CHAPTER 11

11.0 RADIOACTIVE WASTE MANAGEMENT

CHAPTER 11
RADIOACTIVE WASTE MANAGEMENT

TABLE OF CONTENTS

CHAPTER 11
RADIOACTIVE WASTE MANAGEMENT

TABLE OF CONTENTS (continued)

CHAPTER 11
RADIOACTIVE WASTE MANAGEMENT

TABLE OF CONTENTS (continued)

CHAPTER 11
RADIOACTIVE WASTE MANAGEMENT

LIST OF TABLES

CHAPTER 11
RADIOACTIVE WASTE MANAGEMENT

LIST OF FIGURES

11.0 <u>RADIOACTIVE WASTE MANAGEMENT</u>

11.1 <u>SOURCE TERMS</u>

11.1.1 REACTOR COOLANT ACTIVITIES

The parameters used in the calculation of the reactor coolant fission product inventory, including pertinent information concerning the expected coolant cleanup flow rate and demineralizer effectiveness, are presented in Table 11.1.1-1. The results of the calculations are presented in Table 11.1.1-2. In these calculations one percent defects in the fuel rods were assumed to be present at initial core loading, uniformly distributed throughout the core. The fission product escape rate coefficients are therefore based upon an average fuel temperature.

The fission product activity in the reactor coolant during operation with small cladding pinholes or cracks in one percent of the fuel rods was computed using the following differential equations:

For parent nuclides in the coolant,

$$\frac{dN_{wi}}{dt} = D\nu N_{C_i} - \left(\lambda_i + R\eta_i + \frac{B'}{B_o - \tau B'}\right) N_{wi}$$

for daughter nuclides in the coolant,

$$\frac{dN_{wj}}{dt} = D\nu_j N_{C_j} - \left(\lambda_j + R\eta_j + \frac{B'}{B_o - \tau B'}\right) N_{wj} + \lambda_i N_{w_i}$$

where:

where:	N	=	population of nuclide
	D	=	fraction of fuel rods having defective cladding
	R	=	purification flow, coolant system volumes per sec
	B_o	=	initial boron concentration, ppm
	B_t	=	boron concentration reduction rate by feed and bleed, ppm per sec
	η	=	removal efficiency of purification cycle for nuclide
	λ	=	radioactive decay constant
	ν	=	escape rate coefficient for diffusion into coolant

Subscript C refers to core
Subscript w refers to coolant
Subscript i refers to parent nuclide
Subscript j refers to daughter nuclide

TABLE 11.1.1-1

PARAMETERS USED IN THE CALCULATION OF DESIGN BASIS FISSION AND CORROSION PRODUCT ACTIVITIES

1.	Ultimate core thermal power (Mwt)	2300(h)*
2.	Reactor coolant volume (ft^3)	9400
3.	Reactor coolant full power average temperature (ºF)(a)*	583
4.	Purification flow rate, normal (gpm) (b)*	60
5.	Effective cation demineralizer flow (gpm)(c)*	6.0
6.	Volume control tank	
	a. Vapor volume (ft^3)	180
	b. Liquid volume (ft^3)	120
7.	Nuclide release coefficients	

The nuclide release coefficient is the product of the failed fuel fraction and the fission product escape rate coefficient.

a.	Failed fuel fractions: Equivalent fraction of core power produced by fuel rods containing small cladding defects	0.01
b.	Fission product escape rate coefficients during full power operation (sec^{-1}):	
	1) Kr and Xe isotopes	6.5×10^{-8}
	2) Br, I, and Cs isotopes	1.3×10^{-8}
	3) Mo isotopes	2.0×10^{-9}
	4) Te isotopes	1.0×10^{-9}
	5) Sr and Ba isotopes	1.0×10^{-11}
	6) Y, La, Ce, and Pr isotopes	1.6×10^{-12}

8. Mixed bed demineralizers

Demineralizer isotopic decontamination factors (d)*

a.	Kr and Xe isotopes, Cs134, Cs136, Cs137, Y-90, Mo-99	1
b.	Other isotopes	10

*See end of Table for notes

TABLE 11.1.1-1 (Cont'd)

PARAMETERS USED IN THE CALCULATION OF DESIGN BASIS FISSION AND CORROSION PRODUCT ACTIVITIES

9. Cation bed demineralizer

Demineralizer isotopic decontamination factors (d)*

a.	Cs-136, Cs-134, Cs-137, Y-90, Mo-99	10
b.	Other isotopes, including noble gases and corrosion products	1

10. Volume control tank noble gas stripping fractions (based on no purge to the Gaseous Waste Management System)

ISOTOPE	STRIPPING FRACTION (e)*
Kr-85m	0.27
Kr-85	2.3×10^{-5}
Kr-87	0.60
Kr-88	0.43
Xe-133m	0.037
Xe-133	0.016
Xe-135m	0.80
Xe-135	0.18
Xe-138	1.0

11. Initial boron concentrations (ppm) in primary coolant(f)* -

Initial Cycle	950
Equilibrium Cycle	1000

12. Plant full-power operating times (weeks) -

Initial Cycle	70
Equilibrium Cycle	49

13. Secondary Coolant Parameters

a.	Total steam generator water mass (lb) (one generator)	72,600
b.	Total steam flow rate at 2190 MWt (lb/hr)	9.47×10^{6}
c.	Blowdown rate (gpm) (g)* per steam generator	26.5
d.	Total primary-to-secondary leak rate (lb/day)	48
e.	Steam generator partition factor:	
	1) Br, I	0.01
	2) Others	0.001

*See end of Table for notes

TABLE 11.1.1-1 (Cont'd)

PARAMETERS USED IN THE CALCULATION OF DESIGN BASIS
FISSION AND CORROSION PRODUCT ACTIVITIES
Notes to Table 11.1.1-1

(a) A Reactor Coolant average temperature of 583ºF was used in the analysis to bound actual operating conditions.

(b) Flow measured at charging pump discharge at 2250 psia and 130ºF.

(c) An effective cation demineralizer flow rate of 6.0 gpm was obtained from a 60 gpm purification flow rate and the fraction of time the cation demineralizers are utilized (0.1).

(d) A removal decontamination factor (as distinct from demineralizer DF) was assumed to account for removal mechanisms other than ion exchange; such as plateout, etc.

(e) The nuclide stripping fractions are calculated using the following equation:

$$\psi_i = 1 - \left[\frac{KQ}{KQ + \lambda(KL + V) + P} \right]$$

where:

ψ	=	nuclide volume control tank stripping fraction
K	=	$\frac{RT}{MH}$ 4
R	=	gas constant = 45.59 $\frac{\text{atm/cm}^3}{\text{g mole/}^\circ\text{R}}$ 5
T	=	nominal volume control tank temperature (ºR)
M	=	molecular weight of water = 18.0 g/g mole
H	=	Henry's Law Constant
H	=	3.02×10^4 atm/mole fraction for krypton, at 115ºF
H	=	2.04×10^4 atm/mole fraction for xenon, at 115º
Q	=	letdown or purification flowrate (g/sec)
λ	=	nuclide decay constant (1/sec)
L	=	volume control tank liquid mass (g)
V	=	volume control tank vapor volume (cm^3)
P	=	volume control tank purge rate to the gaseous waste management system, at volume control tank conditions (cm^3/sec)

(f) The initial boron concentration is used to model the feed and bleed affect on radionuclide concentrations. Higher initial boron concentrations require higher feed and bleed flows to dilute the RCS from Beginning-of-Cycle to End-of-Cycle boron concentrations. High feed and bleed flow rates reduce the radionculide concentrations; therefore, the calculated concentrations will continue to be conservative and bounding when the initial boron concentration exceeds the assumed value.

(g) Flow assumed to be at normal conditions with primary and secondary boundary intact.

(h) Although this analysis was performed at 2300 MWt, the RCS Technical Specification activity limits ensure that the results represent a bounding source term.

TABLE 11.1.1-2

REACTOR COOLANT SYSTEM EQUILIBRIUM ACTIVITIES
(COOLANT TEMPERATURE 583 F)

Activation Products	μCi/cc
Mn-54	3.64×10^{-4}
Mn-56	7.85×10^{-2}
Co-58	1.09×10^{-2}
Fe-59	2.52×10^{-4}
Co-60	1.29×10^{-3}
Cr-51	8.10×10^{-5}

Gaseous Fission Products	μCi/cc
Kr-85	4.21
$Kr-85^{m}$	1.01
Kr-87	0.693
Kr-88	2.49
Xe-133	$1.66 \times 10^{+2}$
Xe-135	4.57
Xe-138	3.18×10^{-1}

Non-Volatile Fission Products (Continuous Full Power Operation)

	μCi/cc		μCi/cc
H-3	2.5 (max)	I-131	1.50
Br-84	2.6×10^{-2}	Te-132	1.65×10^{-1}
Rb-88	2.48	I-132	5.54×10^{-1}
Rb-89	5.8×10^{-2}	I-133	2.42
Sr-89	2.5×10^{-3}	Te-134	1.86×10^{-2}
Sr-90	7.5×10^{-5}	I-134	3.40×10^{-1}
Y-90	9.4×10^{-5}	Cs-134	1.60×10^{-1}
Sr-91	1.15×10^{-3}	I-135	1.30
Y-91	4.4×10^{-3}	Cs-136	2.30×10^{-2}
Y-92	4.06×10^{-3}	Cs-137	8.69×10^{-1}
Zr-95	5.22×10^{-4}	Cs-138	4.44×10^{-2}
Nb-95	5.19×10^{-4}	Ba-140	5.37×10^{-4}
Zr-97	1.60×10^{-5}	La-140	5.53×10^{-4}
Mo-99	1.97	Ce-144	1.91×10^{-3}
Ru-105	4.5×10^{-4}	Pr-144	2.06×10^{-3}

11.1.2 Tritium

During the operation of a nuclear reactor, the abundance of tritium in the coolant increases due to several sources. These include neutron absorption by deuterium in the coolant, direct tritium knockout reactions with B^{10} and α knockout reactions with Li^6 and Li^7 in the coolant as well as leakage from the fuel rods of fission products created in the fuel. Tritium is removed from the coolant during reactor operation as the boron is diluted out during the cycle. The parameters used in the calculation of the tritium production rate are presented in Table 11.1.2-1. A detailed description of the methodology used to calculate tritium released can be found in Reference 11.1.2-1.

11.1.2.1 Production Mechanisms

The tritium produced within the fuel rods is calculated by a single ORIGEN (Reference 11.1.2-2) run covering the range from 0 to 57,064 MWd/MTU burnup. The enrichment used for the ORIGEN run is the lowest average enrichment anticipated for operation of H.B. Robinson. The lower the enrichment, the greater the tritium produced for a fixed power and burnup.

For production in the coolant, the most important reactions are tritium knockout from B^{10} and α knockout from Li^6. The overall significance of the interaction with lithium is very sensitive to the assumed isotopic distribution of the LiOH used to buffer the primary coolant. Normally, the lithium in the resin exchange column is at least 99.9% Li^7. The reactions for the coolant and the ions it normally carries are summarized below.

Boron - There are two paths by which tritium can be produced from B^{10}.

1. $B^{10} + n \rightarrow H^3 + Be^8$

   where the Be^8 decays to two α particles with a time constant of the order of 10^{-16} seconds.

2. $B^{10} + n \rightarrow Li^7 + He^4$

   The Li^7 created in this way becomes part of the total lithium in the primary coolant, which is an alternative source of tritium.

Of these two paths, only No. 1 is a significant contributor since the lithium created in No. 2 is removed from the coolant to maintain the total lithium shown in Figure 11.1.2-4.

Lithium - There are two isotopes of lithium involved here. Li^7 is far more abundant but has a much smaller cross-section than Li^6. The reactions are as follows:

$Li^7 + n \rightarrow He^4 + H^3 + n$

and

$Li^6 + n \rightarrow He^4 + H^3$

Deuterium - Deuterium can pick up a neutron and become tritium. This reaction is of the form:

$H^2 + n \rightarrow H^3$

11.1.2.2 Coolant Tritium

During the operating cycle, the boron and lithium concentrations change. The boron concentration is adjusted by adding fresh water and sending the excess reactor coolant to a CVCS holdup tank. The lithium concentration and isotopic concentrations are maintained by the demineralizer.

Table 11.1.2-2 contains the results of the calculations used to determine the concentration of tritium in the reactor coolant. The licensing basis analysis takes into account tritium production in the coolant, 1% leakage from failed fuel and assumes that 10% of the tritium produced within the fuel rod leaks out into the coolant. Figure 11.1.2-1 shows the daily tritium production in the coolant from all direct reactions. Figures 11.1.2-2 and 11.1.2-3 show the total tritium activity in the coolant and the cumulative tritium activity that would be processed for recycle or release for the cycle.

TABLE 11.1.2-1

ASSUMPTIONS USED TO CALCULATE TRITIUM PRODUCTION IN THE REACTOR COOLANT

Basic Assumptions:

Plant Parameters:

Core Thermal Power, (MW)	2300.0***
Average Neutron Flux (n/cm^2-second)	4.011×10^{13}
Cycle Length (EFPD) (Corresponds to an 18-month cycle)	455
Outage length (days)	30
Reactor Coolant System Volume (ft^3)	9,400.0
Volume of water in Reactor Core (ft^3)	569.6
Average Enrichment (w/o U^{235})	3.69
Number of Assemblies	157
Reload Batch Size*	40
Mass of an Assembly	461.4 kgU
Lithium Concentration****	See Figures 11.1.2-4 and 11.1.2-5
Boron Concentration**	See Figure 11.1.2-6
Boron Concentration for Switch to Coolant Recirculation (ppm)	45
Atomic Fraction of B^{10} in Boron	0.199
Atomic Fraction of Li^6 in Lithium	$\leq$ 0.001
Natural Abundance of Deuterium	0.00015
Average Density of Coolant (lbm/ft^3)	45.19
Cross Sections (barns) for:	
B^{10} {n,t} Be^8	0.0744
B^{10} {n,} Li^7	2,450
Li^7 {n,n} H^3	0.0516
Li^8 {n,} H^3	553
H^2 {n,t}	2.5×10^{-4}

* The effect of the batch size is minor because the average burnup at any point in the cycle will be adjusted to produce the same core reactivity. Weighted flux variations will therefore be about the same for different batch sizes.

** The boron concentrations used in the analysis are higher than the boron concentrations expected during actual operation in order to create a bounding analysis.

*** Although this analysis was performed at a power level of 2300 MWt, evaluations have shown that the results remain bounding for operation at 2339 MWt.

**** Evaluation has shown that the effect of the increased lithium concentration due to the RCS pH change does not challenge the analysis of record results. Therefore the tritium production analysis remains bounding.

TABLE 11.1.2-2

CALCULATION OF TRITIUM PRODUCTION IN THE REACTOR COOLANT

	Ci/Cycle Equilibrium Cycle
A. Tritium from fuel rods released to coolant	
(assuming release fraction of 0.10 and 1% fuel failure)	3140
B. Tritium from Coolant	
Total Release to Coolant	858
C. Total Tritium Released to Coolant	3998
D. Total Tritium Processed	
(for recycle or release)	3685
E. Maximum Tritium in Coolant	
(occurring 231 EFPDs into the Cycle)	1588

REFERENCES: SECTION 11.1

11.1.2-1 H. B. Robinson Tritium Production Analysis, EMF-95-039 (P), March 1995, Siemens Power Corporation.

