# SECTION 9
# PLANT RADIOACTIVE WASTE CONTROL SYSTEMS

## TABLE OF CONTENTS

**Page**

## TABLE OF CONTENTS [Continued]

## LIST OF TABLES

## TABLE OF CONTENTS [Continued]

## LIST OF DRAWINGS

THIS PAGE IS LEFT INTENTIONALLY BLANK

# SECTION 9 PLANT RADIOACTIVE WASTE CONTROL SYSTEMS

## 9.1 SUMMARY DESCRIPTION

### 9.1.1 General Systems Description

Radioactive fluids entering the Waste Disposal System are collected in intermediate holding tanks for determination of subsequent treatment. They may be sampled and analyzed to determine the quantity of radioactivity, with an isotopic analysis if necessary. The liquid wastes are then processed as required for reuse or released under controlled conditions and in accordance with applicable limits of 10CFR20 and the design objectives of Appendix I to 10CFR50.

The bulk of the radioactive liquid drained from the Reactor Coolant System is processed by the Chemical and Volume Control System recycle train and retained inside the plant. This minimizes liquid input to the Waste Disposal System which processes relatively small quantities of generally low activity level wastes. The processed water from the waste disposal system, from which the majority of the radioactive material has been removed may be reused in plant or released through a monitored line to the canal downstream of the cooling towers. 01-082

Waste gases are processed by one of two interconnected equipment trains. The low level loop, provides sufficient storage capacity for cover gases from the nitrogen blanketing system to minimize the need to vent gases which accumulate as a result of load follow operations. Discharges of fission gases from the system are limited to maintenance vents, unavoidable equipment leaks, and infrequent gas decay tank releases to dispose of gases accumulated by inflows from shutdown operations and miscellaneous vents. Controls are provided to regulate the rate of release from these tanks through the monitored plant vent. 01-081

The high level loop was designed to accumulate, concentrate and contain fission gases at high activity concentrations from continuous purging of the volume control tanks gas space. It would provide continuous removal of fission gases from the letdown coolant to maintain the coolant fission gas concentrations at a low residual level. This loop can perform these functions and/or be used for reserve holdup capacity of low level loop gas. 01-081

The spent resins from demineralizers, filter cartridges and concentrates from the evaporators are packaged and stored onsite until shipment offsite for processing and disposal. 01-082

The Waste Disposal System Process Flow Diagrams are shown in Figures 9.1-1 through 9.1-10 and Performance Data are given in Table 9.1-1. With the exception of the SGB system, containment building sumps and pumps, reactor coolant drain tanks and drain tank pumps, and associated piping and valves, the Waste Disposal System is common to Units 1 and 2.

The Waste Disposal System collects and processes all potentially radioactive reactor plant wastes for removal from the plant site well within limitations established by regulations.

Fluid wastes are collected, sampled and analyzed to determine the quantity of radioactivity, with an isotopic analysis if necessary. Depending on the results of the analysis, these wastes are processed as required and reused in the plant or released to the environment.

If the wastes are to be released from the plant site, they are released under controlled conditions. Radiation monitors are provided to maintain surveillance over the release operation, and a permanent record of activity released is provided by radiochemical analysis of the known quantities of waste and substantiated by plant recording instruments. The system is capable of processing all wastes generated during continuous operation of the primary system, assuming that fission products escape to the reactor coolant by diffusion through defects in the cladding of no more than one percent of the fuel rods.

At least two valves must be manually opened to permit discharge of liquid or gaseous waste from the Waste Disposal System. One of these valves is normally locked closed. An additional control valve will trip closed on a high effluent radioactivity level signal to prevent discharge to the environment.

As secondary functions, system components supply hydrogen and nitrogen to primary system components as required during normal operation, and provide facilities to transfer fluids from the containment to other systems outside the containment.

The system is controlled from local control panels in the auxiliary building and the radwaste building. Malfunctions of the system are locally alarmed in the auxiliary and radwaste buildings, as well as being annunciated in the control room. All system equipment is located in the radwaste building, the auxiliary building, or the reactor containment buildings.

The design basis for the radwaste building is described in Section 12.2.1.4.3.2, Structural Design Basis for Class I* Structures.

The radwaste building is supplied with outside air which can be preheated by heating coils in the air-handling unit. Exhaust flow is directed through charcoal adsorber beds and a HEPA filter prior to release to the surroundings. The cement dust filter fan exhaust is not directed through the adsorber bed or the HEPA filter. All releases are monitored by the Radwaste Building Radiation Monitor Channel R-35 as described in 01-082
Table 7.5-1. In addition, unit heaters are provided throughout the radwaste building for heating in the winter.

Adjacent to the Radwaste Building is the resin disposal building which receives, dewaters and handles spent resins from the condensate polishing system (See Section 11.8.)

### 9.1.2 Component Design Considerations

Codes applying to components of the Waste Disposal System are shown in Table 9.1-2. Component summary data are shown in Table 9.1-3.

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

Piping carrying liquid wastes is stainless steel or fiberglass while gas piping is carbon or stainless steel. Steel piping connections are welded except where flanged connections 01-081
are necessary to facilitate equipment maintenance.

Valves exposed to gases are carbon or stainless steel. Those exposed to liquids are stainless steel. 01-081
Globe valves are installed with flow over the seats when such an arrangement reduces the possibility of leakage.

Isolation valves are provided to isolate equipment for maintenance, to direct the flow of 01-081
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. Tanks containing wastes which are normally free of gaseous activity are vented locally.

Outleakage 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.

THIS PAGE IS LEFT INTENTIONALLY BLANK

# 9.2 LIQUID RADWASTE SYSTEM

## 9.2.1 Design Basis

Criterion: The facility design shall include those means necessary to maintain control over the plant radioactive effluents, whether gaseous, liquid, or solid. Appropriate holdup capability shall be provided for retention of gaseous, liquid, or solid effluents, particularly where unfavorable environmental conditions can be 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 10CFR20 requirements, for both normal operations and for any transient situation that might reasonably be anticipated to occur and (b) on the basis of 10CFR100 dosage level guidelines for potential reactor accidents of exceedingly low probability of occurrence. (GDC70)

Liquid, gaseous, and solid waste disposal facilities are designed so that discharge of effluents and off-site shipments are a small percentage of the applicable governmental regulations.

The liquid radwaste systems' design objective is to have the capability of processing the discharge of radioactive material under normal operating conditions so as to approach essentially zero (i.e., actual river background) and to ensure that activity released under design basis conditions will be a small fraction of the applicable limits in 10CFR20.

### 9.2.1.1 Liquid Radwaste

The liquid radwaste system is designed to collect, process and dispose of all radioactive liquid wastes generated in the operation of the plant. The system is designed to accommodate the radioactive input resulting from the design basis maximum fuel leakage condition.

The radioactive waste system has been shown to meet the requirements of Appendix I to 10CFR50. The radwaste systems reduce the activity released to acceptable levels.

### 9.2.1.2 Monitoring Radioactive Releases

Criterion: Means shall be provided for monitoring the containment atmosphere and the facility effluent discharge paths for radioactivity released from normal operations, from anticipated transients, and from accident conditions. An environmental program shall be maintained to confirm that radioactivity releases to the environs of the plant have not been excessive. (GDC 17).

The containment atmosphere, the shield building vent, the auxiliary building vent, the control room ventilation system, the spent fuel pool exhaust, the RHR cubicle ventilation exhaust, the condenser air ejector exhaust, the circulating water discharge, the containment fan coolers cooling water discharge, blowdown from the steam generators, the component cooling water, and the Waste Disposal System liquid effluent are monitored for radioactivity concentration during normal operations, anticipated transients, and accident conditions. High radiation in any of these is indicated and alarmed in the control room.

All gaseous effluent from possible sources of accidental radioactive release external to the reactor containment (e.g., the spent fuel pool and waste handling equipment) will be exhausted from an auxiliary building vent, which is monitored. Leaks from piping carrying radioactive liquids are contained within the reactor containment buildings, radwaste building, or auxiliary building. Any contaminated liquid effluent released to the condenser circulating water is monitored. For any leakage from the reactor containment under accident conditions, the plant radiation monitoring system supplemented by portable survey equipment provides adequate monitoring of radioactivity release.

### 9.2.2 Description

The waste disposal system collects, processes, stores and disposes of radioactive liquid waste originating in the plant. The subsystems comprising the Liquid Radioactive Waste Disposal System are: Reactor Coolant Drain (RCD), Auxiliary and Reactor Building Drain (ARD), Steam Generator Blowdown Treatment (SGBT), Non-Aerated Drain, and Aerated Drains Treatment (ADT). The system has the capability of storing 60,000 gallons.

The major sources of liquid waste are:

Reactor Coolant System drains and leaks
Chemical and Volume Control System drains and leaks
Non-aerated equipment drains and leaks
Aerated equipment drains and leaks
Chemical laboratory drains
Decontamination area drains
Radiochemical laboratory drains
Sampling System
Steam Generator Blowdown
Auxiliary Coolant System drains

To facilitate storage, processing and disposal, the system is designed to segregate various waste streams at their point of collection into the following categories:

Non-aerated waste
Aerated waste
Chemical drains
Steam Generator Blowdown
Resin waste

Non-aerated waste is primarily from Reactor Coolant System drainage which is collected from the following sources and transferred directly to the Chemical and Volume Control System (CVCS) holdup tanks, or the waste holdup tank (depending on fluid composition) for processing:

a. Reactor coolant loops

b. Pressurizer relief tank

c. Reactor coolant pump secondary seals

d. Excess letdown (during startup)

e. Accumulators

f. Reactor vessel flange leakoffs

Fluid directed to the reactor coolant drain tanks is pumped to the CVCS holdup tanks, the waste holdup tank, or the refueling water storage tanks by the reactor coolant drain tank pumps. There is one reactor coolant drain tank with two reactor coolant drain tank pumps located inside of each reactor containment building.

The remaining non-aerated liquid waste originates in the Chemical and Volume Control System charging and letdown paths and the gas decay tank drains. These liquid waste streams are collected and handled in an anaerobic manner to minimize the hydrogen explosion hazard and prevent the escape of gaseous radioactivity. This is accomplished by collecting non-aerated waste in a closed piping system that drains to a non-aerated sump tank. The non-aerated sump tank is isolated from the atmosphere by a flexible diaphram type seal. Normally non-aerated waste is transferred to the CVCS holdup tanks for processing. (see Section 10.2.3)

If the water is not suitable or it is not desirable to send the non-aerated waste to the CVCS holdup tanks, the water can be pumped to the waste holdup tank.

Aerated waste originates primarily from the floor drains, aerated equipment drains and leaks, the laundry equipment drains, and the decontamination area drains.

Where possible, aerated waste is collected by gravity drainage to the aerated sump tank. In other cases, aerated waste is drained to local sumps from where it is pumped to the aerated sump tank. From the aerated sump tank, aerated waste can be pumped to the two aerated monitor tanks, the ADT collection tanks or the waste holdup tank. Normally the discharge from the aerated sump tank pump is aligned to the waste holdup tank due to its capacity and shielded location. When enough water has been collected in the waste holdup tank for processing purposes, the waste holdup tank is gravity drained to the aerated sump tank, which is pumped to the ADT collection tanks.

