11.3 Gaseous Waste Management System

The information in this section of the reference ABWR DCD, including all subsections, tables, and figures, is incorporated by reference with the following departures and supplements.

STD DEP 10.4-3

STD DEP 10.4-5 (Table 11.3-3, Figure 11.3-1, 11.3-2)

STD DEP 11.3-1 (Table 11.3-2 through 11.3-4 and Figure 11.3-1 and Figure 11.3-2)

11.3.2.1 Offgas System Compliance With Part 20.1406

The Offgas System meets the requirements of 10 CFR 20.1406. The Offgas System design will minimize, to the extent practicable, contamination of the facility and the environment by removing the radioactive isotopes of noble gases and gaseous iodines drawn from the condenser and allowing them to decay to acceptable levels before the offgas stream discharges the decayed radionuclides to the environment via the plant stack. The Offgas System includes discharge monitoring that will automatically isolate the Offgas System from the environment in the unlikely event an unacceptable level of activity is detected in the Offgas System effluent. The Offgas System will be operated using approved plant procedures.

The Offgas System is designed to minimize the generation of radioactive waste in that the charcoal in the carbon beds is not intended to be replaced during the entire plant life. To minimize carbon usage and to greatly reduce the potential for the Offgas System to spread contamination, the radiolysis-generated hydrogen and oxygen removed from the condenser by the Offgas System is recombined in a controlled manner in piping designed to withstand hydrogen and oxygen detonation. The resulting offgas is cooled and partially condensed to reduce the total influent mass and increase the relative radionuclide concentration that the carbon delay beds process. This increases the efficiency of the carbon delay beds and, therefore, reduces the mass of charcoal adsorbent. In addition, the cooler gas and resultant overall lower gas flow rate produces conditions for radionuclides to be more efficiently retained on the carbon in the delay beds. Additionally, a guard bed is positioned at the front end of the series of charcoal delay beds and is designed to bear the brunt of potential offgas operating events so that the follow on beds are minimally affected during the event

The initial loading of carbon is designed to adsorb the radionuclide gases present in the offgas stream without requiring periodic replacement. This design provides an objective that, during the operating life of the plant, carbon in the Offgas System delay beds should not contribute to or be processed into solid radwaste. The design objective can provide, at the end of the plant life, Offgas System decommissioning that primarily entails the removal of carbon adsorbent from the delay beds and processing it as dry solid radwaste.

11.3.3 Process Description

STD DEP 11.3-1

11.3.3.1 Process Functions

STD DEP 10.4-5

Major process functions of the Offgas System include the following:

(1) *Dilution of air ejector offgas with steam to less than 4% hydrogen by volume*

(2) *Recombination of radiolytic hydrogen and oxygen into water to reduce the gas volume to be treated and the explosion potential in downstream process components*

(3) *Two-stage condensation of bulk water vapor first using ~~condensate~~*Turbine Building Cooling Water (TCW) *and then chilled water as the coolant reducing the gaseous waste stream temperature to ~~18~~*10°*C or less*

(4) *Dynamic adsorption of krypton and xenon isotopes on charcoal at about ~~38~~*25°*C*

(5) *Filtration of offgas*

(6) *Monitoring of offgas radioactivity levels and hydrogen gas concentration*

(7) *Release of processed offgas to the atmosphere*

(8) *Discharge of liquids to the main condenser and radwaste systems*

Major process functions of the ventilation systems are described in Section 9.4.

11.3.3.2 Process Equipment

Major process equipment of the Offgas System consists of the following:

(1) *Process piping starting from the final steam dilution jets (SJAE) of the ~~main condenser evacuation system~~*Main Condenser Evacuation System (not a part of the Offgas System)

(2) *~~Integral recombiners,~~*Recombiner trains which include *~~including~~a Preheater ~~section~~, a Recombiner ~~section~~, and a Condenser ~~section~~*per train

(3) *Cooler-condensers*

(4) *Activated charcoal adsorbers*

(5) *High efficiency particulate air (HEPA) filter*

(6) *Monitoring instrumentation*

(7) *Process instrumentation and controls*

(8) *Offgas Evacuation System*

Major process equipment of the ventilation systems are described in Section 9.4.

