1.87(-4)	1.87(-8)	1.87(-10)	1.89(-10)	1.87(-5)	1.87(-5)	1.87(-5)	1.87(-9)	1.87(-11)	1.89(-11)
Cs-138	32.0 min.	2.26(-1)	7.25(-3)	7.25(-3)	7.25(-7)	7.25(-9)	3.90(-20)	2.26(-2)	7.25(-4)	7.25(-4)	7.25(-8)	7.25(-10)	3.90(-21)
Ba-137m	2.55 min.		1.76(-4)	1.76(-4)	1.76(-8)	1.76(-10)	1.77(-10)		1.76(-5)	1.76(-5)	1.76(-9)	1.76(-11)	1.77(-11)
Ba-139	85.0 min.	1.87(-1)	1.59(-2)	1.59(-2)	1.59(-6)	1.59(-8)	6.59(-13)	1.87(-2)	1.59(-3)	1.59(-3)	1.59(-7)	1.59(-9)	6.59(-14)
Ba-140	13.0 d.	9.36(-3)	9.11(-3)	9.11(-3)	9.11(-7)	9.11(-9)	8.69(-9)	9.36(-4)	9.11(-4)	9.11(-4)	9.11(-8)	9.11(-10)	8.69(-10)
Ba-141	18.0 min.	2.11(-1)	3.80(-3)	3.80(-3)	3.80(-7)	3.80(-9)	9.18(-29)	2.11(-2)	3.80(-4)	3.80(-4)	3.80(-8)	3.80(-10)	9.18(-30)
Ba-142	11.0 min	2.03(-1)	2.23(-3)	2.23(-3)	2.23(-7)	2.23(-9)	5.51(-41)	2.03(-2)	2.23(-4)	2.23(-4)	2.23(-8)	2.23(-10)	5.51(-42)
Ce-141	33.0 d	4.13(-5)	1.01(-4)	1.01(-5)	1.01(-9)	1.01(-9)	1.01(-9)	4.13(-6)	1.01(-5)	1.01(-5)	1.01(-10)	1.01(-10)	1.01(-10)
Ce-143	33.0 hr.	3.67(-5)	2.89(-5)	2.89(-6)	2.89(-10)	2.89(-10)	1.89(-10)	3.67(-6)	2.89(-6)	2.89(-6)	2.89(-11)	2.89(-11)	1.89(-11)
Ce-144	284. d.	3.67(-5)	3.67(-5)	3.67(-6)	3.67(-10)	3.67(-10)	3.66(-10)	3.67(-6)	3.67(-6)	3.67(-6)	3.67(-11)	3.67(-11)	3.66(-11)

TABLE 11.2-4
(Sheet 3 of 3)

CHEMICAL WASTE/FLOOR DRAIN SYSTEM SOURCE TERMS

		DESIGN Isotopic Concentration (ûCi/ml)						NORMAL OPERATION Isotopic Concentrations (ûCi/ml)					
NODE POINT		1	2	3	4	5	6	1	2	3	4	5	6
FLOW (gpm)		10.4	30.	30.	30.	30.	10.4	10.4	30.	30.	30.	30.	10.4
Isotope	Half-Life												
La-140	40.0 hr.		1.67(-3)	1.67(-3)	1.67(-7)	1.67(-9)	3.89(-9)		1.67(-4)	1.67(-4)	1.67(-8)	1.67(-10)	3.89(-10)
La-141	3.8 hr.		3.74(-3)	3.74(-3)	3.74(-7)	3.74(-9)	8.85(-11)		3.74(-4)	3.74(-4)	3.74(-8)	3.74(-10)	8.85(-12)
La-142	92.5 min.		2.23(-3)	2.23(-3)	2.23(-7)	2.23(-9)	2.22(-13)		2.23(-4)	2.23(-4)	2.23(-8)	2.23(-10)	2.22(-14)
Pr-143	13.6 d.	3.98(-5)	3.99(-5)	3.99(-6)	3.99(-10)	3.93(-10)	3.38(-10)	3.98(-6)	3.99(-6)	3.99(-7)	3.99(-11)	3.39(-11)	3.38(-11)
Pr-144	17.3 min.		3.61(-5)	3.61(-6)	3.61(-10)	3.61(-10)	3.66(-10)		3.61(-6)	3.61(-7)	3.61(-11)	3.61(-11)	3.66(-11)
Nd-147	11.1 d.	1.48(-5)	1.44(-5)	1.44(-6)	1.44(-10)	1.44(-10)	1.36(-10)	1.48(-6)	1.44(-6)	1.44(-7)	1.44(-11)	1.44(-11)	1.36(-11)
Np-239	2.33 d.	9.90(-2)	8.56(-2)	8.56(-2)	8.56(-6)	8.56(-8)	6.58(-8)	9.90(-2)	8.56(-2)	8.56(-2)	8.56(-6)	8.56(-8)	6.58(-8)
Na-24	15.0 hr.	6.00(-4)	3.62(-4)	3.64(-4)	3.64(-8)	3.62(-10)	1.36(-10)	6.00(-4)	3.62(-4)	3.62(-4)	3.64(-8)	3.62(-10)	1.36(-10)
P-32	14.3 d.	6.00(-6)	5.86(-6)	5.86(-6)	5.86(-10)	5.86(-21)	5.61(-12)	6.00(-6)	5.86(-6)	5.86(-6)	5.86(-10)	5.86(-12)	5.61(-12)
Cr-51	27.0 d.	1.50(-4)	1.48(-4)	1.48(-5)	1.48(-9)	1.49(-9)	1.45(-9)	1.50(-4)	1.48(-4)	1.48(-5)	1.48(-9)	1.49(-9)	1.45(-9)
Mn-54.	310. d.	1.20(-5)	1.20(-5)	1.20(-6)	1.20(-10)	1.20(-10)	1.20(-10)	1.20(-5)	1.20(-5)	1.20(-6)	1.20(-10)	1.20(-10)	1.20(-10)
Mn-56	2.59 hr.	1.50(-2)	2.34(-3)	2.34(-4)	2.34(-8)	2.34(-8)	8.73(-11)	1.50(-2)	2.34(-3)	2.34(-4)	2.34(-8)	2.34(-8)	8.73(-11)
Co-58	70.0 d.	1.50(-3)	1.50(-3)	1.50(-4)	1.50(-8)	1.50(-8)	1.48(-8)	1.50(-3)	1.50(-3)	1.50(-4)	1.50(-8)	1.50(-8)	1.48(-8)
Co-60	5.21 yr.	1.50(-4)	1.50(-4)	1.50(-5)	1.50(-9)	1.50(-9)	1.50(-9)	1.50(-4)	1.50(-4)	1.50(-5)	1.50(-9)	1.50(-9)	1.50(-9)
Fe-59	45.0 d.	2.40(-5)	2.39(-5)	2.39(-6)	2.39(-10)	2.39(-10)	2.36(-10)	2.40(-5)	2.39(-5)	2.39(-6)	2.39(-10)	2.39(-10)	2.36(-10)
Ni-65	2.56 hr.	9.00(-5)	1.39(-5)	1.39(-6)	1.39(-10)	1.39(-10)	4.86(-13)	9.00(-5)	1.39(-5)	1.39(-6)	1.39(-10)	1.39(-10)	4.86(-13)
Zn-65	229. d.	6.00(-7)	5.99(-7)	5.99(-7)	5.99(-11)	5.99(-13)	5.98(-13)	6.00(-7)	5.99(-7)	5.99(-7)	5.99(-11)	5.99(-13)	5.98(-13)
Zn-69m	14.0 hr.	9.00(-6)	5.26(-6)	5.26(-6)	5.26(-10)	5.26(-12)	1.85(-12)	9.00(-6)	5.26(-6)	5.26(-6)	5.26(-10)	5.26(-12)	1.85(-12)
Ag-110m	270. d.	1.80(-5)	1.80(-5)	1.80(-6)	1.80(-10)	1.80(-10)	1.80(-10)	1.80(-5)	1.80(-5)	1.80(-6)	1.80(-10)	1.80(-10)	1.80(-10)
W-127	1.00 d.	9.00(-4)	6.51(-4)	6.51(-5)	6.51(-9)	6.51(-9)	3.53(-9)	9.00(-4)	6.51(-4)	6.51(-5)	6.51(-9)	6.51(-9)	3.53(-9)

TABLE 11.2-5
(Sheet 1 of 1)

DRYWELL EQUIPMENT DRAIN TANK AND PUMPS

Tank	
Internal Size	4 ft 6 in. diameter, 5 ft 6 in deep
Connections	Inlet, overflow, drain
Overflow	Allows 3 in freeboard
Material	AISI 304 or 316 Stainless Steel
External Pressure Requirement	API 650, APP. J.
Pumps	
Number of Pumps	2
Pump Capacity	50 gpm each
Total Developed Head	85 ft.
Submergence from DEDT bottom	2.25 ft.
Pump Type	Duplex, vertical, centrifugal
Water Temperature, maximum	120°F - 140°F
Material	
Casing	Cast iron, ASTM A48
Impeller	Cast iron, ASTM A48/Bronze
Shaft	Steel
Coupling	Rigid, flanged, keyed
Packing	Graphited asbestos/Mechanical Seal

TABLE 11.2-6
(Sheet 1 of 1)

REACTOR BUILDING EQUIPMENT DRAIN TANK (RBEDT) AND PUMP

Tank	
Volume	5000 gal.
Size	Horizontal, 8 ft. OD, 15 ft.
Material	Carbon Steel, 0.025 in. corrosion allowance
Code	API 650, APP. J.
Design Conditions	0 psig, 150°F
Connections	One 20 in. manhole
	Two 6 in. inlets
	Two 4 in. inlets
	One 4 in. vent
	One 4 in. overflow
	One 2 in outlet
	One 4 in. flanged instrument
	One ¾ in. instrument
Pumps	
Number of RBEDT Pumps	1
Pump Capacity	50 gpm.
Total Developed Head	75 ft.
Suction Pressure	1 to 9 ft.
Pump Type	Horizontal, centrifugal
Seal	Packed
Material	
Casing	Steel
Impellller	Bronze
Shaft	Steel
Bearings	Antifriction, oil lubrication with constant level oilers
Couplings	Falk Steelflex, or Thomas Duty 4.

TABLE 11.2-7
(Sheet 1 of 1)

RADWASTE EQUIPMENT DRAIN SUMP (REDS) AND PUMPS
NEW SUBMERSIBLE PUMPS

Sump	
Internal Size	4 ft by 4 ft, 3.8 ft deep
Material	Stainless Steel lined
Pumps	
Number of REDS Pumps	2
REDS Pump Capacity	225 gpm at 60 ft. per FLYGT curve
Total Developed Head	60 ft
Submergence from REDS bottom	4 to 6 in.
Strainer Elevation	4 to 6 in. from tank bottom
Pump Type	Vertical, centrifugal
Water Temperature, maximum	120°F
Material	
Casing	Cast aluminum
Impeller	Chrome alloyed cast iron
Shaft	Stainless Steel

TABLE 11.2-8
(Sheet 1 of 1)

HIGH PURITY LIQUID WASTE SYSTEM TANKS

High Purity Waste Collector Tank

Location	New Radwaste Building
Volume	34,375 Gallons
Size	
Overall Height	19 ft. 10 in.
Outside Diameter	19 ft.
Wall Thickness	1/4"
Top	Conical
Bottom	Flat, sloped
Material	304 Stainless Steel
Code	API-650, App. J
Design Condition	
Pressure	Atmospheric
Temperature	150°F

Waste Collector Tank

Location	Old Radwaste Building
Volume	30,000 Gallons
Size	Vertical, 17-ft. OD, 23-ft. deep
Wall Thickness	1/4 in.
Top	Open
Bottom	Cove
Material	Carbon steel with internal lining of Devoe 167 primer and Devoe 184 epoxy coating.
Code	API-650, App. J
Design Condition	0 psig, 150°F
Connections	One 4 in. flanged outlet One 6 in. flanged overflow Two 2 in. flanged instruments

TABLE 11.2-9
(Sheet 1 of 1)

WASTE SURGE TANK (WST)*

Tank

Volume	100,000 gallons
Size	Vertical, 30 ft. OD, 20 ft. Deep 1/4" wall thickness
Top	Cove
Bottom	Flat
Location	Outdoors
Material	
Plates	5020 Aluminum H-32
Structural	6061-T-6 Aluminum
Code	API 650, App. J
Design Condition	0 psig, 150°F
Connections	One 4 in. outlet One 8 in. overflow One 4 in. drain One 6 in. vent One 6 in. inlet One 4 in. inlet One 4 in. inlet One 4 in. mixing nozzle (recycle) One 2 in. instrument (level) Two 20 in. manholes

* Tank has been abandoned in place.

TABLE 11.2-10
(Sheet 1 of 1)

HIGH PURITY WASTE FILTERS

Filter Vessel	
Design Conditions	
Pressure	200 psi
Temperature	150°F
Code	ASME VIII, Div. 1
Flow Rate	150 gpm
Materials	Stainless Steel
Precoat System	
Precoat tank	
Code	API-650
Pressure	Atmos.
Volume	420 gal.
Materials	Stainless Steel
Precoat Pump	
Type	Centrifugal
Materials	Stainless Steel
Capacity	150 gpm
Body Feed System	
Body Feed Tank	
Code	API-650, App. J
Pressure	Atmos.
Volume	230 gallons
Materials	Stainless Steel
Body Feed Pump	
Type	Metering
Materials	Stainless Steel
Capacity	80 gph

TABLE 11.2-11
(Sheet 1 of 1)

HIGH PURITY WASTE DEMINERALIZERS

Design Code	ASME Section VIII, Div. 1
Number Installed	2
Demineralizer Type	Mixed bed with approximately 3 ft. minimum depth
Shell Size	6 ft. 6-in. OD, 7 ft. High, 9/16 in. wall thickness
Design Conditions	200 psig, 150°F
Materials	
Shell	Carbon Steel
Internal Surfaces	Lined with 3/16 in. thick natural latex rubber
Support Screens and Hardware	Stainless Steel, Type 304
Resin Volume	Approximately 150 cubic feet
Resin	New or partially expended resin from the Condensate Demineralizers
Flow Rate	150 gpm, maximum, 5 gpm per square foot of resin bed crosssection
Operating Temperature	90°F - 120°F
Influent Quality	1-300 uS/cm
Effluent Quality	1.0 uS/cm maximum

TABLE 11.2-12
(Sheet 1 of 1)

HIGH PURITY WASTE RESIN TRAPS

Design Flow Rate:	150 gpm
Filter Rating at % Efficient:	25 Microns at 98%
Cartridge Type:	Depth
Process Inlet and Outlet Nozzle:	3" Sch 10S
Code:	Manufacturer's Standards
Materials:	
Castings	ASTM A351 GR CF8
Forgings	forged stainless steel
Plates	ASTM SA240 Type 304
Piping	seamless stainless steel
G-Rings	Ethylene Propylene

TABLE 11.2-13
(Sheet 1 of 1)

WASTE SAMPLE TANKS (WST) AND HIGH
PURITY WASTE SAMPLE PUMPS (HPWSP)

Tanks	
Number of Tanks	2
Volume	30,000 Gallons
Size	17 ft. OD, 18 ft. deep vertical 3/16" wall thickness
Top	Cove
Bottom	Flat
Location	Outdoors
Material	
Plates	5052 Aluminum H-32
Structural	6061-T-6 Aluminum
Code	API 650
Design Conditions	0 psig, 150°F
Connections	One 4 in. outlet
	One 6 in. overflow
	One 2 in. drain
	One 4 in. vent
	One 4 in. inlet
	One 4 in. mixing nozzle
(recycle)	
	One 2 in. instrument (level)
	Two 20 in. manhole
Pumps	
Number	Two
Capacity	300 gpm
TDH	120 ft. of H_2O Gould
Type	Chempump conventional frame-mounted centrifugal
Operating Temperature	42-120°F
Operating Pressure	120-150 ft. H_2O
Eductor Inlet Criteria	300 gpm @ 50 ft. H_2O
(Sample Tank Recirculation)	
Condensate Recovery	150-200 gpm (HP-FCV-013)
Overboard Discharge	150-200 (HP-FCV-012)
"Of-Spec" Recycle	200 gpm-max. (RO-622)
Casing Design Pressure	75 psig
Design Temperature	150°F

TABLE 11.2-14)
(Sheet 1 of 1)

DRYWELL FLOOR DRAIN SUMP (DFDS) AND PUMPS

Sump Internal Size	4 ft 6 in. x 2 ft 6 in x 4 ft. 6 in. deep
Sump Material	Steel-lined concrete with Lithcoat Surface
Number of DFDS Pumps	2
DFDS Pump Capacity	50 gpm Minimum
Pump Type	Submersible, centrifugal

TABLE 11.2-15
(Sheet 1 of 1)

REACTOR BUILDING FLOOR DRAIN SUMPS
(RBFDS AND PUMPS

Number of Sumps	Two (with interconnections
Sump Internal Size	4 ft. x 4 ft 6 in. deep
Sump Material	Steel-lined concrete with Lithcoat Surface
Number of Pumps	Two (mounted on 1-7 sump)
Pump Type	Vertical, Centrifugal
Pump Capacity	100 gpm each
Total Developed Head	95 feet
Submergence from Sump Bottom	2.25 ft
Strainer Elevation from Sump Bottom	3 to 6 in.
Water Temperature, Maximum	100°F
Pump Material	
Casing	Cast iron, ASTM A48
Impeller	Cast iron, ASTM A48
Shaft	Steel
Coupling	Rigid, flanged, keyed
Packing	Graphited asbestos
Total Developed Head	Two are 100 feet One is 90 feet
Submergence from TBFDS Bottom	2.25 feet
Strainer Elevation from TBFDS Bottom	3 to 6 in.
Pump Type	Submersible, centrifugal
Water Temperature Maximum	120°F, 100°F, 90°F, respectively
Pump Material	
Casing	Cast aluminum,
Impeller	Chrome alloyed cast iron
Shaft	Stainless Steel
O-Rings	Nitrile Rubber

TABLE 11.2-16
(Sheet 1 of 2)

OLD RADWASTE FLOOR DRAIN SUMPS AND PUMPS
(NEW SUBMERSIBLE PUMPS)

Number of Sumps	Two (not interconnected)
Sumps Internal Sizes	6 ft. x 3 ft. x 4 ft. deep 3 ft x 3 ft x 4 ft deep
Sump Material	Steel-lined concrete with Lithcoat surface
Number of Pumps	Four (two on each sump)
Pump Capacity	275 gpm and 225 fpm respectively*
Total Developed Head	35 ft. and 55 ft. respectively
Submergence from Sump bottom	4 to 6 inches
Strainer Elevation from Sump bottom	4 to 6 inches
Pump Type	Vertical, centrifugal
Water Temperature, maximum	100°F
Pump Material	
Casing	Aluminum
Impeller	Chrome alloyed cast iron
Shaft	Stainless Steel

* Used TDH of 35 ft. & 55 ft. and referred to pump curve for gpm.