Waste water in the ADT Collection tanks is normally processed through the ADT Cartridge Filters. The filtrate is collected in the ADT Condensate Receiver Tanks, and then processed through the ADT Ion Exchangers and collected in the ADT Monitor Tanks. The ADT Monitor Tanks are analyzed, and based on the analysis, may be released or reprocessed.

Waste from the hot sampling station and hot chemical laboratory is collected in the chemical drain tank. Periodically this waste is neutralized, if needed, then pumped to the aerated sump tank.

Waste water from the resin disposal building sump is pumped to the miscellaneous drains collection tank or the waste holdup tank. Waste water from the truck loading enclosure sump is pumped to the aerated sump tank.

Control of radioactivity of the laundry and hot shower wastes is gained by using disposable clothing in areas of known high contamination. The laundry and hot shower waste liquid is directed to the aerated sump tank through the floor drain system. The laundry and hot shower liquid waste is then processed through the ADT system.

Steam Generator Blowdown is discharged to a flash tank shared by both steam generators of a unit. The blowdown line from each steam generator is equipped with two motor-operated containment isolation valves, one inside and one outside of containment. As shown in Tables 5.2-1 Part A (U1) and Part B (U2) only the outside valve is credited for Containment Isolation. The other redundant barrier is the Steam Generator (see Appendix G). Flow into the flash tank from each steam generator is controlled by a single control valve. Flow rate from each steam generator is manually controlled from the control room.

The steam generator blowdown motor operated isolation valves are designed to close upon receipt of a containment isolation signal.

The SGB flow control valves are designed to trip closed if one of the following conditions occur:

1. Either Auxiliary Feedwater Pump for the associated unit starts.

2. High activity is detected in the associated steam generator blowdown radiation monitor (R19).

Normally steam generator blowdown from the flash tank is directed to the SGB Holdup Tanks from which it is pumped through a filter and ion exchanger to the respective condenser. This is called ”reclaim”. Occasionally, to control steam generator chemistry, blowdown is released to the circulating water canal via a radiation monitor. Such is the case during unit startup. In the event that radioactivity exceeds the setpoint of the SGB Radiation Monitor, the discharge valve to the river automatically closes thus securing the release. The steam from the blowdown flash tank is normally routed to the extraction steam inlet to Feedwater Heater No. 3. Steam can also be routed to the main condenser or to the atmosphere. The noncondensible gases removed from the condenser (by an air ejector) pass through a radiation monitor at all times.

SGB Monitor Tank liquid releases are made based on radiochemical batch analysis of the tank contents and are monitored by the waste disposal system liquid effluent monitor.

Information on concentrations in these effluents that are below the functional alarm levels are provided by the routine radiochemistry analysis and continuous ERCS/MIDAS monitor.

### 9.2.2.1 Components

#### 9.2.2.1.1 Laundry and Hot Shower Tanks

The laundry and hot shower tanks are constructed of welded stainless steel. The inlets to these tanks have been closed off. Laundry and hot shower waste is now directed to the floor drain system.

#### 9.2.2.1.2 Chemical Drain Tank

The chemical drain tank is stainless steel and collects drainage from the chemistry laboratory. After analysis, the tank contents are treated as aerated waste.

#### 9.2.2.1.3 Reactor Coolant Drain Tanks

The reactor coolant drain tanks are right circular cylinders with spherically dished heads. The tanks, which are all welded stainless steel, serve as a drain collecting point for the Reactor Coolant System drains and other equipment located inside the reactor containments. The tank contents can be discharged to the CVCS, waste holdup tank, or to the refueling water storage tanks.

#### 9.2.2.1.4 Waste Holdup Tank

The waste holdup tank receives radioactive liquids from various aerated plant systems and drains. Various non-aerated equipment can also be aligned to the waste holdup tank. The tank is constructed of welded stainless steel and can be drained to the aerated sump tank or pumped to either the waste evaporator or the waste condensate tanks.

#### 9.2.2.1.5 Aerated Sump Tank and Pumps

The aerated sump tank serves as a collecting point for auxiliary building floor drains and various aerated equipment system drains. A horizontal centrifugal sump pump or shared backup pump are used to transfer the tank contents to the waste holdup tank, ADT collection tanks, or the aerated monitor tanks. All wetted parts of the pumps are stainless steel. The aerated sump tank is constructed of welded stainless steel.

#### 9.2.2.1.6 Non-Aerated Sump Tank

The non-aerated sump tank serves as a collecting point for waste water from the charging pump seal water, gas decay tank drains, demineralizer drains, and other various non-aerated equipment drains. A horizontal centrifugal pump or shared backup pump transfers this collected liquid normally to the CVCS holdup tank, but can be aligned to transfer the contents to the waste holdup tank. The tank is constructed of welded stainless steel with a diaphragm seal to prevent entrained gases from escaping to the atmosphere. This tank can be vented to the waste gas compressor suction.

#### 9.2.2.1.7 Aerated Drains Treatment (ADT) Monitor Tanks

The ADT monitor tanks are constructed of welded stainless steel and can receive water from the ADT ion exchangers and the SGB monitor tanks. The tanks serve as a final collection point for water which has been processed through the liquid radwaste treatment system. Depending upon chemical analysis, the water in the ADT monitor tanks can be released to the environment, reprocessed, or returned to the waste holdup tank or SGB monitor tanks, for decay.

#### 9.2.2.1.8 Aerated Drains Treatment (ADT) Collection Tanks

The aerated drains treatment collection tanks can receive liquid from the aerated sump tank, the miscellaneous drains collection tank, the ADT monitor tanks, or the SGB system for processing in the radwaste building. The ADT collection tank water is normally processed through the ADT cartridge filters, but can be directed to the waste holdup tank for additional decay. The ADT collection tanks are constructed of welded stainless steel.

### 9.2.2.1.9 Aerated Drains Treatment (ADT) Ion-Exchangers

The ADT system uses three flushable ion-exchangers that can be operated in parallel or series and are shared by Units 1 and 2. Each ion exchanger contains approximately 35 cu. ft. of resin. Each vessel is constructed of stainless steel, with a stainless steel retention screen.

### 9.2.2.1.10 Miscellaneous Drains Collection Tank

The miscellaneous drains collection tank receives liquids from floor drains of the radwaste building and from the resin disposal building sump. It can be used as excess storage in series with the ADT collection tanks. The miscellaneous drains collection tank is constructed of welded stainless steel.

### 9.2.2.1.11 SGB Monitor Tanks

The SGB monitor tanks are constructed of welded stainless steel and can serve as a collecting point for the SGB ion exchanger outlet. The tanks are occasionally used for ADT water waiting reprocessing.

### 9.2.2.1.12 SGB Ion Exchanger

Two flushable ion exchangers, operated in parallel, are shared by Units 1 and 2. Each ion exchanger contains approximately 37 cu. ft. of resin. Each vessel is constructed of stainless steel, with a stainless steel resin retention screen.

### 9.2.2.1.13 Waste Evaporators

Equipment not used.

#### 9.2.2.1.13.1 2 GPM Radwaste Evaporator

Equipment not used.

#### 9.2.2.1.13.2 Waste Feed

Equipment not used.

#### 9.2.2.1.13.3 Steam Supply

Equipment not used.

#### 9.2.2.1.13.4 Cooling Water Supply

Equipment not used.

#### 9.2.2.1.13.5 Distillate System

Equipment not used.

#### 9.2.2.1.13.6 Concentration Level

Equipment not used.

#### 9.2.2.1.13.7 Nitrogen Blanketing

Equipment not used.

### 9.2.2.1.14 ADT Evaporator (5 GPM)

Equipment not used.

#### 9.2.2.1.14.1 Evaporator

Equipment not used.

#### 9.2.2.1.14.2 Vapor Condenser

Equipment not used.

#### 9.2.2.1.14.3 Concentrate Cooler

Equipment not used.

#### 9.2.2.1.14.4 Recirculation Pump

Equipment not used.

#### 9.2.2.1.14.5 Distillate Cooler

Equipment not used.

### 9.2.2.1.14.6 Vent Cooler

Equipment not used.

### 9.2.2.1.15 Waste Condensate Tanks

The waste condensate tanks are constructed of welded stainless steel and are used for excess holdup capacity for liquids awaiting processing.

### 9.2.2.1.16 ADT Condensate Receiver Tanks

The ADT condensate receiver tanks are constructed of welded stainless steel and serve as an intermediate holding point for radwaste water processing.

### 9.2.2.1.17 Aerated Monitor Tanks

The aerated monitor tanks are constructed of welded stainless steel and are available for holdup of excess waste liquid awaiting processing via the liquid radwaste system.

### 9.2.2.1.18 Waste Liquid Discharge Header

The waste liquid discharge header begins below grade just outside of the auxiliary building and travels to the circulating water distribution basin discharge structure at the head of the circulating water discharge canal. The header then enters the discharge canal and travels along the canal's bottom terminating in a mixing diffuser just upstream of the circulating water canal discharge structure at the Mississippi River. 01024596

The buried portion of the header is a polypropylene dual wall containment system with leak detection. Adjacent to the circulating water distribution basin discharge structure the header terminates into a sump system which allows sampling for leakage. The portion of the header within the discharge canal is single wall polypropylene pipe. (References 2,3)

### 9.2.3 Performance Analysis

Liquid wastes are generated primarily by plant maintenance and unit operation. Under normal conditions, these wastes are treated as necessary to meet release requirements and discharged to the environment.

The Liquid Radwaste System was analyzed and evaluated to show plant capability to meet the design objectives of Appendix I to 10CFR50. See Reference 1 for details. The liquid source terms were calculated using the GALE code and are presented in Table 9.2-3. The following assumptions were used in the analysis.

a. Part of the reactor coolant letdown stream (called "shim bleed") is diverted to the Chemical Volume Control System (CVCS) hold up tank. After further processing, it was assumed that the entire shim bleed is released to the circulating water discharge canal.

b. Equipment and clean wastes, which are collected in the reactor coolant drain tank and the nonaerated drain sump tank, respectively, are processed together with the shim bleed. In the analysis, it was assumed that all the wastes treated were released to the discharge canal downstream of the cooling towers.

c. Dirty wastes originating from the aerated drain system are usually collected in the aerated drain treatment (ADT) collection tank. Following processing, the wastes were assumed processed through two ADT ion exchangers in series and the entire content was discharged to the circulating water discharge canal.

d. Steam generator blowdown is normally processed through the steam generator blowdown (SGB) ion exchanger and then discharged to the condenser. Blowdown is released to the circulating water discharge canal approximately 5 days a month with no processing. For the analysis, it was assumed that the blowdown was continuously processed through the SGB ion exchanger (mixed bed) and pumped to the SGB monitor tank where the entire contents are released to the discharge canal.

e. Detergent wastes which originate from the laundry and hot shower drains are collected in the laundry and hot shower tanks. For the analysis, it was assumed that the wastes were discharged through the laundry tank strainer to the discharge canal without treatment. In addition, the amount of detergent wastes was assumed to be 450 gal/day as indicated in NUREG-0017. Table 9.2-4 contains information pertinent to the above liquid radwastes.