11.3.3.3 Process Facility

STD DEP 10.4-5

STD DEP 11.3-1

~~*Reactor condensate*~~Turbine Building Cooling Water (TCW) *is used as the coolant for the offgas condensers. In this capacity:*

(1) The temperature of ~~*condensate*~~coolant *supplied to the offgas condenser should not exceed 56.6°C during periods of normal operation nor 43°C during periods of startup (main condenser evacuation) operation.*

(2) The pressure of ~~*condensate*~~coolant *supplied to the offgas condenser should not exceed the design pressure of the condenser.*

(3) ~~*Reactor condensate*~~TCW *isolation valves should be normally open to both recombiner condensers.*

~~*If any of these conditions cannot be met with reactor condensate, the coolant should be supplied by a closed cooling water system of reliability and quality equal to that of reactor condensate.*~~

The gaseous waste stream is then cooled to ~~*18*~~10 °*C or less in the cooler condenser. Chilled water (7 °C) is used from the HNCW System (Subsection 9.2.12). The cooler condenser is located immediately above the offgas condenser and is designed to remove any condensed moisture from the gaseous waste stream. The condensed moisture drains into the offgas condenser where it is sent to the main condenser.*

The gaseous waste stream is heated to approximately ~~*38*~~25 *°C by ambient heating in the charcoal vault.*

11.3.4.2 Process Design

STD DEP 11.3-1

Primary design requirements and the process data for startup and normal operating conditions are shown on the process flow diagram (PFD) (Figure 11.3-1) and the piping and instrument diagram (P&ID) (Figure 11.3-2). The Offgas System instrument setpoints are given in Table 11.3-4.

A flow meter is provided to measure the dilution steam flow to the last-stage air ejectors. If the dilution steam flow falls below a specified value, the process offgas line suction valve between the main condenser and SJAE closes automatically. The event is alarmed in the main control room. The valve will remain closed until proper steam flow has been established. A high dilution steam flow above a specified value also alarms in the main control ~~*room.*~~room. This flow meter is shown on Figure 10.4.1.

The SJAE provides superheated steam at the inlet to the preheaters. The driving steam (dilution steam) to the SJAEs is nuclear steam or steam of nuclear quality. Nuclear quality steam is defined as steam having impurities in concentrations not exceeding that of nuclear steam.

*~~Recombiner preheaters~~*Preheaters *preheat gases to about ~~177~~*150 *°C for efficient catalytic recombiner operation and to ensure the absence of liquid water, which suppresses the activity of the recombiner catalyst. Maximum preheater temperature does not exceed ~~210~~*170*°C should gas flow be reduced or stopped. This is accomplished by using a maximum steam pressure of ~~1.72~~*0.96 *MPa, saturated. At startup, steam at this pressure is available before the process offgas is routed through the preheater to the recombiner catalyst. Electrical preheaters directly exposed to the offgas are not allowed. Each preheater connects to an independent final stage air ejector to permit separate steam heating of both recombiners during startup or drying one recombiner while the other is in operation. Preheater steam flow quantities are shown on the PFD. Preheater steam is ~~nuclear steam~~*nuclear quality steam for *reliability. The preheater is sized to handle a dilution steam load of 115% of that shown on the PFD in addition to allowing for 5% plugged tubes.*

11.3.4.2.3 Condensing

*The offgas condensers cool the recombiner effluent gas to a maximum temperature of 68 °C for normal operation and 57 °C for startup operation. The condenser includes baffles to reduce moisture entrainment in the offgas. The unit is sized to handle a dilution steam load of 115% of that shown on the PFD, in addition to allowing for 5% plugged tubes. The drain is capable of draining the ~~entire process~~*collected *condensate, including the 15% excess plus 9 m^3/h, from the unit at both startup and normal operating conditions, taking into account the possibility of condensate flashing in the return line to the main condenser. The drain also incorporates a flow element so that higher flows due to tube leakage can be easily identified. The drain is a passive loop seal with a block valve operable from the main control room.*