TABLE 11.2-16
(Sheet 2 of 2)

NEW RADWASTE FLOOR DRAIN SUMPS AND PUMPS

Number of Sumps	Three (not interconnected)
Sumps Internal Sizes	4 ft x 4 ft x 4.5 ft deep
	4 ft x 4 ft x 4.75 ft deep
Sump Material	Stainless steel liner
Number of Pumps	Six (two in each sump)
Pump Capacity	50 gpm @ TDH
Total Head Developed	100 ft.
Submergence from Sump bottom	6 inches

TABLE 11.2-17
(Sheet 1 of 1)

STACK EQUIPMENT DRAIN SUMP (SEDS)

Pumps	
Manufacturer and Type	FLYGT Submersible Pumps
TDH	80 ft.
Capacity	175 gpm at 80 ft per FLYGT curve
Motors	
Manufacturer and Type	FLYGT Corporation
Horsepower	6
Full-Load Current	7.7 amp
Power Requirements	460 volts, 3 phase
Power Source	MCC 1A24, 1B24

TABLE 11.2-18
(Sheet 1 of 2)

REGENERATION SYSTEM TANKS AND PUMPS

Waste Tank	
Type	Two-compartment cubicle, 4 ft. by 8 ft. by 4 ft. high, closed top with gooseneck vent for each compartment
Material	Carbon-steel plate, ASTM A283, Grade C
Lining	3/16 in. natural latex rubber vulcanized in place
Waste Transfer Pumps	
Manufacturer and Type	Deming Division, Crane Co., size 3 x 2 - 9 1/2 Unit A-60 end suction, center-line discharge, open impeller, centrifugal
Fluid Handled	
Pumps 1-1, 1-2	5% sulfuric acid solution up to 140°F.
Pumps 1-3, 1-4	5% caustic solution up to 100°F
TDH	60 ft.
Capacity	200 gpm
Bhp at Design Point	516
Shutoff Head	80 ft.
Materials, Pumps 1-1 and 1-2	
Liquid-end parts, stuffing-box sleeve	Alloy 20 stainless steel
Frame and base	Cast iron
Shaft	Stainless steel, AISI 304
Packing	Braided white asbestos impregnated with 35% virgin teflon
Materials, Pumps 1-3 and 1-4	
Frame and base	Cast iron
Packing	Braided white asbestos impregnated with 35% virgin teflon
Bearings	Ball

TABLE 11.2-18
(Sheet 2 of 2)

REGENERATION SYSTEM TANKS AND PUMPS

Pump Motor	
Manufacturer and Type	General Electric, open drip- proof, Class B insulation, continuous duty, 65% temperature rise, NEMA Design B
Horsepower	7.5
Speed	1750 rpm
Full-Load Current	
Locked-Rotor Current	
Service Factor	1.15

TABLE 11.2-19
(Sheet 1 of 1)

LABORATORY DRAIN TANK (LDT) AND PUMP

Tank	
Volume	400 Gal., below overflow with 6 in. freeboard
Size	Vertical, open top, 4 ft.. OD, 5 ft. high
Material	Stainless steel, AISI 304 or 316
Code	API 650, APP. J
Pumps	
Number of LDT Pumps	1
Pump Type	Horizontal, centrifugal
Pump Material	AISI 304 or 316
Chemical Temperature, maximum	150°F
Submergence	Elevation 26 ft. in tank; with pump at elevation 23 ft. 6 in.
Coupling	Flexible, Thomas Type
Seal	Packed with split gland, or water injection

TABLE 11.2-20
(Sheet 1 of 1)

CHEMICAL WASTE/FLOOR DRAIN COLLECTION TANKS AND PUMPS

Chemical Waste/Floor Drain Collection Tanks	
Number of tanks	3
Volume	14,000 gallons
Size	12'-6" diameter x 18'-6" high
Top	Conical
Bottom	Flat, sloped
Tank Material	Alloy 20
Code	API 650, App. J
Design Conditions	
Pressure	Atmospheric
Temperature	120°F max.
Chemical Waste/Floor Drain Pumps	
Number	Two (2) WC-P-1A, 1B
Capacity	200 gpm
TDH	350 ft.
Type	Centrifugal
Design Temperature	150°F
Design Pressure	200 psig (casing)
Materials of Construction	
Casing	Stainless Steel
Impeller	Stainless Steel Type 316
Shaft	Stainless Steel

TABLE 11.2-21
(Sheet 1 of 1)

CHEMICAL WASTE/DEWATERING FILTERS

Filter Vessel	
Design Conditions	
Pressure	200 psig
Temperature	150°F
Code	ASME VIII, Div. 1
Flow Rate	60 gpm
Materials	Stainless Steel
Precoat System	
Precoat Tank	
Code	API-650
Pressure	Atmos.
Volume	200 gallons
Materials	Stainless Steel
Precoat Pump	
Type	Centrifugal
Materials	Stainless Steel
Body Feed System	
Body Feed Tank	
Code	API-650
Pressure	Atmos.
Volume	120 gallons
Materials	Stainless Steel
Body Feed Pump	
Type	Metering
Materials	Stainless Steel
Capacity	23 gph

TABLE 11.2-22
(Sheet 1 of 2)

RADWASTE CONCENTRATORS

Feed Preheater	
Type	Shell and U-Tube
Design Conditions	Shell (steam) side/tube (process) side
Pressure	65/178 psig
Temperature	350/300°F
Code	ASME III, Class 3 – design ASME VIII, Div. 1 – stamp
Materials	Carbon steel/titanium
Gas Stripper	
Type	Counter current flow/packed column
Design Conditions	
Pressure	15 psig
Temperature	300°F
Code	ASME III, Class 3 – design ASME VIII, Div. 1 – stamp
Materials	Incoloy 825 shell with stainless internals
Evaporator	
Type	Shell and tube
Design Conditions	Shell (process) side/tube (steam) side
Pressure	15/65 psig
Temperature	300/350°F
Code	ASME III, Class 3 - design;ASME VIII, Div. 1 – stamp
Materials	Incoloy 825 shell with Incoloy 825 tube bundles
Absorption Tower	
Type	Reflux/demister
Design Conditions	
Pressure	15 psig
Temperature	300°F
Code	ASME III, Class 3 – design ASME VIII, Div. 1 – stamp
Materials	Incoloy 825 shell, stainless steel internals

TABLE 11.2-22
(Sheet 2 of 2)

RADWASTE CONCENTRATORS

Condenser	
Type	Shell and U-tube
Design Conditions	Shell (process) side/tube (cooling water) side
Pressure	15/200 psig
Temperature	300/200°F.
Code	ASME III, Class 3 – design ASME VIII, Div. 1 – stamp
Materials	Stainless steel/carbon steel with stainless tubes
Distillate Cooler	
Type	Shell and U-tube
Design Conditions	Shell (cooling water) side/tube (process) side
Pressure	200/125 psig
Temperature	200/300°F.
Code	ASME III, Class 3 – design ASME VIII, Div. 1 – stamp
Materials	Carbon steel/stainless steel
Vent Condenser	
Type	Shell and U-tube
Design Conditions (shell/tube)	
Pressure	15/200 psig
Temperature	300/200°F
Code	ASME III, Class 3 – design ASME VIII, Div. 1 – stamp
Materials	Stainless steel/carbon steel with stainless tubes
Distillate Pump	
Characteristics	36 gpm @ 200 ft. TDH
Design Conditions	
Temperature	220°F
Pressure	150 psig
Materials	Stainless steel
Concentrate Pump	
Design Conditions	
Pressure	75 psig
Temperature	250°F
Capacity	50 gpm @ 77 ft. THD
Material	Alloy – 20

TABLE 11.2-22
(Sheet 3 of 3)

DELETED

TABLE 11.2-23
(Sheet 1 of 1)

CONCENTRATOR DISTILLATE DEMINERALIZERS

Design Code	ASME Section VIII, Div. 1
Number Installed	2
Demineralizer Type	Mixed bed with approximately 3 ft minimum depth
Shell Size	3 ft. 6 in. OD, 6 ft. 11 1/2 in. high, 1/4 in. wall thickness
Design Conditions	150 psig, 300°F
Materials	
Shell	Carbon Steel
Internal Surfaces	Lined with 3/16 in. thick natural latex rubber
Support Screens and Hardware	Stainless Steel, Type 304
Resin Volume	Approximately 30 cubic feet
Resin Grade	Commercial Grade
Flow Rate	30 gpm, maximum 5 gpm per square foot
Operating Temperature	90°F – 120°F

TABLE 11.2-24
(Sheet 1 of 1)

CHEMICAL WASTE DISTILLATE SAMPLE TANKS AND PUMPS

Tanks	
Number	2
Volume	10,000 gal.
Size	11 ft. OD
Top	Conical
Bottom	Flat
Location	Outside
Material	Carbon Steel, lined
Code	API-650, App. J
Design Conditions	ATM. 150°F
Pumps	
Number	Two (2) WC-P-2A, 2B
Capacity	200 gpm
TDH	120 ft. of H_2O
Type	Gould
Design Temperature	150°F
Design Pressure	75 psig (casing)
Rated Speed	3500 rpm
Materials of Construction	
Casing	Stainless Steel
Impeller	Stainless Steel
Shaft	Stainless Steel

TABLE 11.2-25
(Sheet 1 of 3)

EXPECTED ANNUAL LIQUID RELEASES BY NUCLIDE (ûCi)

SYSTEM		Normal Operation Annual Isotopic Release microcuries		
		High Purity Waste	Chem Waste/ Floor Drains	Total
Isotope	Half-Life			
N-13	9.96 min.	9.90(-26)	3.53(-35)	9.90(-26)
F-18	1.83 hr.	1.42(+0)	1.05(-2)	1.42(+0)
Br-83	2.41 hr.	1.10(+1)	1.22(-1)	1.11(+1)
Br-84	31.8 min.	5.17(-7)	9.46(-11)	5.17(-7)
Br-85	3.00 min	0.0	0.0	0.0
Kr-83m	1.86 hr.	3.27(+3)	2.57(-1)	3.27(+3)
Kr-85	10.7 yr.	3.89(+0)	2.22(-3)	3.89(+0)
Kr-85m	4.4 hr.	2.18(+3)	4.50(-1)	2.18(+3)
Sr-89	50.0 d.	1.16(+3)	6.51(+0)	1.17(+3)
Sr-90	28.0 yr.	9.23(+1)	5.08(-1)	9.28(+1)
Sr-91	9.70 hr.	9.51(+3)	3.21(+1)	9.54(+3)
Sr-92	2.60 hr.	1.26(+2)	1.54(-1)	1.26(+2)
Y-90	64.0 hr.	2.37(+1)	1.56(-1)	2.39(+1)
Y-91	59.0 d.	2.53(+2)	1.52(+0)	2.55(+2)
Y-91m	50.0 min.	7.41(+3)	2.51(+1)	7.44(+3)
Y-92	3.53 hr.	1.10(+3)	2.04(+0)	1.10(+3)
Zr-95	64.0 d.	1.51(+3)	8.48(-1)	1.51(+3)
Zr-97	74.0 min.	1.49(-2)	5.10(-7)	1.49(-2)
Nb-95	35.2 d.	1.58(+3)	8.90(-1)	1.58(+3)
Mo-99	67.0 hr.	6.66(+5)	3.46(+2)	6.66(+5)
Tc-99m	6.0 hr.	2.85(+5)	2.40(+2)	2.85(+5)
Tc-101	14.0 min.	1.35(-17)	4.62(-25)	1.35(-17)
Ru-103	40.0 d.	7.36(+8)	4.13(-1)	7.36(+2)
Ru-106	1.0 hr.	1.01(+2)	5.66(-2)	1.01(+2)
Te-129m	33.0 d.	1.49(+1)	8.34(-2)	1.50(+1)
Te-129	1.14 hr.	9.51(-0)	5.31(-2)	9.56(+0)
Te-132	3.25 d.	1.49(+4)	7.84(+1)	1.50(+4)
I-129	1.57×10^{7} yr.	2.28(-2)	6.03(-4)	2.34(-2)
I-131	8.20 d	4.73(+3)	2.59(+2)	4.99(+3)
I-132	2.30 hr.	1.54(+4)	8.29(+1)	1.55(+4)

TABLE 11.2-25
(Sheet 2 of 3)

EXPECTED ANNUAL LIQUID RELEASES BY NUCLIDE (ûCi)

SYSTEM		Normal Operation Annual Isotopic Release microcuries		
		High Purity Waste	Chem Waste/ Floor Drains	Total
Isotope	Half-Life			
I-133	21.0 hr.	1.52(+4)	6.66(+2)	1.59(+4)
I-134	53.0 min.	2.53(-2)	3.53(-5)	2.53(-2)
I-135	6.88 hr.	4.35(+3)	1.21(+2)	4.47(+3)
Xe-133	5.30 d.	1.24(+6)	8.40(+2)	1.24(+6)
Xe-133m	1.66 d.	5.97(+4)	3.84(+1)	5.97(+4)
Xe-135	9.10 hr.	3.91(+6)	1.50(+3)	3.91(+6)
Xe-135m	15.0 min.	1.71(+4)	3.40(+0)	1.71(+4)
Cs-134	2.20 yr.	6.03(+1)	3.40(-1)	6.06(+1)
Cs-135	$3x10^6$ yr.	3.50(+3)	3.05(+2)	3.81(+3)
Cs-136	13.0 d.	3.80(+1)	2.09(-1)	3.82(+1)
Cs-137	29.9 yr.	7.38(+1)	3.92(-1)	7.42(+1)
Cs-138	32.0 min.	4.28(-6)	8.09(-11)	4.28(-6)
Ba-137m	2.55 min.	6.91(+1)	3.67(-1)	6.94(+1)
Ba-139	85.0 min.	2.95(+0)	1.37(-3)	2.95(+0)
Ba-140	13.0 d.	3.26(+3)	1.80(+1)	3.28(+3)
Ba-141	18.0 min.	4.65(-13)	1.90(-19)	4.65(-13)
Ba-142	11.0 min.	7.20(-23)	1.14(-31)	7.20(-23)
Ce-141	33.0 d.	3.48(+3)	2.09(+0)	3.48(+3)
Ce-143	33.0 hr.	8.01(+2)	3.84(-1)	8.01(+2)
Ce-144	284. d.	1.35(+3)	7.59(-1)	1.35(+3)
La-140	40.0 hr.	1.18(+3)	8.07(+0)	1.19(+3)
La-141	3.8 hr.	1.01(+2)	1.84(-1)	1.01(+2)
La-142	92.5 min.	8.52(-1)	4.60(-4)	8.52(-1)
Pr-143	13.6 d.	1.47(+3)	7.01(-1)	1.47(+3)
Pr-144	17.3 min.	1.35(+3)	7.59(-1)	1.35(+3)
Nd-147	11.1 d.	2.06(+3)	2.82(-1)	2.06(+3)
Np-239	2.33 d.	2.67(+5)	1.36(+3)	2.68(+5)
Na-24	15.0 hr.	7.08(+2)	2.82(+0)	7.11(+2)
P-32	14.3 d.	2.11(+1)	1.16(-1)	2.11(+1)
Cr-51	17.0 d.	5.40(+4)	3.01(+1)	5.40(+4)

TABLE 11.2-25
(Sheet 3 of 3)

EXPECTED ANNUAL LIQUID RELEASES BY NUCLIDE (ûCi)

		Normal Operation Annual Isotopic Release microcuries		
SYSTEM		High Purity Waste	Chem Waste/ Floor Drains	Total
Isotope	Half-Life			
Mn-54	310. d.	4.43(+3)	2.49(+0)	4.43(+3)
Mn-56	2.59 hr.	1.49(+4)	1.81(+0)	1.49(+4)
Co-58	70.0 d.	5.49(+5)	3.07(+2)	5.49(+5)
Co-60	5.21 yr.	5.55(+4)	3.11(+1)	5.55(+4)
Fe-59	45.0 d.	8.73(+3)	4.89(+0)	8.73(+3)
Ni-65	2.56 hr.	8.41(+1)	1.01(-2)	8.41(+1)
Zn-65	229. d.	2.21(+0)	1.24(-2)	2.22(+0)
Zn-69m	14.0 hr.	9.79(+0)	3.84(-2)	9.83(+0)
Ag-110m	270. d.	6.64(+3)	3.73(+0)	6.64(+3)
W-187	1.00 d.	1.62(±5)	7.32(±1)	1.62(±5)
	Totals	2.17(+6)	2.78(+4)	2.20(+6)

TABLE 11.2-26
(Sheet 1 of 1)

POPULATION DOSES FROM LIQUID EFFLUENTS

	Population Doses (1970 Population)		
Pathway	Thyroid Man-Rem/Yr	Total Body Man-Rem/Yr	Total Man-Rem/Yr
Salt Water Fish	1.44E-01	3.45E-03	1.47E-01
Salt Water Shellfish	1.03E-00	2.31E-02	1.05E-00
Ocean Shoreline Deposits	3.37E-04	3.37E-04	6.74E-04
Swimming	4.21E-05	4.21E-05	8.42E-05
Boating	1.91E-06	1.91E-06	3.82E-06
Total Liquid Population Dose	1.17E-00	2.69E-02	1.20E-00

TABLE 11.2-27
(Sheet 1 of 1)

DEDT SYSTEM LIMITATIONS, SETPOINTS, AND PRECAUTIONS

The setpoints for the level and temperature instruments are shown below.

Function	Current Setpoints*
Alarm (HI-HI Level)	13 ft. 9 in.
Lead and Lag Pumps ON, Level	13 ft. 7 in.
Lead Pump ON, Level	13 ft. 4 in.
Both Pumps OFF, Level	11 ft. 4 1/2 in. (6 in. above tank bottom)
Both Pumps Discharge (Transfer Mode) Cut Off, Level	11 ft. 7 in.
Alarm (High Temp)	190°F
Lead Pump ON, High Temperature	180°F
Lead and Lag Pumps ON, HI-HI Temperature	200°F

The circuit breaker, equipped with undervoltage trip release, can be manually reset only after restoration of the voltage, provided there is common control power to the drywell equipment drain tank control circuit.

The heat exchanger shall not be bypassed during normal plant operation.

* Level Setpoints are Elevation above mean sea level

Table 11.2-28
(Sheet 1 of 1)

AUGMENTED OFFGAS BUILDING FLOOR DRAIN SUMPS AND PUMPS

Number of Sumps	Two
Sumps Internal Sizes	4 ft x 4 ft x 4 ft deep 2 ft x 2 ft x 2.4 ft deep
Sump Material	Steel-lined concrete
Number of Pumps	Four (Two in each sump)
Pump Capacity	20 gpm - 50 gpm

11.3 GASEOUS WASTE MANAGEMENT SYSTEMS

The Gaseous Radwaste Treatment Systems are provided to collect, process, hold, control and dispose of radioactive gaseous waste. The Augmented Offgas System will reduce releases to the environs to the level which is within the requirements of 10CFR50, Appendix I. The operability of the Augmented Offgas System (AOG) charcoal adsorber ensures that they will be available for use whenever main condenser offgases require treatment prior to release to the environment. The appropriate portions of this system provide reasonable assurance that the release of radioactive material in gaseous effluents will be kept "as low as is reasonably achievable."