The results of the analysis demonstrated the plant's capability of keeping the levels of radioactivity in effluents as low as reasonably achievable. Maximum offsite dose from all possible pathways was shown to be well within the design objectives of Appendix I of 10CFR50.

Tritium exists as a gas or combined in water. In the presence of water the majority of the tritium will remain with the water and not appear as a gas.

The tritium release rates in the plant offgases and liquid radwaste discharges result in concentration well below the 10 CFR 20 limits. The dose rate to the environs due to tritium is negligible and therefore not considered significant in the radioactive waste systems.

However, as a further means of lowering the potential for tritium to enter local groundwater, the discharge point of liquid radwaste and steam generator blowdown was extended from its original point of discharge at the head of the circulating water discharge canal to just upstream of the circulating water canal discharge structure at the Mississippi River. The extended discharge header ensures that any tritium that may be present in the liquid release is not retained within the discharge canal as it travels down its entire length but is mixed into the circulating water discharge immediately before it enters the river (Reference 3). The extension effectively bypasses the Circulating Water Monitor (R-21). This is discussed in USAR Section 7.5.2. 01024596

Protection against accident and/or off standard releases of wastes is provided by appropriate system interlocks; detection instrumentation alarms on off standard conditions and automatically closes the discharge valve. All radwaste tankage, filters and equipment are either contained in a Class I* portion of the plant or specially constructed areas to provide a substantial degree of control of the wastes. These arrangements are provided to assure that in the event of a failure of the liquid waste systems or errors in operation of the system the potential for inadvertent release of liquids is minimal. This assures control and containment of any leaks, spills, or overflows from the equipment.

The liquid waste system components are found in the containment, auxiliary, and radwaste buildings. In addition, all vessels which are used for waste storage are located inside structures such as sumps, dikes or vaults which will retain any spilled liquid. The reactor coolant drain tank is located at the ground floor of the containment and can be pumped to the liquid waste system.

The Miscellaneous Drains Collection Tank, ADT Collection Tanks, ADT Condensate Receiver Tanks, ADT Monitor Tanks, ADT evaporator and waste concentrates tank (located in the radwaste building) were designed Class III*. The waste concentrates tank is in a vaulted room that holds its entire volume. The rest of the tanks are located either in rooms with dikes or drain directly to the radwaste building sump.

The radwaste system was designed to permit operation of the rest of the plant for extended periods without requiring its being continually operable.

The CVCS holdup tanks are also equipped with safety pressure relief valves and designed to withstand the established seismic forces at the site. Liquids in the Chemical and Volume Control System flowing into and out of these tanks are controlled by manual operation and governed by prescribed administrative procedures.

The volume control tank design philosophy is similar in many respects to that applied for the CVCS holdup tanks. Level alarms, pressure relief valves and automatic tank isolation and valve control assure that a safe condition is maintained during system operation. Excess letdown flow is directed either to the CVCS holdup tanks via the reactor coolant drain or the volume control tank. The waste holdup tank is a horizontal tank which is continuously maintained at atmospheric pressure. Its vent is routed to the auxiliary building exhaust ducts. Should a complete failure of any tank containing radioactive liquid wastes occur its contents will be retained. The potential hazard from these processes or waste liquid releases is derived only from the volatilized components. The potential for accidental release is summarized in Section 14.5.2.

All radioactive liquid waste processed through the radioactive waste collection and treatment systems is discharged to the circulating water discharge channel. The probability of unmonitored releases to the discharge channel is exceedingly small because at least two barriers must be abridged to permit release; e.g. steam generator tubes and condenser tubes or residual heat exchanger and component cooling heat exchanger. In addition the pressure differential, in essentially all operating modes, opposes leakage into the discharge and the Circulating Water Monitor would indicate abnormal radiation levels.

After waste disposal system liquid has been sampled for radiochemical batch analysis and is determined acceptable for release, the liquid is transferred through a radiation trip valve to the auxiliary building standpipe, then on to the waste liquid discharge header. 01024596

Periodic samples are taken from the discharge channel before it enters the river for radiation monitoring to further confirm proper operation of the circulating water monitor. 01024596
Although the radiochemical analysis establishes the basis for releases, the radiation monitors provide surveillance over the release operation and automatically close the discharge valve if the liquid activity release rate would exceed the limits of 10CFR20.

The most severe airborne radioactivity concentrations which might be postulated to result from open cycle cooling tower operation was investigated and was compared with the concentration limits specified in Table II of 10CFR20. It was observed that even though the basic assumptions relating to the composition of activity and the associated release rates are factors of 10 to 1000 greater than what might be experienced under any conceivable abnormal situation, the airborne concentrations in the cooling tower vapor at the site boundary would still be well below of the 10CFR20 limits.

Periodic sampling of the intake water for radioactivity and appropriate environs monitoring are performed as a further precaution that no unforeseen abnormal condition results in undesirable radiological effects.

# 9.3 GASEOUS RADWASTE SYSTEM

## 9.3.1 Design Basis

### 9.3.1.1 Gaseous Radwaste System

The gaseous radwaste system is designed to process and control the release of gaseous radioactive effluents to the site environs so that the offsite radiation dose rate does not exceed the limits specified in 10CFR20 and the design objectives of Appendix I to 10CFR50 are met.

### 9.3.1.2 Monitoring Fuel and Waste Storage Areas

Criterion: Monitoring and alarm instrumentation shall be provided for fuel and waste storage and associated handling areas for conditions that might result in loss of capability to remove decay heat and to detect excessive radiation levels. (GDC 18)

Monitoring and alarm instrumentation is provided for fuel and waste storage and handling areas to detect deviation from normal water level, inadequate cooling and excessive radiation levels. Radiation monitors are provided to maintain surveillance over the release of radioactive gases and liquids, and the permanent record of activity releases is provided by radiochemical analysis of known quantities of waste.

A controlled ventilation system removes gaseous radioactivity from the atmosphere of the fuel storage and waste treating areas of the auxiliary building and discharges it to the atmosphere via the auxiliary building vent. Radiation monitors are in continuous service in these areas to actuate high-radiation alarms on the control board annunciator, as described in Section 7.5.3.

### 9.3.1.3 Protection Against Radioactivity Release from Spent Fuel and Waste Storage Areas

Criterion: Provisions shall be made in the design of fuel and waste storage facilities such that no undue risk to the health and safety of the public could result from an accidental release of radioactivity. (GDC 69)

All waste handling and storage facilities are contained and equipment is designed so that accidental releases directly to the atmosphere are monitored and will not exceed the guidelines of 10CFR100, as described in Sections 9.1.2, 14.5.2, and 14.5.3.

### 9.3.2 Description

During plant operation, potentially radioactive gases are received mainly from the following sources:

a. Displacement of cover gases as liquids accumulate in various tanks.

b. Miscellaneous equipment vents and relief tanks.

c. Sampling operations and automatic gas analysis for hydrogen and oxygen in cover gases.

d. Nitrogen stripping of reactor coolant to remove hydrogen during shutdown operations.

The waste gas system consists of two interconnected process loops. A low level loop and a high level loop. The waste gas system is very similar to the Westinghouse Environmental Assurance System with the exception of the volume of a gas decay tank which is slightly smaller than the EAS.

The low level loop is designed to contain and process influent gases from sources “a” through “d” above. It is also used to process and contain fission gases resulting from occassional hydrogen stripping of the reactor coolant. Gases vented into the low level loop vent header flow to the waste gas compressor suction header. One of two compressors is in continuous operation with the second unit instrumented to act as backup for peak load conditions or failure of the first unit. Under normal operating conditions, the gas flow from the compressor is split through the hydrogen recombiner and to the decay tanks. Outlet flow from the gas decay tanks is varied to maintain proper pressure in the vent header and holdup tank header.

When the tank in service becomes pressurized to approximately 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 so a new backup tank may be selected. Pressure indicators are provided to aid the operator in selecting the backup tank. Any net flow into or out of the loop accumulates in, or is made up from, the gas decay tanks. A backup supply of gas is provided from the nitrogen header in the event that return flow from the gas decay tanks to the CVCS holdup tanks is not available.

Most of the gas received by the low level loop during normal operation is cover gas displaced from the Chemical and Volume Control System holdup tanks as they fill with liquid. This gas is primarily nitrogen, but it also contains hydrogen originally dissolved in the letdown coolant. As the gas circulates around the loop, hydrogen is oxidized to water vapor and condensed in the recombiner. The gas decay tank capacity is adequate for storing all of the holdup tank cover gas when those tanks are filled with liquid. There is normally no need to vent the system to atmosphere, although an occasional discharge will be required to dispose of gases accumulated from shutdown operations and inflows from miscellaneous vents.

The high level waste gas loop was designed to process and contain gases with high activity received during infrequent hydrogen stripping of the reactor coolant to remove fission gases. Since reactor coolant fission gas is usually at a low activity level, the high level waste gas loop is normally not used. The high level loop compressor is normally aligned to the low level loop and is used during times of high demand. The high level gas decay tanks are normally used for reserve holdup capacity of low level loop gas. This helps to minimize the frequency of gas decay tank releases.

When a low level loop gas decay tank must be discharged to the environment, its contents are sampled and analyzed to determine and record the activity to be released, and then will be discharged to the auxiliary building vent at a controlled rate. The isolation valve in the discharge line is closed automatically by a high activity level indication in the auxiliary building vent.

During operation, gas samples are drawn automatically from the in service low level loop gas decay tank, and the various tanks vented to the low level waste gas system. The sample stream is automatically analyzed to determine the hydrogen and oxygen content. There should be no significant oxygen concentration in any of the tanks. An alarm will warn the operator if any sample shows two percent or higher of oxygen by volume.

The nitrogen and hydrogen supply systems shown on Figure 9.1-6 are designed to provide a supply of gas to various NSSS components. Operation is identical for both systems. Each system consists essentially of multiple banks of gas cylinders, dual manifolds, each with pressure regulator, and branch line to the various pieces of equipment. Each branch line has a shut off valve and a pressure control valve.

Two independent manifolds are provided for each system, one for normal operation and one spare. Each manifold has a pressure regulator, pressure indicator, a common pressure switch and a common alarm. When the gas cylinder banks supplying the operating manifold are low in pressure, an alarm sounds. The exhausted gas cylinders are removed from service and another group of cylinders are placed in service.

### 9.3.2.1 Components

#### 9.3.2.1.1 Gas Decay Tanks

Fifteen welded carbon steel tanks are provided to accumulate and contain radioactive gases. Nine tanks are supplied in the low level loop to store cover gases displaced from various tanks until they are returned to the tanks. The remaining six tanks are supplied in the high level loop.