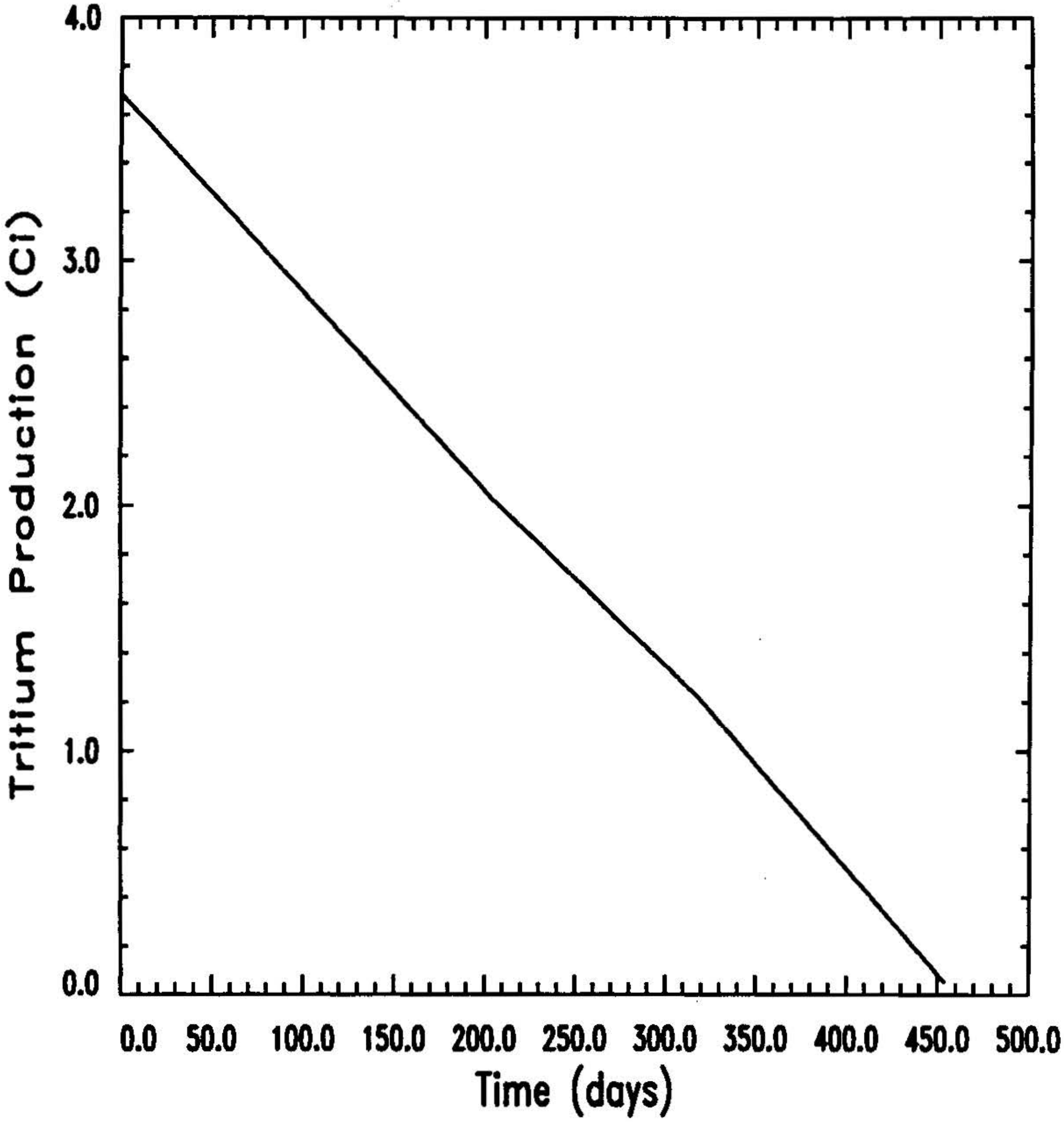
11.1.2-2 Bell, M. J., ORIGEN - The ORNL Isotope Generation and Depletion Code, Oak Ridge National Laboratory, ORNL-4628, May 1973.

11.1.3 LEAKAGE PREVENTION

Quality control of the material and the installation of the Chemical and Volume Control valves and piping which are designated for radioactive service is provided in order to essentially eliminate leakage to the atmosphere. The components designated for radioactive service are provided with welded connections to prevent leakage to the atmosphere. However, to permit removal for maintenance, flanged connections are provided in each charging pump suction and discharge, on each boric acid pump suction and discharge, on each relief valve inlet and outlet, on three-way valves and on the flow meters.

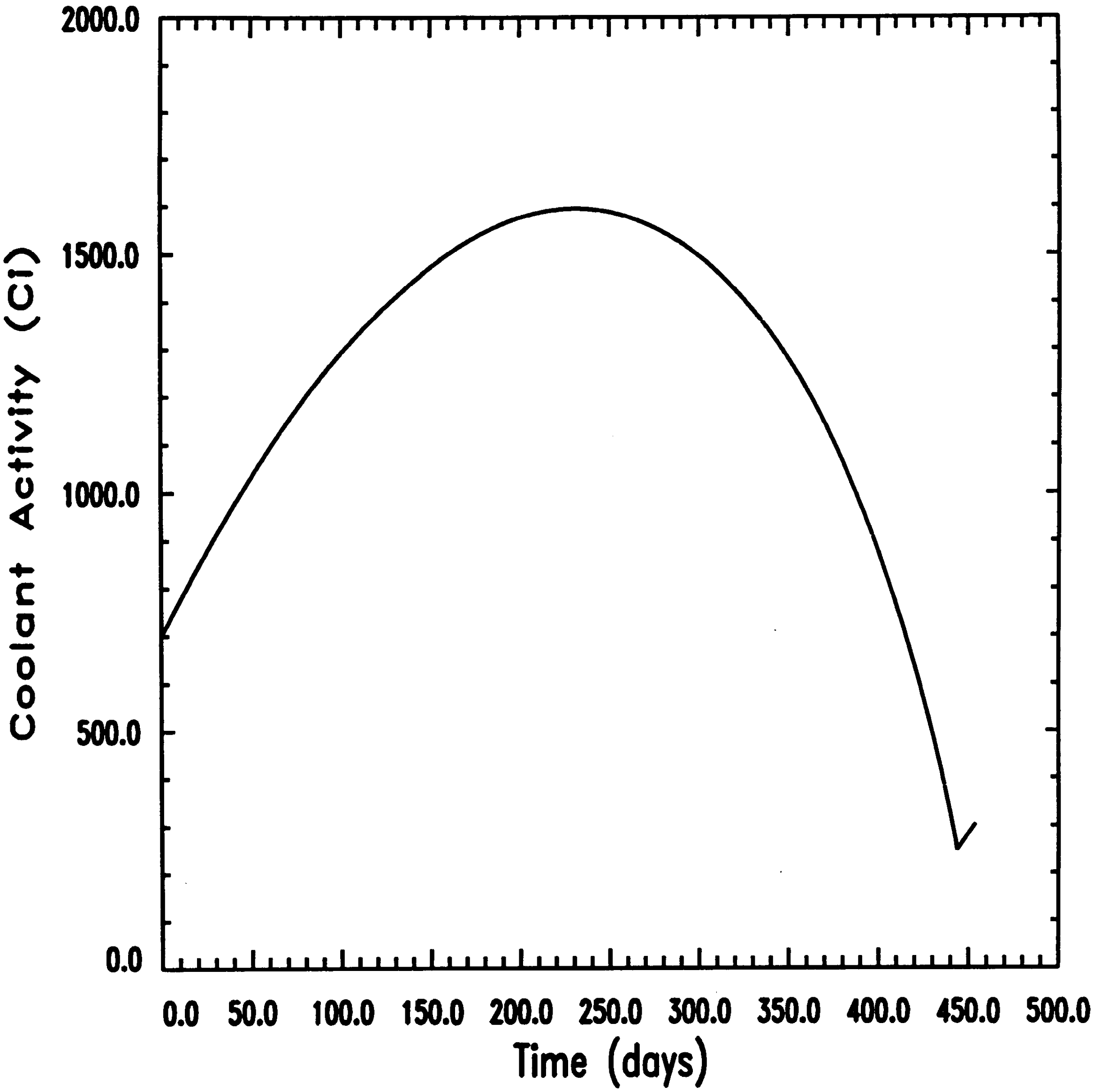
The positive displacement charging pump stuffing boxes are provided with leakoffs to collect reactor coolant before it can leak to the atmosphere. With the exception of valves which have been live loaded and had leakoff lines capped, valves which are larger than 2 in. and which are designated for radioactive service at an operating fluid temperature above 212°F are provided with a stuffing box and lantern leakoff connections. Leakage to the atmosphere is essentially zero for these valves. Control valves are either provided with stuffing box and leakoff connections or are totally enclosed or have leak off connections capped. Leakage to the atmosphere is essentially zero for these valves.

Diaphragm valves are provided where the operating pressure and the operating temperature permit the use of these valves. Leakage to the atmosphere is essentially zero for these valves.



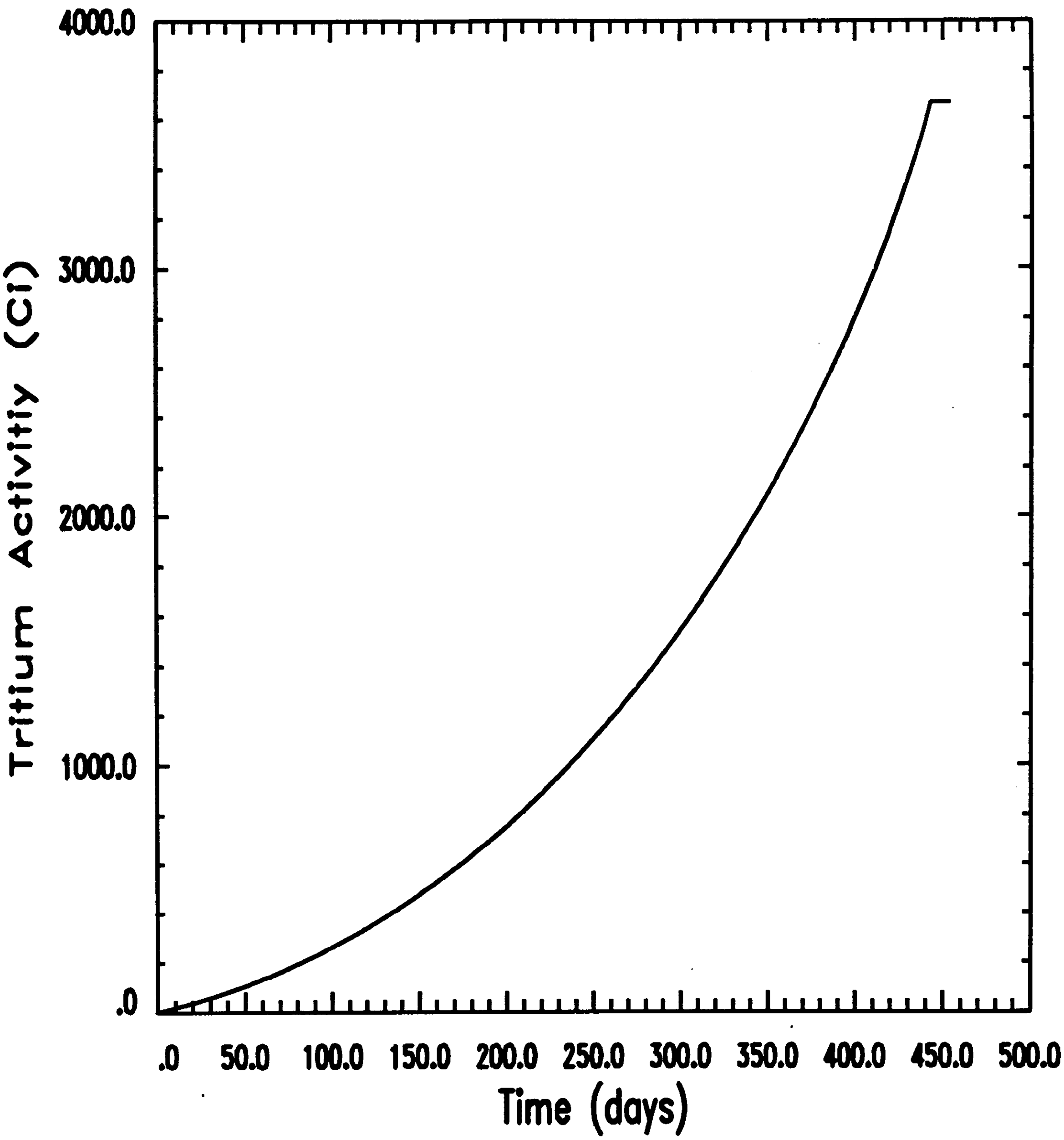
REVISION NO. 13

H. B. ROBINSON UNIT 2 Carolina Power & Light Company UPDATED FINAL SAFETY ANALYSIS REPORT	Tritium Activity Produced in the Coolant Each Day in Ci	FIGURE 11.1.2-1



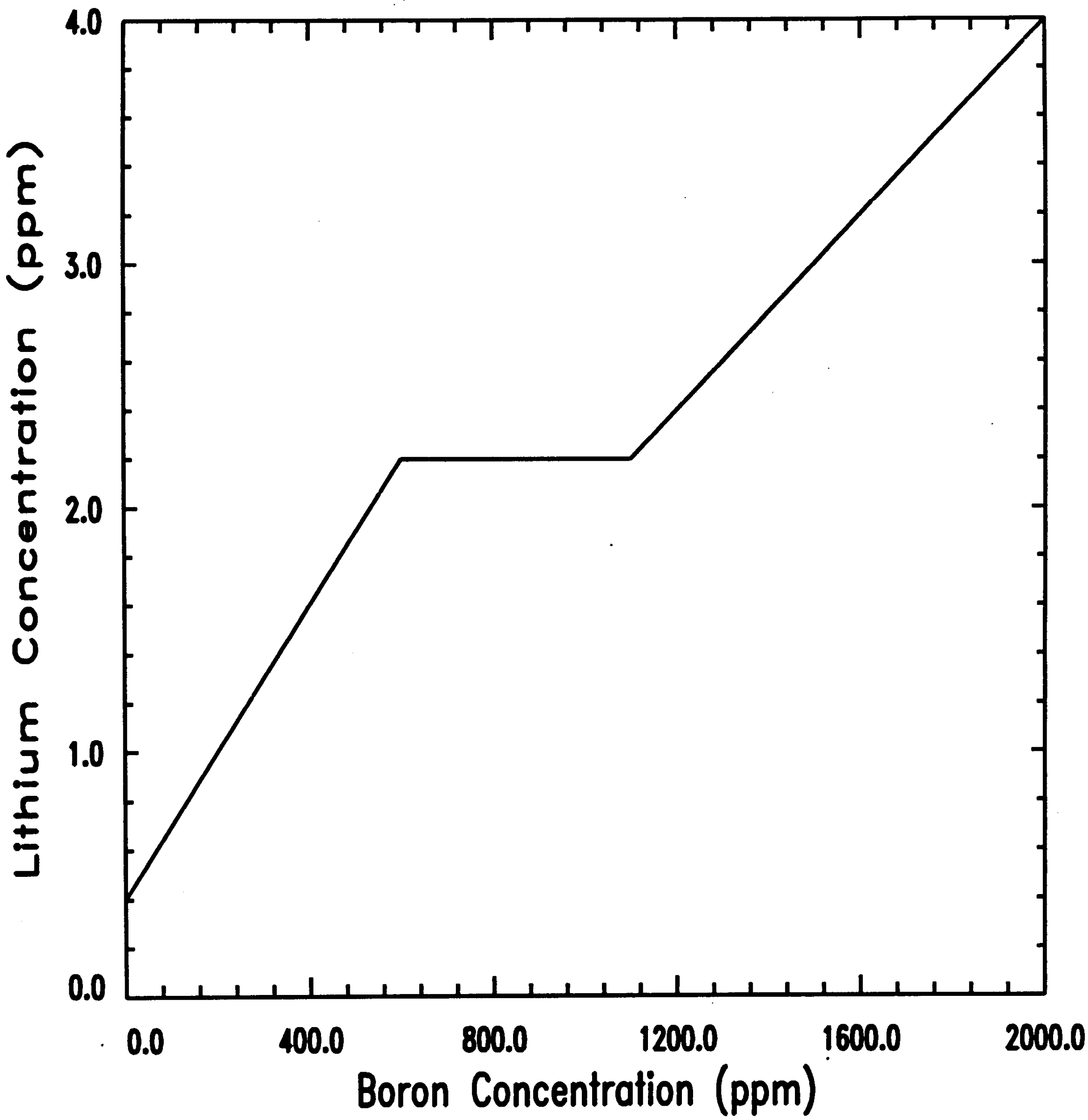
REVISION NO. 13

H. B. ROBINSON UNIT 2 Carolina Power & Light Company UPDATED FINAL SAFETY ANALYSIS REPORT	Tritium Activity in the Coolant	FIGURE 11.1.2-2



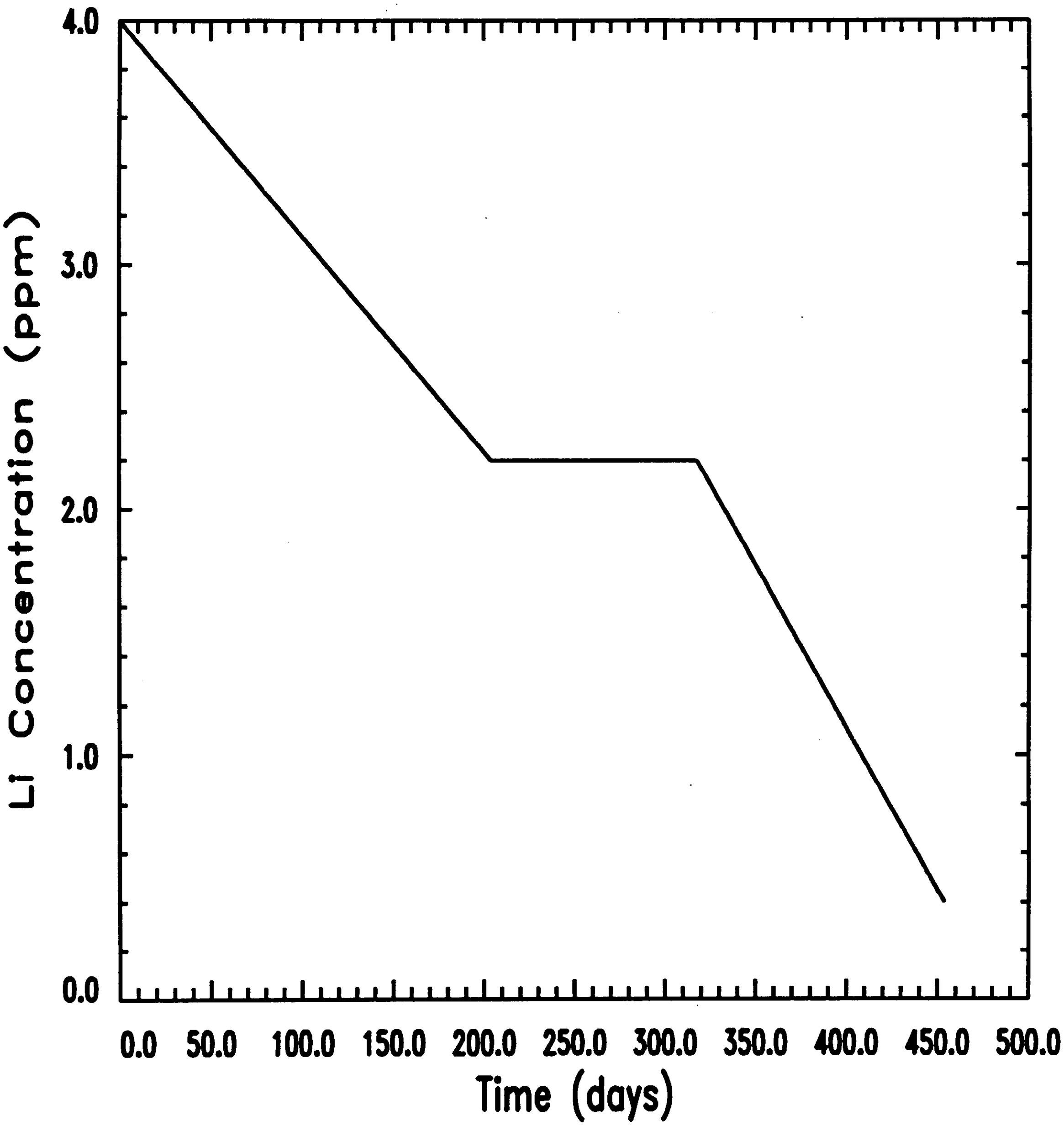
REVISION NO. 13

H. B. ROBINSON UNIT 2 Carolina Power & Light Company UPDATED FINAL SAFETY ANALYSIS REPORT	Tritium Activity Processed for Recycle or Release	FIGURE 11.1.2-3