11.3.1 Design Bases

The system is designed to Quality Group D (augmented). The system and building seismic classification is in conformance with Regulatory Guide 1.29 and is non seismic. The system incorporates the following design features to achieve ALARA exposures per recommendations given in USNRC Regulatory Guide 8.8:

a. Equipment which may require servicing are so designed and located as to minimize service time.

b. Instruments requiring in situ calibration have been located on racks outside equipment cubicle.

c. Equipment and components requiring servicing have been located and designed to be movable to the lowest practicable fields or purged prior to service. Valves are located in galleries remote from the equipment with which they are associated.

d. To minimize leakage and spillage of radioactive materials care has been exercised in selecting valves, valve packing and gasket materials. Diaphragm valves are used extensively.

e. Penetration of shielding and containment walls by ducts and other openings have been designed to minimize exposure. Void content in the shielding design is limited by specifying the following densities:

    1. 145 lb/ft^3 for cast in place shielding and,
    2. 125 lb/ft^3 for block type shielding.

f. To minimize the spread of contamination all the floor drains are routed to the sump and the equipment drains are "hard piped" to the sump; HEPA filters at the end of the AOG System Train will filter all particulates before final discharge to the atmosphere through the stack, welded joints are provided to the extent practical within the system; and finally the Offgas Building is maintained at negative pressure to contain activity within the building. To facilitate decontamination in the event spillage occurs, the building interior surfaces are covered with a non porous special coating which permits thorough cleaning.

g. To minimize the buildup of contaminants in the piping system, the pipe layout includes features such as minimizing the number of turns, using long radius

elbows and employing welded connections. A duct velocity of 1800 feet per minute is maintained in the Ventilation system to minimize the buildup of contaminants.

h. Systems and equipment which may become contaminated have been provided with flush connections.

i. In the Ventilation system the airborne contaminants are controlled by directing the flow of air from areas of low contaminant potential to areas of high contaminant potential. During maintenance operations airborne contaminants are controlled by directing building vent intake toward the maintenance area "sweeping" the activity away into the discharge stream.

j. Area radiation monitors and airborne hydrogen monitors have been provided to alert personnel to potentially hazardous conditions.

k. The ventilation system is designed for easy access and service to keep doses within ALARA limits during alterations, maintenance, decontamination and filter changes.

l. Shielding is provided between radiation sources and areas in which personnel require routine access. Shielding is designed to maintain doses within ALARA limits.

m. The sampling station is located in a low radiation zone to keep doses within ALARA limits while carrying out sampling operation.

The system is designed to:

a. Provide control of collecting, processing and releasing gaseous radwaste according to established guidelines.

b. Reduce radioactive particulate releases to the atmosphere.

c. Allow time for operator response should off-standard conditions develop.

d. Provide sufficient capacity and appropriate redundancy to achieve the desired level of system reliability.

e. Reduce the detonation potential of hydrogen in the offgas, by use of dilution, recombination, monitoring, controls and alarms.

f. Provide adequate shielding to reduce the radiation exposure to plant personnel during operation, maintenance and inspection of the system.

g. Allow isolation of the condenser offgas system within 10 minutes of a system failure.

Design parameters for the Augmented Offgas System are shown in Table 11.3-1, for normal operation, including anticipated operational occurrences. The source terms for normal operating conditions are based on operating experience at Oyster Creek and Table 11.1-1,

"Noble Radiogas Source Terms" in the GESSAR. Nuclide concentrations and flow rates are listed on Table 11.3-2 for the design basis and on Table 11.3-3 for normal operating conditions.

11.3.2 System Description

11.3.2.1 General

The sources of gaseous radioactive waste at OCNGS are:

a. Main Condenser offgas

b. Turbine gland seal effluent

c. Reactor Building and Drywell Ventilation System

d. Old Radwaste Building Ventilation System

e. New Radwaste Building Ventilation System

f. Turbine Building Ventilation System and ground level discharge.

The condenser air (Steam Jet Air Ejectors, see Section 10.4) ejectors are the major source of gaseous radwaste at Oyster Creek. The Air Extraction and Offgas Systems are shown in Drawing BR 2008. The flow rate from the condenser air ejectors are normally about 95 CFM. The offgas is delayed approximately 60 minutes in a 6800 cubic foot delay pipe and passed through a HEPA filter to remove particulate and solid daughter products before entering the Augmented Offgas System.

Gland Seal release rates have been shown to be a factor of 1000 less than condenser offgas releases (Reference 1).

Measurements (Reference 1) show very small amounts of noble gas activity originating from the fuel pool cleanup and demineralizer area within the Reactor Building. The composite sources in the Reactor Building main exhaust duct have an apparent age of 49 hours. The Xe-133 released from the Reactor Building main exhaust duct was measured to be about 0.2% of the Xe-133 released as condenser offgas. Iodine-131 releases from the Reactor Building main exhaust duct were determined to be 0.0017 microcuries per second at a time when condenser offgas releases were approximately 100,000 microcuries per second. To establish a design basis release, the I-131 activity was increased by a factor of 2.6.

The Old Radwaste Building's ventilation system exhausts to the Ventilation Stack. The New Radwaste Building ventilation system exhausts the building atmosphere through a filter train equipped with a HEPA filter prior to being sent to the plant ventilation stack.

The major sources of noble gas releases within the Turbine Building were determined to originate from steam leaks in the heater bay and condenser area. The measured Xe-133 release rate from this area was 0.05% of the offgas Xe-133 release rate. The Xe-133 release rate from the Turbine Building due to all sources except the heater bay and condenser area was measured to be 0.1% of the offgas Xe-133 release rate. (For a more detailed discussion of source terms and their related values see Section 11.1.)

The radioactive gases from the reactor pass through the steam lines to the Turbine and then to the Main Condenser where they are extracted by the air ejector, and passed through holdup piping and HEPA filters before entering the Augmented Offgas System. The Augmented Offgas (AOG) System is in operation whenever the Main Condenser Steam Jet Air Ejectors are in operation, except during startup or shutdown with reactor power less than 40 percent of rated capacity (see Section 11.3.2.8). In addition, the AOG System need not be in operation during end-of-cycle coast-down periods when the system can no longer function due to the low offgas flow rates. The offgas is diverted to the AOG Building via a 4 inch pipe. This tie-in is upstream of the AOG bypass valve. This offgas mixture contains nearly all of the non-condensable radioactive offgases and also consists of an explosive mixture of hydrogen and oxygen and a considerable amount of moisture.

The permanent Hydrogen Water Chemistry System at OCNGS mitigates the potential for IGSCC in the reactor coolant piping by reducing the dissolved oxygen level in the reactor coolant via the addition of hydrogen gas into the feedwater. With the decrease in the dissolved oxygen concentration in the reactor coolant, less oxygen is carried to the condenser with the main steam resulting in less oxygen in the offgas which is diverted to the AOG System. An oxygen deficiency at the AOG recombiner could lead to possible hydrogen rich mixtures downstream of the recombiner due to excessive hydrogen.

11.3.2.2 Augmented Offgas System

The primary flow path piping and equipment for the AOG System are designed to withstand a hydrogen detonation. All pressure vessels are designed to withstand at least 350 psig static pressure. Piping and valving are designed to resist dynamic pressure encountered in long runs of piping at their respective design temperatures. Pipe wall thicknesses conform to schedule 40, as a minimum, in accordance with ANSI B36.10. Steel pipe flanges and fittings are Class 300 in accordance with ANSI B16.5. Valves are Class 600 and either welded or flanged in accordance with ANSI B16.34.

The AOG System is designed to operate unattended, and consists of a flame arrestor upstream of completely redundant recombiner subsystems, each including a blower, preheater, recombiner and cooler/condenser. A three stage water removal subsystem is also provided. It consists of three first stage water cooled condensers and three second and third stage condenser/freezers. The water removal subsystem is designed to operate alternately so that while one unit is going through a defrosting cycle the remaining two units serve as an active and spare standby. Four low temperature charcoal delay beds are furnished to holdup noble gases. These are arranged in series and are not redundant, although the first bed may be isolated. Redundant HEPA filters follow the charcoal delay beds and complete the treatment of condenser offgas. Major equipment items of the Augmented Offgas System are listed in Table 11.3-4. Charcoal beds and HEPA filters specifications are provided in Table 11.3-5. Equipment decontamination factors are listed in Table 11.3-6.

11.3.2.2.1 Flame Arrestor

The wet flame arrestor is provided in the offgas inlet line to the Augmented Offgas System to limit the propagation and consequences of an internal detonation. Typical arrangement of the wet flame arrestor relative to other equipment and piping in AOG System is shown in Drawing BR M608.

The flame arrestor provides a barrier between other Augmented Offgas System components downstream and the delay pipe and Main Condenser upstream. The flame arrestor functions by passing the inlet gas stream through a pool of water, thereby transforming the inlet stream into streams of fine bubbles. Should a detonation occur in the Augmented Offgas System, the detonation would be stopped by the flame arrestor, limiting the combustion to less than 30 cubic feet of hydrogen rich offgas downstream of the flame arrestor vessel.

11.3.2.2.2 Recombiner Subsystem

The recombiner subsystem consists of a blower, a preheater, a catalytic recombiner, a cooler/condenser, and associated valves, piping (capable of withstanding a pressure of 350 psig) and instrumentation in each of two redundant trains. Either train can handle the full recombination needs of the system. This duplication of components allows for maintenance of equipment without the need for shutting down the entire system. Each recombiner train has an inlet and outlet air operated isolation valve. Hydrogen rich condenser offgas is diluted in a recirculating air stream to reduce the free hydrogen concentration to less than 4% by volume. Uniform and safe mixing is accomplished through the use of a mixing tee with multiple gas nozzles.

Diluted offgas from the mixing tee is moved to the rest of the Augmented Offgas System by means of a blower. The blower provides motive force to the steam by raising the process pressure to about 4.5 psig to establish the recycle flow and drives the process gas through the Augmented Offgas System for final discharge through the Ventilation Stack. The heat of compression is sufficient to preheat the diluted process gas to above a desired temperature of 240°F after a short period of operation.

A preheater is provided between the blower and the recombiner to heat the recycle stream and catalyst to operating temperature prior to startup of the recombiner. The heat of compression of the blower during normal operation is more than sufficient to preheat the diluted condenser offgas stream. If the temperature of the recycle stream entering the recombiner drops below 240°F, the preheater will automatically be activated to maintain the required minimum inlet temperature of 240°F.

The catalytic recombiner is located downstream of the preheater. Its function is to combine hydrogen and oxygen in the diluted offgas stream and thus reduce the volume of offgas for further processing through the water removal system and the charcoal delay beds. The process temperature increases from 240°F to between 600-700°F during this process.

The recombiner is sized to reduce the design basis hydrogen generation rate of 85 (Standard Cubic Foot per Minute) SCFM to less than 1% (by volume) of the minimum condenser air inleakage rate plus air injection. The design basis air inleakage rate ranges from 5 SCFM to 20 SCFM.

The processed offgas exits the recombiner between 500-700°F (design basis 770°F), and is desuperheated, condensed and subcooled to 125-150°F in the cooler/condenser. Condensed vapor is discharged to the Offgas Building Floor Drain Sump where it is directed to the Liquid Radwaste System. The process gas exiting the recombiner cooler/condenser consists principally of air saturated with water vapor. Process gas, equal in volume to condenser air inleakage of about 20 SCFM is withdrawn from the recycle stream for further processing downstream. The balance of the flow (about 2200 SCFM) is recycled to the mixing tee.

11.3.2.2.3 Drying Equipment

Three 3 stage water removal subsystems are provided to remove moisture from the process gas before it enters the charcoal delay beds. The first stage is a water cooled shell and tube heat exchanger which reduces the process gas dewpoint to 105°F. A chiller reduces the dewpoint of the process gas to 35°F. This is followed by a freeze out dryer which reduces the dewpoint to -5 to +5°F. Water removal subsystems are provided as shown on Drawing BR M608. Process gas cycles between two of these during normal operation. When the operating unit enters its defrost cycle, the standby unit comes on line. The third unit acts as a backup should a malfunction shut down one of the cycling units.

The chiller and freeze out drier are cooled directly by freon refrigerant. A freon detector with alarm is provided in the processed offgas line downstream of the drying equipment.

11.3.2.2.4 Charcoal Delay Beds

The hold-up time for the charcoal delay beds is dependant on the amount of flow through the charcoal beds. Xenon is delayed for a minimum of 20 days and krypton for 26 hours in four low temperature charcoal delay beds operating at 50°F or less with a design basis air flow rate of 20 SCFM. Iodine isotopes are essentially completely removed from the process gas. Each charcoal tank holds 6 tons for a total of 24 tons of activated charcoal in the system.

The adsorber tanks are located in a vault that provides shielding and insulation. The vault is maintained at less than 50°F by the continuous operation of two refrigeration units. Table 11.3-4 lists significant data for the charcoal delay beds.

11.3.2.2.5 HEPA Filters

The effluent from the charcoal bed adsorbers is reheated in a heat traced pipe and then passed through HEPA filters before final discharge through the ventilation stack. This ensures the removal of any particulates including charcoal fines which may escape the beds. One filter is placed in service at a time and the other provides an installed spare. Table 11.3-5 lists significant data for these filters.

11.3.2.2.6 AOG Building Sumps

The low point of the incoming offgas line drains to the pipe chase sump. The flame arrestor drains are also directed to the pipe chase sump. The pipe chase sump has two level controlled sump pumps that discharge to the main sump.

The main sump receives effluent from the pipe chase sump, recombiner and water removal subsystems and the floor drains. The main sump is pumped to the sump at the base of the stack by two level controlled sump pumps.

11.3.2.2.7 Air Injection Subsystem

The air injection subsystem introduces air between the offgas holdup piping and the flame arrestor into the offgas stream to reduce the hydrogen rich mixture and allow maximum hydrogen recombination. This system consists of two (2) 100% dedicated air compressors, a

tie-in with existing plant service air as an alternate source, a control panel, and all interconnecting piping, valves and instrumentation.

A locally mounted pressure switch and pressure gauges are provided to monitor system operation. An in-line flow element and locally mounted flow transmitter are provided to monitor flow through each of two parallel flow control trains. Local control panel mounted flow indicator and flow recorder are provided to monitor air injection flow rate. Two locally mounted oxygen analyzers are provided to monitor residual oxygen content in the AOG recombiner discharge piping. Controls are provided to allow the operator to control the air injection flow rate and air inlet isolation valve. The Air Injection Flow Control System was designed to operate in either automatic or manual. Normally the flow controller automatically controls the air injection rate based on excess oxygen content in the AOG recombiner discharge. However, if needed, the Air Injection Controllers can be operated in manual for indefinite periods of time. The air inlet isolation valve is provided with a control switch on the local control panel which allows the operator to manually isolate air injection. Air injection and AOG system isolate on either low residual oxygen content or low air injection header pressure. Alarms are provided at the local control panel and are also tied into the air injection AOG trouble alarm in the Main Control Room for these events.

11.3.2.3 Mechanical Vacuum Pump

Air can be removed from the Main Condenser by a mechanical vacuum pump, which discharges to the gland seal holdup pipe and through the plant stack. This pump is used for hogging the condenser during plant startup and for purging the condenser after plant shutdown (see Subsection 10.4.2.2).

11.3.2.4 Turbine Gland Seal Effluent

The turbine gland seal effluent is delayed 1.75 minutes in the 30 inch gland seal holdup pipe. Its isotopic composition is approximately the same as for a condenser offgas sample of the same age. Gland seal release rates are approximately 0.1% of condenser offgas releases. Table 11.1-4 lists the estimated gland seal isotopic release rates for design basis normalized to a condenser offgas release of 0.3 curies per second after 30 minutes delay. Table 11.1-4 lists the gland seal release rates for normal operating conditions.

11.3.2.5 Reactor Building Ventilation System

The air flow exhausted from the Reactor Building through the plant stack is approximately 76,700 CFM. It is discharged through the 368 foot above grade Ventilation stack without any prior treatment. However, the air is monitored for radiation levels and at a predetermined setpoint, is then discharged through the Standby Gas Treatment System. Table 11.1-4 lists the design basis isotopic release rates for this source (see Sections 6.5 and 9.4).

11.3.2.6 Old Radwaste Building Ventilation System

The Old Radwaste Building main exhaust discharges at a rate of about 15,000 CFM to the plant stack. Table 11.1-4 lists the design basis isotopic release rates.

The New Radwaste Building Ventilation System discharges the building's atmosphere through a HEPA filter to the plant ventilation stack. The Offgas Building ventilation system discharges

through a roof vent equipped with a HEPA filter. Table 11.1-4 lists the design basis isotopic release rates.

11.3.2.7 Turbine Building Ventilation System

There are two monitored exhaust points from the Turbine Building, the plant stack and the Turbine Building roof stack. Approximately 90,870 CFM of the air flow from the Turbine Building is exhausted through the plant stack via fan EF 1-7 when Turbine Building Exhaust Fan EF 1-33 is not running. Approximately 68,670 CFM of air flow from the Turbine Building is exhausted through the plant stack via fan EF 1-7 when Turbine Building Exhaust Fan EF 1-33 is running. During refueling outages when EF 1-2 and EF 1-3 are used approximately 4000 CFM additional is exhausted through the plant stack. Approximately 46,000 CFM is discharged through the Turbine Building roof stack when Turbine Building Exhaust Fan EF 1-33 and EF 1-4 are running. Approximately 10,000 CFM is discharged through the Turbine Building roof stack when Turbine Building Exhaust Fan EF 1-33 is not running and Exhaust Fan EF 1-4 is running. The noble gas and iodine release rates for the Turbine Building are listed in Table 11.1-4.

11.3.2.8 AOG System Bypass

The AOG System can be bypassed by means of a bypass valve. The bypass mode is used for short periods during startup and may be used during normal plant operation if a system malfunction occurs as described below. In the bypass mode, offgas is normally delayed about 60 minutes in the 6800 cubic foot delay line and passed through a HEPA filter prior to discharge from the plant stack.

Two isolation valves (one for each recombiner train) are installed in the process line downstream of the flame arrestor. Independent manual control of these valves is incorporated in the AOG System design. The control switches are located on the AOG System control cabinet.

In normal operation, one of the valves is open and the other closed. When the associated control switch is in the "AUTO" position, the AOG System will be isolated by automatic closure of the open valve in the event any of the following adverse conditions arises:

a. Low flow in the recirculation line around the recombiner cooling unit.

b. High hydrogen content in the exit stream from the recombiner.

c. High temperature of the exit stream from the recombiner.

d. High temperature of the exit stream from the recombiner cooling unit.

e. Low pressure in the blower suction.

f. High pressure in the blower suction.

g. High hydrogen content in inlet stream to recombiner.

h. Low residual oxygen level downstream of operating recombiner.

i. Low air pressure at Air Injection Header.

j. High or Low water level in the flame arrestor.

Placing the isolation valve control switch in the "CLOSE" position will close the respective isolation valve and keep it closed. Position indication of the isolation valve and "By-Pass Valve" are provided on the AOG System control cabinet.