#### 9.3.2.1.2 Compressors

Three compressors are provided to circulate gases around the two process loops. These compressors are water-sealed centrifugal machines. All three compressors are available for use in the low level loop. One compressor is normally in service on the low level loop with a second compressor in standby. Operation of two compressors in the low level loop is controlled by the vent header pressure. Two of the compressors are available for use on the high level loop if needed. Construction is primarily carbon steel. A mechanical seal is provided in each of the three units to minimize leakage of seal water.

#### 9.3.2.1.3 Recombiners

One recombiner is provided in each of the two waste gas system process loops. The units are skid mounted packages complete with separate control panels for remote installation. Instrumentation provided in the recombiner will control oxygen addition to maintain effluent hydrogen concentration. The catalyst is palladium on kaolin beads approximately one-eighth inch in diameter.

#### 9.3.2.1.4 Nitrogen Manifold

Nitrogen is supplied at a nominal pressure of 100 psig to purge the vapor spaces of various NSSS components. Purging reduces the hydrogen concentration or replaces the fluid that has been removed. Each of the dual manifolds are provided with gas supply connections from a nitrogen storage facility.

#### 9.3.2.1.5 Hydrogen Manifold

Hydrogen is supplied at a nominal pressure of 100 psig to the main generators, volume control tanks and to other various NSSS components from a central storage facility. Hydrogen is used as the heat transfer medium to cool the main generators and for reducing the oxygen concentration in the volume control tank to less than 5% by volume. Hydrogen is supplied to the plant systems by a remote hydrogen storage facility outside of the turbine building, installed under modification EC12191 (Ref. 5). 01145513

The remote hydrogen storage facility consists of three permanent tube banks connected to a common header. On each of the three banks, the individual tubes are joined together by a manifold. Each of the three banks can be isolated from the common header individually by a single isolation valve between the tube bank manifold and the header. Only one tube bank is placed into service at a given time, in order to limit the volume of hydrogen being supplied to the header. The tube banks are refilled on site by a delivery tube trailer.

01253589
01145513

The design criteria for the storage facility were selected in accordance with the Electrical Power Research Institute report NP-5283-SR-A, "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations – 1987 Revision" (Ref. 4), and associated NRC Safety Evaluation Report, dated July 1987. The hydrogen storage facility meets the design criteria as prescribed within the aforementioned documents.

#### 9.3.2.1.6 Gas Analyzer

An automatic gas analyzer is provided to monitor the concentrations of oxygen and hydrogen in the cover gas of tanks and vessels which might accumulate a hazardous mixture of the two gases.

### 9.3.3 Performance Analysis

Gaseous wastes consist primarily of hydrogen stripped from coolant discharged to the CVCS holdup tanks during boron dilution, nitrogen and hydrogen gases purged from the volume control tank, and nitrogen from the closed gas blanketing system. Hydrogen is removed by oxidation and condensation in the recombiners. Nitrogen from the gas blanketing system is stored and reused. The majority of gas discharged from the system is nitrogen received as a result of shutdown operations and miscellaneous vents.

The gaseous waste process flow diagram is shown on Tables 9.3-2 and 9.3-3. These tables illustrate flow rates, temperatures, pressures, and specific isotope radioactivity. No minimum holdup time is specified. The design of the high level loop provides for indefinite holdup.

Gaseous source terms were calculated using the GALE code and are presented in Table 9.3-1. Detailed assumptions and methodology used in the calculation are discussed in Reference 1. Maximum offsite dose from all possible pathways was shown to be well within the Design Objectives of Appendix I to 10CFR50. The releases are described and their effects are summarized in Section 14.5.3.1.

THIS PAGE IS LEFT INTENTIONALLY BLANK

# 9.4 SOLID RADWASTE SYSTEM

## 9.4.1 Design Basis

The solid radwaste system is designed to package, store and provide shielded storage facilities for solid wastes and to allow temporary storage prior to shipment from the plant for offsite processing or disposal. The system is designed to meet the requirements of 10CFR20, 10CFR71, and 49CFR170-189.

## 9.4.2 Description

Solid wastes consist mainly of dry active waste (DAW) such as contaminated paper, plastic, wood, etc., contaminated metals and spent resin.

DAW may be compacted for disposal or storage or may be sent off-site for further processing, such as sorting or incineration. The by-product of such off-site processing, for example, incinerator ash, may be returned to the plant site for storage if no disposal site is available.

Contaminated metals may be compacted on-site for storage or disposal. Contaminated metals may also be sent off-site for processing such as decontamination or metal melting. 95130

Spent resin originates in any of several system ion exchangers.

Spent resin is flushed to a resin shipping liner for disposal or off-site processing. Alternatively, resin may be placed in on-site storage if a disposal site is not available.

## 9.4.3 Performance Analysis

Solid wastes received at disposal sites must meet the requirements of 10CFR61 relating to waste form and classification as well as disposal site-specific regulations.

Annual generation of DAW is estimated at approximately 50,000 lbs.

Annual generation of spent bead resin is estimated at approximately 500 cu. ft.

THIS PAGE IS LEFT INTENTIONALLY BLANK

## 9.5 REFERENCES

1. Letter, L O Mayer (NSP) to D. L. Ziemann (NRC), Appendix I Submittals, June 4, 1976 and July 21, 1976. (10501/1800) (10501/2070)

2. Prairie Island Modification 92L377, Waste Liquid Discharge Header Replacement.

3. Prairie Island Modification 89Y065, Waste Liquid Discharge Line Extension.

4. EPRI NP-5283-SR-A, “Guidelines for Permanent BWR Hydrogen Water Chemistry Installations – 1987 Revision”, September 1987.

5. Passport Engineering Change #12191, “Hydrogen Storage System.” 01145513

THIS PAGE IS LEFT INTENTIONALLY BLANK

**TABLE 9.1-1 WASTE DISPOSAL SYSTEM PERFORMANCE DATA**

01353916

| | |
|---|---|
| Original Plant Design Life | 40 years |
| Normal process capacity, liquids | 2 gpm |
| Estimated Annual liquid input to Radwaste System(*) | |
| Volume (2 units) | 531,240 gal. |
| Activity (2) | |
| Tritium Design Value (2 units) | $5.2 \times 10^3$ curies |
| Tritium, Expected Value (2 units) | $8.2 \times 10^2$ curies |
| Other (2 units) | 8.04 curies |
| Annual gaseous release | |
| Activity (2 units) | 1278 curies/year |
| Annual generation of Dry Active Waste (2 units) | 50,000 lbs |
| Annual generation of spent resin | 500 $ft^3$ |

01-082

(*) estimated based on FSAR Table 11.1-4, equilibrium cycle

## TABLE 9.1-2 WASTE DISPOSAL COMPONENTS CODE REQUIREMENTS

| Component | Code | |
|---|---|---|
| Chemical Drain Tank | No code | |
| Reactor Coolant Drain Tank | ASME III, [1] Class C | |
| Sump Tanks | No code | |
| Monitor Tanks | No code | |
| Waste Holdup Tanks | No code | |
| Collection Tanks | No code | |
| Waste Condensate Tank | No code | |
| Ion-Exchange Shells | No code | |
| Laundry and Hot Shower Tank | No code | 01-082 |
| Waste Filter | ASME III, [1] Class C | |
| Piping and Valves | USAS-B31.1 [2] Section 1 | |
| Gas Decay Tank | ASME III, [1] Class C | 01-082 |
| Recombiner | ASME III, [1] Class C | |

[1] ASME III - American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, Section III, Nuclear Vessels

[2] USAS-B31.1 - Code for pressure piping American Standards Association and special nuclear casses where applicable.

**TABLE 9.1-3 COMPONENT SUMMARY DATA**

(Page 1 of 4)

**Tanks**

| | **Qty** | **Type** | **Volume** | **Design Pressure psig** | **Design Temp °F** | **Material[(1)]** | |
|---|---|---|---|---|---|---|---|
| | | | | | | | 05-054 |
| Reactor Coolant Drain (per unit) | 1 | Horiz | 350 gal | 25 | 267 | ss | |
| Laundry & Hot Shower | 2* | Vert | 700 gal | Atm | 180 | ss | |
| Chemical Drain | 1* | Vert | 600 gal | Atm | 180 | ss | |
| Aerated Sump | 1* | Vert | 600 gal | Atm | 180 | ss | |
| Non-Aerated Sump | 1* | Vert | 300 gal | Atm | 125 | ss | |
| Waste Holdup | 1* | Horiz | 24,490 gal | Atm | 180 | ss | |
| Waste Condensate | 2* | Vert | 1,000 gal | Atm | 180 | ss | |
| Gas Decay | 15* | Vert | 470 $ft^3$ | 150 | 150 | cs | |
| SGB Flash (per unit) | 1 | Vert | 2,000 gal | 100 | 325 | cs | |
| Aerated Drains Monitor | 2* | Vert | 1,000 gal | Atm | 125 | ss | |
| SGB Holdup (per unit) | 2 | Vert | 10,000 gal | Atm | 135 | ss | |
| SGB Monitor (per unit) | 2 | Vert | 10,000 gal | Atm | 135 | ss | |
| ADT Collection | 2* | Vert | 3,000 gal | Atm | 180 | ss | |
| Misc. Drains Collection | 1* | Vert | 3,000 gal | Atm | 180 | ss | |
| Laundry Sludge | 1* | Vert | 800 gal | Atm | 180 | ss | |
| Coagulation | 1* | Vert | 900 gal | Atm | 180 | ss | |
| ADT Condensate | 2* | Vert | 2,400 gal | Atm | 180 | ss | |
| ADT Monitor | 2* | Vert | 5,000 gal | Atm | 180 | ss | |
| Spent Resin | 1* | Vert | 2,200 gal | 30 | 180 | ss | |
| Waste Concentrate | 1* | Vert | 1,700 gal | 33 | 180 | ss | 05-054 |

(1) Material contacting fluid

(2) Mechanical seal provided

* Shared by Units 1 and 2

## TABLE 9.1-3 COMPONENT SUMMARY DATA

(Page 2 of 4)