*The gaseous waste stream is then cooled to ~~18~~*10 *°C or less in the cooler condenser. The cooler condenser is designed to remove any condensed moisture by draining it to the offgas condenser.*

11.3.4.2.4 Adsorption

*The activated charcoal uses "arbitrary" adsorption coefficient Karb values for krypton and xenon at 25 °C of at least 60 and 1170 cm^3/g, respectively (cm^3 defined at ~~0~~*25*°C, ~~and~~1.0 atmosphere* and 0% humidity). *Separate Karb laboratory determinations of krypton and xenon are made for each manufacturer's lot unless the manufacturer can supply proof convincing to the purchaser that other lots of the same production run immediately adjacent to the lot ~~rested~~*tested *are equivalent to the lot tested with respect to krypton and xenon adsorption. Other adsorption tests (e.g., dynamic coefficients) may be acceptable, provided their equivalence to Karb tests for this purpose can be demonstrated. Charcoal particle size is 8-16 mesh (USS) with less than 0.5% under 20 mesh. Moisture content is less than 2% by weight. Ignition temperature will be above*

150 °C in air. Properties of activated charcoal used in the adsorber vessels are an optimization of the following:

11.3.4.2.5 Filtration

The filter assembly contains a single high efficiency water-resistant filter element capable of removing at least 99.97% of 0.3 micrometer particles, as tested at the factory with mono-dispersed dioctylphthalate (DOP) smoke. The initial flow resistance of the filter does not exceed 2.54 cm water gauge (WG) at a water saturated air flow of ~~425~~96.4 m^3 /h. An upstream demister pad is not required in the filter assembly. The filter is capable of operating under 100% relative humidity conditions.

11.3.4.2.8 Charcoal Vault Temperature

The charcoal adsorber vault air conditioning system is controlled at any selected temperature within a range of ~~29~~23 °C to ~~41~~31 °C. The temperature of the vault is maintained as indicated in Subsection 11.3.4.3.13.

STP DEP 10.4-3

11.3.4.2.9 Rangeability

STP DEP 10.4-3

STP DEP 11.3-1

~~*In addition, the process can mechanically accommodate a startup high air flow as shown on the Process Data Sheet upon initiation of the steam jet air ejectors. This startup air flow results from evacuation of the turbine condensing equipment while the reactor is in the range of about 3 to 7% of rated power.*~~

The process can accommodate reactor operation from 0 to 100% of full power (full power is defined as the Normal Operating Case shown on the PFD). In normal operation, radiolytic gas production varies linearly with thermal power. The process can accommodate an air flow at 10 to ~~425~~96.4 m^3 /h for the full range of reactor power operation.

11.3.4.3 Mechanical Design

STD DEP 11.3-1

11.3.4.3.3 Equipment Room Ventilation Control

The equipment rooms are under positive ventilation control. Environmental conditions are maintained within the following ranges:

Area	Pressure (static cm water gauge)	Temp (°C)	Relative Humidity (%)	Air Turnover Rate (room air changes)
Offgas Bldg. Area, except Equipment Cells	*0.0 to - 0.63*	*4.4 Min* *21 normal* *40 Max*	*20 Min* *40 normal* *90 Max*	*3/h*
Charcoal Vault	*- 0.63 to -1.26*	~~*4.4*~~23 Min ~~*35*~~25 normal ~~*65.6*~~*31 Max*	*20 Min* *40 normal* *70 Max*	*3/h*
Other offgas Equipment Cells	*- 0.63 to -1.26*	*4.4 Min* *21 normal* *48.9 Max*	*20 Min* *40 normal* *90 Max*	*3/h*