"Offgas System Isolated" annunciation is provided to alert operators that both isolation valves, the bypass valve, and the drain valve are closed.

An offgas release rate exceeding the Technical Specification limit of 0.3 curries per second, measured at 30 minute delay time, will automatically isolate the entire Offgas System by closing both AOG isolation valves, the AOG bypass valve and the drain valve.

High stack gas radiation will close the by-pass valve automatically, but will not close the drain valve or isolate the Augmented Offgas System.

The control function from the Main Control Room overrides all controls in the Offgas Building. Automatic valve closure via the offgas or stack gas radiation monitors supersedes all other controls.

11.3.2.9 Instrumentation and Control

The Gaseous Waste Management System is equipped with flow, temperature, pressure, humidity and radiation instrumentation. Instrumentation to indicate water level in the flame arrestor is provided. In addition, hydrogen analyzers are located before and after recombiners to monitor recombiner performance and to ensure that the hydrogen concentration is maintained below the flammable limit of 4% by volume. Radiation monitors are located before and after the charcoal bed adsorbers and after the HEPA filters. Provision has been made for offgas sampling points (at the inlet and outlet of all major equipment) to be used for periodic analysis of the offgas composition. This information is used for calibrating the monitors and estimating the decontamination factors which are presented in Table 11.3-6.

The AOG System Primary Flow Path Control Valves used for automatic isolation are air operated. The downstream isolation and control valves on the recombiner skid 'fail open' upon loss of power or control air, and a bypass line containing a 'fail open' solenoid valve is provided in the recombiner skid outlet line to vent the recombiner skid following a loss of power. The Air Injection Isolation Valve is an automatic solenoid valve.

All other control valves in the process stream are designed to 'fail closed' upon loss of power or control air. Control functions of these valves include isolation of the AOG System, isolation of the individual water removal subsystems, and automatic switchover of the water removal subsystems. Loss of instrument air will close these valves and as a result, the AOG System will be isolated.

In addition a control loop consisting of two control valves is provided on the discharge side of the closed cooling water passing through the cooler/ condenser. One valve controls flow rates between 20 and 100 gpm, and the other controls flow rates between 100 and 200 gpm. These valves are designed to throttle so as to maintain the proper exit temperature of the offgas from the cooler/condenser. These valves will 'fail open' upon loss of instrument air or electric power. The 'fail open' design allows the maximum flow of cooling water through the cooler/condenser thus preventing buildup of excessive heat in the cooler/condenser resulting from the recombination of oxygen and hydrogen upstream of the equipment.

11.3.2.9.1 Freon Monitor

Freon leaking from the water removal subsystem into the Offgas System piping will be retained by the charcoal downstream. Such a leak would tend to reduce the adsorption capability of the charcoal. Freon analyzers have been provided to detect Freon leakage and annunciate this condition in the Main Control Room and also at the AOG control cabinet in the Offgas Building.

Immediate action is required upon annunciation of this condition. The operator has two options:

a. Isolate the operating water removal subsystem, and manually switch the process stream over to the second (defrosting) unit, if it is ready to receive the process gas (defrosting cycle time is approximately one hour). Start the standby unit for initial preoperational cooling.

b. Isolate and bypass the AOG System in the event the defrosting unit is not ready to receive the offgas. At the same time, switch over to the standby water removal subsystem and start initial preoperational cooling on the same.

If the AOG System must be bypassed, it would not be necessary to do so for more than one hour. Prompt operator action, as is required by the operating procedure, will prevent any measurable degradation of charcoal bed performance.

11.3.3 Radioactive Releases

11.3.3.1 Release Points

The stack is the release point for the following radioactive gaseous waste sources:

a. Main Condenser offgas

b. Turbine gland seal effluent

c. Building ventilation (except as noted below)

d. New Radwaste Building Ventilation

Release point (stack) parameters are listed in Table 11.3-7. Roof-Top vents are as follows:

a. Turbine Building (ground level)*

b. Turbine Building ventilation from the condensate and feedwater pump room (released in the wake of the Turbine Building)

c. Turbine Building reheater protection room vent (located at the NW corner of the Turbine Building)

d. Offgas Building

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* RAGEMS II

Table 11.3-8 provides annual rates of release of radionuclides by source for normal operation (these values are below the limits specified in 10CFR Part 20, Appendix B, Table II, Column I).

11.3.3.2 Dilution Factors

Atmospheric dilution factors used in dose calculations are described in Section 2.3. Dilution factors are estimated for stack and ground level releases. Table 11.3-9 lists the dispersion factors (values of X/Q) as a function of distance and direction from the plant.

These values were used for determining beta and thyroid doses. Gamma doses are estimated using the finite plume model described in TID-2480 (Reference 2).

11.3.3.3 Estimated Doses

Annual average isotope release rates from normal operation of the Augmented Offgas System are shown in Table 11.3-1.

Total plant release rates of each isotope are given in Table 11.3-8 for both elevated and building wake releases.

Models used to calculate doses to man from atmospheric effluents are described in (Reference 3). Assumptions for consumption rates and occupation times for individuals are given in Table 11.3-10. Doses to individuals having the highest exposure potential are given in Table 11.3-11 for total plant releases.

Population doses and per capita consumption rate and occupation time assumptions used to calculate population doses are given in Table 11.3-12 for total plant releases.

11.3.4 References

(1) Helmholz, H.R., Gilbert, R.S., and Meek, M.E., NEDM-12340, "Noble Gas and Iodine Activity in the Oyster Creek Ventilation and Offgas Systems," August 30, 1972.

(2) Slade, D.H., "Meteorology and Atomic Energy, 1968," U.S. Atomic Energy Commission, TID-24190, 1968.

(3) Atomic Energy Commission, "Draft, Regulatory Guides For Implementation," Docket No. RM-50-2, February, 1974.

TABLE 11.3-1
(Sheet 1 of 1)

AUGMENTED OFFGAS SYSTEM DESIGN PARAMETERS

Nuclide	Half-Life	Design Basic 30 Minute Delay (uCi/sec.)	Design (Ci/yr.)	(Normal Operation) (Ci/yr.)
Kr-83m	1.86 hr	7,540	44.9	4.5
Kr-85m	4.4 hr	14,560	12,434.9	1,243.5
Kr-85	10.74 yr	26 to 52	821.3 to 1642.5	82.1 to 164.3
Kr-87	76.0 m	39,000	4.36	.436
Kr-88	2.79 hr	46,800	4,929.8	493.0
Kr-89	3.18 m	468	0.0	0.0
Xe-131m	11.96 d	39	379.9	38.0
Xe-133m	2.26 d	739	50.55	5.1
Xe-133	5.27 d	21,320	48,984.	4,898.
Xe-135m	15.7 m	17,940	0.0	0.0
Xe-135	9.16 hr	57,200	0.0	0.0
Xe-137	3.82 m	1,742	0.0	0.0
Xe-138	14.2 m	54,600	0.0	0.0
Total (Noble Gases)		260,000	68,000	6,800
I-131	8.06 d	0.86	0.0	0.0
I-133	20.8 h	2.57	0.0	0.0
I-135	6.68 h	5.06	0.0	0.0
Total (Iodines)		8.49	0.0	0.0

TABLE 11.3-2
(Sheet 1 of 1)

AOG SYSTEM
INPUT WASTE STREAMS DESIGN

Nuclide	Half-Line	Node Point 1 Concentration ûCi/cc	Rate ûCi/sec	Node Point 8 Concentration ûCi/cc	Rate ûCi/sec	Node Point 9 Concentration ûCi/cc	Rate ûCi/sec	Node Point 10 Concentration ûCi/cc	Rate ûCi/sec
Kr 83m	1.86 h	9.97(-2)	65.88(2)	6.9 (-1)	65.14(2)	6.86(-1)	64.76(2)	1.52(-4)	14.35(-1)
Kr 85m	4.4 h	2.12(-1)	14.00(3)	1.48	13.97(3)	1.47	13.88(3)	4.20(-2)	39.65(1)
Kr 85	10.74 y	7.86(-4)	51.94	5.5 (-3)	51.92	5.5 (-3)	51.92	5.52(-3)	51.92
Kr 87	76. m	5.04(-1)	33.3 (3)	3.47	32.76(3)	3.44	32.47(3)	1.48(-5)	13.97(-2)
Kr 88	2.79 h	6.43(-1)	42.49(3)	4.47	42.20(3)	4.45	42.0 (3)	1.66(-2)	15.67(1)
Kr 89	3.18 m	1.71(-4)	11.3	8.16(-4)	7.70	7.99(-4)	7.54	0.0	0.0
Xe 131m	11.96 d	5.90(-4)	38.99	4.13(-3)	38.99	4.13(-3)	38.98	1.28(-3)	12.08
Xe 133m	2.26 d	1.13(-2)	7.47(2)	7.88(-2)	74.38(1)	7.88(-2)	74.38(1)	1.71(-4)	16.14(-1)
Xe 133	5.27 d	3.21(-1)	21.21(3)	2.24	21.15(3)	2.24	21.15(3)	1.66(-1)	15.67(2)
Xe 135m	15.7 m	1.17(-1)	7.73(3)	7.58(-1)	71.56(2)	7.30(-1)	68.91(2)	0.0	0.0
Xe 135	9.16 h	8.38(-1)	55.38(3)	5.85	55.22(3)	5.85	55.22(3)	9.11(-16)	86.0(-13)
Xe 137	3.82 m	1.33(-3)	87.7	6.76(-3)	63.8	6.67(-3)	63.0	0.0	0.0
Xe 138	14.2 m	5.15(-1)	34.03(3)	3.35	31.62(3)	3.24	30.59(3)	0.0	0.0
Total		3.26	215,664	2.24(1)	211,496	2.22(1)	209,582	2.32(-1)	2,187
I-131	8.06 d	1.3 (-5)	85.9 (-2)	9.07(-5)	85.62(-2)	9.07(-5)	85.62(-2)	0.0	0.0
I-133	20.8 h	3.88(-5)	25.64(-1)	2.71(-4)	25.58(-1)	2.71(-4)	25.58(-1)	0.0	0.0
I-135	6.68 h	7.57(-5)	50.02(-1)	5.29(-4)	49.93(-1)	5.28(-4)	49.84(-1)	0.0	0.0
Total		1.28(-4)	8.425	8.91(-4)	8.407	8.90(-4)	8.398	0.0	0.0

TABLE 11.3-3
(Sheet 1 of 1)

AOG SYSTEM
INPUT WASTE STREAMS

NORMAL OPERATION

Nuclide	Half-Line	Node Point 1 Concentration ûCi/cc	Rate ûCi/sec	Node Point 8 Concentration uCi/cc	Rate ûCi/sec	Node Point 9 Concentration ûCi/cc	Rate ûCi/sec	Node Point* 10 Concentration ûCi/cc	Rate ÛCi/sec
Kr 83m	1.86 h	9.97(-3)	65.88(1)	6.9(-2)	65.14(1)	6.86(-2)	64.76(1)	1.52(-5)	14.35(-2)
Kr 85m	4.4 h	2.12(-2)	14.00(2)	1.48(-1)	13.97(2)	1.47(-1)	13.88(2)	4.20(-3)	39.65
Kr 85	10.74 y	7.86(-5)	51.94(-1)	5.5 (-4)	51.92(-1)	5.5(-4)	51.92(-1)	5.52(-4)	51.92(-1)
Kr 87	76. m	5.04(-2)	33.3 (2)	3.47(-1)	32.76(2)	3.44(-1)	32.47(2)	1.48(-6)	13.97(-3)
Kr 88	2.79 h	6.43(-2)	42.49(2)	4.47(-1)	42.20(2)	4.45(-1)	42.0(2)	1.66(-3)	15.67
Kr 89	3.18 m	1.17(-5)	1.13	8.16(-5)	0.77	7.99(-5)	7.54(-1)	0.0	0.0
Xe 131m	11.96 d	5.90(-5)	38.99(-1)	4.13(-4)	38.99(-1)	4.13(-4)	38.98(-1)	1.28(-4)	12.08(-1)
Xe 133m	2.26 d	1.13(-3)	7.47(1)	7.88(-3)	74.38	7.88(-3)	74.38	1.71(-5)	16.14(-2)
Xe 133	5.27 d	3.21(-2)	21.21(2)	2.24(-1)	21.15(2)	2.24(-1)	21.15(2)	1.66(-2)	15.67(1)
Xe 135m	15.7 m	1.17(-2)	7.73(2)	7.58(-2)	71.56(1)	7.30(-2)	68.91(1)	0.0	0.0
Xe 135	9.16 h	8.38(-2)	55.38(2)	5.85(-1)	55.22(2)	5.85(-1)	55.22(3)	9.11(-17)	86.0(-14)
Xe 137	3.82 m	1.33(-4)	8.77	6.76(-4)	6.38	6.67(-4)	6.30	0.0	0.0
Xe 138	14.2 m	5.15(-2)	34.03(2)	3.35(-1)	31.62(2)	3.24(-1)	30.59(2)	0.0	0.0
Total		3.26(-1)	21,566	2.24	21,150	2.22	20,958	2.32(-2)	219
I-131	8.06 d	1.30(-6)	85.9 (-3)	9.07(-6)	85.62(-3)	9.07(-6)	85.62(-3)	0.0	0.0
I-133	20.8 h	3.88(-6)	25.64(-2)	2.71(-5)	25.58(-2)	2.71(-5)	25.58(-2)	0.0	0.0
I-135	6.68 h	7.57(-6)	50.02(-2)	5.29(-5)	49.93(-2)	5.28(-5)	49.84(-2)	0.0	0.0
Total		1.28(-5)	0.8425	8.91(-5)	0.8407	8.90(-5)	0.8398	0	0

TABLE 11.3-4
(Sheet 1 of 2)

AUGMENTED OFFGAS SYSTEM MAJOR EQUIPMENT

Spenser Turbines

Number Furnished	2
Model Number	GH-3060-H modified
Material of Construction	Carbon Steel
Capacity	2673 SCFM
Discharge Pressure	80 inches H_20
Motor Horsepower	100 hp
Design Operating Temperature	300°F

Recombiner

Number Furnished	2
Material of Construction	Carbon Steel
Catalyst	Precious Metal on porous ceramic
Design Pressure	350 psig
Design Temperature	900°F

Cooler Condenser

Number Furnished	2
Material of Construction	Carbon Steel
Duty	1,930,000 Btu/hr.
Design Pressure: Shell	350 psig
Tube	150 psig
Design Temperature: Shell	900°F
Tube	200°F

Integrated Water Removal System (3 Stages)

Number Furnished	3
Shell Material	304 SS
Design Pressure	350 psig
Design Temperature	-50 to 150°F
Tube Material	304 SS
Design Pressure	150 psig
Design Temperature	-50 to 150°F
Duty: 1st stage	64,000 Btu/hr.
2nd. Stage	6,500 Btu/hr.
3rd. Stage	2,500 Btu/hr.

TABLE 11.3-4
(Sheet 2 of 2)

AUGMENTED OFFGAS SYSTEM MAJOR EQUIPMENT

Charcoal Adsorber Beds

Number Furnished	4
Material of Construction	SA-515
Design Pressure	350 psig
Design Temperature	-20 to 200°F
Weight of Charcoal per bed	12,000 pounds

Flame Arrestor

Number Furnished	1
Type	Horizontal, Hydraulic
Material of Construction	Stainless Steel
Design Pressure	300 psig
Vessel Design Specification	ASME Section VIII
Design Temperature	350°F
Design Flow Rate	125 SCFM

Air Injection Compressors

Number Furnished	2
Type	Reciprocating, Single-Stage, oil-free, direct-coupled motor
Volumetric Flow	268 SCFM
Discharge Pressure	100 PSIG
Air Receiver	240 gallons
Horsepower	10 HP
Voltage	460 V

TABLE 11.3-5
(Sheet 1 of 1)

CHARCOAL AND HEPA FILTER DATA

Charcoal		
Manufacturer	Union Carbide	
Quantity	24 tons	
Ignition Temperature	700°F	
	Krypton	Xenon
Theoretical Adsorption Coefficient (cm^3/gram)	71	1625
Service Adsorption Coefficient (cm^3/gram)	40	720
HEPA Filter		
Design Flow	20 SCFM	
Maximum Flow	40 SCFM	
Minimum Flow	5 SCFM	
Allowable dP	10 inches of H_20	
Efficiency (0.3 MICRO DOP)	99.97%	
Quantity/Train	2/2	

TABLE 11.3-6
(Sheet 1 of 1)

EQUIPMENT DECONTAMINATION FACTORS

Nuclide	T l/2	Delay Pipe	Recombiner Subsystem	Charcoal Adsorber Beds
Kr-83m	1.86 h	1.34	1.01	4.51 (03)
Kr-85m	4.4 h	1.14	1.01	3.50 (01)
Kr-85	10.74 y	1.00	1.00	1.00
Kr-87	76. m	1.56	1.03	2.40 (05)
Kr-88	2.79 h	1.22	1.01	2.68 (02)
Kr-89	3.18 m	2.99 (+04)	1.50	
Xe-131m	11.96 d	1.00	1.00	3.23
Xe-133m	2.26 d	1.01	1.00	4.60 (02)
Xe-133	5.27 d	1.00	1.00	1.35 (01)
Xe-135m	15.7 m	8.75	1.12	
Xe-135	9.16 h	1.03	1.00	6.42 (15)
Xe-137	3.82 m	4.45 (+03)	1.37	
Xe-138	14.2 m	6.88	1.11	
I-131	8.06 d	1.00	1.00	
I-133	20.8 h	1.03	1.00	
I-135	6.68 h	1.09	1.00	

TABLE 11.3-7
(Sheet 1 of 1)

STACK DATA

Base Elevation	23'6"
Orifice Elevation	391'6"
Orifice Inside Diameter	8'6"
Effluent Velocity (Minimum – Normal Power)	3,000 fpm
Heat Input	Negligible

TABLE 11.3-8
(Sheet 1 of 1)

TOTAL ISOTOPE DISCHARGE RATES
NORMAL OPERATION

	Stack(1)		Ground(2)	
	Ci/yr	ûCi/sec	Ci/yr	ûCi/sec
Kr-83m	46.9	1.49	1.1	3.49E-2
Kr-85m	1328	42.2	2.8	8.88E-2
Kr-85	165	5.24	0.015	4.76E-4
Kr-87	232	7.37	5.7	1.81E-1
Kr-88	753	23.9	7.4	2.35E-1
Kr-89	709	22.5	1.5	4.76E-2
Xe-131m	38.6	1.22	0.015	4.76E-4
Xe-133m	14.1	0.448	0.27	8.57E-3
Xe-133	5195	165	8.0	2.54E-1
Xe-135m	249	7.90	4.4	1.40E-1
Xe-135	379	12.0	14.7	4.67E-1
Xe-137	958	30.4	3.3	1.05E-1
Xe-138	857	27.2	14.2	4.51E-1
I-131	0.0389	1.23E-3	0.00978	3.10E-4
I-133	0.0832	2.64E-3	0.056	1.78E-3
I-135	0.1424	4.52E-3	0.011	3.49E-4

(1) Gland Seal + Reactor Building + Old Radwaste Building + AOG System + (0.92 x Turbine Building), based on normal operations.