**Pumps**

05-054

| | Qty | Type | Flow gpm | Head ft | Design Pressure psig | Design Temp °F | Material[(1)] |
|---|---|---|---|---|---|---|---|
| 11 Reactor Coolant Drain Tank (per unit) | 1 | Horiz cent[(2)] | 60 | 200 | 150 | 267 | ss |
| 12 Reactor Coolant Drain Tank (per unit) | 1 | Horiz cent[(2)] | 200 | 200 | 150 | 267 | ss |
| Chemical Drain Tank | 1* | Horiz cent[(2)] | 20 | 100 | 375 | 150 | ss |
| Laundry | 2* | Horiz cent[(2)] | 20 | 100 | 150 | 150 | ss |
| SGB Flash Tank Transfer (per unit) | 1 | Horiz cent[(2)] | 120 | 130 | 150 | 140 | ss |
| 11 SGB Holdup Tank (per unit) | 1 | Horiz cent[(2)] | 120 | 310 | 150 | 140 | ss |
| 12 SGB Holdup Drain Tk (per unit) | 1 | Horiz cent[(2)] | 60 | 125 | 150 | 140 | ss |
| SGB Monitor Drain Tk (per unit) | 1 | Horiz cent[(2)] | 60 | 125 | 150 | 125 | ss |
| Aerated Drains Monitor Tank | 1* | Horiz cent[(2)] | 60 | 150 | 150 | 125 | ss |
| Non-Aerated Sump Tank | 1* | Horiz cent[(2)] | 60 | 80 | 150 | 125 | ss |
| Laundry & Hot Shower Tank | 2* | Horiz cent[(2)] | 60 | 100 | 150 | 125 | ss |
| Aerated Sump Tank | 1* | Horiz cent[(2)] | 20 | 100 | 150 | 150 | ss |
| Backup Sump Tank | 1* | Horiz cent[(2)] | 20 | 100 | 150 | 150 | ss |
| Waste Evaporator Feed | 1* | Horiz cent[(2)] | 20 | 100 | 150 | 150 | ss |
| Waste Condensate Tank | 2* | Horiz cent[(2)] | 20 | 100 | 150 | 150 | ss |

(1) Material contacting fluid
(2) Mechanical seal provided
* Shared by Units 1 and 2

## TABLE 9.1-3 COMPONENT SUMMARY DATA



### Pumps

05-054

| | **Qty** | **Type** | **Flow gpm** | **Head ft** | **Design Pressure psig** | **Design Temp °F** | **Material[1]** |
|---|---|---|---|---|---|---|---|
| ADT Collection Tank | 2* | Horiz cent[2] | 20 | 110 | 150 | 200 | ss |
| Misc. Collection Tank | 2* | Vert cent[2] | 60 | 100 | 150 | 200 | ss |
| Coagulation Tank | 1* | Horiz cent[2] | 20 | 80 | 150 | 125 | ss |
| Laundry Sludge Tank | 1* | Horiz cent[2] | 30 | 115 | 150 | 125 | ss |
| ADT Condensate Receiver Tank | 2* | Horiz cent[2] | 60 | 100 | 150 | 200 | ss |
| ADT Monitor Tank | 2* | Horiz cent[2] | 60 | 100 | 150 | 200 | ss |
| 121 Spent Resin | 1* | Horiz cent[2] | 30 | 145 | 150 | 125 | ss |
| 122 Spent Resin | 1* | Horiz diaphragm | 20 | 200 | 150 | 125 | ss |
| Waste Concentrate Tank | 1* | Horiz diaphragm | 20 | 200 | 150 | 125 | ss |

### Heat Exchangers

| | **Qty (per unit)** | **Type** | **Shell Flow (lb/hr)** | **Tube Flow (lb/hr)** | **Btu/hr** | **Shell Design Press/ Temp (psi)/(°F)** | **Tube Design Press/ Temp (psi)/(°F)** | **Shell Matl.** | **Tube Matl.** |
|---|---|---|---|---|---|---|---|---|---|
| SGB Heat Exch. 11 | 1 | Shell & Tube | 75,000 | 6,900** | 1,159,200 | 150/130 | 150/130 | cs | ss |
| SGB Heat Exch. 12 | 1 | Shell & Tube | 57,776 | 2,481,862 | 10,377,000 | 150/130 | 600/150 | cs | ss |

** This is a maximum blowdown liquid capacity as a result of blowdown system modifications. This corresponds to a blowdown rate of approximately 15 gpm per steam generator.

(1) Material contacting fluid

(2) Mechanical seal provided

* Shared by Units 1 and 2

## TABLE 9.1-3 COMPONENT SUMMARY DATA

(Page 4 of 4)

**Strainer and Filter**

| | Qty | Flow gpm | Design Pressure psig | Design Temp °F | Housing Material |
|---|---|---|---|---|---|
| Filters | | | | | |
| SGB Reclaim | 2 | 20 | 150 | 125 | cs |
| Aerated Drain | 1* | 20 | 150 | 125 | ss |
| Non-Aerated Drain | 1* | 20 | 150 | 125 | ss |
| 123/124 ADT | 2* | 40 | 150 | 125 | ss |
| 123 ADT IX | 1* | 20 | 150 | 125 | ss |
| 121/122 ADT | 2* | 20 | 150 | 125 | ss |
| Strainers | | | | | |
| SGB Ion Exchanger | 2 | 60 | 150 | 125 | ss |

**Miscellaneous**

| | Qty | Capacity | Type |
|---|---|---|---|
| Waste Gas Compressors | 3* | 40 CFM | Horiz (2) cent |
| ADT Ion Exchanger | 3* | 60 gpm | |

(1) Material contacting fluid
(2) Mechanical seal provided
* Shared by Units 1 and 2

## TABLE 9.2-1 PERFORMANCE DATA AND SERVICE REQUIREMENTS

(2 GPM Waste Evaporator)

Equipment not used. 01-082

**TABLE 9.2-2 PERFORMANCE DATA AND SERVICE REQUIREMENTS**

(5 GPM ADT Evaporator)

Equipment not used.

01-082

# TABLE 9.2-3 LIQUID SOURCE TERMS FROM THE PRAIRIE ISLAND PLANT (PER UNIT)



| | | | | | ANNUAL RELEASES TO DISCHARGE CANAL | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Coolant Concentrations | | | | | | | Adjusted | Detergent | Total | |
| Nuclide | Half-Life | Primary | Secondary | Boron RS | Misc. Wastes | Secondary | Turb Bldg | Total LWS | Total | Wastes | | |
| | (Days) | (Micro CI/ML) | (Micro CI/ML) | (Curies) | (Curies) | (Curies) | (Curies) | (Curies) | (CI/YR) | (CI/YR) | (CI/YR) | |
| **CORROSION AND ACTIVATION PRODUCTS** | | | | | | | | | | | | |
| CR 51 | 2.78E+01 | 1.72E-05 | 2.27E-07 | .00001 | .00016 | .00027 | .00000 | .00044 | .00054 | 0.00000 | .00054 | |
| MN 54 | 3.03E+02 | 2.80E-04 | 5.43E-08 | .00000 | .00001 | .00006 | .00000 | .00009 | .00011 | .00100 | .00110 | |
| FE 55 | 9.50E+02 | 1.44E-03 | 1.90E-07 | .00001 | .00014 | .00023 | .00000 | .00038 | .00046 | 0.00000 | .00046 | |
| FE 59 | 4.50E+01 | 9.03E-04 | 1.39E-07 | .00000 | .00009 | .00017 | .00000 | .00026 | .00031 | 0.00000 | .00031 | |
| CO 58 | 7.13E+01 | 1.44E-02 | 1.93E-06 | .00009 | .00139 | .00230 | .00002 | .00379 | .00459 | .00400 | .00460 | 01-082 |
| CO 60 | 1.92E+03 | 1.80E-03 | 2.44E-07 | .00001 | .00017 | .00029 | .00000 | .00048 | .00058 | .00870 | .00930 | |
| NP239 | 2.35E+00 | 1.12E-03 | 1.27E-07 | .00000 | .00009 | .00015 | .00000 | .00024 | .00029 | 0.00000 | .00029 | |
| **FISSION PRODUCTS** | | | | | | | | | | | | |
| BR 83 | 1.00E-01 | 5.28E-03 | 2.90E-07 | .00000 | .00002 | .00024 | .00001 | .00026 | .00032 | 0.00000 | .00032 | |
| BR 84 | 2.21E-02 | 2.97E-03 | 5.51E-08 | 0.00000 | .00000 | .00001 | .00000 | .00001 | .00001 | 0.00000 | .00001 | |
| RB 86 | 1.87E+01 | 8.05E-05 | 1.21E-08 | .00000 | .00038 | .00014 | .00000 | .00052 | .00063 | 0.00000 | .00063 | |
| RB 88 | 1.24E-02 | 2.30E-01 | 2.34E-06 | 0.00000 | .00000 | .00133 | .00000 | .00133 | .00160 | 0.00000 | .00160 | 01-082 |
| SR 89 | 5.20E+01 | 3.16E-04 | 5.55E-08 | .00000 | .00003 | .00007 | .00000 | .00010 | .00012 | 0.00000 | .00012 | |
| SR 91 | 4.03E-01 | 6.65E-04 | 6.04E-08 | .00000 | .00002 | .00007 | .00000 | .00009 | .00010 | 0.00000 | .00010 | |
| Y 91M | 3.47E-02 | 4.08E-04 | 7.75E-08 | .00000 | .00001 | .00006 | .00000 | .00007 | .00009 | 0.00000 | .00009 | 01-082 |
| Y 91 | 5.88E+01 | 5.78E-05 | 6.30E-09 | .00000 | .00001 | .00001 | .00000 | .00002 | .00002 | 0.00000 | .00002 | |
| ZR 95 | 6.50E+01 | 5.42E-05 | 8.28E-09 | .00000 | .00001 | .00001 | .00000 | .00002 | .00002 | 0.00000 | .00002 | |
| NB 95 | 3.50E+01 | 4.52E-05 | 8.43E-09 | .00000 | .00000 | .00001 | .00000 | .00001 | .00002 | 0.00000 | .00002 | |
| MO 99 | 2.79E+00 | 7.82E-02 | 1.20E-05 | .00004 | .00626 | .01415 | .00011 | .02057 | .02488 | 0.00000 | .02500 | |
| TC 99M | 2.50E-01 | 5.05E-02 | 3.91E-05 | .00000 | .00557 | .04190 | .00025 | .04775 | .05776 | 0.00000 | .05800 | |
| RU 103 | 3.96E+01 | 4.07E-05 | 5.60E-09 | .00000 | .00000 | .00001 | .00000 | .00001 | .00001 | .00014 | .00015 | |
| RM 103M | 3.96E-02 | 5.09E-05 | 5.04E-08 | .00000 | .00000 | .00003 | .00000 | .00003 | .00004 | 0.00000 | .00004 | |
| TE 127M | 1.09E+02 | 2.53E-04 | 2.46E-08 | .00000 | .00002 | .00003 | .00000 | .00006 | .00007 | 0.00000 | .00007 | |
| TE 127 | 3.92E-01 | 8.71E-04 | 2.05E-07 | .00000 | .00004 | .00022 | .00000 | .00027 | .00033 | 0.00000 | .00033 | |
| TE 129M | 3.40E+01 | 1.27E-03 | 1.69E-07 | .00001 | .00012 | .00020 | .00000 | .00035 | .00040 | 0.00000 | .00040 | |
| TE 129 | 4.79E-02 | 1.80E-05 | 1.45E-06 | .00000 | .00008 | .00086 | .00000 | .00094 | .00114 | 0.00000 | .00110 | 01-082 |
| I 130 | 5.17E-01 | 2.11E-03 | 2.18E-07 | .00000 | .00008 | .00024 | .00002 | .00034 | .00041 | 0.00000 | .00041 | |