11.3.4.3.7 Valves

*(2) A valve having a double stem seal and lantern ring type bonnet, with Grafoil or equivalent packing with the lantern ring leakoff connection pressurized with nitrogen or air ~~form~~*from *an oil-free compressor to a pressure exceeding the normal system operating pressure. The pressurization line includes a flow indicating device mounted on the valve (such as a purge gas rotameter Schutte and Koerting Type 1875-V or equivalent) with a scale in the 0.5 to 1.0 cm^3/s (at standard atmosphere) range, direct reading.*

11.3.4.3.11 Recombiners

~~*The recombiners are mounted with the gas inlet at the bottom.*~~ *The inlet piping* for the recombiner *has sufficient drains, traps and moisture separators to prevent liquid water from entering the recombiner vessel during startup. The recombiners are catalytic type with a nondusting catalyst supported on metallic screens or ribbons. The catalyst is replaceable without requiring replacement of the external pressure vessel.*

11.3.4.3.13 Charcoal Adsorber Vault

The temperature within the charcoal adsorber vault is maintained and controlled by appropriate connection(s) to the Turbine Building HVAC System. The flow rate and temperature of the air supplied to the vault has the capacity to cool the vault and equipment within from 66 °C to 27 °C in 48 hours. The decay heat is sufficiently small that, even in the no-flow condition, there is no significant loss of adsorbed noble gases due to temperature rise in the adsorbers. The HVAC design is capable of controlling the vault temperature within ~~3°C over~~the range of ~~27 to 38~~ 23 to 31°C.

*The charcoal adsorber vault temperature is controlled in the range ~~27~~*23*°C to ~~38~~*31*°C. If it becomes necessary to heat a vessel or the vault to 66 °C to facilitate drying the charcoal, portable heaters can be used. A smoke detector is installed in the exhaust ventilation duct from the charcoal adsorber vault to detect and provide alarm to the operator, as a charcoal fire within the vessel(s) usually results in the burning of the exterior painted surface.*

11.3.5 Other Radioactive Gas Sources

The following information supplements the existing information in this subsection of the reference ABWR DCD.

The main condenser mechanical vacuum pumps which ~~is~~are part of the main condenser evacuation system ~~is~~are described in section 10.4.

11.3.11 COL License Information

11.3.11.1 Compliance with Appendix I to 10 CFR50

The following supplemental information is provided for COL License Information Item 11.2.

~~*Compliance with Appendix I to 10 CFR50 numerical guidelines for offsite radiation doses as a result of gaseous or airborne radioactive effluents during normal plant operations, including anticipated operational occurrences is provided in the cost benefit analysis performed in accordance with the NEI topical report for numerical design objectives for 10 CFR50 App I. In accordance with 10 CFR 50.71(e), the FSAR will updated with reference to NEI Topical Report when the information is available.*~~

Compliance with numerical guidelines in Appendix I to 10 CFR 50 for offsite radiation doses as a result of gaseous effluents during normal plant operations, including anticipated operational occurrences, is provided in Subsection 12.2.2.2. To demonstrate compliance with Section II, paragraph D of Appendix I, a cost-benefit analysis was performed in accordance with the guidance of Regulatory Guide 1.110. The analysis postulated the addition of one augment of reasonably demonstrated technology to the Gaseous Waste Management System (GWMS). This augment was:

- *the addition of one 3-ton charcoal adsorber to the GWMS.*

Regulatory Guide 1.110 cost data used to evaluate the augment to the GWMS are summarized in the Table 11.3-5.