(2) (0.08 x Turbine Building) + Condensate and Feedwater Pump Room, based on normal operations.

TABLE 11.3-9
(Sheet 1 of 1)

VALUES OF THE ATMOSPHERIC DISPERSION FACTOR, X/Q[(1)]

(sec/m^3)

GROUND RELEASE	DIRECTION FROM WHICH WIND BLOWS															
Distance (Miles)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
.3	6.9E-06	4.4E-06	5.1E-06	5.7E-06	6.8E-06	4.7E-06	5.9E-06	6.6E-06	7.5E-06	1.0E-05	1.1E-05	1.5E-05	1.5E-05	1.6E-05	1.8E-05	1.3E-05
1.5	5.2E-07	3.3E-07	3.8E-07	4.2E-07	5.1E-07	3.5E-07	4.3E-07	5.0E-07	5.8E-07	7.9E-07	8.8E-07	1.2E-06	1.2E-06	1.2E-06	1.4E-06	9.5E-07
2.5	2.5E-07	1.6E-07	1.8E-07	1.9E-07	2.4E-07	1.6E-07	2.0E-07	2.4E-07	2.8E-07	3.8E-07	4.3E-07	5.9E-07	5.7E-07	5.7E-07	6.9E-07	4.7E-07
3.5	1.6E-07	9.7E-08	1.1E-07	1.2E-07	1.4E-07	9.9E-08	1.3E-07	1.5E-07	1.7E-07	2.3E-07	2.7E-07	3.7E-07	3.6E-07	3.6E-07	4.3E-07	3.0E-07
4.5	1.1E-07	6.7E-08	7.6E-08	8.0E-08	9.9E-08	6.8E-08	8.7E-08	1.0E-07	1.2E-07	1.6E-07	1.9E-07	2.6E-07	2.5E-07	2.5E-07	3.0E-07	2.1E-07
7.5	5.5E-08	3.3E-08	3.7E-08	3.8E-08	4.8E-08	3.3E-08	4.3E-08	5.0E-08	5.6E-08	7.9E-08	9.4E-07	1.3E-07	1.2E-07	1.3E-07	1.5E-07	1.1E-07
15.0	2.1E-08	1.2E-08	1.4E-08	1.4E-08	1.8E-08	1.2E-08	1.6E-08	1.9E-08	2.1E-08	3.0E-08	3.6E-08	5.0E-08	4.8E-08	4.8E-08	6.0E-08	4.1E-08
25.0	1.1E-08	6.1E-09	6.8E-09	6.8E-09	8.7E-09	6.0E-09	7.9E-09	9.3E-09	1.8E-08	1.5E-08	1.8E-08	2.4E-08	2.4E-08	2.4E-08	2.9E-08	2.1E-08
35.0	7.0E-09	4.0E-09	4.4E-09	4.4E-09	5.7E-09	4.0E-09	5.2E-09	6.1E-09	6.8E-09	9.7E-09	1.2E-08	1.6E-08	1.6E-08	1.6E-08	2.0E-08	1.3E-08
45.0	5.1E-09	2.9E-09	3.2E-09	3.2E-09	4.1E-09	2.9E-09	3.7E-09	4.4E-09	4.9E-09	7.0E-09	8.6E-09	1.2E-08	1.1E-08	1.1E-08	1.4E-08	9.9E-09

STACK RELEASE	DIRECTION FROM WHICH WIND BLOWS															
.3	1.2E-08	7.6E-09	3.9E-09	1.4E-09	3.9E-09	6.3E-09	1.5E-08	1.9E-09	2.2E-09	7.8E-10	8.8E-09	6.1E-09	1.3E-08	3.4E-08	2.9E-08	3.3E-08
1.5	9.4E-09	1.2E-08	1.6E-09	2.0E-08	2.0E-08	1.9E-08	2.1E-08	2.0E-08	1.8E-08	1.3E-08	1.2E-08	1.2E-08	1.9E-08	2.4E-08	1.5E-08	1.1E-08
2.5	1.1E-08	1.4E-08	1.9E-08	2.3E-08	2.3E-08	2.1E-08	2.2E-08	2.3E-08	2.2E-08	1.8E-08	1.4E-08	1.6E-08	2.2E-08	2.8E-08	1.8E-08	1.3E-08
3.5	1.0E-08	1.3E-09	1.7E-08	2.0E-08	2.1E-08	1.9E-08	1.9E-08	2.1E-08	2.1E-08	1.8E-08	1.3E-08	1.5E-08	2.0E-08	2.6E-08	1.7E-08	1.2E-08
4.5	9.3E-09	1.1E-08	1.4E-08	1.7E-08	1.8E-08	1.6E-08	1.6E-08	1.7E-08	1.8E-08	1.6E-08	1.2E-08	1.3E-08	1.8E-08	2.3E-08	1.5E-08	1.1E-08
7.5	6.6E-09	7.5E-09	9.0E-09	1.1E-08	1.2E-08	1.0E-08	9.8E-09	1.1E-08	1.2E-08	1.1E-08	8.4E-09	9.2E-09	1.2E-08	1.5E-08	1.0E-08	7.6E-08
15.0	3.7E-09	3.8E-09	4.3E-09	5.0E-09	5.1E-09	5.0E-09	4.7E-09	5.4E-09	5.9E-09	6.0E-09	4.6E-09	4.9E-09	6.2E-09	7.7E-09	5.2E-09	4.0E-09
25.0	2.3E-09	2.2E-09	2.4E-09	2.8E-09	3.1E-09	2.8E-09	2.6E-09	3.1E-09	3.3E-09	3.5E-09	2.7E-09	2.9E-09	3.6E-09	4.4E-09	3.0E-09	2.4E-09
35.0	1.6E-09	1.6E-09	1.7E-09	1.9E-09	2.1E-09	1.9E-09	1.8E-09	2.1E-09	2.3E-09	2.4E-09	1.9E-09	2.0E-09	2.4E-09	3.0E-09	2.1E-09	1.7E-09
45.0	1.2E-09	1.2E-09	1.3E-09	1.4E-09	1.5E-09	1.4E-09	1.3E-09	1.5E-09	1.7E-09	1.8E-09	1.4E-09	1.5E-09	1.8E-09	2.2E-09	1.6E-09	1.3E-09

(1) The first distance is the minimum distance from the Turbine Building to the Site Boundary, 454 meters.

TABLE 11.3-10
(Sheet 1 of 1)

CONSUMPTION RATES AND OCCUPATION TIMES
GASEOUS RELEASES

Pathway	Adult	Infant
External Radiation from Plume	8,760 hr/yr	8,760 hr/yr
Ingestion of Cow Milk[(a)]	0.51 liters/day	1.0 Liters/day
Ingestion of Goat Milk[(a)]	0.35 liters/day	0.7 Liters/day
Inhalation m^3/day	3.0 m^3/day	20.0
Ingestion of Vegetation[(b)]	200.0 gm/day	None

(a) 10 month/year grazing season
(b) 3 month/year availability

TABLE 11.3-11
(Sheet 1 of 1)

GASEOUS EFFLUENT DOSES TO INDIVIDUALS

(rem/year)

	Total Body	Skin	Adult Thyroid	Infant Thyroid
Direct Radiation from Plume	4.1E-4[1]	5.5E-4[2]	4.1E-4[1]	4.1E-4[1]
Inhalation[3]	-	-	1.8E-4	2.2E-4
Ingestion of Vegetation[3]	-	-	4.5E-4	
Ingestion of Cow Milk[4]	-	-	2.4E-6	4.8E-5
Ingestion of Cow Milk[5]	-	-	3.0E-6	6.1E-5
Ingestion of Goat Milk[6]				

(1) 0.3 mi ESE Based on finite plume model

(2) 0.3 mi ESE Stack X/Q = 3.4E-8 sec/m^3, ground X/Q = 1.6E-5 sec/m^3

(3) 0.3 mi SE Stack X/Q = 2.9E-8 sec/m^3, ground X/Q = 1.8E-5 sec/m^3

(4) 5.5 mi S Stack X/Q = 8.1E-9 sec/m^3, ground X/Q = 8.4E-8 sec/m^3

(5) 6.6 mi NNE Stack X/Q = 1.2E-8 sec/m^3, ground X/Q = 9.4E-8 sec/m^3

(6) 9.0 mi SW Stack X/Q = 7.4E-9 sec/m^3, ground X/Q = 2.9E-8 sec/m^3

TABLE 11.3-12
(Sheet 1 of 1)

POPULATION DOSES FROM GASEOUS EFFLUENTS WITH AND WITHOUT THE AOG SYSTEM

	People Exposed	Population Total Body Dose (man-rem/yr) with AOG	Population Tyroid Dose (man rem/yr) without AOG
External Radiation from Plume	7.8E6[a]	8.1	8.1
Ingestion of Cow Milk[b][c]	9.0E5[c]	-	2.2
Inhalation[b]	7.8E6[a]	-	2.3
Ingestion of Vegetation[d]	7.0E6[a]	-	5.6
Total		8.1	18.2

(a) 2010 projected population, resident and transient

(b) Population assumed to be 90% adult, 10% infant.

(c) 10 months/year grazing season, population exposed limited by milk production from 7.8 cows/mi^2 on land between 15 and 50 miles from Oyster Creek site. Milk yield is 13 1/day-cow. (Data derived from New Jersey data in Tables 280, 1042, 1045 from the American Almanac, 1974).

(d) 3 months/year availability.

11.4 SOLID WASTE MANAGEMENT SYSTEM

The Solid Waste Management System collects, processes, holds, and packages wet and dry solid radioactive wastes generated as a result of normal operation, including anticipated operational occurrences. This system provides temporary storage on the site in shielded structures to permit radioactive decay and/or accumulation prior to shipment from the plant.

11.4.1 Design Bases

The Solid Waste Management System is designed to limit offsite radiation exposures below the levels of 10CFR50, Appendix I. The New Radwaste Building is a non nuclear safety class (NNS), Seismic Category I (foundations and retaining areas) designed structure. Sufficient system capacity, redundancy and reliability exists to provide the processing and holdup of waste during normal operation, including anticipated operational occurrences.

The Solid Waste Management System is designed to receive an annual input of 1.64×10^4 curies of radioactive solid wastes resulting from normal operation, including anticipated operational occurrences. The isotopic distribution and curie content of the inputs to the Solid Waste Management System for normal operation and design conditions are presented in Table 11.4-1 and 11.4-2, respectively.

The Solid Waste Management System is designed to:

a. Provide collection, processing, packaging, and storage of solid wastes resulting from normal plant operations, including anticipated operational occurrences, without limiting the operation or availability of the plant.

b. Provide a reliable means of handling solid wastes and to allow system operation with as low as reasonably achievable radiation exposure of plant personnel.

c. Package radioactive solid wastes for offsite shipment and burial in accordance with applicable regulations, including 10CFR61.*

   *NOTE: Waste may be shipped in liquid form to a licensed processor for volume reduction prior to disposal. The shipment must comply with DOT regulations for shipment and license conditions of the recipient.

d. Prevent the release of significant quantities of radioactive materials to the environs so as to keep the overall exposure to the public well within 10CFR20 limits.

e. Provide a reliable means for detecting free standing water in the solidified waste and prescribe procedures and provisions to ensure elimination of free-standing water prior to shipment.

System design features, layout and shielding to be such that radiation exposure to plant personnel are in accordance with the guidelines of Regulatory Guide 8.8.

The piping associated with the Solid Waste Management System is designed, fabricated, inspected and installed in accordance with the ANSI B31.1, Power Piping Code. All piping components are fabricated from either stainless steel or Carpenter 20 material depending upon the service conditions and the process medium. Some exceptions for the use of hose in

accordance with the Quality Assurance Topical Report (QATR) NQ-AA-10 are allowed. Since there is no safety related equipment in the Solid Waste Management System and none interacting with it, the entire solidification system is classified as non seismic and non safety related.

All the pressure vessels in the system are designed to the requirements of ASME Section VIII, Division 1.

11.4.2 System Description

11.4.2.1 General

The Solid Waste Management System's flow and process instrumentation diagram is shown in Drawing GE148F437.

The activities of the solid wastes entering this system are dependent on the liquid activities in the various liquid systems such as the Condensate, Reactor Water Cleanup, Spent Fuel Pool Cleanup, High Purity and Chemical Waste Floor Drain Systems whose activities are in turn a function of the reactor coolant activity.

The quantities of solid waste generated will be dependent on the plant operating factor, extent of equipment leakage, plant maintenance and housecleaning operations and decontamination requirements.

The Solid Waste Management System is designed to process radioactive wastes such as evaporator bottoms (concentrated liquid waste), filter sludges, spent resins, and maintenance wastes into disposal containers in an acceptable form for shipment to offsite burial.

The Solid Waste Management System is divided into the following two waste categories:

a. Wet Solid Waste System

b. Dry Solid Waste System

11.4.2.2 Wet Solid Waste System

The wet solid waste handling system processes concentrated liquid wastes, chemical filter sludges, high purity filter sludges, reactor water cleanup filter sludges and resins, fuel pool cleanup filter sludges and resins, dewatered sludges and demineralizer resins from various plant demineralizers. The system is divided into three waste streams, as follows:

1. Concentrated Liquid Waste (CLW): Which are the bottoms of the chemical waste evaporates. These are stored in the two concentrated liquid waste tanks located at the New Radwaste Building.

2. Filter Sludge: Which is the discharge filter cake from the High Purity and Chemical Waste/Floor Drain, and from the Reactor Cleanup System and Spent Fuel Pool Filter System. The sludges are held in the two radwaste holdup tanks and the batch tank located at the New Radwaste Building.

3. Spent Ion Exchange: Which are resins from the condensate demineralizers Reactor Cleanup, Fuel Pool, High Purity, and Chemical Waste/Floor Drain demineralizers. These spent resins are stored in the two spent tanks, located at the New Radwaste Building.

Spent resins are transferred via the Spent Resin Transfer System into disposable high integrity containers, which are fitted with dewatering filters so that the resins can be dewatered to less than or equal to one percent free standing water in the Truck Bay.

CLW is currently shipped offsite for processing. However, a vendor supplied mobile solidification system with NRC approved topical report and state approved burial ground processing requirements can be made available upon demand.

Filter sludge may be dewatered similar to spent resin, or solidified similar to CLW.

A detailed description of the above three waste streams follows:

Concentrated Liquid Waste

Concentrate liquid waste is collected in two tanks with a capacity of 6,000 gallons each. The tanks were designed with heaters to maintain the concentrated liquid waste at 125°F to prevent Na_2SO_4 from precipitating out of solution and crystalizing. For expected waste generation rates of up to 3,000 gallons per week, these tanks could accommodate more than three weeks of storage capacity. Since the practice of resin regeneration was discontinued at Oyster Creek, the Chemical Waste Evaporator is seldom used. This has resulted in significantly lower CLW volumes and greatly extended storage capacity time. The concentrated liquid waste tanks are monitored for radiation, temperature and level. High and low temperatures and levels are annunciated remotely.

Filter Sludge

Filter sludge is discharged from four horizontal leaf precoat filters (NRW) to the holdup tanks. Two candle type filters for Reactor Cleanup and Fuel Pool Clean-up Systems also contribute to filter sludge inventory, however, this sludge is directed to the batch tank.

Currently, filter sludge is dewatered and treated with biocide for disposal. However, filter sludge can also be solidified, if desired. Both produce acceptable final waste forms.

As previously stated, the solidification system is a vendor supplied mobile unit which has an NRC approved topical report and meets burial ground state approved processing requirements. The various chemicals and cement used in the solidification also kill any bacteria. So gas production is arrested.

Dewatering of filter sludge is accomplished in a similar manner as with spent resin. It is directed to a high integrity container equipped with filters for dewatering prior to shipment. Initially, a gross dewatering is performed. The water withdrawn is routed to an ultrafiltration system for final processing and then to a floor drain to be returned to the plant's overall water inventory via the Chem Waste/Floor Drain System. Following the gross dewatering, a biocide is injected into the high integrity container holding the filter

sludge. The biocide also arrests gas generation. It is allowed to soak into the sludge. The high integrity container is then dewatered to less than or equal to one percent of free standing water. This time, however, the water withdrawn is routed to a holding container because it still contains biocide. This biocide/water solution is held in this intermediary container for reuse for the next high integrity container of filter sludge. Additional water and/or biocide may be added as needed to make up to this closed loop system.

Spent Resin

Bead Resins are collected in two 600-cubic foot capacity stainless steel tanks. These tanks collect bead resins used for reactor water cleanup, fuel pool cleanup condensate demineralization, high purity waste demineralization and concentrator distillate demineralization. Each tank can store up to 300 cubic feet of resin with an additional 300 cubic feet available for freebroad.

Tank contents are slurried by backflushing with condensate through the underdrain system. The tank is then isolated and pressurized using service air. The resin/water slurry is directed to a high integrity container which is equipped with filters for dewatering prior to shipment.

The spent resins can also be transferred to the radwaste holdup tanks and subsequently solidified via a vendor supplied mobile solidification system, if desired.

The withdrawn condensate is routed to a Chemical Waste/Floor Drain Collection Tank for processing. The volume of this input is considered negligible as compared to the other inputs.

High integrity containers and solidified liners processed in the NRW Building are moved into the storage area or the Low Level Radwaste Storage Facility where they await transportation to an offsite burial ground for final disposal.

11.4.2.2.1 Equipment Description

A description of all tanks and pumps comprising the Wet Solid Waste System is contained in the following pages. The system layout is shown on Drawing GE148F437.

a. Concentrated Liquid Waste Tank (CLWT) and Pumps (CLWP)

   Two Concentrated Liquid Waste tanks are provided to collect and store the wastes from the evaporator bottoms.

   The tanks are vented to their own cubicles, and overflows from these tanks are discharged at the floor level to the building sump via the floor drain system. Each tank is provided with sprays to clean the tank walls prior to maintenance. The spargers located near the tank bottoms are provided to thoroughly mix the contents and suspend or resuspend sediments in the tanks at any time. The tanks are equipped with level and temperature indicators. In addition, radiation level is also indicated for each tank.

The Concentrated Liquid Waste Pumps located at the discharge of the Concentrated Liquid Waste Tanks are used: a) to recirculate tank contents, or b) pump the contents to the solidification station. The pumps are conventional centrifugal, coupled pumps. This minimizes the system down time due to maintenance. Tank and pump data are listed on Table 11.4-3.

b. Spent Resin Tanks (SRT)

Two spent resin tanks are provided. The tanks are vented to their own cubicles and overflows from these tanks are discharged at the floor level. Each tank is provided with a condensate spray connection to spray clean the tank walls. Underdrains are provided in the tanks to slurry the contents. Removal of excess water is achieved through the underdrains by pressurizing the tanks. Transfer of spent resin is accomplished by reslurrying the tank contents and forcing slurry through the standpipes, after the tank is isolated and pressurized. The appropriate resin transfer line valve is then opened to transfer via the standpipe. Each tank is equipped with a level indicator, a temperature indicator and a radiation indicator. Tank data is listed on Table 11.4-4.

c. Radwaste Holdup Tank (RHT) and Radwaste Feed Pump (RFP)

Two Radwaste Holdup Tanks are provided. Each tank is provided with temperature and level indicators with "high" and "low" annunciations, a radiation indicator with "high" level alarm, a dewatering element, an electric mixer and a heat tracing element. In addition, Tank "A" has a load cell attached as the primary indication.