## TABLE 9.2-3 LIQUID SOURCE TERMS FROM THE PRAIRIE ISLAND PLANT (PER UNIT)



| | | | | | ANNUAL RELEASES TO DISCHARGE CANAL | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Coolant Concentrations | | | | | | | Adjusted | Detergent | Total | |
| Nuclide | Half-Life | Primary | Secondary | Boron RS | Misc. Wastes | Secondary | Turb Bldg | Total LWS | Total | Wastes | | |
| | (Days) | (Micro CI/ML) | (Micro CI/ML) | (Curies) | (Curies) | (Curies) | (Curies) | (Curies) | (CI/YR) | (CI/YR) | (CI/YR) | |
| TE 131M | 1.25E+00 | 2.40E-03 | 2.75E-07 | .00000 | .00015 | .00032 | .00000 | .00047 | .00057 | 0.00000 | .00057 | |
| TE 131 | 1.74E-02 | 1.26E-03 | 1.41E-06 | .00000 | .00008 | .00024 | .00000 | .00027 | .00033 | 0.00000 | .00033 | |
| I 131 | 8.05E+00 | 2.45E-01 | 3.46E-05 | .00508 | .02216 | .04110 | .00337 | .07171 | .00675 | .00006 | .08700 | |
| TE 132 | 3.25E+00 | 2.50E-02 | 3.06E-06 | .00002 | .00206 | .00341 | .00003 | .00572 | .00691 | 0.00000 | .00690 | |
| I 132 | 9.58E-02 | 1.10E-01 | 2.19E-05 | .00002 | .00244 | .01880 | .00038 | .02163 | .02617 | 0.00000 | .02600 | |
| I 133 | 8.75E-01 | 3.70E-01 | 4.25E-05 | .00016 | .02002 | .04856 | .00347 | .07221 | .08735 | 0.00000 | .08700 | |
| I 134 | 3.67E-02 | 5.32E-02 | 1.46E-06 | .00000 | .00001 | .00062 | .00000 | .00063 | .00076 | 0.00000 | .00076 | |
| CS 134 | 7.49E+02 | 2.35E-02 | 3.39E-06 | .00035 | .11364 | .04047 | .00003 | .15449 | .18688 | .01300 | .20000 | |
| I 135 | 2.79E-01 | 1.98E-01 | 1.72E-05 | .00000 | .00392 | .01792 | .00092 | .02276 | .02753 | 0.00000 | .02000 | |
| CS 136 | 1.30E+01 | 1.24E-02 | 1.56E-06 | .00008 | .05733 | .01862 | .00002 | .07605 | .09199 | 0.00000 | .09200 | |
| CS 137 | 1.10E+04 | 1.69E-02 | 2.26E-06 | .00025 | .08186 | .02693 | .00002 | .10907 | .13193 | .02400 | .16000 | |
| BA 137M | 1.77E-03 | 1.85E-02 | 2.48E-05 | .00024 | .07654 | .02518 | .00002 | .10198 | .12336 | 0.00000 | .12000 | 01-082 |
| BA 140 | 1.28E+01 | 2.00E-04 | 2.70E-08 | .00000 | .00002 | .00003 | .00000 | .00005 | .00006 | 0.00000 | .00006 | |
| LA 140 | 1.68E+00 | 1.42E-04 | 3.86E-08 | .00000 | .00002 | .00005 | .00000 | .00006 | .00007 | 0.00000 | .00007 | |
| CE 141 | 3.24E+01 | 6.33E-05 | 8.46E-09 | .00000 | .00001 | .00001 | .00000 | .00002 | .00002 | 0.00000 | .00002 | |
| PR 143 | 1.37E+01 | 4.54E-05 | 5.95E-09 | .00000 | .00000 | .00001 | .00000 | .00001 | .00001 | 0.00000 | .00001 | |
| CE 144 | 2.84E+02 | 2.98E-05 | 5.43E-09 | .00000 | .00000 | .00001 | .00000 | .00001 | .00001 | .00520 | .00520 | |
| PR 144 | 1.20E-02 | 3.79E-05 | 5.83E-08 | .00000 | .00000 | .00001 | .00000 | .00001 | .00001 | 0.00000 | .00002 | |
| ALL OTHERS | | 4.76E-08 | 3.09E-08 | .00000 | .00001 | .00002 | .00000 | .00003 | .00003 | 0.0 | .00003 | 01-082 |
| TOTAL (EXCEPT TRITIUM) | | 1.47E+00 | 2.14E-04 | .00642 | .39494 | .30556 | .00868 | .71561 | .86561 | .06234 | .93000 | |

TRITIUM RELEASE 330 CURIES PER YEAR

## TABLE 9.2-4 PRAIRIE ISLAND LIQUID RADWASTE SYSTEM

| | | | SHIM BLEED | EQUIPMENT DRAINS & CLEAN WASTE | DIRTY WASTES | BLOWDOWN WASTES | DETERGENT WASTES | |
|---|---|---|---|---|---|---|---|---|
| 1. | Sources | | Reactor Coolant Letdown | Non-Aerated Drain System & Reactor Coolant Drain Tank | Aerated Darin System | Blowdown from Steam Generator | Laundry and Hot Shower Drains | |
| 2. | Flow Rate (gpd) | | 1,440 | 362 | 1,000 | 86,300 | 450 | |
| 3. | Activity (FPCA) | | 1.0 | 1.0 | 0.07 | - - | - - | |
| 4. | Collection Tank Volume (gal) | | 65,830 | 65,830 | 3,000 | 2,000 | 600 | |
| 5. | Collection Rate (gpd) | | 1,802* | 1,802* | 1,000 | 86,300 | 450 | |
| 6. | Collection Time (days) | | 29.2 | 29.2 | 1.2 | 0.009 | 1.07 | |
| 7. | Processing Rate (gpm) | | 15 | 15 | 20 | 20 | 20 | |
| 8. | Processing Time (days) | | 2.44 | 2.44 | 0.042 | 0.028 | 0.017 | |
| 9. | Discharge Tank Volume (gal) | | 10,000 | 10,000 | 5,000 | 10,000 | Same as Collection Tank | |
| 10. | Discharge Rate (gpm) | | 100 | 100 | 60 | 60 | Same as Collection Tank | 01-082 |
| 11. | Discharge Time (days) | | 0.055 | 0.055 | 0.023 | 0.046 | Same as Collection Tank | |
| 12. | Fraction of Processed Stream Released | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | |
| | | | 2 Evaporator Feed Ion Exchangers (cation) | Evaporator condensate Demineralizer (anion) | 2 ADT Ion Exchangers (Mixed Bed) | SGBT Ion Exchanger (Mixed Bed) | | |
| 13. | DF's | Iodine | 1(1) | $10^2$ | $10^2$ (10) | $10^2$ | | |
| 14. | | Cs, Rb | 10(10) | 1 | 2 (10) | 10 | | 01-082 |
| 15. | | Others | 10(10) | 1 | $10^2$ (10) | $10^2$ | | |
| 16. | Regenerant Time (days) | | Not | Not | Not | Not | NA | |
| 17. | Regenerant Volume (gal) | | Regenerated | Regenerated | Regenerated | Regenerated | | |
| 18. | Regenerant Activity | | | | | | | |
| 19. | Fraction of Regenerants Discharged | | | | | | | |
| 20. | Treatment of Regenerants | | | | | | | |
| 21. | Source Terms | | See Table 9.2-3 | See Table 9.2-3 | See Table 9.2-3 | See Table 9.2-3 | See Table 9.2-3 | |

*Sum of Shim Bleed, Equipment Wastes, and Clean Waste input flows.

## TABLE 9.3-1 GASEOUS SOURCE TERMS FROM THE PRAIRIE ISLAND PLANT (PER UNIT)



| | | | GASEOUS RELEASE RATE - CURIES PER YEAR | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gas Stripping | | Building Ventilation | | | | | |
| | **PRIMARY COOLANT (MICROCI/GM)** | **SECONDARY COOLANT (MICROCI/GM)** | **SHUTDOWN** | **CONTINUOUS** | **REACTOR** | **AUXILIARY** | **TURBINE** | **BLOWDOWN VENT OFF GAS** | **AIR EJECTOR EXHAUST** | **TOTAL** |
| KR-83M | 2.418E-02 | 1.415E-08 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| KR-85M | 1.26E-01 | 7.529E-08 | 0.0 | 0.0 | 0.0 | 3.0E+00 | 0.0 | 0.0 | 2.0E+00 | 5.0E+00 |
| KR-85 | 7.313E-02 | 4.338E-08 | 1.5E+01 | 1.4E+02 | 2.2E+01 | 2.0E+00 | 0.0 | 0.0 | 0.0 | 1.8E+02 |
| KR-87 | 6.917E-02 | 3.908E-08 | 0.0 | 0.0 | 0.0 | 1.0E+00 | 0.0 | 0.0 | 0.0 | 1.0E+00 |
| KR-88 | 2.299E-01 | 1.340E-07 | 0.0 | 0.0 | 1.0E+00 | 5.0E+00 | 0.0 | 0.0 | 3.0E+00 | 9.0E+00 |
| KR-89 | 5.776E-03 | 3.427E-09 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| XE-131M | 9.248E-02 | 5.522E-08 | 0.0 | 0.0 | 2.1E+01 | 2.0E+00 | 0.0 | 0.0 | 1.0E+00 | 2.4E+01 |
| XE-133M | 2.328E-01 | 1.390E-07 | 0.0 | 0.0 | 2.0E+01 | 5.0E+00 | 0.0 | 0.0 | 3.0E+00 | 2.8E+01 |
| XE-133 | 1.738E+01 | 1.023E-05 | 0.0 | 0.0 | 2.7E+03 | 3.7E+02 | 0.0 | 0.0 | 2.3E+02 | 3.3E+03 |
| XE-135M | 1.501E-02 | 8.808E-09 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| XE-135 | 3.978E-01 | 2.336E-07 | 0.0 | 0.0 | 6.0E+00 | 8.0E+00 | 0.0 | 0.0 | 5.0E+00 | 1.9E+01 |
| XE-137 | 1.040E-02 | 6.119E-09 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| XE-138 | 5.081E-02 | 2.936E-08 | 0.0 | 0.0 | 0.0 | 1.0E+00 | 0.0 | 0.0 | 0.0 | 1.0E+00 |
| TOTAL NOBLE GASES | | | | | | | | | | 3.6E+03 |
| I-131 | 2.449E-01 | 3.838E-05 | 0.0 | 0.0 | 5.5E-04 | 3.9E-02 | 2.1E-03 | 0.0 | 2.4E-02 | 6.6E-02 |
| I-133 | 3.697E-01 | 4.643E-05 | 0.0 | 0.0 | 3.0E-04 | 5.9E-02 | 2.5E-03 | 0.0 | 3.7E-02 | 9.9E-02 |
| TRITIUM GASEOUS RELEASE | | | | 330 CURIES/YR | | | | | | |

0.0 appearing in the table indicates release is less than 1.0 Ci/yr for noble gas, 0.0001 Ci/yr for Iodine.