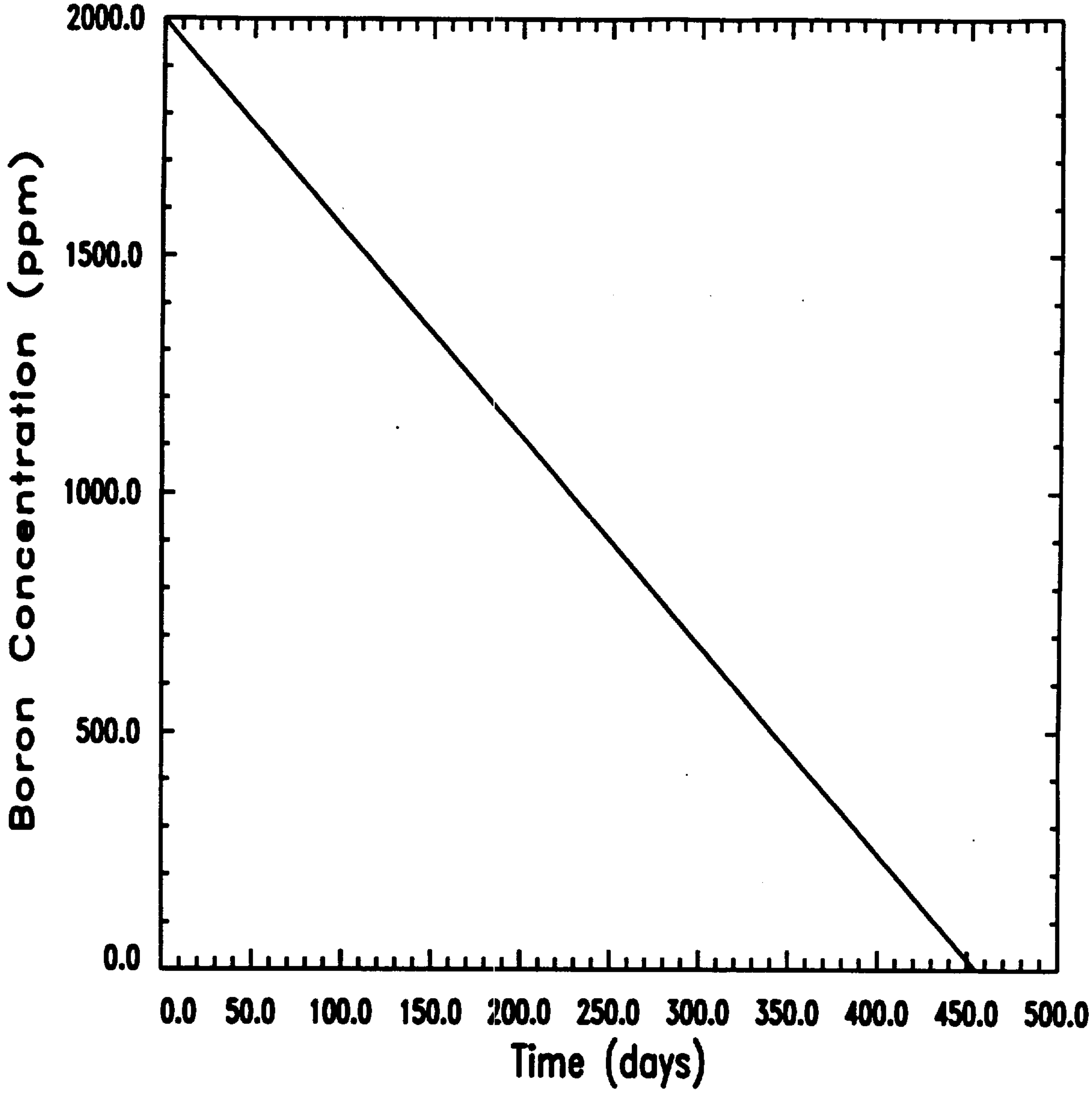
REVISION NO. 13

H. B. ROBINSON UNIT 2 Carolina Power & Light Company UPDATED FINAL SAFETY ANALYSIS REPORT	EPRI Lithium Concentration Curve	FIGURE 11.1.2-4



REVISION NO. 13

H. B. ROBINSON UNIT 2 Carolina Power & Light Company UPDATED FINAL SAFETY ANALYSIS REPORT	Lithium Concentration versus Cycle Time	FIGURE 11.1.2-5



REVISION NO. 13

H. B. ROBINSON UNIT 2 Carolina Power & Light Company UPDATED FINAL SAFETY ANALYSIS REPORT	Boron Letdown Curve	FIGURE 11.1.2-6

11.2 LIQUID WASTE MANAGEMENT SYSTEMS

Liquid waste disposal facilities are designed so that discharge of effluents and offsite shipments are in accordance with applicable governmental regulations. The ODCM provides the methodologies to be used by the plant to comply with technical specifications for release of liquid and gaseous radioactive effluent. The NPDES permit lists the limits and sampling requirements for chemical species released in plant effluents.

Radioactive fluids entering the Waste Disposal System (WDS) are collected in sumps and tanks until determination of subsequent treatment can be made. They are sampled and analyzed to determine the quantity of radioactivity. Before discharge, radioactive fluids are processed as required and then released under controlled conditions. The system design and operation are characteristically directed toward minimizing releases to unrestricted areas. Discharge streams are appropriately monitored and safety features are incorporated to preclude releases in excess of the limits of 10 CFR 20.

Contaminated mop water and other decontamination solutions can be collected and processed to meet NPDES limits before being pumped to a WCT for release. Charcoal can be used to remove oil and grease and filters can be used to remove suspended solids to meet NPDES limits.

The bulk of the radioactive liquids discharged from the Reactor Coolant System (RCS) are processed and retained inside the plant by the Chemical and Volume Control System (CVCS) and Waste Water Demineralization System (WWDS). Processed wastes are stored until shipped for offsite disposal.

11.2.1 DESIGN BASIS

The facility design shall include those means necessary to maintain control over the plant liquid radioactive effluents. Appropriate holdup capacity shall be provided for retention of liquid effluents, particularly where unfavorable environmental conditions are expected to require operational limitations upon the release of radioactive effluents to the environment. In all cases, the design for radioactivity control must be justified:

a) On the basis of 10 CFR 20 requirements, for normal operations and for any transient situation that might reasonably be anticipated to occur.

b) On the basis of 10 CFR 50.67 requirements, for potential accidents of exceedingly low probability of occurrence.

The system is capable of processing all wastes generated during continuous operation of the primary system assuming that fission products escape from one percent of the fuel into the reactor coolant.

A program designed to reduce leakage from systems outside containment that would or could contain highly radioactive fluids during a serious transient or accident is implemented in accordance with Improved Technical Specifications (ITS) Section 5.5.2, "Primary Coolant Sources Outside Containment." The program applies to the following portions of the Liquid Waste Disposal System:

a. From reactor coolant drain tank,

b. Sump A and Transfer pump,

c. Residual Heat Removal Pump Pit Sump Pumps, and

d. Waste Holdup Tank.

This program includes the following:

a. Preventative maintenance and periodic visual inspection requirements, and

b. Integrated leak test requirements for each system at refueling cycle intervals or less.

The program employs visual inspections of the mechanical joints and seals of the systems to detect leakage. The inspections are conducted with the system pressurized to normal system pressure using the system fluid as a test medium. The observed leakage is evaluated if the leakage is "as low as practical." Any leakage evaluated as not being "as low as practical" that cannot be corrected by the inspector will be identified on a work request.

The Liquid Waste Disposal components with their associated design parameters are presented in Table 11.2.1-1 and the applicable code requirements for these components are presented in Table 3.2.2-5.

At least two valves must be manually opened to permit discharge of liquid waste from the WDS. One of these valves is normally locked closed. The control valve will trip closed on a high effluent radioactivity level signal.

TABLE 11.2.1-1

LIQUID WASTE MANAGEMENT SYSTEM, COMPONENTS, AND DESIGN PARAMETERS

COMPONENTS

REACTOR COOLANT DRAIN TANK

Number	1
Volume	350 gal
Design pressure, internal	25 psig
Design pressure, external	60 psig
Design temperature, internal	267ºF
Design temperature, external	120ºF
Normal operating pressure range	0.5 - 2.0 psig
Normal operating temperature range	80 - 200ºF
Material of construction	Austenitic SS

LAUNDRY AND HOT SHOWER TANKS

Number	2
Volume, each	600 gal
Design pressure	Atmospheric
Design temperature	180ºF
Normal operating pressure	Atmospheric
Normal operating temperature	80 - 160ºF
Material of construction	Austenitic SS

CHEMICAL DRAIN TANK

Number	1
Volume	375 gal
Design pressure	Atmospheric
Design temperature	180ºF
Normal operating pressure	Atmospheric
Normal operating temperature	80 - 140ºF
Material of construction	Austenitic SS

WASTE HOLDUP TANK

Number	1
Volume	3000 ft^3/22,440 gal
Design pressure	Atmospheric
Design temperature	150ºF
Normal operating pressure	Atmospheric
Normal operating temperature	80 - 140ºF
Material of construction	Austenitic SS

TABLE 11.2.1-1 (Cont'd)

LIQUID WASTE MANAGEMENT SYSTEM, COMPONENTS, AND DESIGN PARAMETERS

SPENT RESIN STORAGE TANK

Number	1
Volume, each	300 ft^3/2,244 gal
Design pressure	100 psig
Design temperature	150ºF
Normal operating pressure	0.5 - 15 psig
Normal operating temperature	Ambient
Material of construction	Austenitic SS

WASTE CONDENSATE TANKS A AND B

Volume, each	1000 gal
Design pressure	Atmospheric
Design temperature	180ºF
Normal operating pressure	Atmospheric
Normal operating temperature	80 - 160ºF
Material of construction	Austenitic SS

WASTE CONDENSATE TANKS C, D, AND E

Volume, each	11,250 gal
Design pressure	2.1 psi
Design temperature	200ºF
Normal operating pressure	Atmospheric
Normal operating temperature	80 - 160ºF
Material of construction	Stainless steel

AUXILIARY BUILDING SUMP TANKS

Number	2
Volume	375 gal
Design pressure	Atmospheric
Design temperature	180ºF
Normal operating pressure	Atmospheric
Normal operating temperature	80 - 140ºF
Material of construction	Austenitic SS

CONCENTRATES HOLDING TANK

Number	1
Type	Cylindrical, heated
Volume	925 gal
Design pressure	Atmospheric
Design temperature	250ºF
Normal operating temperature	150ºF
Material of construction	Austenitic SS

TABLE 11.2.1-1 (Cont'd)

LIQUID WASTE MANAGEMENT SYSTEM, COMPONENTS, AND DESIGN PARAMETERS

REACTOR COOLANT DRAIN TANK PUMPS

Number			2
Type			Canned
Design flow rate,	Pump A		50 gpm
	Pump B		150 gpm
Total head at design flow rate,		Pump A	169 ft
		Pump B	165 ft
Design pressure			150 psig
Design temperature			267ºF
Required NPSH at design flow,		Pump A	5 ft
		Pump B	6 ft
Material of construction, wetted surfaces			Austenitic SS

CHEMICAL DRAIN TANK PUMP

Number	1
Type	Horiz. Cent.
Design flow rate	20 gpm
Design head	100 ft
Design pressure	150 psig
Design temperature	180ºF
Required NPSH at design flow	10 ft
Material of construction, wetted surfaces	Austenitic SS

LAUNDRY AND HOT SHOWER TANK PUMP

Number	1
Type	Horiz. Cent.
Design flow rate	20 gpm
Design head	100 ft
Design pressure	150 psig
Design temperature	180ºF
Required NPSH at design flow	10 ft
Material of construction, wetted surfaces	Austenitic SS

AUXILIARY BUILDING SUMP TANK PUMPS

Number	4
Type	Horiz. Cent.
Design flow rate	20 gpm
Design head	100 ft
Design pressure	150 psig
Design temperature	180ºF
Required NPSH at design flow	10 ft
Material of construction, wetted surfaces	Austenitic SS

TABLE 11.2.1-1 (Cont'd)

LIQUID WASTE MANAGEMENT SYSTEM, COMPONENTS, AND DESIGN PARAMETERS

EVAPORATOR FEED PUMPS A AND B

Number	2
Type	Horiz. Cent.
Design Flow Rate	150 gpm at 3500 rpm
Design Head	150 ft
Material of construction, wetted surfaces	Austenitic SS

WASTE CONDENSATE PUMPS A AND B

Type	Horiz. Cent.
Design flow rate	20 gpm at 3500 rpm
Design head	100 ft
Material of construction, wetted surfaces	Austenitic SS

WASTE CONDENSATE PUMPS C AND D

Type	Horiz. Cent.
Design flow rate	55 gpm at 3500 rpm
Design head	160 ft
Material of construction, wetted surfaces	Austenitic SS

WASTE CONDENSATE TANK RECIRC. PUMP

Number	1
Type	Horiz. Cent.
Design flow rate	275 gpm at 1750 rpm
Design head	110 ft
Material of construction, wetted surfaces	Austenitic SS

CONCENTRATES HOLDING TANK PUMP

Number	1
Type	Rotary screw
Design flow rate	Variable
Design head	Variable
Material of construction, wetted surfaces	Austenitic SS

CONCENTRATES HOLDING TANK ELECTRIC HEATER

Number	1
Heat transfer rate	3.0 kW
Material of construction	Austenitic SS

TABLE 11.2.1-1 (Cont'd)

LIQUID WASTE MANAGEMENT SYSTEM, COMPONENTS, AND DESIGN PARAMETERS

CONCENTRATES FILTER

Number	1
Type	Disposable cartridge
Design pressure	200 psig
Design temperature	250ºF
Design flow rate	20 gpm
Pressure drop at 20 gpm, clean	5 psi
Retention for 25 micron particles	98%
Maximum pressure drop at 20 gpm	20 psi
Material of construction (vessel)	Austenitic SS

LAUNDRY TANK BASKET STRAINER

Number	1
Design temperature	200ºF
Design pressure	150 psig
Design flow	40 gpm
Material in contact with fluid	Stainless steel

WASTE FILTER

Number	1
Design temperature	180ºF
Design pressure	150 psig
Design flow	20 gpm
Material	Stainless steel
Type	Replaceable cartridge

"A" WASTE EVAPORATOR - HISTORICAL DATA NOT UPDATED

Number	1
Type	Vacuum
Design process rate	2 gpm
Feed composition, dissolved solids	Variable
activity	Variable
Bottoms composition, dissolved solids	Variable
activity	40 μCi/cc max
Condensate composition, dissolved solids	Variable
activity	4 x 10^{-5} μCi/cc max
Decontamination factor:	
Bottoms activity / Condensate activity	10^6
Steam supply, flow rate	1200 lb/hr
pressure (saturated)	15 psig
Cooling water, flow rate	90 gpm
inlet temperature	105ºF
outlet temperature	128ºF
Basic material of construction	Austenitic SS

TABLE 11.2.1-1 (Continued)

LIQUID WASTE MANAGEMENT SYSTEM, COMPONENTS, AND DESIGN PARAMETERS

"B" WASTE EVAPORATOR - NOT USED

Number	1
Type	Positive Pressure (0-5 psig)
Design process rate	15 gpm
Feed composition, dissolved solids	Variable
Steam supply, flow rate	10,500 lbs/hr
Cooling water, flow rate	850 gpm
Inlet temperature	105ºF
Outlet temperature	Variable
Basic material of construction	Austenitic SS

COOLING TOWER - NOT USED

Number	1 (Double unit)
Type	Counter flow blow through
Design cooling rate	8.8×10^6 BTU/hr
Fan capacity	126,000 cfm
Basic material of construction	Galvanized steel

"B" WASTE EVAPORATOR COOLING WATER PUMP - NOT USED

Number	1
Type	Horiz. Cent.
Design flow rate	850 gpm at 1780 rpm
Design head	235 ft
Material of construction, wetted surfaces	Austenitic SS

POLISHING ION EXCHANGERS

Number	2
Resin type	IRN 150
Capacity	30 cu ft
Material of construction	Austenitic SS

E&RC BUILDING LAB/WASTE SUMP TANK

Volume	1122 gal.
Design Pressure	Atmospheric
Design Temperature	200ºF
Normal Operating Temperature	120ºF
Normal Operating Pressure	Atmospheric
Material of Construction	Reinforced Concrete

E&RC BUILDING LAB/WASTE SUMP PUMP

Type	Vertical Sump
Design Flow Rate	30 gpm
Design Head	25 ft.