The tanks are vented to their own cubicles and overflows from these tanks are discharged at the floor level.

The radwaste feed pumps located at the discharge of these tanks will be used to: (a) recirculate tank contents or (b) pump the contents to the batch tank or solidification station. The pumps are positive displacement type and flow rate is calibrated against motor rpm. RHT and RFP data are listed in Table 11.4-5.

d. Overhead Bridge Crane

An overhead bridge crane is provided to position liners in the storage area and to transfer liners from the storage area to a truck for shipping to the burial site or the Low Level Radwaste Storage Facility.

e. Closed Circuit Television (CCTV) System

Portable television cameras are used throughout the NRW Building to monitor equipment in high radiation areas. Examples are the Ultrafiltration Skid, Batch Tank and HIC level all located in the Fill Aisle. Locations may be included or deleted as deemed necessary.

f. Shield Doors

Two shield doors are provided. The truck bay shield door separates the large container fill station from the liner storage area and the fill aisle shield door separates

the liner storage area from the fill aisle area.

The truck bay shield door is 5 1/2 inches thick steel and is 10 feet wide by 10 feet high. The normal radiation level in the liner storage area varies considerably. Depending on the type and quantity of waste stored and/or processed in this area, radiation levels will vary. The shielding provided by the truck bay shield door is of sufficient quantity to maintain radiation exposure levels As-Low-As-Reasonably-Achievable (ALARA).

The truck bay door in the closed position separates the fill station area from the liner storage area. The radiation level in the truck bay area is expected to be 2.5 mr/hr max. This radiation level will allow the necessary operations such as dewatering and capping a liner to be performed without exposing personnel to excessive dose rates.

g. Radwaste Solidification Batch Tank (SL-T-008)

One Radwaste Solidification Batch tank is installed in the New Radwaste Building fill aisle with the following features:

- Capacity to hold the volume of waste required to process 240 cubic feet.
- HI-HI Level Switch to interlock with a waste isolation valve to automatically secure waste transfer and prevent overflowing the batch tank in case of an operator error; TV camera for visual confirmation of level; the tank is located inside the NRW "bathtub" to provide additional assurance that an overflow will be contained.
- Decant capability to remove the excess water required to fluidize the waste prior to transfer to the batch tank.
- Reusable decant filters that can be back flushed to clear in case of binding during decant evolutions.
- Spray nozzles that allow for fluidizing the waste for transfer to a process liner. Air can be connected to the spray nozzles to assist in fluidizing the waste, reducing the volume of water required. Also, the spray nozzles can be used to perform flushes on the batch tank when empty, reducing radiation levels.
- Recirculation of waste in the batch tank to ensure a representative sample is obtained for the performance of a PCP prior to processing.
- Vent connection to a HEPA filter to eliminate any airborne contamination.

11.4.2.3 Dry Solid Waste System

Deleted

11.4.2.3.1 Equipment Description

a. Compactor

Compactor is no longer used at Oyster Creek.

b. Waste Containers

They are economical, non reusable containers for solid waste which maximizes the volume/cubic space displacement ratio. Thus, providing the additional advantages in storage, transportation, and cubic capacity. Containers consist of four sides, a bottom, and a top cover. All corners have continuous full fillet welds on interior seams of container. Three stand off pads are welded to underside to facilitate handling with a fork lift. The cover is attached to container after loading is completed. Compactor and waste container data are presented in Table 11.4-6.

c. Drum Compactor

The drum compactor is no longer used at Oyster Creek.

d. DOT 17-H Steel Drums

These are non reusable containers for solid waste. Containers are commonly known as 55 gallon 17-H steel drums. The top of the drum is fully removable and is sealed closed after loading is completed.

11.4.2.4 Expected Volumes

The expected volumes of the various wet wastes and their curie content and principal nuclides are listed on Tables 11.4-1 and 11.4-2 for normal operation and design bases, respectively.

11.4.2.5 Packaging

Solidified waste must be free of water prior to capping a liner. To assure this a Process Control Program (PCP) has been implemented.

Casks, liners and high integrity containers approved in accordance with the Quality Assurance Topical Report (QATR) NQ-AA-10 and burial site requirements are used to package and ship solidified or dewatered radioactive waste. Selection of a cask system depends upon the type, quality and the specific activity level of the wastes.

For dry solid waste B-25 waste containers, DOT 17-H drums 20' and 40' freight container are being used (see Subsection 11.4.2.3.1).

In all cases, the requirements as set forth by the USNRC and the United States Department of Transportation (DOT) in the applicable parts and subparts of Titles 10 and 49 respectively of the code of Federal Regulations, are met.

11.4.3 Storage Facilities

Storage space has been provided for up to 1360 cubic feet of solidified wastes. The storage area is identified on Drawing 3E-155-02-001.

Concentrated liquid waste is stored in the Concentrated Liquid Waste Tanks prior to processing and shipment. This waste is not stored in the storage area as a matter of normal operating procedure. By processing into a truck mounted liner, in plant, unshielded liner handling is not required.

Resin is generally shipped on a yearly schedule. Tables 11.4-7 and 11.4-8 give the expected decay of the solidified waste during a three month storage period.

Additional storage space is provided in the Low Level Radwaste (LLRW) Storage Facility. The primary purpose of the facility is to house packaged low level radwaste generated at Oyster Creek in a retrievable mode during such time that access to low level radwaste burial sites is not available. A secondary function of the facility is to provide for the temporary storage of reusable radioactive contaminated equipment/materials. The facility can store approximately 81,600 cubic feet of waste in liners and 52,920 cubic feet of waste in boxes. The third function of the facility is to house radioactive sealed sources for Radiac calibration.

Plant Safety Evaluation (SE) 402533-001 (Reference 1), as revised, describes changes to the onsite LLRW facility. This SE provides information concerning the onsite storage of low-level radioactive material/waste and contaminated equipment at Oyster Creek and discusses the operation of the LLRW facility. Since this SE provides applicable information for the LLRW facility, the SE is “incorporated by reference” and should be considered when evaluating changes to the LLRW facility.

Additional storage space is provided elsewhere onsite for reusable radioactive contaminated equipment/material. The locations involved are:

The cleaned-out radwaste drum storage area in the Old Radwaste Building;

The Scaffold Storage shed attached to the south wall of the New Radwaste Building;

Rad material storage freight containers and trailers within the protected area.

11.4.4 References

(1) Plant Safety Evaluation (SE) 402533-001, “SER in Support of an On Site Low Level Radioactive Waste Storage Facility,” as revised.

TABLE 11.4-1
(Sheet 1 of 4)

SOURCE TERMS AND EXPECTED ANNUAL OUTPUT OF THE SOLID WASTE SYSTEM
(NORMAL OPERATION)

Isotopic Activities (ûCi/batch)

			Spent Resin			Filter Sludge		
Isotope	Half-Life	Concentrated Liquid Waste	High Purity Waste System	Chem. Waste Floor Drain System	RWCU	High Purity Waste System	Chem Waste Floor Drain System	RWCU
N-13	9.96 min.		7.98(+2)	1.79(-2)		1.38(-33)	3.51(-27)	
F-18	1.83 hr.	2.39(+3)	7.53(+3)	2.25(+0)		2.58(+0)	2.99(+0)	
Br-83	2.41 hr.	5.38(+3)	1.54(+4)	5.11(+0)		3.23(+1)	2.82(+1)	
Br-84	31.8 min.	5.45(+2)	2.26(+3)	5.12(-1)		8.96(-9)	3.27(-7)	
Br-85	3.00 min.	3.16(+0)	1.32(+1)	2.96(-3)		0.0	0.0	
Kr-83m	1.86 hr.		2.15(+4)	8.47(+0)		1.24(+2)	1.03(+2)	
Kr-85	10.7 yr.		3.22(+0)	2.17(-2)		5.47(-2)	3.03(-2)	
Kr-85m	4.4 hr.		5.02(+2)	2.06(-1)		1.29(+1)	8.07(+0)	
Sr-89	50.0 d.	1.75(+4)	8.14(+5)	1.90(+2)		1.59(+4)	8.91(+3)	
Sr-90	28.0 yr.	1.34(+3)	7.37(+4)	5.01(+1)	5.99(+7)	1.24(+3)	6.89(+2)	5.00(+6)
Sr-91	9.70 hr.	2.92(+5)	8.51(+5)	4.41(+1)		8.83(+4)	4.90(+4)	
Sr-92	2.60 hr.	4.31(+4)	1.31(+5)	4.46(+0)		4.15(+2)	3.40(+2)	
Y-90	64.0 hr.	2.27(+2)	6.25(+4)	4.94(+1)		3.49(+2)	2.13(+2)	
Y-91	59.0 d.	2.59(+3)	2.25(+5)	5.88(+1)		3.76(+3)	2.05(+3)	
Y-91m	50.0 min.	2.12(+5)	6.04(+5)	3.29(+1)		6.90(+4)	3.83(+4)	
Y-92	3.53 hr.	7.87(+4)	1.94(+5)	8.80(+0)		5.78(+3)	3.77(+3)	
Zr-95	64.0 d.	2.27(+1)	9.91(+2)	2.76(-1)		4.09(+2)	2.30(+2)	
Zr-97	17.0 hr.	2.98(-1)	1.05(+0)	2.76(-5)		2.11(+2)	4.55(+2)	
Nb-95	35.2 d.	2.37(+1)	1.14(+3)	4.16(-1)		4.29(+2)	2.41(+2)	
Mo-99	67.0 hr.	1.10(+4)	1.02(+5)	6.80(+0)		1.71(+5)	9.51(+4)	

TABLE 11.4-1
(Sheet 2 of 4)

SOURCE TERMS AND EXPECTED ANNUAL OUTPUT OF THE SOLID WASTE SYSTEM
(NORMAL OPERATION)

Isotopic Activities (ûCi/batch)

		Spent Resin				Filter Sludge		
Isotope	Half-Life	Concentrated Liquid Waste	High Purity Waste System	Chem. Waste Floor Drain System	RWCU	High Purity Waste System	Chem Waste Floor Drain System	RWCU
Tc-99m	6.0 hr.	5.50(+5)	1.13(+6)	5.37(+1)		1.66(+5)	9.29(+4)	
Tc-101	14.0 min.	5.12(+2)	2.31(+3)	5.21(-2)		6.85(-23)	1.62(-18)	
Ru-103	40.0 d.	1.11(+1)	4.51(+2)	8.99(-2)		1.99(+2)	1.12(+2)	
Ru-106	1.0 yr.	1.51(+0)	7.29(+1)	4.11(-2)		2.73(+1)	1.53(+1)	
Te-129m	33.0 d.	2.25(+2)	9.70(+3)	1.67(+0)		2.03(+2)	1.14(+2)	
Te-129	1.14 hr.	1.41(+2)	6.17(+3)	1.06(+0)		1.29(+2)	7.27(+1)	
Te-132	3.25 d.	2.43(+5)	2.83(+6)	1.90(+2)		1.95(+5)	1.09(+5)	
I-129	1.57×10^{7} yr.	1.97(-1)	1.56(+2)	3.88(-1)		3.23(-1)	1.90(+1)	
I-131	8.10 d.	7.32(+4)	1.75(+6)	1.37(+3)		6.35(+4)	3.56(+4)	
I-132	2.30 hr.	2.83(+5)	2.98(+6)	3.07(+2)		2.01(+5)	1.12(+5)	
I-133	21.0 hr.	3.38(+5)	1.31(+6)	7.87(+2)		1.74(+5)	9.57(+4)	
I-134	53.0 min.	1.32(+4)	5.15(+4)	1.24(+1)		5.87(-3)	2.88(-2)	
I-135	6.70 hr.	2.08(+5)	5.19(+5)	2.43(+2)		3.41(+4)	1.95(+4)	
Xe-133	5.30 d.	3.39(+4)	1.38(+6)	1.01(+3)		4.38(+4)	2.48(+4)	
Xe-133m	1.66 d.	1.78(+3)	3.47(+4)	2.40(+1)		2.18(+3)	1.23(+3)	
Xe-135	9.10 hr.	2.17(+5)	6.58(+5)	3.96(+2)		1.11(+5)	6.06(+4)	
Xe-135m	16.0 min.	5.82(+4)	1.45(+5)	6.82(+1)		9.58(+3)	5.48(+3)	
Cs-134	2.20 yr.	9.04(+2)	4.88(+4)	3.04(+1)	3.77(+7)	8.27(+2)	4.65(+2)	3.38(+6)
Cs-135	3×10^{6} yr.	5.28(+2)	7.29(+4)	1.97(+2)		1.08(+3)	5.96(+2)	
Cs-136	13.0 d.	5.18(+2)	1.82(+4)	1.73(+0)		5.15(+2)	2.89(+2)	

TABLE 11.4-1
(Sheet 3 of 4)

SOURCE TERMS AND EXPECTED ANNUAL OUTPUT OF THE SOLID WASTE SYSTEM
(NORMAL OPERATION)

Isotopic Activities (ûCi/batch)

			Spent Resin			Filter Sludge		
Isotope	Half-Life	Concentrated Liquid Waste	High Purity Waste System	Chem. Waste Floor Drain System	RWCU	High Purity Waste System	Chem Waste Floor Drain System	RWCU
Cs-137	29.9 yr.	1.05(+3)	5.67(+4)	3.82(+1)	4.66(+7)	9.52(+2)	5.47(+2)	3.86(+6)
Cs-138	32.0 min.	3.69(+3)	1.66(+4)	3.76(-1)		7.72(-8)	2.73(-6)	
Ba-137m	2.55 min.	9.59(+2)	5.30(+4)	3.57(+1)-	8.90(+2)	5.11(+2)		
Ba-139	85.0 min.	2.12(+4)	7.89(+4)	2.16(+0)-	3.06(+0)	5.11(+0)		
Ba-140	13.0 d.	4.98(+4)	1.56(+6)	1.48(+2)-	4.41(+4)	2.48(+4)		
Ba-141	18.0 min.	1.09(+3)	4.94(+3)	1.11(-1)		5.93(-17)	1.07(-13)	
Ba-142	11.0 min.	3.91(+2)	1.78(+3)	3.99(-2)		6.95(-30)	3.80(-24)	
Ce-141	33.0 d.	1.07(+2)	7.88(+3)	1.16(+0)		1.06(+3)	6.10(+2)	
Ce-143	33.0 hr.	1.46(+1)	7.60(+1)	4.83(-3)		1.94(+2)	1.07(+2)	
Ce-144	284. d.	2.03(+1)	9.72(+2)	5.20(-1)		3.66(+2)	2.06(+2)	
La-140	40.0 hr.	1.20(+4)	1.49(+6)	1.51(+2)		1.87(+4)	1.07(+4)	
La-141	3.8 hr.	1.14(+4)	3.16(+4)	1.24(+0)		5.17(+2)	3.41(+2)	
La-142	92.5 min.	3.58(+3)	1.29(+4)	3.65(-1)		1.07(+0)	1.57(+0)	
Pr-143	13.6 d.	2.20(+1)	1.08(+3)	5.99(-1)		3.99(+2)	2.25(+2)	
Pr-144	17.3 min.	2.02(+1)	9.72(+2)	5.20(-1)		3.66(+2)	2.06(+2)	
Nd-147	11.1 d.	7.86(+0)	2.05(+2)	1.82(-2)		1.37(+2)	7.69(+1)	
Np-239	2.33 d.	4.49(+6)	3.93(+7)	2.59(+3)		3.42(+6)	1.90(+6)	
Na-24	15.0 hr.	1.66(+4)	5.77(+4)	3.28(+0)		7.53(+3)	4.14(+3)	
P-32	14.3 d.	3.21(+2)	1.05(+4)	1.05(+0)		2.85(+2)	1.60(+2)	
Cr-51	27.0 d.	8.16(+2)	3.03(+4)	4.54(+0)		1.45(+4)	8.17(+3)	

TABLE 11.4-1
(Sheet 4 of 4)

SOURCE TERMS AND EXPECTED ANNUAL OUTPUT OF THE SOLID WASTE SYSTEM
(NORMAL OPERATION)

Isotopic Activities (ûCi/batch)

		Spent Resin				Filter Sludge		
Isotope	Half-Life	Concentrated Liquid Waste	High Purity Waste System	Chem. Waste Floor Drain System	RWCU	High Purity Waste System	Chem Waste Floor Drain System	RWCU
Mn-54	310 d.	6.63(+1)	3.19(+3)	1.74(+0)		1.20(+3)	6.74(+2)	
Mn-56	2.59 hr.	5.16(+3)	1.42(+4)	4.85(-1)		9.65(+2)	7.94(+2)	
Co-58	70.0 d.	8.25(+3)	3.64(+5)	1.07(+2)	1.60(9)	1.48(+5)	8.34(+4)	5.32(+8)
Co-60	5.21 yr.	8.33(+2)	4.10(+4)	2.69(+1)	3.63(+8)	1.50(+4)	8.45(+3)	6.13(+7)
Fe-59	45.0 d.	1.31(+2)	5.45(+3)	1.19(+0)		2.36(+3)	1.33(+3)	
Ni-65	2.56 hr.	3.03(+1)	8.40(+1)	2.85(-3)		5.36(+0)	4.44(+0)	
Zn-65	229.0 d.	3.31(+1)	1.74(+3)	8.77(-1)		3.02(+1)	1.70(+1)	
Zn-69m	14.0 hr.	2.38(+2)	8.00(+2)	4.49(-2)		1.02(+2)	5.63(+1)	
Ag-110m	270. d.	9.94(+1)	4.77(+3)	2.52(+0)		1.80(+3)	1.01(+3)	
W-187	1.00 d.	3.19(+3)	1.32(+4)	8.12(-1)		3.75(+4)	2.06(+4)	
Total Activity, Ci/batch		7.32	59.2	0.0083	2110.0	5.08	2.824	600.5

Annual Solid Waste Output

	Concentrated Liquid Waste	High Purity Waste System	Chem. Waste Floor Drain System	RWCU	High Purity Waste System	Chem Waste Floor Drain System	RWCU
Solid Volume/batch (ft^3)	80	250	60	150	10	5	1
Batches per year	180	1	1	2	30	200	9
Annual Solid Waste (ft^3)	14,400	250	60	300	300	1,000	9
Total Activity (Ci/yr)	1,318	59.2	0.0083	4,220	152.3	564.8	5,405

TABLE 11.4-2
(Sheet 1 of 4)

SOURCE TERMS OF THE SOLID WASTE SYSTEM
(Design Basis)

Isotopic Activities (ûCi/batch)