01-081

## TABLE 9.3-1 GASEOUS SOURCE TERMS FROM THE PRAIRIE ISLND PLANT (PER UNIT)
## Page 2 of 2

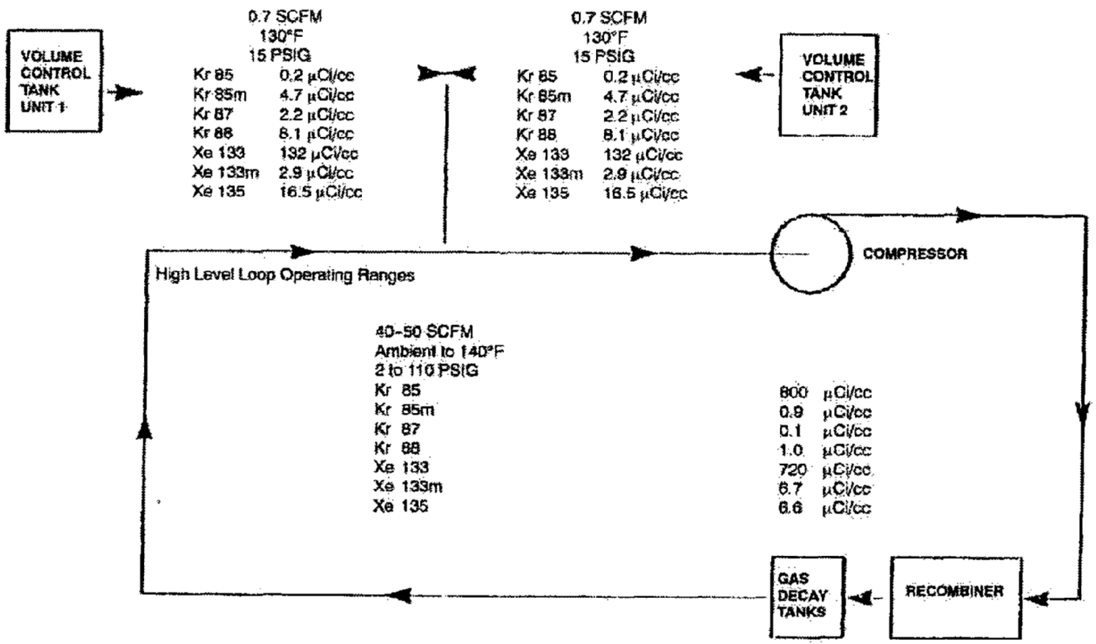
AIRBORNE PARTICULATE RELEASE RATE-CURIES PER YEAR

01-081

| NUCLIDE | WASTE GAS SYSTEM | BUILDING VENTILATION REACTOR | BUILDING VENTILATION AUXILIARY | TOTAL |
|---|---|---|---|---|
| MN-54 | 4.5E-05 | 2.0E-05 | 1.8E-02 | 1.8E-02 |
| FE-59 | 1.5E-05 | 6.7E-06 | 6.0E-03 | 6.0E-03 |
| CO-58 | 1.5E-04 | 6.7E-05 | 6.0E-02 | 6.0E-02 |
| CO-60 | 7.0E-05 | 3.0E-05 | 2.7E-02 | 2.7E-02 |
| SR-89 | 3.3E-06 | 1.5E-06 | 1.3E-03 | 1.3E-03 |
| SR-90 | 6.0E-07 | 2.7E-07 | 2.4E-04 | 2.4E-04 |
| CS-134 | 4.5E-05 | 2.0E-05 | 1.4E-02 | 1.8E-02 |
| CS-137 | 7.5E-05 | 3.4E-05 | 3.0E-02 | 3.0E-02 |