The total annual costs associated with implementing the augment to the GWMS and the corresponding benefit-cost ratio are determined using the methodology prescribed in Regulatory Guide 1.110, the cost data provided in Table 11.3-5, and the collective 50 mile total body dose (due to gaseous releases) that is presented in Table 5.4-9 of the STP 3 & 4 Environmental Report. The collective 50 mile total body dose is conservatively considered to be the total dose saved as a result of implementing this augment to the GWMS. The total annual costs of the augment to the GWMS and the associated benefit cost ratio are in Table 11.3-6. These results demonstrate that the total annual cost associated with the augment to the GWMS is substantially larger than the benefit derived from the augment. The cost-benefit numerical analysis, required by 10 CFR 50 Appendix I Section II Paragraph D, demonstrates that the addition of items to the GWMS of reasonably demonstrated technology will not provide a favorable cost benefit. Therefore, the STP 3 & 4 prescribed GWMS meets the numerical guides for dose design objectives.

Table 11.3-2 Offgas System Major Equipment Items

~~Recombiner (Item D005, 2 required, contains preheater, catalyst, and condenser sections)~~
~~Carbon steel shell~~
~~Shell length: approximately 70m~~
~~Shell OD: approximately 1.3m~~
~~Total unit height: approximately 2.95m~~
~~Design pressure: 2.41 MPa~~
~~Design temperature: 232 °C~~
~~Code of construction: ASME Section VIII, Division 1~~
~~Preheater section~~
~~Shell and tube heat exchanger~~
~~Tubes: stainless steel, rolled into stainless steel tube sheet~~
~~Tube-side design pressure: 2.41 MPa~~
~~Design temperature: 232 °C~~
~~Catalyst section~~
~~Catalyst support: stainless steel~~
~~Design temperature: 482 °C~~
~~Catalyst: precious metal on ceramic or metal base~~
~~Offgas condenser section~~
~~Shell and tube heat exchanger~~
~~Tubes: stainless steel, rolled into stainless steel tube sheet~~
~~Tube-side design pressure: 2.41 MPa~~
~~Design temperature: 482 °C~~
~~Cooler condenser (Item B010, 2 required)~~
~~Type: Shell and tube heat exchanger carbon steel vessel~~
~~Shell length: 3.05m~~
~~Shell-side design pressure: 2.41 MPa~~
~~Shell-side design temperature: 0 to 121°C~~
~~Tubes: stainless steel, welded into stainless tube sheet~~
~~Tube-side design pressure: 0.69 MPa~~
~~Tube-side design temperature: 0 to 65.6 °C~~
~~Code of construction: TEMA Class C~~
~~Charcoal adsorbers (Items D012A and D012B-J)~~
~~Carbon steel vessels filled with activated charcoal: 4500 kg D012A, 13,600 kg D012B-J~~
~~Height: approximately 10.4m~~
~~Outside diameter: approximately 1.2m D012A, 2.1m D012B-J~~
~~Design pressure: 2.41 MPa~~
~~Design temperature: 4.4 to 121°C~~
~~Code of construction: ASME Section VIII, Division 1~~
~~Filter (Item D016, 1 required)~~
~~Carbon steel vessel with removable HEPA filter~~
~~Height (includes legs): approximately 1.8m~~
~~Outside diameter: approximately 0.61m~~
~~Flow: 425 m^3/h at 2.54 cm H_2O gauge~~
~~Design pressure: 2.41 MPa~~
~~Design temperature: 4.4 to 65.6°C~~
~~Code of construction: ASME Section VIII, Division 1~~

Table 11.3-2 Offgas System Major Equipment Items (Continued)