		Concentrated	Spent Resins			Filter Sludges		
Isotope	Half-Life	Liquid Waste	H-P System	CW/FD	RWCU	H-P System	CW/FD	RWCU
N-13	9.96 min.		7.98(2)	1.79(-2)		1.38(-33)	3.51(-27)	
F-18	1.83 hr.	2.39(3)	7.53(3)	2.25(0)		2.58(0)	2.99(0)	
Br-83	2.41 hr.	5.38(4)	1.54(5)	5.11(1)		3.23(2)	2.82(2)	
Br-84	31.8 min.	5.45(3)	2.26(4)	5.12(0)		8.96(-8)	3.27(-6)	
Br-85	3.00 min.	3.16(1)	1.32(2)	2.96(-2)		0.0(0)		
Kr-83m	1.86 hr.		2.15(5)	8.47(1)		1.24(3)	1.03(3)	
Kr-85	10.7 yr.		3.22(1)	2.17(1)		5.47(-1)	3.03(-1)	
Kr-85m	4.4 hr.		5.02(3)	2.06(0)		1.29(2)	8.07(1)	
Sr-89	50.0 d.	1.75(5)	8.14(6)	1.90(3)		1.59(5)	8.91(4)	
Sr-90	28.0 yr.	1.34(4)	7.37(5)	5.01(2)	5.99(8)	1.24(4)	6.89(3)	5.00(7)
Sr-91	9.70 hr.	2.92(6)	8.51(6)	4.41(2)		8.83(5)	4.90(5)	
Sr-92	2.60 hr.	4.31(5)	1.31(6)	4.46(1)		4.15(3)	3.40(3)	
Y-90	64.0 hr.	2.27(3)	6.25(5)	4.94(2)		3.49(3)	2.13(3)	
Y-91	59.0 d.	2.59(4)	2.25(6)	5.88(2)		2.76(4)	2.05(4)	
Y-91m	5.0 min.	2.12(6)	6.04(6)	3.29(2)		6.90(5)	3.83(5)	
Y-92	3.53 hr.	7.87(5)	1.94(6)	8.80(1)		5.78(4)	3.77(4)	
Zr-95	64.0 d.	2.27(2)	9.91(3)	2.76(0)		4.09(3)	2.30(3)	
Zr-97	17.0 hr.	2.98(0)	1.05(1)	2.76(-4)		2.11(3)	4.55(3)	
Nb-95	35.2 d.	2.37(2)	1.14(4)	4.16(0)		4.29(3)	2.41(3)	
Mo-99	67.0 hr.	1.10(5)	1.02(6)	6.80(1)		1.71(6)	9.51(5)	

TABLE 11.4-2
(Sheet 2 of 4)

SOURCE TERMS OF THE SOLID WASTE SYSTEM
(Design Basis)

Isotopic Activities (ûCi/batch)

Isotope	Half-Life	Concentrated Liquid Waste	Spent Resins H-P System	Spent Resins CW/FD	Spent Resins RWCU	Filter Sludges H-P System	Filter Sludges CW/FD	Filter Sludges RWCU
Tc-99m	6.0 hr.	5.50(6)	1.13(7)	5.37(2)		1.66(6)	9.29(5)	
Tc-101	14.0 min.	5.12(3)	2.31(4)	5.21(-1)		6.85(-22)	1.62(-17)	
Ru-103	40.0 d.	1.11(2)	4.51(3)	8.99(-1)		1.99(3)	1.12(3)	
Ru-106	1.0 yr.	1.51(1)	7.29(2)	4.11(-1)		2.73(2)	1.53(2)	
Te-129m	33.0 d.	2.25(3)	9.70(4)	1.67(1)		2.03(3)	1.14(3)	
Te-129	1.14 hr.	1.41(3)	6.17(4)	1.06(1)		1.29(3)	7.27(2)	
Te-132	3.25 d.	2.43(6)	2.83(7)	1.90(3)		1.95(6)	1.09(6)	
I-129	1.57×10^{7} yr.	1.97(0)	1.56(3)	3.88(0)		3.23(0)	1.90(0)	
I-131	8.10 d.	7.32(5)	1.75(7)	1.37(4)		6.35(5)	3.56(5)	
I-132	2.30 hr.	2.83(6)	2.98(7)	3.07(3)		2.01(6)	1.12(6)	
I-133	21.0 hr.	3.38(6)	1.31(7)	7.87(3)		1.74(6)	9.57(5)	
I-134	53.0 min.	1.32(5)	5.15(5)	1.24(2)		5.87(-2)	2.88(-1)	
I-135	6.70 hr.	2.08(6)	5.19(6)	2.43(3)		3.41(5)	1.95(5)	
Xe-133	5.30 d.	3.39(5)	1.38(7)	1.01(4)		4.38(5)	2.48(5)	
Xe-133m	1.66 d.	1.78(4)	3.47(5)	2.40(2)		2.18(4)	1.23(4)	
Xe-135	9.10 hr.	2.17(6)	6.58(6)	3.96(3)		1.11(6)	6.06(5)	
Xe-135m	16.0 min.	5.82(5)	1.45(6)	6.82(2)		9.58(4)	5.48(4)	
Cs-134	2.20 yr.	9.04(3)	4.88(5)	3.04(2)	3.77(8)	8.27(3)	4.65(3)	3.38(7)
Cs-135	3×10^{6} yr.	5.28(3)	7.29(5)	1.97(3)		1.08(4)	5.96(3)	
Cs-136	13.0 d.	5.81(3)	1.82(5)	1.73(1)		5.15(3)	2.89(3)	

TABLE 11.4-2
(Sheet 3 of 4)

SOURCE TERMS OF THE SOLID WASTE SYSTEM
(Design Basis)

Isotopic Activities (ûCi/batch)

Isotope	Half-Life	Concentrated Liquid Waste	Spent Resins H-P System	Spent Resins CW/FD	Spent Resins RWCU	Filter Sludges H-P System	Filter Sludges CW/FD	Filter Sludges RWCU
Co-137	29.9 yr.	1.05(4)	5.67(5)	3.82(2)	4.66(8)	9.52(3)	5.47(3)	3.86(7)
Co-138	32.0 min.	3.69(4)	1.66(5)	3.76(0)		7.72(-7)	2.73(-5)	
Ba-137m	2.55 min.	9.59(3)	5.30(5)	3.57(2)		8.90(3)	5.11(3)	
Ba-139	85. min.	2.12(5)	7.89(5)	2.16(1)		3.06(1)	5.11(1)	
Ba-140	13.0 d.	4.98(5)	1.56(7)	1.48(3)		4.41(5)	2.48(5)	
Ba-141	18.0 min.	1.09(4)	4.94(4)	1.11(0)		5.93(-16)	1.07(-12)	
Ba-142	11.0 min.	3.91(3)	1.78(4)	3.99(-1)		6.95(-29)	3.80(-23)	
Ce-141	33.0 d.	1.07(3)	7.88(4)	1.16(1)		1.06(4)	6.10(3)	
Ce-143	33.0 hr.	1.46(2)	7.60(2)	4.83(-2)		1.94(3)	1.07(3)	
Ce-144	28.4 d.	2.03(2)	9.72(3)	5.20(0)		3.66(3)	2.06(3)	
La-140	40.0 hr.	1.20(5)	1.49(7)	1.51(3)		1.87(5)	1.07(5)	
La-141	3.8 hr.	1.14(5)	3.16(5)	1.24(1)		5.17(3)	3.41(3)	
La-142	92.5 min.	3.58(4)	1.29(5)	3.65(0)		1.07(1)	1.57(1)	
Pr-143	13.6 d.	2.20(2)	1.08(4)	5.99(0)		3.99(3)	2.25(3)	
Pr-144	17.3 min.	2.02(2)	9.72(3)	5.20(0)		3.66(3)	2.06(3)	
Nd-147	11.1 d.	7.86(1)	2.05(3)	1.82(-1)		1.37(3)	7.69(2)	
Np-233	2.33 d.	4.49(6)	3.93(7)	2.59(3)		3.42(6)	1.90(6)	
Na-24	15.0 hr.	1.66(4)	5.77(4)	3.28(0)		7.53(3)	4.14(3)	
P-32	14.3 d.	3.21(2)	1.05(4)	1.05(0)		2.85(2)	1.60(2)	
Cr-51	27.0 d.	8.16(2)	3.03(4)	4.54(0)		1.45(4)	8.17(3)	

TABLE 11.4-2
(Sheet 4 of 4)

SOURCE TERMS OF THE SOLID WASTE SYSTEM
(Design Basis)

Isotopic Activities (ûCi/batch)

		Concentrated	Spent Resins			Filter Sludges		
Isotope	Half-Life	Liquid Waste	H-P System	CW/FD	RWCU	H-P System	CW/FD	RWCU
Mn-54	310. d.	6.63(1)	3.19(3)	1.74(0)		1.20(3)	6.74(2)	
Mn-56	2.59 hr.	5.16(3)	1.42(4)	4.85(-1)		9.65(2)	7.94(2)	
Co-58	70.0 d.	8.25(3)	3.64(5)	1.07(2)	1.60(9)	1.48(5)	8.34(4)	5.32(8)
Co-60	5.21 yr.	8.33(2)	4.10(4)	2.69(1)	3.63(8)	1.50(4)	8.45(3)	6.13(7)
Fe-59	45.0 d.	1.31(2)	5.45(3)	1.19(0)		2.36(3)	1.33(3)	
Nt-65	2.56 hr.	3.03(1)	8.40(1)	2.85(-3)		5.36(0)	4.44(0)	
Zn-65	229. d.	3.31(1)	1.74(3)	8.77(-1)		3.02(1)	1.70(1)	
Zn-69m	140. hr.	2.38(2)	8.00(2)	4.49(-2)		1.02(2)	5.63(1)	
Ag-110m	270. d.	9.94(1)	4.77(3)	2.52(0)		1.80(3)	1.01(3)	
W-187	1.00 d.	3.19(3)	1.32(4)	8.12(-1)		3.75(4)	2.06(4)	
Total Activity, Ci/batch		32.50	233.5	0.058	3405.0	18.0	11.0	716.0
Annual Solid Waste Output								
Solid Volume, batch, ft^3		80	250	60	150	10	5	9
Batch per year		180	1	1	2	30	200	1
Annual Solid Volume, ft^3		14,400	250	60	300	300	1,000	9
Total Activity per year, Ci		5,850.0	233.5	0.0580	6,810.0	537.5	2,200	716.0

TABLE 11.4-3
(Sheet 1 of 1)

CONCENTRATED LIQUID WASTE SYSTEM COMPONENTS

Tank

Number	2 (SL-T-1A, SL-T-1B)
Volume	5,000 Gallons (Nominal)
Material	Carpenter 20
Code	API-650, Appendix J
Design Condition	
Pressure	Atmospheric
Temperature	120°F

Pumps

Number	2 (SL-P-1A, SL-P-1B)
Type	Conventional Centrifugal Pumps
Design Flow	180 gpm
Design Temperature	180°F
Design Pressure	75 psig
Design Code	ANSI B123.1 AVS

TABLE 11.4-4
(Sheet 1 of 1)

SPENT RESIN TANK (SRT) DATA

Tank

Number	2 (SL-T-2A, SL-T-2B)
Volume	4,500 Gallons (To hold 300 ft^3 resin with 300 ft^3 free-board)
Material	304 Stainless Steel
Code	ASME Section VIII, Division 1
Design Pressure	150 psig
Design Temperature	150°F

TABLE 11.4-5
(Sheet 1 of 1)

RADWASTE HOLDUP COMPONENTS

Tank

Number	2 (SL-T-3A, SL-T-3B)
Volume	1,130 Gallons
Material	304 Stainless Steel
Code	ASME Section VIII, Division 1
Design Pressure	5 psig
Design Temperature	200°F

Pumps

Number	2 (SL-P-3A, SL-P-3B)
Type	Progressive Cavity Type (MOYNO)
Flow	16 gpm
Design Temperature	160°F
Design Pressure	120 psig
Design Code	Manufacturers Standard

RADWASTE SOLIDIFICATION BATCH TANK

Tank

Number	1 (SL-T-008)
Volume	280 cubic feet or 2100 gallons
Material	Stainless Steel
Design Pressure	Atmospheric
Design Temperature	Ambient

TABLE 11.4-6
(Sheet 1 of 1)

DRY SOLID WASTE SYSTEM EQUIPMENT

B-25 Compactor

Weight	3,000 lbs (approx.)
Electrical	3 phase, 480V, 60 H_z
Cylinder Displacement	30 inches
Compaction Speed	95 inches/min.
Cycle Time	1 minute

B-25 Waste Container

Material	#14 Gauge-ASTM-415-low carbon (0.10 max.) hot rolled steel sheet
Finish	Primer only (Interior & Exterior)
Overall Size	72" x 48" x 46"
Weight	410 lbs (approx.)
Volume	98.7 cubic feet

TABLE 11.4-7
(Sheet 1 of 1)

DECAY OF SOLID WASTE ACTIVITY ON WEEKLY BASIS
FOR 13 WEEKS (3 Months)

Activity shown in micro Ci/ft^3 without dilution
(Normal Operation)

Decay Time (Weeks)	Conc. Liquid	H.P. Resin	Chem Resin	RWCU Resin	H.P. Sludge	Chem Sludge	RWCU Sludge
0	9.15(+4)	2.37(+5)	1.38(+2)	1.40(+7)	5.08(+5)	5.65(+5)	6.06(+8)
1	9.24(+3)	3.96(+4)	3.86(+1)	1.33(+7)	7.81(+4)	8.72(+4)	5.70(+8)
2	2.05(+3)	1.51(+4)	2.21(+1)	1.27(+7)	2.97(+4)	3.34(+4)	5.36(+8)
3	8.73(+2)	9.64(+3)	1.57(+1)	1.20(+7)	2.07(+4)	2.33(+4)	5.05(+8)
4	5.76(+2)	7.49(+3)	1.24(+1)	1.14(+7)	1.77(+4)	1.98(+4)	4.76(+8)
5	4.48(+2)	6.26(+3)	1.05(+1)	1.09(+7)	1.59(+4)	1.78(+4)	4.49(+8)
6	3.70(+2)	5.42(+3)	9.28(±0)	1.04(+7)	1.45(+4)	1.63(+4)	4.23(+8)
7	3.18(+2)	4.80(+3)	8.42(±0)	9.89(+6)	1.36(+4)	1.50(+4)	4.00(+8)
8	2.79(+2)	4.32(+3)	7.78(±0)	9.44(+6)	1.24(+4)	1.40(+4)	3.78(+8)
9	2.49(+2)	3.80(+3)	7.27(±0)	9.03(+6)	1.16(+4)	1.30(+4)	3.57(+8)
10	2.26(+2)	3.65(+3)	6.84(±0)	8.64(+6)	1.08(+4)	1.22(+4)	3.38(+8)
11	2.08(+2)	3.36(+3)	6.46(±0)	8.27(+6)	1.01(+4)	1.14(+4)	3.20(+8)
12	1.91(+2)	3.13(+3)	6.14(±0)	7.92(+6)	9.53(+3)	1.07(+4)	3.03(+8)
13	1.73(+2)	3.92(+3)	5.85(±0)	7.61(+6)	8.97(+3)	1.01(+4)	2.87(+8)

TABLE 11.4-8
(Sheet 1 of 1)

DECAY OF SOLID WASTE ACTIVITY ON WEEKLY BASIS
FOR 13 WEEKS (3 Months)

Activity shown in micro Ci/ft^3 without dilution
(Design Basis)

Decay Time (Weeks)	Conc. Liquid	H. P. Resin	Chem Resin	RWCU Resin	H. P. Sludge	Chem Sludge	RWCU Sludge
0	4.06(+5)	9.34(+5)	9.67(+2)	2.27(+7)	1.80(+6)	2.19(+6)	7.95(+7)
1	2.83(+4)	2.04(+5)	3.18(+2)	2.20(+7)	2.44(+5)	2.73(+5)	7.55(+7)
2	1.13(+4)	1.15(+5)	1.96(+2)	2.13(+7)	1.06(+5)	1.20(+5)	7.18(+7)
3	6.80(+3)	8.03(+4)	1.38(+2)	2.06(+7)	6.76(+4)	7.51(+4)	6.83(+7)
4	4.76(+3)	6.20(+4)	1.07(+2)	2.00(+7)	5.16(+4)	5.72(+4)	6.50(+7)
5	3.64(+3)	5.07(+4)	8.86(+1)	1.95(+7)	4.22(+4)	4.68(+4)	6.20(+7)
6	2.93(+3)	4.31(+4)	7.72(+1)	1.89(+7)	3.58(+4)	3.98(+4)	5.91(+7)
7	2.46(+3)	3.77(+4)	6.93(+1)	1.84(+7)	3.36(+4)	3.50(+4)	5.64(+7)
8	2.11(+3)	3.36(+4)	6.37(+1)	1.80(+7)	2.79(+4)	3.13(+4)	5.40(+7)
9	1.85(+3)	2.89(+4)	5.93(+1)	1.75(+7)	2.57(+4)	2.83(+4)	5.16(+7)
10	1.67(+3)	2.80(+4)	5.55(+1)	1.71(+7)	2.30(+4)	2.60(+4)	4.95(+7)
11	1.51(+3)	2.55(+4)	5.23(+1)	1.67(+7)	2.10(+4)	2.39(+4)	4.75(+7)
12	1.38(+3)	2.37(+4)	4.98(+1)	1.64(+7)	1.99(+4)	2.23(+4)	4.56(+7)
13	1.24(+3)	2.21(+4)	4.74(+1)	1.61(+7)	1.86(+4)	2.07(+4)	4.38(+7)

11.5 PROCESS AND EFFLUENT RADIOLOGICAL MONITORING AND SAMPLING SYSTEMS

11.5.1 Design Bases

11.5.1.1 Process Radioactivity Monitoring and Sampling Systems

The process radioactivity monitoring and sampling systems are designed to:

a. Detect radioactive gaseous and liquid leakage

b. Provide warning, and automatic control function as appropriate, when the radioactivity in a particular process stream reaches a preset level threatening to violate the plant radiological effluent limits or process limits as established in the Technical Specifications

c. Provide information on failed fuel

d. Provide a determination of how well components for handling, storage and processing of radioactive material are operating

e. Provide a record of the radioactivity present in the various plant systems

f. Provide a record of the radioactivity released to the environment from various plant systems to determine compliance with 10CFR20 and 10CFR50, Appendix I, requirements.

11.5.1.2 Effluent Radioactivity Monitoring and Sampling System

The effluent radioactivity monitoring and sampling systems are designed to perform the following functions during normal operation and anticipated operational occurrences:

a. Continuously monitor all major effluent paths from the plant, which could have significant radioactivity, to assure that normal releases are within the guidelines of 10CFR20 and Appendix I of 10CFR50.

b. Provide a warning when release rates to the environment may result in exceeding the plant radiological effluent limits established in the Technical Specifications.

c. Initiate alarms and appropriate automatic control functions when the levels of radioactivity exceed plant preset values.

Under accident conditions, the effluent radioactivity monitoring and sampling systems provide the capability to monitor and quantify effluent releases for reporting and dose assessment purposes.