TABLE 11.2.1-1 (Cont'd)

LIQUID WASTE MANAGEMENT SYSTEM, COMPONENTS, AND DESIGN PARAMETERS

RADWASTE BUILDING SHIPPING BAY SUMP

Volume	70 gal.
Design Pressure	Atmospheric
Design Temperature	200ºF
Normal Operating Temperature	60 - 105ºF
Normal Operating Pressure	Atmospheric
Material of Construction	Reinforced concrete

RADWASTE BUILDING SHIPPING BAY SUMP PUMP

Number	1
Type	Vertical Pump
Design Flow Rate	20 gpm
Material of construction, wetted surfaces	316 SS

RADWASTE BUILDING MAIN SUMP

Volume	1650 gal.
Design Pressure	Atmospheric
Design Temperature	200±F
Normal Operating Temperature	60 - 105ºF
Normal Operating Pressure	Atmospheric
Material of Construction	Reinforced concrete with stainless steel liner

RADWASTE BUILDING MAIN SUMP PUMP

Number	2
Type	Vertical Pump
Design Flow Rate	50 gpm
Material of construction, wetted surfaces	316 SS

WASTEWATER DEMINERALIZATION SYSTEM FILTER

Number	6
Type	Disposable cartridge or bag
Design Pressure	150 psig
Design Temperature	140ºF
Design Flow Rate	100 gpm
Micron Rating	Various
Material of Construction (vessel)	Stainless steel

WASTEWATER DEMINERALIZATION

Number	4
Resin Type	Various
Design Pressure	150 psig
Design Temperature	120ºF
Capacity	30 cu. ft.
Material of Construction (vessel)	Stainless steel

11.2.2 System Description

11.2.2.1 Liquid Radioactive Waste Processing

During normal plant operation the WDS processes liquids from the following sources:

1. Equipment drains and leakoffs
2. Radioactive chemical laboratory drains
3. Radioactive shower drains
4. Decontamination area drains
5. Demineralizer regeneration (normally not used)

As shown in the flow diagrams, Figures 11.2.2-1 through 11.2.2-4, the system also collects and transfers liquids from the following sources to the WHUT or CVCS for processing:

1. Reactor coolant loop drains
2. Pressurizer relief tank
3. Reactor coolant pump secondary seals
4. Excess letdown during startup
5. Accumulators
6. Reactor vessel flange leakoffs

These liquids flow to the reactor coolant drain tank and are discharged to the WHUT or the CVCS holdup tanks by the reactor coolant drain pumps which are operated automatically by a level controller in the tank. These pumps also return water from the refueling canal and cavity to the refueling water storage tank.

Where possible, waste liquids drain to the waste holdup tank by gravity flow. Other waste liquids drain to the sump tank and are discharged to the waste holdup tank by pumps operated automatically by a level controller in the tank.

The radioactivity level of waste liquid from the hot shower area will usually be low enough to permit discharge from the site without radwaste processing. However the waste liquid oil & grease level and suspended solids level are usually well in excess of the NPDES limits for those parameters. Once sent to the laundry and hot shower tanks, water that exceeds NPDES limits must be pumped to the WHUT for processing through the Waste Water Demineralization System (WWDS) to remove oil & grease and suspended solids. As an alternative, instead of sending slightly contaminated mop water or decontamination solutions to a laundry and hot shower tank, the solutions may first be processed to meet NPDES limits and then transferred to a WCT for release. Final analysis for record is done on samples from the waste condensate tanks, which can be isolated to ensure no added contamination during sampling, analysis and release.

Liquids from the waste holdup tank and CVCS holdup tanks are processed using the WWDS and Boron Recycle System (BRS). The WWDS and BRS consist of filters and demineralizers with various capabilities selected depending on process conditions. Processed liquids are routed to one of the Waste Condensate Tanks or Monitor Tanks. When the tank is filled, it is isolated and sampled for analysis while an alternate tank is in service. If analysis confirms the activity level is suitable for discharge, the processed liquid is pumped through a flow meter and a radiation monitor to the condenser circulating water discharge. Otherwise, it is returned to the waste holdup tank for reprocessing. Although the radiochemical analysis forms the basis for recording activity releases, the radiation monitor provides surveillance over the operation by closing the discharge valve if the liquid activity level exceeds a preset value.

Liquids in the Radwaste Building sump are to be discharged into the storm sewer if analysis confirms the activity level is suitable for discharge. Otherwise, it is required to be pumped to a radwaste drain.

11.2.2.2 Components

Codes applying to components of the WDS are shown in Table 3.2.2-5. Components summary data are shown in Table 11.2.1-1.

Laundry and Hot Shower Tanks

Two stainless steel tanks collect liquid wastes originating from the hot shower area. When a tank has been filled, its contents are normally pumped to the waste holdup tank for processing to meet NPDES and effluent limits.

Chemical Drain Tank

The stainless steel chemical drain tank is provided to collect drainage from the post accident sample system. After analysis, the tank contents are pumped to the waste holdup tanks or to the waste condensate tanks.

Reactor Coolant Drain Tank

The reactor coolant drain tank is all-welded austenitic stainless steel. This tank serves as a drain collecting point for the RCS and other equipment located inside the reactor containment.

Waste Holdup Tank

The waste holdup tank retains radioactive liquids from the CVCS, sump tank, chemical drain tank, reactor coolant drain tank, and laundry and hot shower tanks. The tank is stainless steel of welded construction.

Sump Tanks and Pumps

The sump tanks serve as collecting points for waste discharged to the basement level drain header. They are located at the lowest point in the Auxiliary Building. All floor drains entering these tanks contain loop seals to prevent gas from leaving the pressure vent system. Two horizontal centrifugal sump pumps drain these tanks. All wetted parts of the pumps are stainless steel. The tanks are all welded austenitic stainless steel.

E&RC Lab/Waste Sump Tank

This tank serves as a collection point for liquid waste discharged from the E&RC laboratory. It is located east of the E&RC Building and is below grade. It is connected to the "B" sump tank in the Auxiliary Building by a 2" stainless steel line (A-312, Type 316). One 30 gpm vertical sump pump pumps liquid waste to the "B" Radwaste Sump in the Auxiliary Building. The E&RC Lab/Waste Sump Tank is constructed of reinforced concrete.

Radwaste Building Sumps

The sumps serve as a collection point for liquid waste originating from the Radwaste Building. The truck bay sump liquid is pumped to the main building sump. The main building sump will be either pumped to the storm sewer or a radwaste drain depending on radioactivity level. The Radwaste Building sumps are constructed of reinforced concrete, and the main sump has a stainless steel liner.

Spent Resin Storage Tank

The spent resin storage tank retains spent resin normally discharged from the mixed bed, cation, deborating, spent fuel pit, base and cation, evaporator condensate, and polisher demineralizers. The deborating and evaporator condensate demineralizers are not normally regenerated. Normally, the tank is filled over a long period of time, the contents are allowed to decay, and then emptied prior to receiving any additional resin. However, the contents can be removed at any time, if sufficient shielding is provided for the spent resin shipping vessel. A layer of water is maintained over the resin surface to prevent resin degradation due to heat generation from decaying fission products. Resin is removed from the tank by first backflushing to loosen the resin bed and then flushing the resin to the radwaste facility with nitrogen entering the top of the tank. The tank is all welded austenitic stainless steel.

Waste Evaporator Package

Historical Data Not Updated

The evaporator concentrates dissolved and suspended solids in the liquid waste. It consists of a batch tank (feed), concentrator, distillate tank, hot water converter, batch tank pump, hot water circulating pump, distillate pump, and control panel.

The length of an evaporator operating cycle is determined either by solids content or activity concentration of the solution. The entire evaporator is austenitic stainless steel of welded construction except for the heat transfer surfaces which are admiralty metal.

"A" and "B" waste condensate tanks are located in the Auxiliary Building in the hallway just outside the pipe alley entrance. These two tanks receive distillate from "A" waste evaporator and provide a temporary storage for this distillate water until it can be released to the environment.

"C", "D", and "E" waste condensate tanks receive distillate from "B" waste evaporator and they are located just north of the Auxiliary Building. When a waste condensate tank gets to approximately 90 percent level, the distillate from the evaporator is aligned to go to an alternate tank. The "full" tank can then be recirculated and sampled for release.

Waste Water Demineralization System Filters

WWDS Filter Vessels contain either replaceable cartridges or a replaceable bag. Cartridge and bag filters are available with various micron ratings. The filter vessel header system provides for isolation and by-pass and has influent and effluent pressure gauges. Each filter vessel has a vent and a low point drain.

Waste Water Demineralizers

Demineralizer Pressure Vessels, designed for down flow application, have cylindrical bar screens located on both the influent and effluent lines to prevent media migration. Media is sluiced into the vessel at the top and sluiced out of the vessel at the bottom. Each vessel has an inspection port located on the top of the vessel, an influent pressure gauge and a sample point.

The medias selected for use may vary depending on process conditions. The process vessel design is compatible with gel ion exchange medias, activated carbon, natural ion exchangers, and silicate based exchangers, which have 60 mesh or larger particle size.

Pumps

Pumps used throughout the system for draining tanks and transferring liquids are shown in Figures 11.2.2-1 and 11.2.2-2. The pumps are either canned motor or mechanically sealed types to minimize leakage.

The wetted surfaces of all pumps are stainless steel or other materials of equivalent corrosion resistance.

Piping

The piping which carries liquid wastes is stainless steel and flexible plastic hose. All gas piping is carbon steel. Piping connections are welded except where flanged or clamped connections are necessary to facilitate equipment maintenance or where taper thread connections and compression fittings are used in the area of the gas analyzer.

Valves

All valves exposed to gases are carbon steel or stainless steel. Valves have stem leakage control. Globe valves are installed with flow over the seats when such an arrangement reduces the possibility of leakage.

Stop valves are provided to isolate equipment for maintenance, to direct the flow of waste through the system, and to isolate storage tanks for radioactive decay.

Relief valves are provided for tanks containing radioactive wastes if the tanks might be overpressurized by improper operation or component malfunction.

Concentrates Holding Tank

The concentrates holding tank is sized to hold the production of concentrates from one batch of evaporator operation. The tank is supplied with an electrical heater which prevents boric acid precipitation and is constructed of austenitic stainless steel.

11.2.3 RADIOACTIVE RELEASES

11.2.3.1 Liquid Effluent Source Terms

Liquid effluents from HBR 2 can occur both continuously and on a batch basis. The following sections discuss the methodology which is utilized to show compliance with 10 CFR 20.

Continuous Releases

Steam generator (SG) blowdown and condensate polisher waste are continuously released from HBR during normal operation. A daily grab sample is taken of SG blowdown. This sample is composited and analyzed weekly for I-131 and various other fission and activation products. Condensate polisher (CP) waste is composited automatically. CP samples are collected weekly and analyzed for radioactive fission and activation products. Compliance with 10 CFR 20 during actual release is established through respective effluent monitor alarm setpoint. However, if a continuous release should occur in which the effluent monitor alarm setpoint is exceeded, then actual compliance with 10 CFR 20 may be determined utilizing the actual radionuclide mix.

Batch Releases

Batch releases occur during normal operation. The radioactivity content of each batch and compliance with 10 CFR 20 will be determined prior to release.

For HBR, the liquid radwaste system discharges to the circulating water system. Therefore, the dilution flow rate (DFR) is a function of the number of circulating water pumps operating. HBR 2 has 3 circulating water pumps. Pump curves show that with 3 pumps operating, the circulating water flow rate is 400,000 gpm, with 2 pumps operating the flow rate is 250,000 gpm, and with 1 pump, the flow rate is 160,700 gpm.

During outages in which the Unit 2 circulating water system is out of service the since retired HBR Unit 1 circulating water pumps will be used as a source for dilution flow. The since retired Unit 1 and Unit 2 circulating water systems share a common discharge canal. In any given situation regarding a liquid waste release, the ratio of release rate to dilution flow will be maintained within regulatory limits.

Releases from the HBR liquid radwaste system may occur from the waste condensate tanks, the monitor tanks, the condensate polisher, and the steam generator (SG). The maximum release rate is 250 gpm from each steam generator and 60 gpm from the monitor and waste condensate tanks and 390 gpm from the condensate polisher waste.

As discussed in Section 11.5, the Steam Generator Liquid Sample Monitors (R-19A, B and C), WDS Liquid Effluent Monitor (R-18), and the Condensate Polisher Waste Monitor (R-37) setpoints will be limited to 10 CFR 20, Appendix B, Table II, Column 2 using the methodology described in the Offsite Dose Calculation Manual (ODCM).

Liquid wastes are generated primarily by plant maintenance and service operations. Considerable operational margin exists between the estimated load on the waste disposal system and the design capability.

11.2.3.2 Doses from Liquid Effluents

The sum of the cumulative doses from all batch and continuous releases for a quarter are compared to one half the design objective doses for total body and any organ. The sum of the cumulative doses from all batch and continuous releases for a calendar year are compared to the design objective doses.

For the calendar quarter,

$$D_\tau \leq 1.5 \text{ mrem total body} \quad (1)$$

$$D_\tau \leq 5 \text{ mrem any organ} \quad (2)$$

For the calendar year,

$$D_\tau \leq 3 \text{ mrem total body} \quad (3)$$

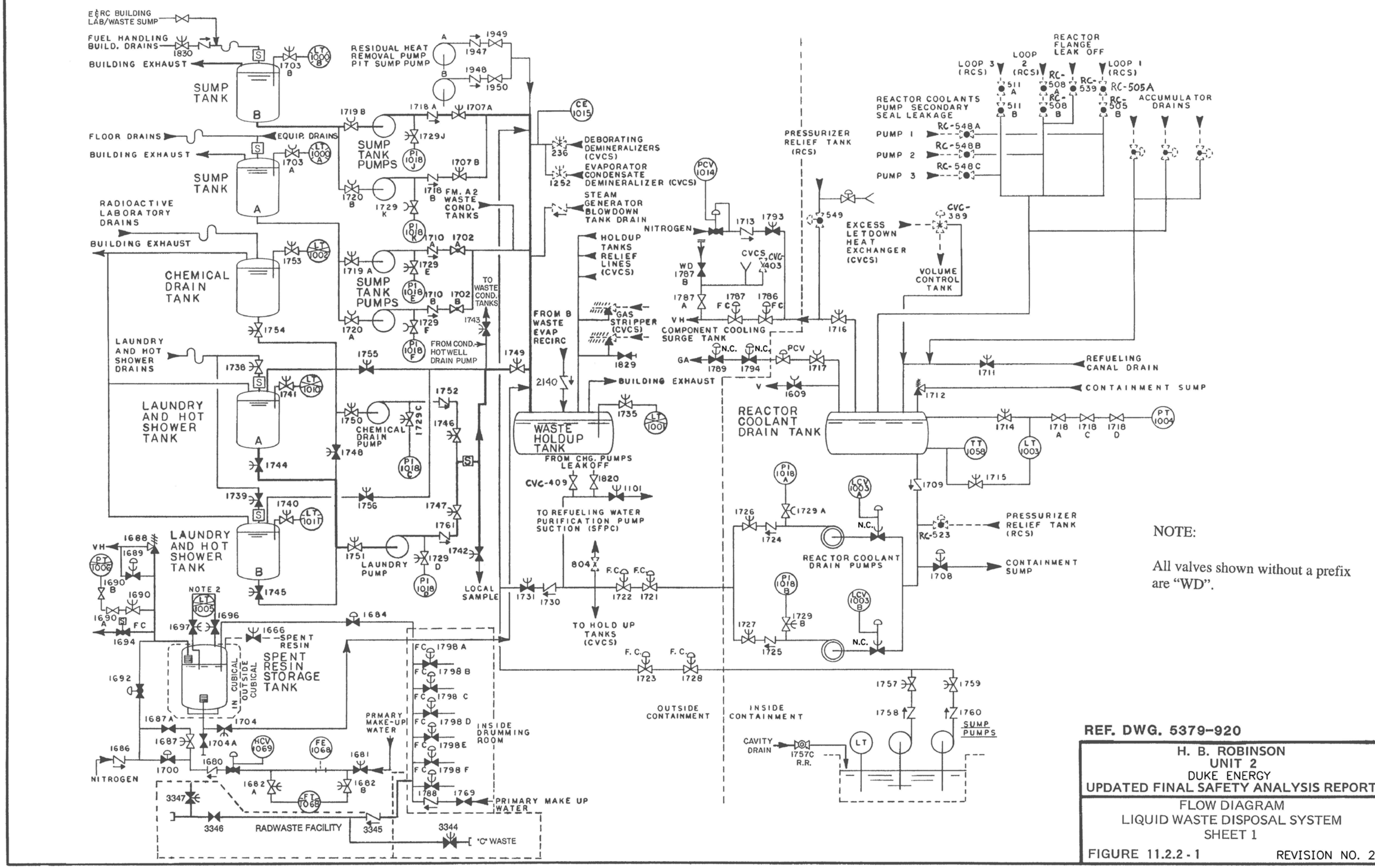
$$D_\tau \leq 10 \text{ mrem any organ} \quad (4)$$

where: D_τ = cumulative total dose to any organ τ or to the total body from continuous and batch releases, mrem

= $D_{\tau b} + D_{\tau c}$

The quarterly limits given above represent one-half the annual design objective of Section II.A of Appendix I of 10 CFR 50. If any of the limits are exceeded, a special report pursuant to Section IV.A of Appendix I of 10 CFR 50 must be filed with the NRC.