Preheater *Quantity: 2* *Type: shell and tube heat exchanger* *Material: stainless steel vessel* *Shell length: approximately 4.5 m* *Shell OD: approximately 2.0m* *Shell-side design pressure: 0.96 MPa* *Shell-side design temperature: 188 °C* *Tubes: stainless steel, expand and welded into stainless steel tube sheet* *Tube-side design pressure: 2.41 MPa* *Tube-side design temperature: 232 °C* *Code of construction: ASME B&PVC, Section VIII, and TEMA*
Recombiner *Quantity: 2* *Material: stainless steel vessels* *Catalyst support: Stainless steel* *Height (includes legs): approximately 4.0m* *Outside diameter: approximately 2.5m* *Design pressure: 2.41 MPa* *Design temperature: 482 °C* *Catalyst: precious metal on ceramic or metal base* *Code of construction: ASME B&PVC, Section VIII*
Condenser *Quantity: 2* *Type: shell and tube heat exchanger* *Material: stainless steel vessel* *Shell length: approximately 5.5m* *Shell OD: approximately 1.0m* *Shell-side design pressure: 2.41 MPa* *Shell-side design temperature: 482 °C* *Tubes: stainless steel, expand and welded into stainless steel tube sheet* *Tube-side design pressure: 1.37 MPa* *Tube-side design temperature: 70 °C* *Code of construction: ASME B&PVC, Section VIII, and TEMA*
Cooler condenser *Quantity: 2* *Type: shell and tube heat exchanger* *Material: stainless steel vessel* *Shell length: approximately 4.0m* *Shell-side design pressure: 2.41 MPa* *Shell-side design temperature: 66 °C* *Tubes: stainless steel, expand and welded into stainless tube sheet* *Tube-side design pressure: 1.37 MPa* *Tube-side design temperature: 70 °C* *Code of construction: TEMA Class C*

Table 11.3-2 Offgas System Major Equipment Items (Continued)

Charcoal adsorbers
- *Quantity: One Guard Bed, four Charcoal adsorber*
- *Material: low carbon steel vessels filled with activated charcoal, one Guard bed of 4,721kg, four Charcoal adsorber of 27,200 kg*
- *Height: Guard bed approximately 5.0 m, Charcoal adsorber approximately 15.0 m*
- *Outside diameter: Guard bed approximately 2.2 m, Charcoal adsorber approximately 2.5 m*
- *Design pressure: 2.41 MPa*
- *Design temperature: 121°C*
- *Code of construction: ASME Section VIII, Division 1*

Filter
- *Quantity: 1*
- *Material: low carbon steel vessel with removable HEPA filter*
- *Height (includes legs): approximately 1.5m*
- *Outside diameter: approximately 1.0m*
- *Flow: 96.4Nm3/h at 250Pa*
- *Design pressure: 2.41 MPa*
- *Design temperature: 66 °C*
- *Code of construction: ASME Section VIII, Division 1*

Vacuum pump
- *Quantity: 2*
- *Type: Rotary type*
- *Material: Stainless steal casing*
- *Height: approximately 1.0 m*
- *Width: approximately 1.0m*
- *Length: approximately 2.0m*
- *Flow: 200 Nm3/h*
- *Code of construction: API-610, API-674, API-675, ASME Section VIII, Division 1, or Division 2*
- *Auxiliary: Recirculation water tank, Recirculation water pump (two units), Recirculation water cooler.*

Table 11.3-3 Equipment Malfunction Analysis

Equipment Item	Malfunction	Consequences	Design Precautions
Preheater~~Recombiner preheater~~	*Steam leak*	*Would further dilute offgas. Steam consumption would increase.*	*Spare recombiner.*
	Low-pressure steam supply	*Recombiner performance would fall off at low-power level, and hydrogen content of recombiner gas discharge would increase eventually to a combustible mixture.*	*Low-temperature alarms on preheater exit (catalyst inlet). Downstream H_2 analyzer.*
Recombiner ~~catalyst~~	*Catalyst gradually deactivates*	*Temperature profile changes through catalyst. Eventually, excess H_2 would be detected by H_2 analyzer or by gas flow meter. Eventually, the gas could become combustible.*	*Temperature probes in catalyst bed and H_2 analyzer provided. Spare recombiner.*
Condenser ~~Recombiner condenser~~	*Cooling water leak*	*The coolant (TCW~~reactor condensate~~) would leak to the process gas (shell) side. This would be detected if drain well liquid level increases. Moderate leakage would be of no concern from a process standpoint. (The process condensate drains to the hotwell.)*	*Drain well high level alarm. Redundant recombiner.*