11.5.1.3 Chemistry Facility

The chemistry facility provides the capability to analyze the chemical and radiological parameters of various plant systems. The facility contains a room dedicated for the monitoring station of the Postaccident Sampling System.

The PASS enhances the capability of the plant to obtain and analyze samples of reactor coolant and of drywell/torus atmosphere under accident conditions which would render the reactor building inaccessible to personnel. Analyses of the samples provide vital information concerning potential core damage and radiological conditions within primary containment.

11.5.2 System Description

The Process and Effluent Radiation Monitoring and Sampling Systems consist of several individual process monitoring subsystems. Those monitoring subsystems which initiate isolation valve closure or plant shutdown are designed so that a single component failure does not prevent the required automatic action. All monitors are capable of self supervision, i.e., give an alarm when downscale or de-energized. For monitoring configurations using offline sampling, alarms are also provided to give warning if the sampling flow is low. All monitors are capable of convenient, operational verification by means of test signals or radioactive check sources.

11.5.2.1 Main Steam Line Monitoring Subsystem

The Main Steam Line Monitoring Subsystem provides for continuous monitoring of each main steam line to permit the prompt indication of gross release of fission products from the fuel to the reactor coolant and subsequently, to the turbine.

Main steam line high radiation is an indication of excessive fuel failure. Under normal operating conditions, gamma radiation in the vicinity of the main steam lines is caused primarily by decay of activation products such as N-16 and O-19 which are carried over as a gas in the steam. Depending on the magnitude of fuel clad failure, the fuel would release fission gases (primarily xenon and krypton), halogens (predominantly radioiodines), particulates representing a wide spectrum of fission products, and fuel and transuranic elements, which also would be transported via the steam. The monitoring system also alerts the operator of fuel releases resulting in detector response above background, which could be indicative of the onset of fuel failures. Four channels of instrumentation are provided to monitor this activity. The detectors are ionization chambers mounted adjacent to each of the two main steam lines just downstream of the outer MSIVs at the drywell penetration. These types of detectors were chosen because they were standard instruments suited to the operational environmental and radiation conditions of concern. Each detector is connected to a logarithmic amplifier. A recorder has an input for each detector. The range of these monitors is 1 to 1 x 10^6 mR/hr. Each channel is indicated continuously, recorded, and alarmed in the Control Room. Drawing GE846D686 show the system configuration. Table 11.5-1 summarizes the subsystem specifications.

11.5.2.2 Process Liquid Monitoring Subsystems

The Process Liquid Monitoring Subsystems are comprised of the Liquid Radwaste Overboard Discharge Monitor, the Reactor Building Closed Cooling Water Monitor, and the Service Water Radiation Monitor. These subsystems have been designed to continuously measure, indicate, and record the radioactivity concentration levels of major process system discharge streams. The subsystems include scintillation detectors, and are set to alarm when concentrations vary significantly from normal levels. These monitors ensure that plant releases do not exceed the limits specified in 10CFR20 and 10CFR50 Appendix I.

The Liquid Radwaste Overboard Discharge Line has been capped and abandoned. The respective radiation monitor has also been abandoned.

The monitor associated with the RBCCW is situated on a lead brick housing immediately adjacent to, and with an unshielded view of, the discharge header of the RBCCW heat exchangers. The output of the detector preamplifier is connected to a seven decade Log Count Ratemeter and a recording pen on a recorder in the plant Control Room.

The Service Water Radiation Monitor is an offline radiation monitor on an enclosed skid located outside the Reactor Building near the Service Water Seal Well, which monitors gross radioactivity of the service water effluent from the RBCCW heat exchangers. The output of the detector preamplifier is connected to a ratemeter with a digital display in the SWRM Building. The output signal from the Ratemeter is connected to a five decade (10 to 1,000,000) Log Countrate recorder located in the Control Room.

The RBCCW and Service Water Log Count Ratemeter trip units generate high, high-high, and downscale trips. The high and downscale trips actuate Control Room alarms.

11.5.2.3 Deleted

11.5.2.4 <u>Air Ejector Offgas Monitoring Subsystem</u>

The Air Ejector Offgas Monitoring Subsystem continuously monitors and records the radioactivity level of the effluent gases removed from the Main Condenser by the Steam Jet Air-Ejectors (SJAEs). The purpose of these monitors is to: (1) obtain a continuous record of radioactivity released to the offgas holdup system through the air ejector and (2) isolate the offgas holdup volume from the stack before the maximum permissible stack release rate is reached.

There are two completely independent channels of instrumentation provided. Each channel consists of an ionization chamber, a six decade logarithmic amplifier, and a recorder that is also used to record one stack gas monitor channel. The logarithmic amplifier is equipped with adjustable high high and downscale alarms. The output of each channel is recorded continuously. Two such recorders are provided. A continuous recording of offgas flow and sample flow is also provided in the Control Room. Low sample flow is annunciated.

In normal operation, a sample of gas is drawn through a coalescing filter (to remove excess moisture), into a sample chamber (a six foot section of four inch, internally polished, stainless steel pipe), adjacent to which are mounted two detectors. The sample line is heat traced so as to minimize condensation, and is designed to provide a holdup time of about two minutes. This holdup time allows for the decay of the N-16 and 0-19 so that the activity of the isotopes signaling the presence of a ruptured fuel element is not masked. The sample is returned to the condenser. When the activity level of the offgas approaches the average stack release rate limit, an alarm is actuated. At up to 10 times this limit, a signal is generated to initiate closure of the Offgas System Isolation valves. Trip logic initiates a 15 minute timer. If the trip logic is not reset during this time, offgas flow is isolated. The time delay allows the operator to evaluate the data and prevent an unwarranted isolation and reactor shutdown. A holdup volume in the offgas line after the sample point is designed to provide 30 minutes after the high radiation signal before the radioactivity passes the isolation valve. Therefore, automatic isolation occurring up to 30 minutes after the high radiation signal prevents high radioactivity from being

discharged. A downscale trip gives warning of instrument malfunction. The alarm logic is so arranged that a closure of the offgas line is initiated by two high level signals, or an upscale in combination with a downscale.

11.5.2.5 Stack RAGEMS

The Radioactive Gaseous Effluent Monitoring System (RAGEMS) has been installed to replace Stack Gas Monitoring Subsystem, so as to meet the expanded monitoring requirements identified in NUREG 0578 and NUREG 0737. The stack RAGEMS system consists of a particulate and iodine station, a sampling station for taking tritium and Marinelli beaker samples, a high range noble gas radiation monitor and two low range noble gas monitors.

The automated portion of the particulate and iodine sample system is located in the Stack RAGEMS Building mainline gas train upstream of the high range and low range gas monitor chambers. The local programmable controller controls the operation of the cartridge changing mechanisms and solenoid operated flow control valves via instructions from the computer. The cartridge changing is a semiautomatic operation in which a computer operator must type in the cartridge changing instructions.

Particulate and iodine samples are collected using automatic cartridge changers where the cartridges are inserted into the main sample line, allowed to collect samples for a specified but variable period of time, then automatically removed from the line for measurement of the radioactivity levels.

Feedback instrumentation in the cartridge changing system provides the Computer operator with information and alarms so that he may take appropriate corrective action upon occurrence of misalignment of ambient in leakage at the seal collar. If a malfunction should occur in the semi automatic cartridge system, the sample gas flow control solenoid valves may be operated using individual valve switches on the local control panel in the stack RAGEMS Building to maintain sample gas flow through the particulate and/or iodine mainline bypass filters and high/low range gas monitors. If the mainline sample gas train must be taken out of service, sample gas flow can be manually directed through the high and low range gas monitors using the external bypass system and particulate/iodine laboratory samples may be taken collected using the external bypass filter station.

Since the high range noble gas monitor portion of the system is a flow through type, the gas sample, with particulate and iodine removed, passes through a six liter chamber which has an ion chamber detector mounted against its exterior inside of a common lead shield.

The high range monitor consists of an ion chamber located adjacent to the six liter chamber and a picoampere indicator located in the Stack RAGEMS building. The signal from this monitor is transmitted to a computer that converts the picoampere signal into units of equivalent X_e-133 ûCi/cc. The high range monitor has a lower limit of detection of approximately 1 x 10^{-1} ûCi/cc which overlaps the upper range of the low range monitors. The high range monitor has an upper limit of detection 127 ûCi/cc, which is higher than the maximum postulated activity resulting from a LOCA.

The sensors for both low range monitor channels are scintillation detectors located in the 2800 cc chamber in the Stack RAGEMS Building. Each channel has two ratemeters for indication located on Panel 1R in the main Control Room. Indicators are described in Table 7.5-5. The lower limit of detection for each monitor is approximately $1x10^{-6}$ ûCi/cc and the upper limit of

detection is approximately 1 ûCi/cc. During a postaccident situation, only one channel will be used to measure the radiation level rise. During the decaying portion of the accident, the other channel will be used to measure the decrease in radiation level.

In order to allow for the calculation of the activity release rates, the RAGEMS is related to Stack Flow measurement. Based upon local indication from the Stack flow transmitter, the sample flow is adjusted through a local flowmeter to maintain an isokinetic sampling rate proportional to the stack flow rate +20% over the system design range as required by NUREG 0737.

11.5.2.6 Turbine Building RAGEMS

The monitoring capability provided for the Turbine Building Vent is similar, though not identical to that provided by the RAGEMS for the stack. The systems differ mainly in the design of the Isokinetic flow control system, and the resultant flow requirements. The Turbine Building RAGEMS consists of two sampling systems. One obtains isokinetic samples from the Feedwater Pump Room exhaust, while the other obtains isokinetic samples of the releases from the Turbine Building Operating Floor, and the Lube Oil Bay area. The sampling and monitoring equipment is housed in an enclosure adjacent to the Turbine Building.

Particulate and iodine samples are collected by standard cartridges which are manually inserted into each of the pump room and combined main operating floor and lube area sample lines. After a specified time duration, these cartridges are manually removed and analyzed in the laboratory. These sampling stations are also used for obtaining tritium and Marinelli beaker noble gas samples for laboratory analysis. After the sample gas streams have passed through the particulate and iodine filters, the two sample streams are combined. The combined flow then passes through a high range noble gas radiation monitor which is identical to the Stack RAGEMS Monitor described in Subsection 11.5.2.5 and also through a single low range gas monitor.

11.5.2.7 Domestic Sewer Effluent Monitor

A monitor is provided to measure radiation level in the domestic sewer prior to discharge from the plant. A recorder with a counts/minute range and a counter are provided. This monitor has two setpoints associated with it, one is an alarm, and the other is a sewer lift pump trip.

11.5.2.8 Deleted

11.5.2.9 Augmented Offgas System Building Ventilation Monitor

This monitor continuously measures and records the radionuclide concentration of Nobel Gases in the Augmented offgas building ventilation exhaust stream. When this concentration reaches a preset alarm setpoint level, an alarm is activated in the Control Room. A sample of exhaust duct air is drawn by an isokinetic probe. Sample air passes in series through a particulate filter, an iodine cartridge filter, a noble gas sample chamber, and a sample pump which discharges back to the exhaust duct. The Noble Gas Channel has a scintillation detector, a check source, and is located within a shielded chamber. The Noble Gas Channel has a logarithmic ratemeter in the Control Room. The range of the channel is 1.0E + 01 to 1.0E + 06 counts per minute (Table 11.5-1). The Particulate and Iodine Sample filters are removed for analysis by the Chemistry Department.

11.5.2.10 Radwaste Building Ventilation Monitor

This monitoring system is no longer used by Operations and has been retired in place.

11.5.2.11 Chemistry Facility Description

The chemistry facility area encompasses a hot chemistry laboratory, a cold chemistry laboratory, an instrument room, a count room and a PASS room. The PASS is described in Subsection 11.5.2.12. The facility is located at floor E1. 35', on the east side of the Office Building North End.

The hot chemistry laboratory provides laboratory space and fume hood(s) analyses of high and moderate radiotoxicity samples. A pressure differential is always maintained so as to direct air through the hoods. Periodic monitoring is performed by means of air and particulate grab samples and beta-gamma survey. The PASS fume hood is connected to the exhaust ductwork of one of the hot chemistry laboratory fume hoods. When the PASS fume hood is used, that hot chemistry laboratory fume hood is not available for use.

The cold chemistry laboratory area is used for samples exhibiting little or no radioactivity.

Various laboratory equipment are used in the Hot, Cold, instrument and count rooms in the laboratory. The equipment is representative of types used in the support of sampling to meet Technical Specifications, NJPDES permit, State or Federal standards for the analysis of solids, liquids and gasses in the support of the operation of a BWR.

The facility serves no safety functions, but adequate measures have been taken to satisfy personnel health and safety.

11.5.2.12 Postaccident Sampling System (PASS)

The PASS was designed to obtain liquid and gaseous samples from the primary and secondary containments for analysis at the sampling station, located within the chemistry facility area.

Reactor coolant samples can be drawn from recirculation loop A, the liquid poison spray header and the shutdown cooling system piping. A torus water sample can be drawn from the Core Spray System piping. All liquid samples are returned to the primary containment through the core spray pumps suction line.

Drywell atmosphere samples can be drawn from the hydrogen monitoring system and the drywell oxygen analyzers, and wetwell atmosphere samples are obtained from the torus oxygen analyzer. A secondary containment atmosphere sample can also be drawn into the PASS station. The gas sampling unit has the capability of collecting iodine and/or particulate samples using a standard in-line filter cartridge. Primary containment gaseous samples are returned to the drywell through the discharge line of the containment particulate monitor. The secondary containment samples are returned to the reactor building atmosphere.

All piping and equipment up to and including the second isolation valves meet the requirements of ASME Boiler and Pressure Vessel Code, Section III (Class 2). Piping and tubing is seismically supported and the second isolation valve is qualified for operation following a seismic event. This piping and tubing was installed in accordance with ASME B&PV Code, Section XI, requirements.

Other piping and tubing meets ANSI B31.1 requirements. Conduits are supported in accordance with seismic Category I requirements. Environmental qualification requirements have been met as necessary.

The sample station is installed along the east wall of the PASS room, and sample coolers are installed on the other side of the Reactor Building wall directly opposite to the sample station. The sample station is provided with between 40-100 cfm air flow which exhausts into the Reactor Building via a 3 1/2 inch ventilation duct. The infiltration air flow is induced by the differential pressure maintained between the Reactor Building and the PASS room.

A radiochemical fume hood, with a 900-cfm air exhaust flow is required for dilution of hot samples before transfer to the counting facility. The fume hood exhausts into the ductwork of one of the hot chemical laboratory fume hoods. When the PASS fume hood is used, that hot chemistry laboratory fume hood is not available for use.

All controls for the system, except for the opening of containment isolation valves, are located on two control panels in the PASS room. The containment isolation valves can only be opened from the Control Room by operating key locked bypass switches on Control Room Panel 11F.

The PASS was installed as required by NRC Order dated July 7, 1981 as generally described in NUREG-0737. In response to industry initiatives, the NRC approved NEDO-32991, "Regulatory Relaxation for BWR Post Accident Sampling Stations (PASS) in its Safety Evaluation dated June 12, 2001." Relaxation of the PASS requirements (Amendment 237 to the Oyster Creek Technical Specification) was contingent on meeting the following commitments.

1. "Each licensee should verify that it has, and make a regulatory commitment to maintain (or make a regulatory commitment to develop and maintain), contingency plans for obtaining and analyzing highly radioactive samples of reactor coolant, suppression pool, and containment atmosphere."

2. "Each licensee should verify that it has, and make a regulatory commitment to maintain (or make a regulatory commitment to develop and maintain), a capability for classifying fuel damage events at the Alert level threshold (typically this is 300 uCi/ml dose equivalent iodine). This capability may utilize the normal sampling system and/or correlations of radiation readings to radioisotope concentrations in the reactor coolant."

3. "Each licensee should verify that it has, and make a regulatory commitment to maintain (or make a regulatory commitment to develop and maintain), an I-131 site survey detection capability, including an ability to assess radioactive iodines released to offsite environs, by using effluent monitoring systems or portable sampling equipment."

These commitments to the NRC are met using a combination of the PASS equipment and other equipment/procedures. The PASS provides the means for obtaining and analyzing highly radioactive samples or reactor coolant, suppression pool and containment atmosphere. The PASS system is maintained in good working order and the operation of the system is described in approved plant procedures. The Station Emergency Plan includes classification of fuel damage events at the Alert level threshold and established an I-131 site survey detection capability. The Station Emergency Plan is controlled in accordance with 10CFR50.47.

11.5.2.13 Containment High Range Radiation Monitoring Subsystem

Two high range radiation monitors are installed within the drywell, with readouts in the Control Room. These monitors provide the capability to monitor radiation levels in the drywell, as required by NUREG-0737, Section II.F.1.3. The signal from these monitors isolate the drywell ventilation on a high radiation reading.

TABLE 11.5-1
(Sheet 1 of 3)

PROCESS AND EFFLUENT RADIATION MONITORS

System	Type of Monitor	No. of Channels	Type of Detector	Range	Automatic Actions
Main Steam Line	Process	4	Ion Chambers	1.0 to $1x10^6$ mR/hr	Alarm
RBCCW	Liquid	1	Scintillation	10^{-1} to 10^6 cps	None
Service Water	Liquid Effluent	1	Scintillation	10 to 10^6 cpm	None
Air Ejector Offgas	Process	2	Ion Chamber	1.0 to $1x10^6$ mR/hr	Close V-7-31 & V-7-29 after time delay (0-15 min.)

TABLE 11.5-1
(Sheet 2 of 3)

PROCESS AND EFFLUENT RADIATION MONITORS

System	Type of Monitor	No. of Channels	Type of Detector	Range	Automatic Actions
RAGEMS Stack	Gaseous Effluent High/Low	½	Ion Chamber/Scintillation Detectors	10^{-1} to 127 ûCi/cc$^{(xe133)}$ 10^{-6} to 1 ûCi/cc	None
	Flow	1		0-1.76 SCFM	
RAGEMS Turbine Building	Gaseous Effluent- High and Low	1/1	Ion Chamber/Scintillation Detector	10^{-1} to 127 ûCi/cc$^{(xe133)}$ 10^{-6} to 1 ûCi/cc	None
	Flow	2		0-1.6 SCFM;0-1.88 SCFM	
Domestic Effluent	Liquid Effluent	1	Scintillation Detector		Trip pump

TABLE 11.5-1
(Sheet 3 of 3)

PROCESS AND EFFLUENT RADIATION MONITORS

System	Type of Monitor	No. of Channels	Type of Detector	Range	Automatic Actions
Offgas Bldg. Exhaust	Particulate	1	Particulate	Sample Station	
	Iodine	1	Iodine	Sample Station	
	Noble Gas	1	Beta Scint	10^1 to 10^6 cps	
New Radwaste Bldg Ventilation Exhaust (Off-line)	Particulate	1	Beta Scint	10^1 to 10^6 cps	
	Iodine	1	Gamma Scint	10^1 to 10^6 cps	
	Noble Gas	1	Beta Scint	10^1 to 10^6 cps	