A summation of all liquid releases, along with offsite dose calculation results, is documented in the Effluent and Waste Disposal Annual Report submitted to the NRC annually.



NOTE:

All valves shown without a prefix are "WD".

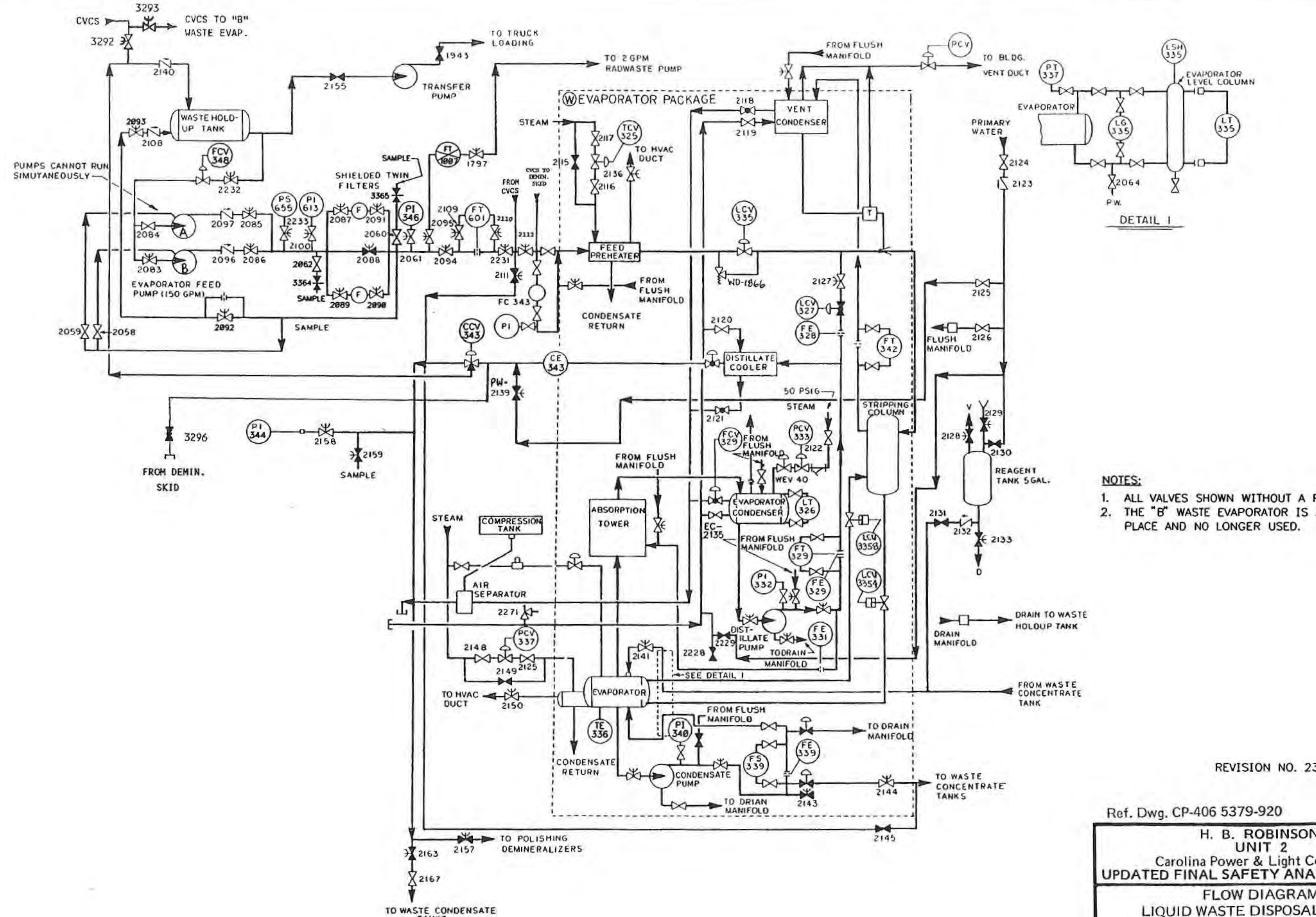
REF. DWG. 5379-920

H. B. ROBINSON
UNIT 2
DUKE ENERGY
UPDATED FINAL SAFETY ANALYSIS REPORT

FLOW DIAGRAM
LIQUID WASTE DISPOSAL SYSTEM
SHEET 1

FIGURE 11.2.2 - 1

REVISION NO. 27



NOTES:

1. ALL VALVES SHOWN WITHOUT A PREFIX ARE "WD".
2. THE "B" WASTE EVAPORATOR IS ABANDONED IN PLACE AND NO LONGER USED.

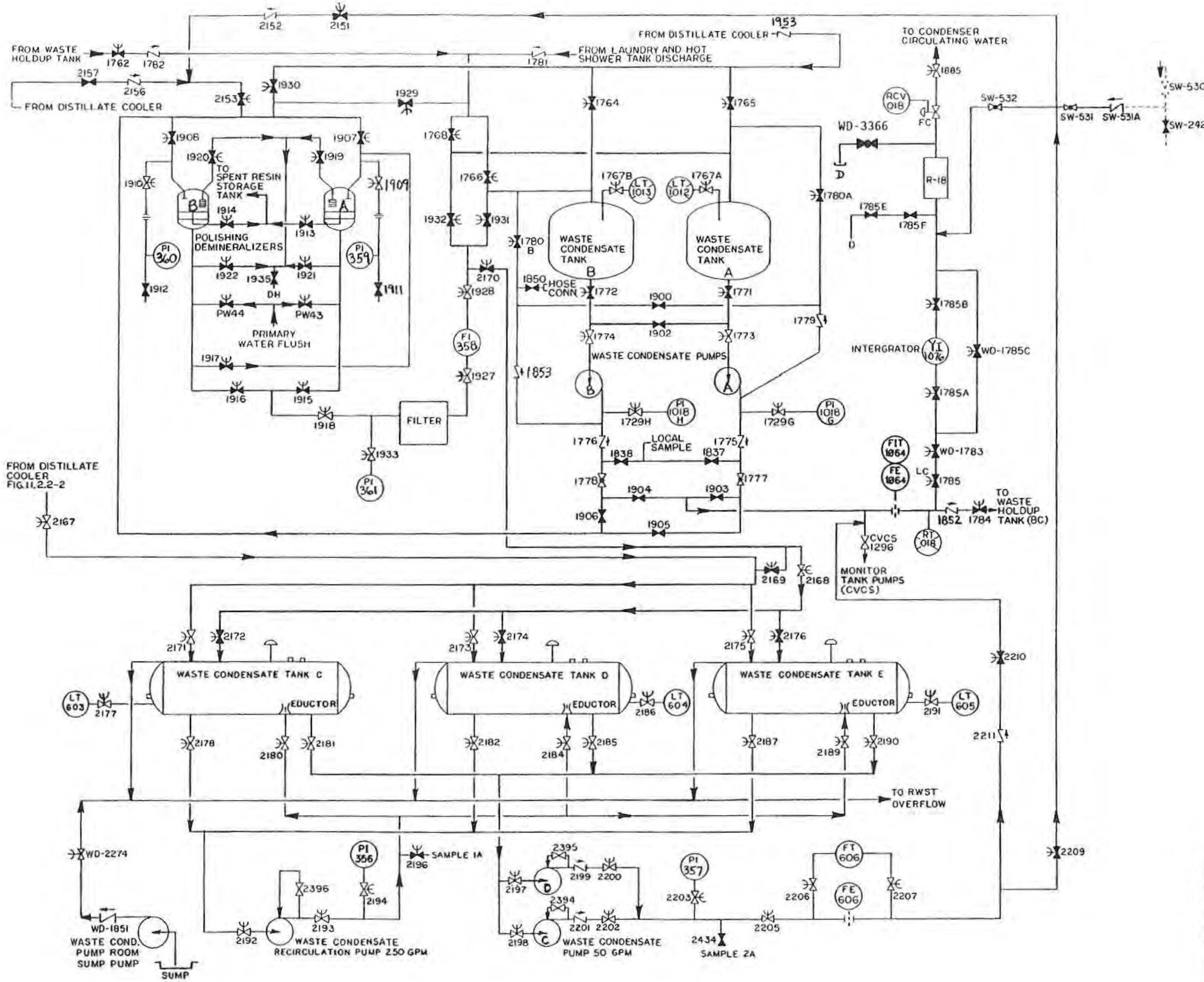
REVISION NO. 23

Ref. Dwg. CP-406 5379-920

H. B. ROBINSON
UNIT 2
Carolina Power & Light Company
UPDATED FINAL SAFETY ANALYSIS REPORT

FLOW DIAGRAM
LIQUID WASTE DISPOSAL SYSTEM
SHEET 2

FIGURE 11.2.2 - 2



NOTE:

All valves shown without a prefix are "WD".

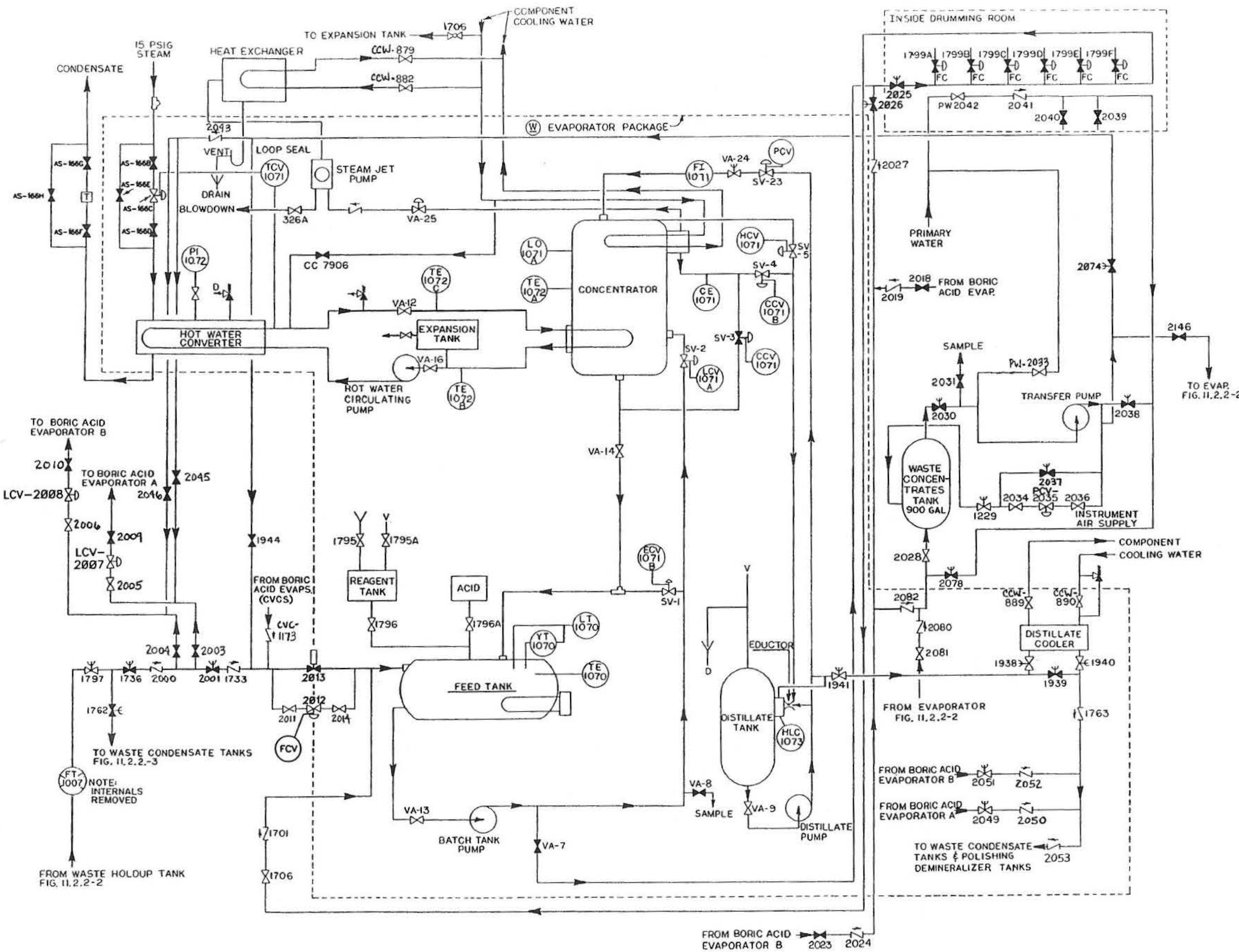
REVISION NO. 23

REF. DWG. 5379-920

H. B. ROBINSON
UNIT 2
Carolina Power & Light Company
UPDATED FINAL SAFETY ANALYSIS REPORT

FLOW DIAGRAM
LIQUID WASTE DISPOSAL SYSTEM
SHEET 3

FIGURE 11.2.2 - 3



NOTE:
All valves shown without a prefix are "WD".

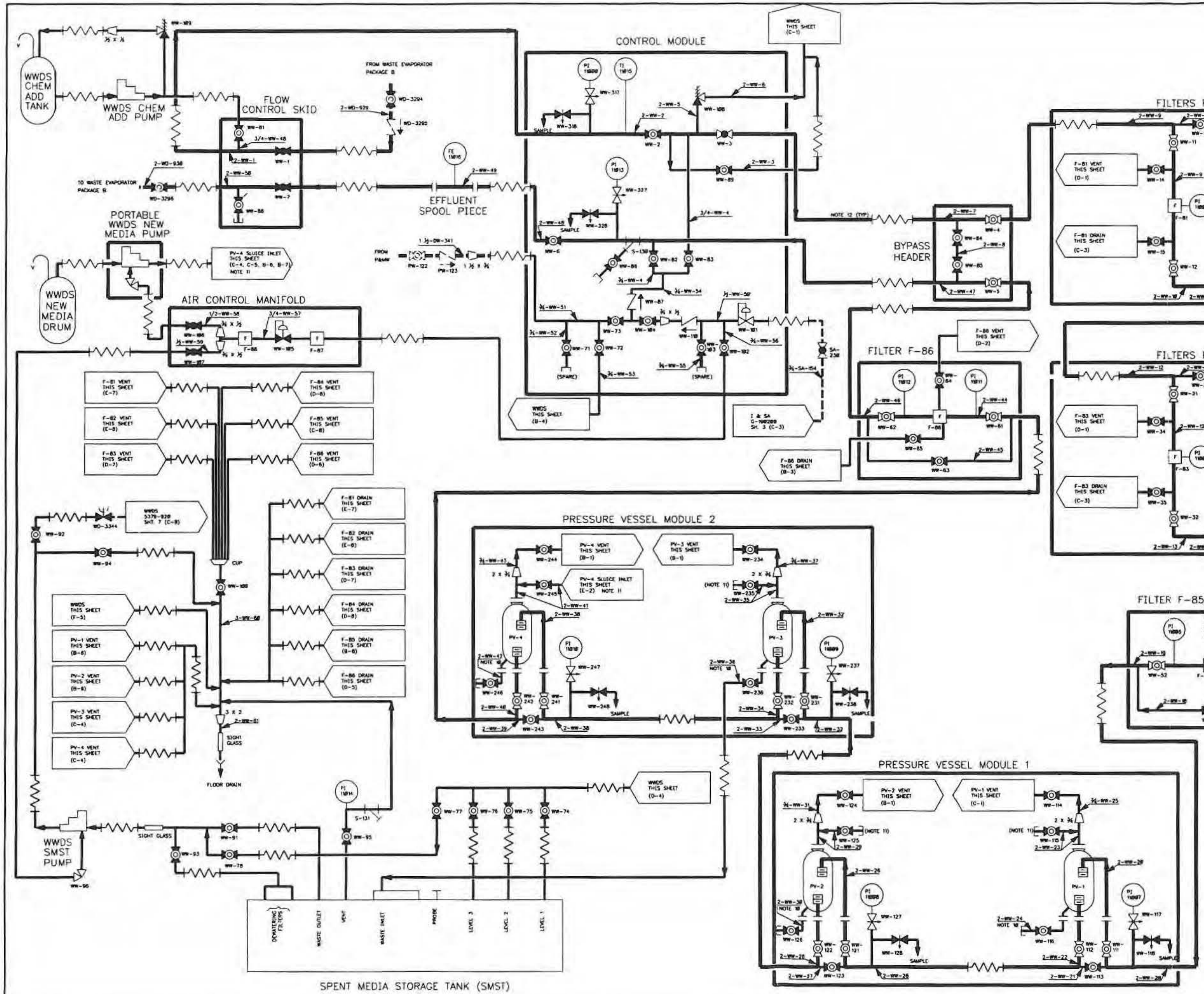
REVISION NO. 23

Ref. Dwg. CP-406 5379-920

H. B. ROBINSON
UNIT 2
Carolina Power & Light Company
UPDATED FINAL SAFETY ANALYSIS REPORT

FLOW DIAGRAM
LIQUID WASTE DISPOSAL SYSTEM
SHEET 4

FIGURE 11.2.2-4



REVISION NO. 15

Ref. Dwg. 5379-920

H. B. ROBINSON
UNIT 2
Carolina Power & Light Company
UPDATED FINAL SAFETY ANALYSIS REPORT

FLOW DIAGRAM
LIQUID WASTE DISPOSAL SYSTEM

FIGURE 11.2.2-5

11.3 GASEOUS WASTE MANAGEMENT SYSTEMS

This section describes the capabilities of the plant to control, collect, process, store, and dispose of gaseous radioactive wastes generated as a result of normal operation including anticipated operational occurrences.
The section discusses the design and operating features of the Gaseous Waste Processing System (GWPS) and the performance of other gas treatment and ventilation systems.