Table 11.3-4 Offgas System Instrument Setpoints

Item	Function	MPL	Normal Range	Operational Limits	Sensor Type (Qualifications)	Scale Range (Tolerance)	Setpoint/ Alarm
1	Steam Flow to Final SJAE (*)	N39-FE005	100-105%	75-115%	Superheated Steam (10 –254 °C) (0 – 4.12 MPa)	0 – 120% (±125 kg/h)	L 75% Trip AH 110% AL 95%
2	Not Used						
3	Preheater Inlet Pressure	PT001	-2.0 kPa	N/A	Offgas and Steam (10 – 315 °C) (-0.1 – 7.24 MPa)	-100 – 400 kPa (± 4 kPa)	AH 295 kPa
4	Air Bleed Pressure	PI101	0.69 – 0.87 MPa	N/A	Air (10 – 65 °C) (0 – 1 MPa)	0 – 1 MPa (± 0.005 MPa)	N/A
5	Air Bleed Flow – Total (**)	FI102	1.7 – 48.2 m^3/h	1.7 – 105 m^3/h	Air (10 – 65 °C) (0 – 1 MPa)	0 – 100 m^3/h (± 5 m^3/h)	N/A
6	Air Bleed Flow – Normal (**)	FI104	1.7 – 2.4 m^3/h	1.7 m^3/h	Air (10 – 65 °C) (0 – 1 m^3/h)	0 – 3.7 m^3/h (± 0.17 m^3/h)	N/A
7	Recombiner Inlet Temp.	TE004	150 °C	105 – 399 °C	Offgas and Steam (10 – 482 °C) (-0.1 – 2.41MPa)	0 – 400 °C (± 5°C)	AL 140 °C
8	Not Used						
9	Temperature Profile of Recombiner	TE006 TE007	150 – 443 °C	121 – 482 °C (***)	Offgas and Steam (10 – 550 °C) (-0.1 to 2.41 MPa)	0 – 550 °C (± 7.5 °C)	AH 443 °C AL 140 °C
10	Not Used						
11	Offgas Cond. Water Level	LT009	< 150 mm	< 260 mm	Water (10 – 100 °C) (-0.1 – 7.24 MPa)	0 – 550 mm (± 5.5 mm)	AH 245 mm
12	Offgas Cond. Loop Seal Water Flow	FI008	9 m^3/h	9.35 m^3/h	Water (10 – 100 °C) (-0.1 – 2.41 MPa)	0 – 20 m^3/h (± 2 m^3/h)	N/A
13	Not Used						

Table 11.3-4 Offgas System Instrument Setpoints (Continued)