11.3.1 DESIGN BASIS

The system was designed to meet proposed General Design Criterion (GDC) 70. See Section 3.1 for a discussion of the GDC.

The design of the GWPS is based on continuous operation of the Unit assuming that one percent of the rated core power is generated by fuel rods containing cladding defects. This condition is assumed to exist over the life of the plant.

A program designed to reduce leakage from systems outside containment that would or could contain highly radioactive fluids during a serious transient or accident is implemented in accordance with Improved Technical Specifications (ITS) Section 5.52, "Primary Coolant Sources Outside Containment." The program applies to the Gaseous Waste Management System.

This program includes the following:

a. Preventative maintenance and periodic visual inspection requirements: and

b. Integrated leak test requirements for each system at refueling cycle intervals or less.

The program employs visual inspections of the mechanical joints and seals of the systems to detect leakage. The inspections are conducted with the system pressurized to normal system pressure using the system fluid as a test medium. The observed leakage is evaluated if the leakage is "as low as practical." Any leakage evaluated as not being "as low as practical" that cannot be corrected by the inspector will be identified on a work request.

11.3.2 SYSTEM DESCRIPTION

11.3.2.1 Gaseous Radioactive Waste Processing

During plant operations, gaseous wastes will originate from:

a) Degassing reactor coolant discharged to the Chemical and Volume Control System (CVCS)

b) Displacement of cover gases as liquids accumulate in various tanks

c) Miscellaneous equipment vents and relief valves

d) Sampling operations and automatic gas analysis for hydrogen and oxygen in cover gases

The flow diagrams for the system are shown in Figures 11.3.2-1 and 11.3.2-2.

Radioactive gases are collected at a slight positive pressure in a vent header. From there, they are pumped by compressors through a manifold to one of the gas decay tanks where they are held a suitable period of time for decay. Cover gases in the nitrogen blanketing system are reused to minimize gaseous wastes. During normal operation, gases are discharged intermittently at a controlled rate from these tanks through the monitored plant vent. The system is provided with holdup capacity and discharge controls for gaseous wastes such that plant operations will not be limited by environmental conditions.

Most of the gas received by the Waste Disposal System during normal operation is cover gas displaced from the CVCS holdup tanks as they fill with liquid. The pressure of cover gases are maintained within a narrow range. As the tanks are filled displacing cover gas, the pressure rises. When the upper limit of the range is approached, the waste gas compressors pump the displaced gas to the gas decay tanks. As the tanks are emptied, the cover gas pressure approaches the lower limit of the range and additional gas is supplied. Since the gas displaced during filling must be replaced when the tanks are emptied, facilities are provided to return gas from the decay tanks to the holdup tanks. A backup supply from the nitrogen header is provided for makeup if return flow from the gas decay tanks is not available. To prevent hydrogen concentration from exceeding the combustible limit during this type of operation, components discharging to the vent header system are restricted to those containing no air or aerated liquids and the vent header itself is designed to operate at a slight positive pressure (0.5 psig minimum to 2.0 psig maximum) to prevent in-leakage. On the other hand, out-leakage from the system is minimized by using diaphragm valves, bellows seals, self- contained pressure regulators and soft-seated packless valves throughout the radioactive portions of the system.

Gases vented to the vent header flow to the waste gas compressor suction header. Both compressors may be operated in a standby mode and start on a pressure signal sensed in the suction line, or, if system load requires, one (1) compressor is placed in run and the other is in a standby mode. The compressors may be operated in manual mode based on system demand. From the compressors, gas flows to one of the gas decay tanks. The control arrangement on the gas decay tank inlet header allows the operator to place one tank in service and to select one tank for backup if the tank in operation becomes fully pressurized. When the tank in service becomes pressurized to 110 psig, a pressure transmitter automatically closes the inlet valve to that tank, opens the inlet valve to the backup tank and sounds an alarm to alert the operator of this event so that he may select a new backup tank. Pressure indicators are supplied to aid the operator in selecting the backup tank.

Gas held in the decay tanks can either be returned to the CVCS holdup tanks, or discharged to the atmosphere if it has decayed sufficiently for release. Generally, the last tank to receive gas will be the first tank emptied back to the holdup tanks in order to permit the maximum decay time before releasing gas to the environment. However, the header arrangement at the tank inlet gives the operator freedom to fill, reuse or discharge gas to the environment simultaneously without restricting operation of the other tanks. During degassing of the reactor coolant prior to a refueling shutdown, it may be desirable to pump the gas purged from the volume control tank into a particular tank and isolate that tank for decay rather than reuse the gas in it. This is done by aligning the control to open the inlet valve to the desired tank and closing the outlet valve to the reuse header. However, one of the other tanks can be opened to the reuse header at this time if desired, while still another might be discharged to atmosphere.

Before a tank can be emptied to the environment, it must be sampled and analyzed to determine and record the activity to be released, and only then discharged to the plant vent at a controlled rate. The effluent is continuously sampled by a radiation monitor. Grab samples are taken manually at the WGDT local sampling station or by opening the isolation valve to the plant vent discharge line and permitting gas to flow to the gas analyzer where it can be collected in one of the sampling system gas sample vessels. In the event of a gas analyzer failure, the gas analyzer grab sample line can be used to obtain grab samples for laboratory analysis. After sampling, the isolation valve is closed until the tank contents are released. During release a trip valve in the discharge line is closed automatically by a high activity level indication in the plant vent.

When waste gases are being released to the environment, the release is automatically terminated if the radioactivity level exceeds a predetermined level (the radiological monitoring and control instrumentation is described in Section 11.5).

During operation, gas samples are drawn periodically from tanks discharging to the waste gas vent header as well as from the particular gas decay tank being filled at the time, and automatically analyzed to determine their hydrogen and oxygen content. The hydrogen analysis is for surveillance since the concentration range will vary considerably from tank to tank. There should be no significant oxygen content in any of the tanks, and an alarm will warn the operator if any sample shows 3 percent by volume of oxygen. This allows time to take the required action before the combustible limit is reached. Another tank is placed in service while the operator locates and eliminates the source of oxygen.

11.3.2.2 Components

Component data are given in Table 11.3.2-1.

Gas Analyzer

An automatic gas analyzer is provided to monitor the concentrations of oxygen and hydrogen in the cover gas of the Waste Disposal System, CVCS tanks, boric acid evaporators and gas stripper. The gas analyzer grab sample line can be used as an alternative method of obtaining gas samples for analysis. Upon indication of a high oxygen level, provisions are made to purge the equipment to the gaseous waste system with an inert gas.

Piping

Gas piping is carbon steel. Piping connections are welded except where flanged connections are necessary to facilitate equipment maintenance. No threaded fittings are used in waste piping.

Valves

Valves exposed to gases are carbon or stainless steel. Valves have stem leakage control. Globe valves are installed with flow over the seats when such an arrangement reduces the possibility of leakage.

Gas Compressors

Two compressors are provided for removal of gases to the gas decay tanks from all equipment that contains or can contain radioactive gases. These compressors are of the water sealed centrifugal displacement type. The operation of the compressors is automatically controlled by the gas manifold pressure. While one unit is in operation, the other serves as a standby for unusually high flows or failure of the first unit. The compressors may also be operated individually in a manual mode, based on system demand.

Gas Decay Tanks

Four welded carbon steel tanks are provided to contain compressed waste gases (hydrogen, nitrogen, oxygen and fission gases). After a period for radioactive decay, these gases may be released at a controlled rate to the atmosphere through the plant vent. All discharges to the atmosphere will be monitored.

TABLE 11.3.2-1

GASEOUS WASTE MANAGEMENT SYSTEM COMPONENTS AND DESIGN PARAMETERS

Waste Gas Compressors

Type	Horizontal-Cent
Design Pressure	150 psig
Design Flow Rate	20 scfm
Design Temperature	150ºF
Normal Operating Pressure-In	.5 to 2.0 psig
Normal Operating Pressure-Out	0 - 110 psig

Seal Water Cooler

Shell Design Flow Rate	42.5 gpm
Inlet Temperature	105ºF

Gas Decay Tanks

Volume	500 ft^3
Design Pressure	150 psig
Design Temperature	150ºF
Operating Pressure	110 psig
Operating Temperature	80 - 140ºF
Carbon Steel Construction	

Gas Analyzer

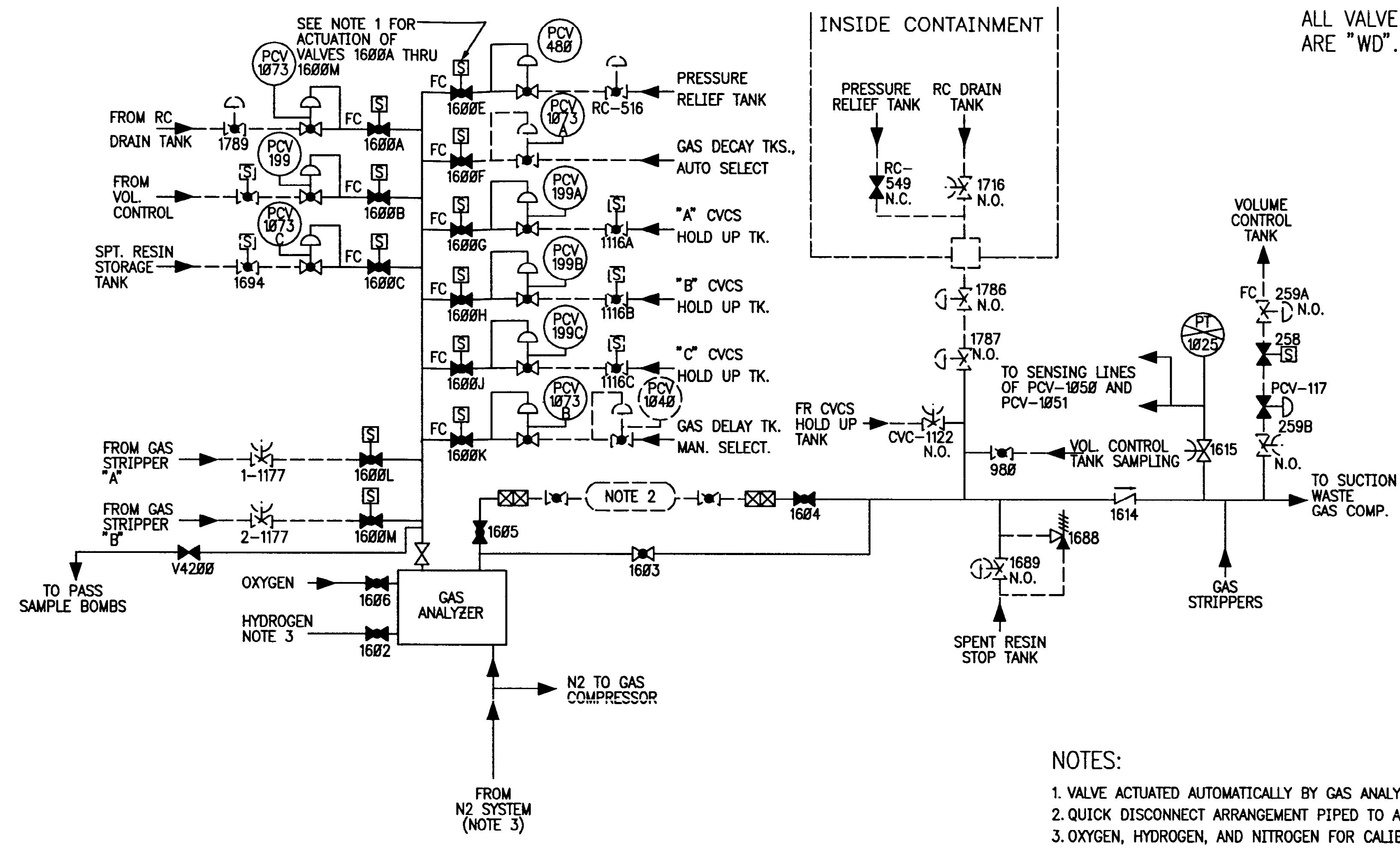
O_2 Analyzer	0 to 5%
H_2 Analyzer	0 to 100%
Warmup Time for Stable Performance	1 hr

11.3.3 RADIOACTIVE RELEASES

The criteria for the release of gaseous wastes from the GWPS are predetermined using the methodologies of the Offsite Dose Calculation Manual (ODCM). The ODCM provides the methodologies to be used by the plant to comply with the Technical Specifications for liquid and gaseous radiological effluents. The ODCM utilizes X/Q and D/Q values derived from the 1978 meteorological study prepared by Dames and Moore to demonstrate compliance with 10CFR50, Appendix I. Setpoints for monitor alarms and automatic cutoff valves are determined so as to limit the release rate of gaseous wastes to less than the allowable values prescribed in 10CFR20.

Airborne releases from HBR 2 are determined by continuous monitors, periodic grab samples and radionuclide analyses. A summation of these releases is documented in an annual report of effluent and waste disposal activity. This report presents total release, average release rate, and percent of Technical Specification Limit. The report data substantiates the fact that plant performance meets the criteria of 10CFR20, Appendix B, Table 2, Column 1, and the design objectives of Appendix I to 10CFR50.

NOTE:
ALL VALVE SHOWN WITHOUT A PREFIX ARE "WD".



NOTES:

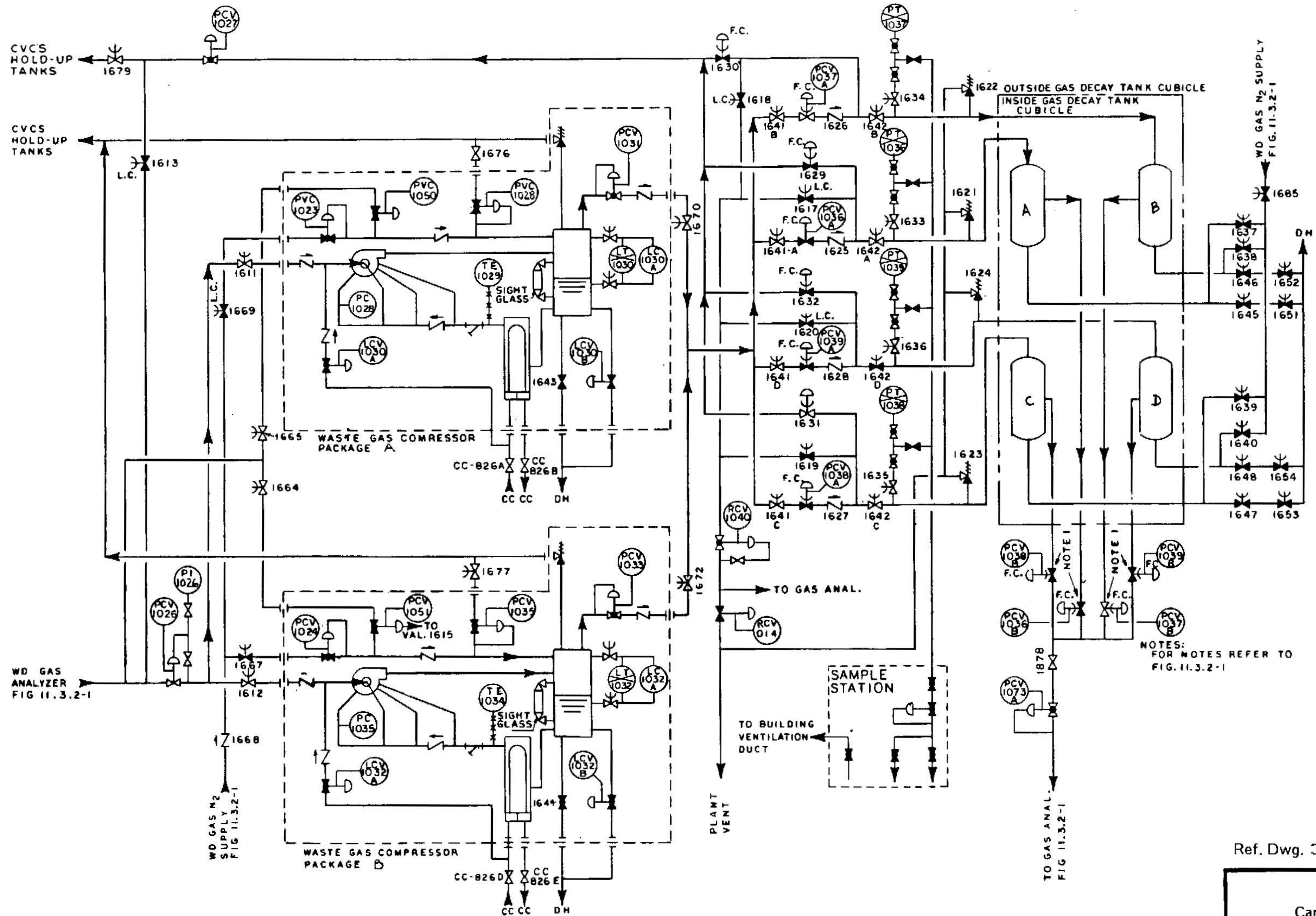
1. VALVE ACTUATED AUTOMATICALLY BY GAS ANALYZER. I AND C CHAN. NO AO-1067.
2. QUICK DISCONNECT ARRANGEMENT PIPED TO ACCOMMODATE GAS SAMPLE.
3. OXYGEN, HYDROGEN, AND NITROGEN FOR CALIBRATING GAS ANALYZER SUPPLIED FROM BOTTLES.

REF. DWG. 5379-921

H. B. ROBINSON
UNIT 2
CAROLINA POWER & LIGHT COMPANY
UPDATED FINAL SAFETY ANALYSIS REPORT

FLOW DIAGRAM
GASEOUS WASTE DISPOSAL SYSTEM
SHEET 1

FIGURE 11.3.2-1 REVISION 17



NOTE:

All valves shown without a prefix are "WD".

Revision 15

Ref. Dwg. CP-406 5379-921

H. B. ROBINSON
UNIT 2
Carolina Power & Light Company
UPDATED FINAL SAFETY ANALYSIS REPORT

FLOW DIAGRAM
GASEOUS WASTE DISPOSAL SYSTEM
SHEET 2

FIGURE 11.3.2 - 2

11.4 SOLID WASTE PROCESSING SYSTEM

Solid wastes consist of spent resins, filter cartridges, bags and miscellaneous materials, such as paper and glassware. Solid wastes are packaged in approved containers such as 55-gallon drums, liners, high integrity containers (HIC) and boxes, for removal to a processing or burial facility. The Solid Waste Processing System (SWPS) is designed so that all radioactive solid waste is processed, packaged, and stored, to keep the discharge of effluents and offsite shipments in accordance with appropriate federal and state standards and in compliance with 49CFR170-179, 10CFR20, 10CFR50, and 10CFR61.

11.4.1 DESIGN BASIS

The objective of the SWPS is to convert radioactive solid wastes into acceptable packaged forms for offsite processing or disposal. In addition, the SWPS is to provide a reliable means for processing the material while minimizing radioactive exposures to plant personnel and the general public in compliance with the guidelines of 10CFR20, 10CFR50, and 10CFR61.

The SWPS collects, controls, processes, packages, handles, and temporarily stores radioactive solid waste generated as a result of the normal operations of the plant, including anticipated operational occurrences. The SWPS receives spent cartridge and bag filters, spent resins, and solid radioactive waste such as contaminated paper, cloth, construction materials, laboratory supplies, and other non-retrievable items.

The specific design basis primary coolant source terms are presented in Section 11.1.

11.4.2 SYSTEM DESCRIPTION

The SWPS packages radioactive wastes generated during normal plant operations for offsite processing or burial. It is designed to provide for processing, packaging, and storage of solid wastes resulting from normal plant operations without limiting the operation or availability of the plant.

Typical data on types of wastes, quantities, activities, and radionuclide distributions are provided in the Annual Radioactive Effluent Release Reports. The seismic criteria and the quality group classification for the solid waste components and piping are given in Section 3.2 of the FSAR.

The piping and instrumentation associated with the SWPS appear in Figures 11.2.2-1 and 11.2.2-4.

11.4.2.1 Components and Inputs

The SWPS input sources are spent resins, filter cartridges and bags, and noncompacted dry active wastes.

All waste collection, processing, packaging, storing and shipping for offsite processing or burial conforms to the guidelines of 49CFR170-179, 10CFR20, 10CFR50, and 10CFR61.

11.4.2.2 Solid Waste Processing

The SWPS processes waste from several sources:

a) Dry radioactive wastes
b) Filter cartridges/bags
c) Spent resins
d) Laboratory wastes

The SWPS packages dry solid wastes in approved containers for removal to processing or burial facilities. Dry radioactive wastes consist of air filters, miscellaneous paper, rags, etc., from contaminated areas and contaminated clothing, tools and equipment parts which cannot be effectively decontaminated, and solid laboratory wastes. These wastes are collected in containers located in designated zones (areas) around the plant.

Because of their low radioactivity content, dry radioactive wastes can be stored until enough waste has accumulated to permit economical transportation to an offsite burial facility for final disposal.

The filled containers are removed for segregation and the contents are placed in the appropriate container and stored for ultimate offsite removal.

The SWPS is also used in accordance with a Process Control Program to process wet radioactive waste to meet shipping and burial requirements.

Depleted radioactive resins are sluiced from their respective ion exchange vessels into the spent resin storage tank or spent media storage tank for temporary storage. To dispose of the resins, the system is lined up from the spent resin storage tank or the spent media storage tank to the spent resin fill connection in the radwaste facility. A flexible hose is connected to this fill connection at one end and the other is placed into a high integrity container (HIC) or liner. The spent resin storage tank is then pressurized with low pressure nitrogen and the resins are forced to the radwaste facility, via installed piping, and down through the flexible hose into the HIC or liner. The Spent Media Storage Tank contents are pumped to the radwaste facility, via installed piping, and down through the flexible hose into a HIC or metal liner. During the sluicing of either the Spent Resin Storage Tank or the Spent Media Storage Tank the process of dewatering takes place. Prior to shipping for burial, a HIC or liner will contain less than 1% free standing liquid. Once full, the HIC or liner can be transported in a shipping cask overland to a radwaste processing or burial facility for ultimate disposal.

Dry radioactive wastes consist of air filters, miscellaneous paper, rags, etc., from contaminated areas and contaminated clothing, tools and equipment parts which cannot be effectively decontaminated, and solid laboratory wastes. These wastes are collected in containers located in designated zones
(areas) around the plant.

Because of their low radioactivity content, dry radioactive wastes can be stored until enough waste has accumulated to permit economical transportation to an offsite burial facility for final disposal.

The filled containers are removed for segregation and the contents are placed in the appropriate container and stored for ultimate offsite removal.

Exhausted cartridge filters are removed from their process vessel, placed in a bag and transferred to a shielded storage container. The filters are stored in the shielded container until they are transferred to a shipping container for shipment to a licensed processing or disposal site.

11.5 PROCESS AND EFFLUENT RADIOLOGICAL MONITORING AND SAMPLING SYSTEMS

11.5.1 DESIGN BASIS

The Process and Effluent Radiological Monitoring Systems are designed to:

a) Warn of any inadvertent release of radioactive effluents to the environment

b) Give early warning of a plant malfunction which might lead to a health hazard or plant damage

c) Detect and monitor high levels of radiation encountered during a radiological accident.

Instruments are located at selected points in and around the plant to detect, compute, and record the radiation levels. In the event the radiation level should rise above a desired setpoint, an alarm is activated locally and/or in the Control Room. The automatic Radiation Monitoring System (RMS) operates in conjunction with regular and special radiation surveys and with chemical and radiochemical analyses performed by the plant staff. Adequate information and warning are thereby provided for the continued safe operation of the plant and compliance with 10CFR20, NUREG 0578 Section 2.18b, NUREG 0737 and Reg. Guide 1.97.

Components of all process monitoring channels are designed for post-accident operation. Process monitors are of a nonsaturating design so that they "peg" full scale if exposed to radiation levels above full scale indication. This is with the exception of R-19A, R-19B, R-19C and R-37 which, due to the RM-80 microprocessor, is of saturated design. Normal and post-accident background radiation levels will not affect their usefulness.

The components of the RMS in the control room are designed according to the following normal environmental conditions:

a) Temperature - an ambient temperature range of 70º to 77ºF,

b) Humidity - 20 to 80 percent relative humidity,

c) Pressure - normal atmospheric pressure,

d) Radiation - Negligible.

11.5.2 SYSTEM DESCRIPTION

11.5.2.1 Components

The Process/Effluent Radiation Monitoring system consists of 28 channels that monitor radiation levels in various plant operating systems. These channels are capable of monitoring radiation levels during and after an accident including radiological releases. Six accident channels are designed to monitor high levels of radiation during and after accidents involving the main steam lines, plant vent and fuel handling building exhaust. The output from 21 of these channels is transmitted to the RMS cabinets located in the Control Room where the radiation level, gallons per day (gpd), or countrate is indicated by a meter and available to a multipoint recorder. Monitors R-24A, R-24B, and R-24C have a dedicated recorder. High radiation level and Fail alarms are annunciated in the Control Room and indicated on the RMS cabinets. The remaining four channels have only local indication, alarms and recording capabilities. These four channels monitor the following areas: E&RC Building Hood Exhaust and Condensate Polishing Waste.

The following 11 process channels have individual microprocessor controlled digital ratemeters in the control room: R-11, 12, 15, 16, 17, 18, 20, 21, 30, 31A, B & C. Each ratemeter provides power to operate its detector and provides outputs to the control room recorder, the ERFIS computer (radiation level and high alarm) and, upon alarm, to the RTGB annunciator panel. For some channels, outputs are also provided to local readouts and to operate plant equipment on various alarm signals. Each detector, located remotely in the plant, receives power from its ratemeter and transmits pulses back to the ratemeter. The pulse rate is averaged by the ratemeter and displayed digitally in counts per minute (CPM) or MR per hour (MR/hr).

Each ratemeter front panel has the following function buttons and lights:

A Circuit Test Button to test the electronics, microprocessor, and alarms;

An Alarm/Reset button which lights on high alarms and, when depressed, displays the setpoint and resets any fail or high alarms;

A Check Source button which operates the remote detector check source solenoid. Performing this remote Source Check provides a quick operational check of the entire ratemeter/detector system;

A High Voltage Off button to test the detector fail alarm;

A Fail Alarm light;

and a Power On light.

The following eight monitor skids (14 process channels) each have one ratemeter located near the skid: R-14 (channels R-14C, 14D, 14E), 19A, 19B, 19C, 20, 22 (channels 22A, 22B, 22C), 24 (channels 24A, 24B, 24C), and 37. Channels for monitor skids R-14, 19A, 19B, 19C, 20, and 24 have:

1. Control Room countrate or gpd rate (readouts and recording) and alarm indications.

2. ERFIS indications (radiation levels or gpd leak rates, and HIGH alarm).

3. Ratemeters and alarm indications are available at the monitor skids. R-14 also has a recorder at the skid.

Channel for monitor skid R-22 has:

1. Countrates (readouts and recording) and alarms indications at the monitor skids.

2. Remote alarms in a more frequently occupied area of the building being monitored.

Channel R-37 countrate (readout and recording) and alarms are indicated in the Condensate polished Control Room. More detailed descriptions of the monitors mentioned in this paragraph are provided in the following sections.

11.5.2.2 Process and Effluent Radiation Monitoring System

The process and effluent RMS consists of the radiation monitoring channels described below. Table 11.5.2-1 lists the detecting medium conditions for each channel, and Table 11.5.2-2 gives their typical sensitivites.

11.5.2.2.1 Containment or plant vent air particulate monitor (R-11).

The monitor is provided to measure air particulate gamma radioactivity in the containment and to ensure that the release rate through the containment vent during purging is maintained below specified limits. It also provides a backup to the plant vent gas monitor. A high radiation level alarm for the channel initiates closure of the containment purge supply and exhaust duct valves and pressure relief line valves.

This channel takes a continuous air sample from either the containment atmosphere, or the plant vent. The sample is drawn from the containment or the plant vent ductwork through a closed, sealed system monitored by a scintillation counter - filter paper detector assembly. The filter paper collects all particulate matter greater than 1 micron in size, on its constantly moving surface, and is viewed by a photomultiplier-scintillation crystal combination. The sample is returned to the containment or plant vent, depending on which sample is being monitored, after it passes through the series connected gas monitor (R-12).

The detector assembly is in a completely enclosed housing. The detector is a hermetically sealed photomultiplier tube - sodium iodide scintillation combination. A preamplifier transmits the pulse signal to the RMS ratemeter in the Control Room. The filter paper has a 25-day minimum supply at normal speed. Lead shielding is provided to reduce the background level to where it does not interfere with the detector's sensitivity. The filter paper mechanism, an electro-mechanical assembly which controls the filter paper movement, is provided as an integral part of the detector unit.

11.5.2.2.2 Containment and plant vent radioactive gas monitor (R-12)

One monitor is provided to measure radioactivity from noble gases in the containment, to ensure that the radiation release rate during purging is maintained below specified limits and to serve as a backup to the plant vent gas monitor. A high gas radiation level alarm initiates closure of the containment purge supply and exhaust duct valves and pressure line relief valves.

This channel takes the continuous air sample from the containment atmosphere or the plant vent after it passes through the air particulate monitor, and draws the sample through a closed, sealed system to the gas monitor assembly. The sample is constantly mixed in the fixed, shielded volume, where it is viewed by the detector. The detector is a hermetically sealed photomultiplier tube - beta phospher scintillation combination. The sample is then returned to the containment or the plant vent depending on which sample is being monitored.

The detector assembly is in a completely enclosed housing containing a beta-scintillation detector mounted in a constant gas volume container. Lead shielding is provided to reduce the background level to a point where it does not interfere with the detector's sensitivity. A preamplifier and impedance matching circuit is mounted at the detector. Its output is transmitted to the RMS ratemeter in the Control Room.

The containment air particulate and radioactive gas monitors (R-11 and R-12) have assemblies that are common to both channels. They are described as follows:

a) The flow control assembly includes a pump unit and selector valves that provide a representative sample (or a "clean" local ambient air sample) to the detector.

b) The pump unit consists of:

1) A pump to obtain the air sample
2) A flowmeter to indicate the flow rate
3) A flow control valve to provide flow adjustment
4) A flow alarm assembly to provide low and high flow alarm signals

c) Selector valves are used to direct the desired sample to the detector for monitoring and to block normal flow when the channel is in maintenance or "purging" condition.

d) A pressure sensor is used to protect the system for high pressure. This unit automatically closes the inlet and outlet valves upon a high pressure condition.

e) Purging is accomplished with a valve control arrangement whereby the normal sample flow is blocked and the detector purged with a "clean" sample. This facilitates detector calibration by establishing the background level and aids in verifying sample activity level.

f) The flow control panel in the Control Room radiation monitoring racks permits remote operation of the flow control assembly. By operating a sample selector switch on the control panel, either the containment, plant vent, or purge sample may be monitored.

g) A sample flow rate indicator is calibrated linearly from 0 to 14 cfm.

h) Grab sample valves are provided on the containment inlet and outlet sample lines to allow samples to be taken for laboratory isotopic analysis.

Alarm lights are actuated by the following:

a) Flow alarm assembly (low or high flow)

b) The pressure sensor assembly (high pressure)

c) The filter paper sensor (paper drive malfunction)

d) The pump power control switch (pump motor on or off)

11.5.2.2.3 Plant Vent Radiation Monitoring System, (R-14)

11.5.2.2.3.1 Components

The system consists of 3 radiation monitoring channels, R-14 C, D, and E. Various support components include a microprocessor based ratemeter, pumps, pressure, temperature and flow gauges, automatic and manual valves, heat tracing, detector shield assemblies, alarm lights and annunciators, and grab sample points. R-14 and F-14 (The Plant Vent Flow Monitoring System) are mounted in two skid units located in the monitor building on the Auxiliary Building roof.

The count rates, in CPM, of channels R-14 C-E are displayed locally on the monitor CRT and on the control room digital displays. Monitor readouts can also be obtained in uCi/cc for the noble gas channels, R-14 C, D and E. Historical data is stored at the ratemeter and may be displayed there in both digital and bar graph format, or printed out.

Each of these channels has a high radiation alarm and a channel fail alarm which lights at the monitor and in the control room. Control room annunciators also activate with each alarm. An R-14 equipment fail alarm lights when other monitor troubles occur. Each channel has a check source for use in verifying channel operability.