Item	Function	MPL	Normal Range	Operational Limits	Sensor Type (Qualifications)	Scale Range (Tolerance)	Setpoint/ Alarm
14	Offgas Cond. Exit Temp.	TE011	< 55 °C	N/A	Offgas (10 – 100°C) (-0.1 – 7.24 MPa)	0 – 100°C (± 2°C)	N/A
15	Hydrogen Analyzer	P91- H2E010 H2E011	0 – 0.1% by V. 0 – 1.0% by V.	0 – 4% by V.	Offgas (10 – 100 °C) (-0.1 to 7.24 MPa)	0 – 4% by V. (± 0.15% by V.)	AH 2% by V.
16	Air Bleed – Inlet at Cooler Cond. (**)	FI104	0 – 1.7 m^3/h	0 – 3.4 m^3/h	Air (10 – 65 °C) (0 to 1 MPa)	0 – 3.4m^3/h (± 0.3 m^3/h)	N/A
17	Cooler Cond. Exit Temp.	TE013	10 – 20 °C	N/A	Offgas (0 – 66 °C) (-0.1 – 7.24 MPa)	0 – 50 °C (± 1°C)	N/A
18	Charcoal Adsorber Inlet Press.	PT022	-14.7 kPa	N/A	Offgas (0 – 66 °C) (-0.1 – 7.24 MPa)	-100 – 200 kPa (± 0.002 MPa)	N/A
19	Charcoal Adsorber Diff. Press.	DPT024	0.002 – 0.02 MPa	0.027 MPa	Offgas (4 – 121 °C) (-0.1 – 7.24 MPa)	0 – 30 kPa (± 0.15 kPa)	AH 0.02 MPa
20	Charcoal Adsorber Vessel Temperature	TE025 TE028	27°C	22 – 32 °C	Offgas (4 – 121 °C) (-0.1 – 7.24 MPa)	0 – 150 °C (± 5 °C)	AH 60 °C
21	Charcoal Adsorber Vault Temp. Control	TE031	24 – 30 °C	23 – 31 °C	Ambient Air (0 – 50 °C)	0 – 50 °C (± 0.5 °C)	27 °C
22	Charcoal Vault Inlet Water Level	LS023	0 – 1 m	0.05 – 1.5 m	Water (4 – 100 °C) (-0.1 – 7.24 MPa)	0 – 1.5 m (± 0.01 m)	AH 1.2 m AL 0.1 m
23	Charcoal Vault Exit Temperature	TE032	N/A	4 – 31 °C	Ambient Air (0 – 50 °C)	0 – 50 °C (± 0.5 °C)	AH 30 °C AL 23 °C

Table 11.3-4 Offgas System Instrument Setpoints (Continued)

Item	Function	MPL	Normal Range	Operational Limits	Sensor Type (Qualifications)	Scale Range (Tolerance)	Setpoint/ Alarm
24	After Filter Differential Pressure	DPT029	50 – 250 Pa	1.0 kPa	Offgas (0 – 121 °C) (-0.1 – 7.24 MPa)	0 – 5 kPa (± 0.032 kPa)	AH 0.9kPa
25	Process Flow (**)	FT020 FT021	10 – 20 m^3/h	0 – 96.4m^3/h	Offgas (0 – 121 °C) (-0.1 – 7.24 MPa)	Narrow Range: 0 – 50 m3/h (± 0.75 m^3/h) Wide Range: 0 – 100 m^3/h (± 1.5 m^3/h)	AL 10 m^3/h AH 40 m^3/h AHH 80 m^3/h

* Based on Full Power Flow of 5000 kg/hr steam
** Flow is at Standard Atmosphere
*** Operational Limit for standby recombiner is 160 – 300°C.

Table 11.3-5 REGULATORY GUIDE 1.110 COST DATA (1)
(Costs are in 1000s of 1975 Dollars)

Cost-Benefit Parameter	3-Ton Charcoal Adsorber
Equipment and Material Direct Cost (2)	53
Direct Labor Cost (DLC) (2)	14
Labor Cost Correction Factor (LCCF) (3)	1
Annual Operating Cost (AOC)	Negligible
Annual Maintenance Cost (AMC)	Negligible

Notes:
(1) All costs are on a per unit basis.
(2) Equipment and Material Direct Costs and Direct Labor Costs are from Table A-1 of Regulatory Guide 1.110.
(3) The Labor Cost Correction Factors are from Table A-4 of Regulatory Guide 1.110. The lowest LCCF is chosen which maximizes the benefit.
(4) The Annual Operating Costs are from Table A-2 of Regulatory Guide 1.110.
(5) The Annual Maintenance Costs are from Table A-3 of Regulatory Guide 1.110.

Table 11.3-6 Gaseous Radwaste Augment Benefit Cost Ratio Summary

Augment	Total Annual Costs (1975 Dollars)	Collective 50 Mile Total Body Dose Saved per Year (Person-Rem)	Benefit in 1975 Dollars (1000 Dollars x Person Rem Saved)	Benefit Cost Ratio
3-Ton Charcoal Adsorber	7,750	0.58	580	7.48E-02