Isokinetic sample flow is either maintained by the Plant Vent Flow Monitoring System, F-14, or set manually via adjustment of sample flow. One of the sample pumps draws the sample from the plant vent through 8 sample nozzles. Sample flow is maintained within a tolerance of ±10% of 1/30,000th of the plant vent flow. The sample flows through heat traced lines to one of two heat traced detector shields. The low range shield containing R-14 C is normally in service.

The off-line monitor draws representative gas samples through low-range, mid-range, and high-range gas detector assemblies for beta and gamma radioactivity measurement. The low-range sample pump draws the sample for the RD-52-40D (R-14C Channel) low-range beta detector. The mid/high-range sample pump draws the sample for the RD-62-04 (R-14D Channel) mid-range and the RD-62-05 (R-14E Channel) high-range beta-gamma detectors. Particulate/iodine filters precede the low-range detector at the low-range sample inlet. The accident/grab sample skid provides particulate/iodine grab sampling filters for the mid/high-range sample inlet.

11.5.2.2.3.1 Deleted

11.5.2.2.3.3 Deleted

11.5.2.2.3.4 Low-Range Noble Gas Channel, R-14 C

After passing through particulate and iodine filters, the sample flows into the noble gas chamber and is monitored by a beta-scintillation detector. The continuous sample is returned to the plant vent. The sample countrate is corrected to account for the partial vacuum in the sample chamber. Countrate results are averaged over time and used for effluent accountability in conjunction with isotopic results from periodic grab sample analyses.

Remote indication and annunciation for this channel are also provided on the Waste Disposal System Control Board. The channel provides assurance that gaseous releases from the Waste Disposal System are below the 10 CFR 20 limits using the methodology of the ODCM. If the channel countrate exceeds the release setpoint, for 10 CFR 20 compliance, a channel high alarm occurs. The alarm automatically closes valve RCV-014 in the Waste Gas System.

During accident conditions, if the channel countrate exceeds a preset value in its top decade, the monitor automatically switches flow from the low range to the mid/high-range channels. This causes both the R-14 C High and Fail alarms in the control room to stay lit until the monitor switches back to the low-range channel. The control room display for R-14 C will also default to a reading of 1.0 E 6 CPM.

11.5.2.2.3.5 High-Range Particulate and Iodine Sampling

Once sample flow has switched over to the High-Range, the sample enters the mid/high-range detectors. The sample passes particulate and iodine filters. During an accident, the filters may be removed and placed in a portable shield for transport to a shielded work area in a laboratory hood, prior to analysis.

11.5.2.2.3.6 Mid-Range Noble Gas Channel, R-14 D

After leaving the prefilters, the sample enters the next shielded chamber and is monitored for noble gases by a cadmium telluride (chlorine-doped) detector. The mid-range channel is designed to overlap both the low-range noble gas channel and the high-range noble gas channel by at least one decade. If the channel countrate drops below a preset value in its bottom decade, the monitor automatically switches flow back to the low-range channel.

11.5.2.2.3.7 High-Range Noble Gas Channel, R-14 E

After the sample leaves the mid-range chamber, it flows into the high-range chamber where it is monitored by a high-range cadmium telluride (chlorine-doped) detector similar to R-14 D. This detector meets the high range requirements of NUREG 0737 and Reg. Guide 1.97.

11.5.2.2.4 Condenser Air Ejector Gas Monitor (R-15)

This channel continuously monitors the gaseous effluent from the air ejector exhaust header of the condensers. Radioactivity in this effluent stream indicates primary to secondary system leakage. The air ejector effluent flows into the plant vent where particulate, iodine and noble gas activity is monitored by the plant vent monitoring system.

The detector output is transmitted to the RMS cabinets in the Control Room. The activity is indicated on a digital ratemeter and available to a multipoint recorder. High-activity and channel fail alarm indications are displayed on the ratemeter and on the control board annunciator.

A beta-gamma sensitive GM tube is used to monitor the gaseous radiation level. The detector is inserted into an in-line fixed volume container which includes adequate shielding to reduce the background radiation to a value consistent with the detector's maximum sensitivity.

11.5.2.2.5 Containment HVH Units Fan and Motor Cooling Water Monitor (R-16)

This channel monitors the containment fan and motor coolers service water for radiation indicative of a leak from the containment atmosphere into the cooling water. A small bypass flow from each of the heat exchangers is mixed in a common header and monitored by a sodium iodide scintillation detector mounted in a shielded assembly. Upon indication of a high radiation level, each heat exchanger can be individually sampled to determine which unit is leaking. This sampling sequence is achieved by manually selecting the desired unit to be monitored and allotting sufficient time for sample equilibrium to be established (approximately 1 min).

11.5.2.2.6 Component cooling liquid monitor (R-17)

This channel continuously monitors the component cooling loop of the Auxiliary Coolant System for activity indicative of a leak of reactor coolant from either the Reactor Coolant System, the recirculation loop or the residual heat removal loop of the Auxiliary Coolant System. A sodium iodide scintillation counter is located in a shielded in-line well at the component cooling pump suction header. The detector assembly output is amplified by a preamplifier and transmitted to the ratemeter in the Control Room. The countrate is displayed on the ratemeter and available to a multipoint recorder. High-activity and channel fail alarm indications are displayed on the digital ratemeter and on the control board annunciator.

11.5.2.2.7 Waste disposal system liquid effluent monitor (R-18)

This channel continuously monitors all Waste Disposal System liquid releases from the plant. Automatic valve closure action is initiated by this monitor to prevent further release after a high-radiation level is indicated and alarmed. A sodium iodide scintillation detector in the shielded holdup tank assembly monitors these effluent discharges. Remote indication and annunciation are provided on the Waste Disposal System control board and on the ratemeter and annunciator in the control room.

11.5.2.2.8 Steam generator liquid sample monitor R-19A, B, and C

These channels monitor the liquid phase of the secondary side of the steam generator for radiation, which would indicate a primary-to-secondary leak. This provides backup information to the condenser air removal gas monitor. The blowdown sample from each steam generator is continuously monitored by a dedicated skid-mounted unit before going to the secondary sample building.

This monitor has the following features:

The pulses are multiplied in the detector's multiplier tube before passing to a preamplifier which further amplifies and discriminates the pulse. The preamplifier discriminator circuit provides an integral output to the I/O circuit.

Circuitry tests are continually performed using a digital signal. Check source tests are operator-initiated locally but will automatically discontinue after one minute. The energy emission ranges are similar to the radiation energy-spectra being monitored.

There is a local digital display on the RM-80 and an indicator and recorder in the control room. The monitor range is from 10^1 to 10^7 cpm.

There are three alarm circuits in the RM-80. The High Radiation Alarm Circuits provide the signal to shut the Blowdown and Sample Isolation Valves. The Alert Alarm Circuit provides the control room process monitor alarm annunciation signal at the operator set level. The Operate/Status Alarm Circuit annunciates as R-19A, B, and C Trouble on APP-021 in the control room. This circuit gets signals from loss of counts, loss of flow, and check source fail.

11.5.2.2.9 Fuel Handling Building Basement Exhaust Monitor (R-20)

This channel, located near the point of atmospheric discharge, continuously monitors noble gas releases from this vent. A sample pump draws the sample into a shielded chamber where a beta-scintillation detector monitors low level beta and gamma activity. The sample is drawn from an isokinetic probe, and a particulate and iodine filter is provided for grab sample collection. The setpoint for R-20 is determined in accordance with the methodology of the ODCM. There are no isolation functions associated with the alarm on R-20. The channels count-rate is displayed locally on the RM-2000 microprocessor in the control room on a dedicated display, and available to a multipoint recorder. High-activity and channel fail alarms are displayed locally on the RM-2000 microprocessor, in the control room adjacent to the display, and annunciated on the control board annunciator.

11.5.2.2.10 Fuel Handling Building Upper Level Exhaust Vent (R-21)

This channel consists of one radio noble gas monitor, which continuously monitors releases through the duct exhausted by fan HVE-15. A sample pump draws the sample into a shielded chamber where a beta-scintillation detector monitors low level beta and gamma activity. The channel count-rate is displayed on the ratemeter in the control room and available to a multi-point recorder. High activity and channel fail alarms are displayed on the ratemeter and annunciated on the control board annunciator. The setpoint for R-21 is determined in accordance with the methodology of the ODCM. If the predetermined alarm point is exceeded, the exhaust fan HVE-15 automatically shuts down, thus ending any release to the environment. Exhaust fan HVE-15 only runs when fuel is not being moved in the Fuel Handling building. When fuel is being moved in the Fuel Handling Building, exhaust fan HVE-15A is in service which has pre-filters, charcoal and HEPA filters. The exhaust from fan HVE-15A enters the common duct shared by HVE-15 and exhausts through the plant ventilation stack monitored by R-14.

11.5.2.2.11 E&RC Building Hood Exhaust Monitor (R-22)

This unit continuously monitors the exhaust from the eight laboratory hoods and the respirator room hood in the E&RC building. An isokinetic probe in the exhaust plenum removes the sample from the air stream and sends it to R-22. The sample rate is 2.5 cfm. The maximum exhaust flow rate is 11,500 scfm. Particulate, iodine and noble gas activity are monitored and the results are displayed continuously on the CRT. The display is in counts per minute and is in scientific notation. An alarm will cause the specific status block on the CRT to light continuously or to blink on and off. In addition, any high, alert and low alarms are indicated by a local and remote bell as well as local and remote colored lights.

A recorder provides a permanent record of the particulate, iodine and noble gas activity as well as the exhaust duct CFM. The recorder is activated by an alarm condition. A 27-column printer is provided for alarm printouts also. It is activated by an alarm condition or operator action.

The particulate and noble gas detectors are beta scintillation detectors (phosphor). The iodine detector is a gamma scintillation detector (sodium iodine). The detectors are housed in lead and steel shield assemblies. The electronics of the R-22 have a 5-decade range, 10 to 10^6 cpm.

The operator may perform detector checks. Each detector has an associated radioactive check source which may be used to generate a quick functional test of the detector and post-detector electronics. The R-22 has a self diagnostic check and alarm system for detector or electronics failure.

11.5.2.2.12 Radwaste Building Exhaust Monitor (R-23)

R-23's automatic monitoring and recording functions have been disabled. Particulate and Iodine will be continuously collected while there is a provision for manual grab samples of noble gas and tritium.

11.5.2.2.13 Fuel Handling Building Basement Exhaust High Range Radioactive Gas Monitor (R-30)

This channel continuously monitors the ventilation exhaust air (HVE-14) from the Fuel Handling Building basement and Hot Machine Shop for gaseous radioactivity. The system consists of a GM type detector mounted on the exterior of the exhaust duct in a lead collimator. The monitor overlaps the upper end of R-20's range by a factor of 10, and also meets the upper end of the range required by NUREG 0737 and Reg. Guide 1.97.

11.5.2.2.14 Main Steamline Radiation Gas Monitors (R-31A, B, and C)

These three channels continuously monitor the main steam lines. The GM tube detectors are externally mounted next to the steam line between the containment and the steam line PORV. The detectors are located in collimated lead shields designed to reduce background from design based levels. Calculations were made to account for the low energy gamma rays being attenuated by the approximately one inch steel steam line wall. Noble gas resulting from a primary to secondary leak has the potential of escaping to the atmosphere through an open main steam line PORV.

11.5.2.2.15 Condensate Polisher Waste Monitor (R-37)

This channel continually monitors condensate polisher waste from the neutralization tank and sump pumps. Annunciation of this monitor would be indicative of a past primary-to-secondary system leak. Sump effluent and neutralized waste, which are independent of each other and intermittent, are mixed in a common header and are monitored by R-37 before discharging into the storm drain system. Upon indication of a high-radiation level, an air piston operated butterfly valve, located downstream of the monitor, isolates the waste from the storm drain system.

A remote display module and recorder are located on the condensate polisher control panel.

The detector is a photomultiplier tube - gamma scintillation counter (NaI crystal), cast lead shielded. A solenoid-actuated CS-137 checksource verifies detector operation. Signal processing is achieved with a digital microprocessor. Monitor has a sensitivity of 7.81×10^{8} μCi/cc and a range of 10^{1} to 10^{7} cpm.

R-37 has high and alert radiation level alarms which annunciate on the RM-80, RM-23, and condensate polisher control panel. If not acknowledged, high radiation will annunciate the RTGB as "Condensate Polisher Trouble." On circuit trouble, the green "OPERATE" status light extinguishes.

Both the alert and high radiation level alarm circuits are bistable for R-37. Setpoint is adjustable over the range of the instrument.

A remotely operated long half-life radiation check source is furnished for the operable channel. The energy emission ranges are similar to the radiation energy-spectra being monitored.

11.5.2.2.16 <u>TSC/EOF Accident Monitor, R-38</u>

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11.5.2.2.17 Main Steam Line N-16 Monitor (R-24A, B, and C)

These three channels continuously monitor their respective main steam line to detect and measure the nitrogen-16 radioactivity, which would indicate a primary-to-secondary leak. The monitoring of N-16 response will detect small leak rate changes. This provides backup information to the condenser air removal gas monitor. This monitor provides a clear indication of a steam generator tube rupture if the rupture occurs while the reactor is at power.

This monitor has the following features:

The monitor uses three, externally mounted, Adjacent-to-Line detectors, one for each of the three main steam lines between the containment and the R-31 detectors. The detectors consist of lightly shielded NaI(Tl) scintillation crystal/photomultiplier (PM) tube-type detectors. Internal amplification drives the output signal to feed the input to the RM-80.

The monitor includes a single, wall-mounted skid containing a separate detector heater control assembly for each detector, two RM-80 microprocessor assemblies, and a customer interface junction box (CIJB). One RM-80 processes two detectors and the third detector is supported by the other RM-80. Each RM-80 front panel includes a local digital display (RM-23L) and a green “OPERATE” status indicator.

The “OPERATE” status signal is energized when power is applied to the monitor, the database is loaded, and the monitor is operating properly. On circuit trouble, the “OPERATE” status light extinguishes. The two RM-80 Operate/Status Alarm relays are combined in the CIJB to annunciate a common “R-24 Trouble” on APP-036 in the control room.

The CIJB transmits an analog output signal for each detector to feed a recorder in the RMS cabinets in the control room. The recorder will provide an indication of each detectors’ calculated gallons per day (GPD) and a common annunciator signal to APP-36 at an operator set value to assist in monitoring. The RM-80 microprocessors calculate a power compensated GPD using CPM from the detectors, a reactor power input, and the RNP-specific stored database.

The monitor range is from 1 to 500 (nominal) GPD.

TABLE 11.5.2-1

PROCESS AND EFFLUENT RADIOLOGICAL MONITORING SYSTEM

DETECTING MEDIUM CONDITIONS

CHANNEL	MEDIUM	TEMPERATURE RANGE (°C)
R-11	Air	10-50
R-12	Air	10-50
R-14C, D and E	Air	4-50
R-15	Air	10-70
R-16	Water	15-93
R-17	Water	4-50
R-18	Water	15-50
R-19A, B, and C	Water	15-50
R-20	Air	10-50
R-21	Air	10-50
R-22A, B and C	Air	4-50
R-23 (Sample only)	Air	4-50
R-24A, B and C	Steam	0-60
R-30	Air	20-70
R-31A, B and C	Steam	20-70
R-37	Water	2-38

TABLE 11.5.2-2

PROCESS AND EFFLUENT RADIATION MONITORING SYSTEM CHANNEL SENSITIVITIES

CHANNEL	TYPICAL SENSITIVITY RANGE (µCi/cc)	DETECTED ISOTOPES
R-11	10^{-9} to 10^{-6}	Co^{58}, Co^{60}, Cs^{134}, Cs^{137}
R-12	10^{-6} to 10^{-1}	Kr^{85}, Ar^{41}, Xe^{135}, Xe^{133}
R-14C	10^{-7} to 10^{-2}	Activation and Mixed Fission Products
R-14D	10^{-3} to 10^{2}	Activation and Mixed Fission Products
R-14E	10^{0} to 10^{5}	Activation and Mixed Fission Products
R-15	10^{-6} to 10^{-1}	Ar^{41}, Xe^{135}, Xe^{133}
R-16	10^{-5} to 10^{-2}	Co^{60}, Mixed Fission Products
R-17	10^{-5} to 10^{-2}	Co^{60}, Mixed Fission Products
R-18	10^{-5} to 10^{-2}	Co^{60}, Mixed Fission Products
R-19A, 19B, 19C, R-37	10^{-7} to 10^{-2}	Co^{60}, Mixed Fission Products
R-20	10^{-6} to 10^{-1}	Kr^{85}, Ar^{41}, Xe^{135}, Xe^{133}
R-21	10^{-6} to 10^{-1}	Kr^{85}, Ar^{41}, Xe^{135}, Xe^{133}
R-22A	10^{-5} to 10^{-1}	Co^{58}, Co^{60}, Cs^{134}, Cs^{137}
R-22B	10^{-9} to 10^{-6}	I^{131}
R-22C	10^{-7} to 10^{-2}	Kr^{85}, Ar^{41}, Xe^{135}, Xe^{133}
R-24A, 24B, 24C	10^{-8} to 10^{-1}	N-16
R-30	10^{-2} to 10^{3}	Activation and Mixed Fission Products
R-31A, B, & C	10^{-2} to 10^{3}	Activation and Mixed Fission Products