## TABLE 9.3-2 PRAIRIE ISLAND - HIGH LEVEL LOOP PROCESS CONDITIONS AND MAXIMUM ISOTOPIC CONCENTRATIONS

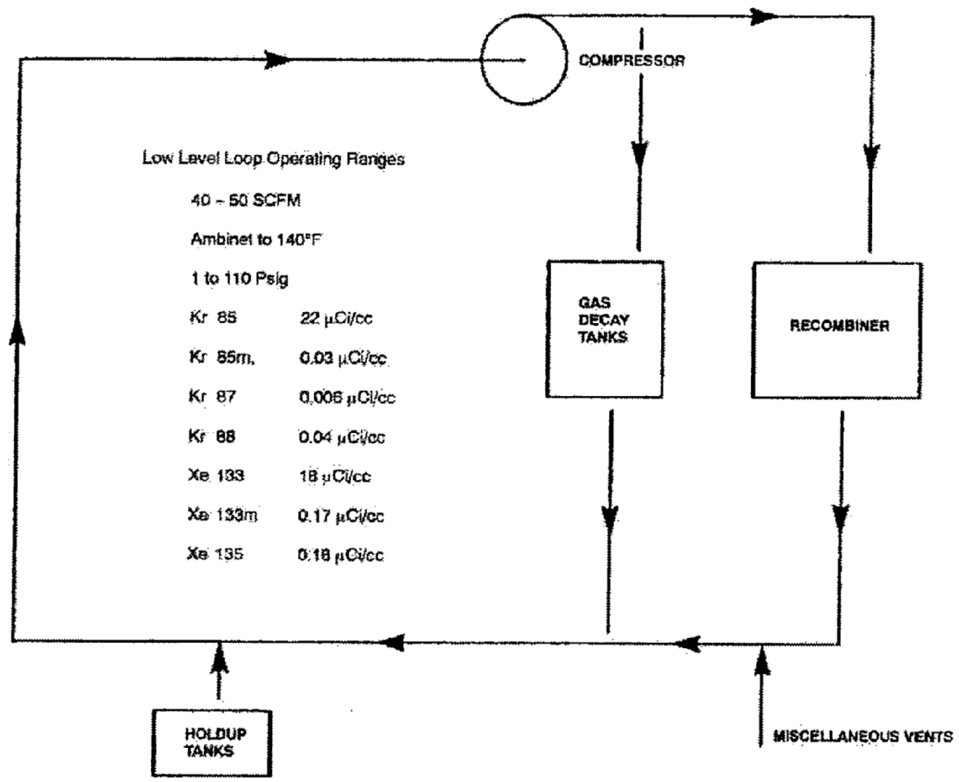
01-081




01-081

## TABLE 9.3-3 PRAIRIE ISLAND - LOW LEVEL LOOP PROCESS CONDITIONS AND MAXIMUM ISOTOPIC CONCENTRATIONS

01-081




01-081

THIS PAGE IS LEFT INTENTIONALLY BLANK

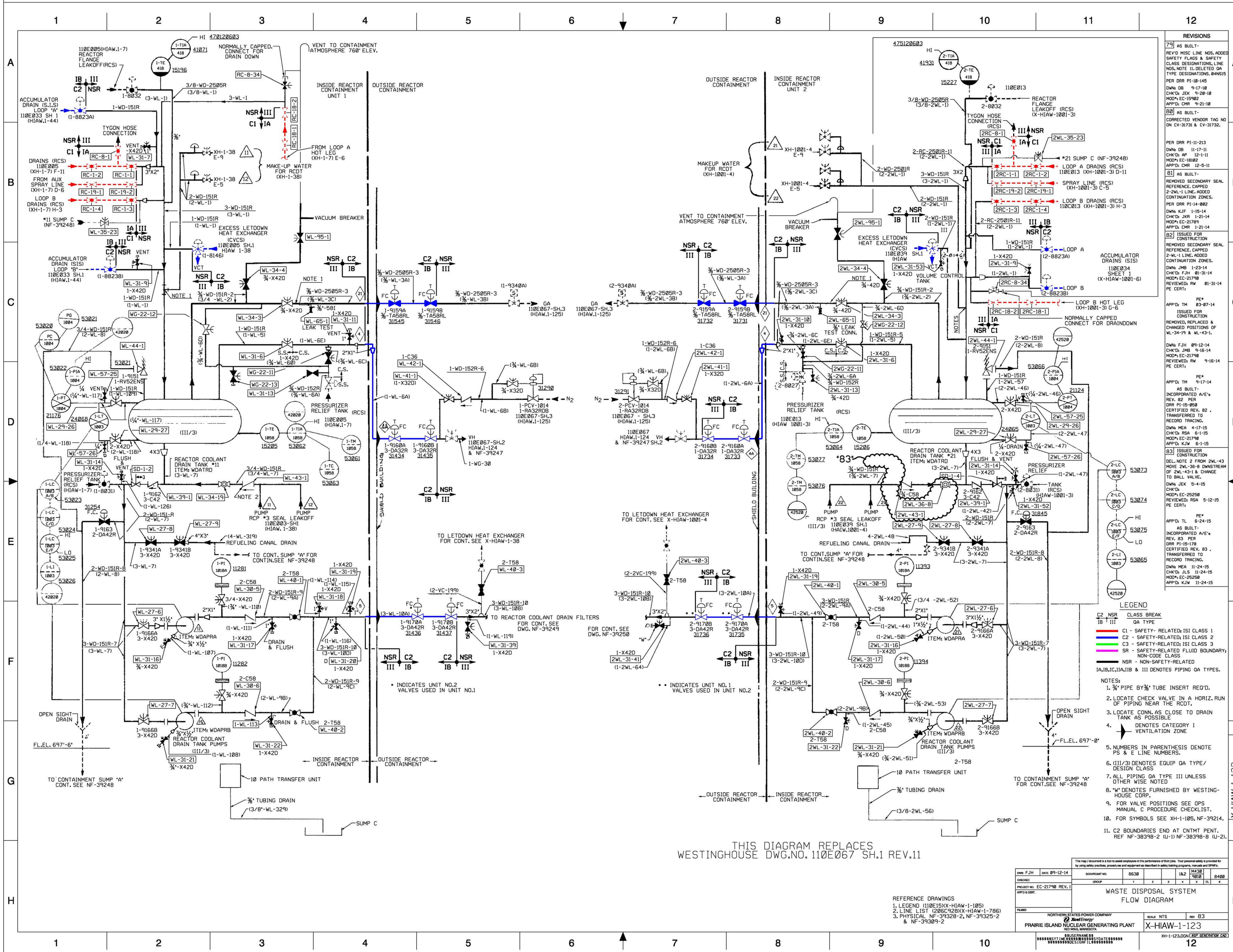



FIGURE 9.1-1 REV. 34

CAD FILE: U09101.DGN

01516979

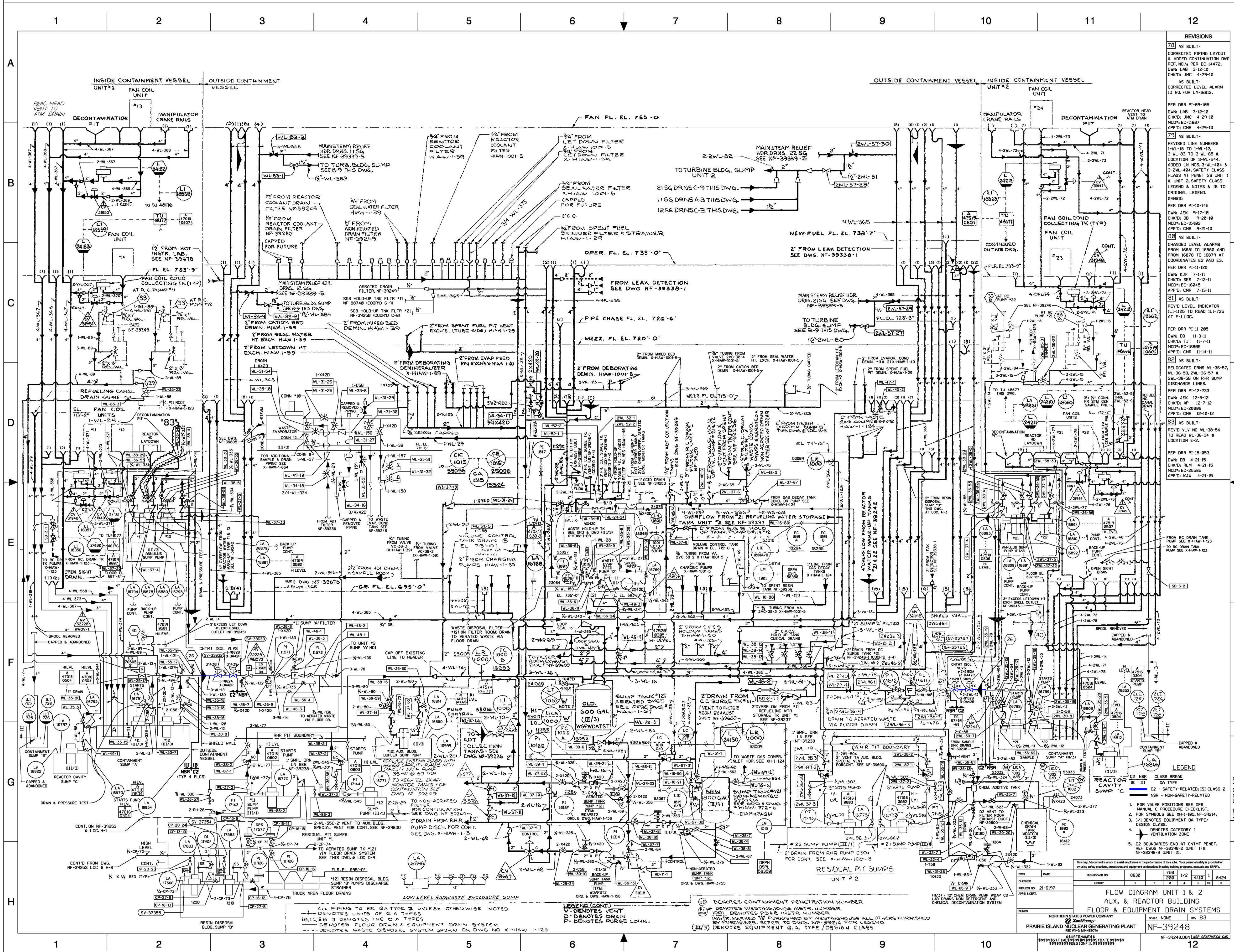



**FIGURE 9.1-2 REV. 34**

01516979

CAD FILE: U09102.DGN

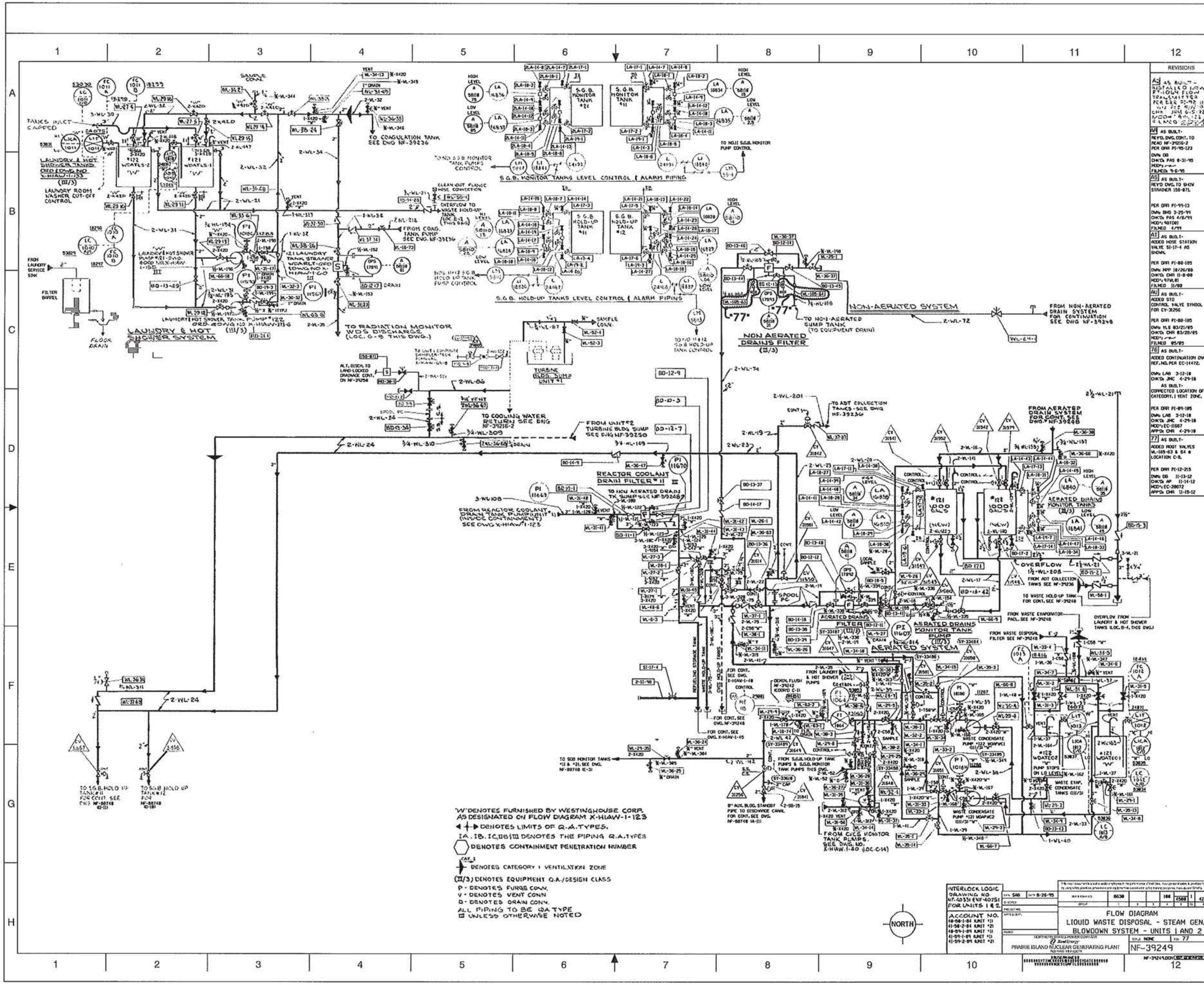



**FIGURE 9.1-3 REV. 33**

CAD FILE: U09103.DGN

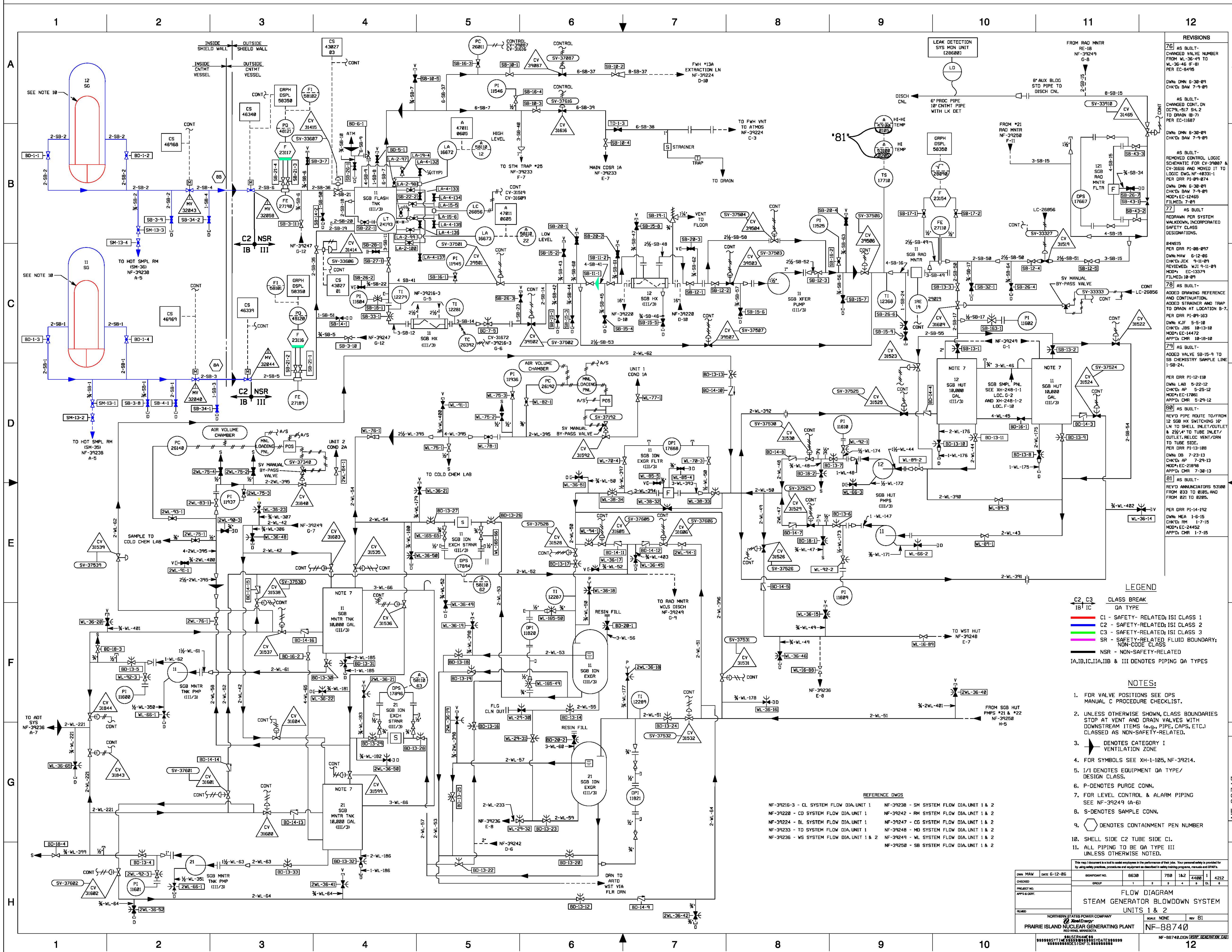



**FIGURE 9.1-4** **REV. 34**

01516979

CAD FILE: U09104.DGN

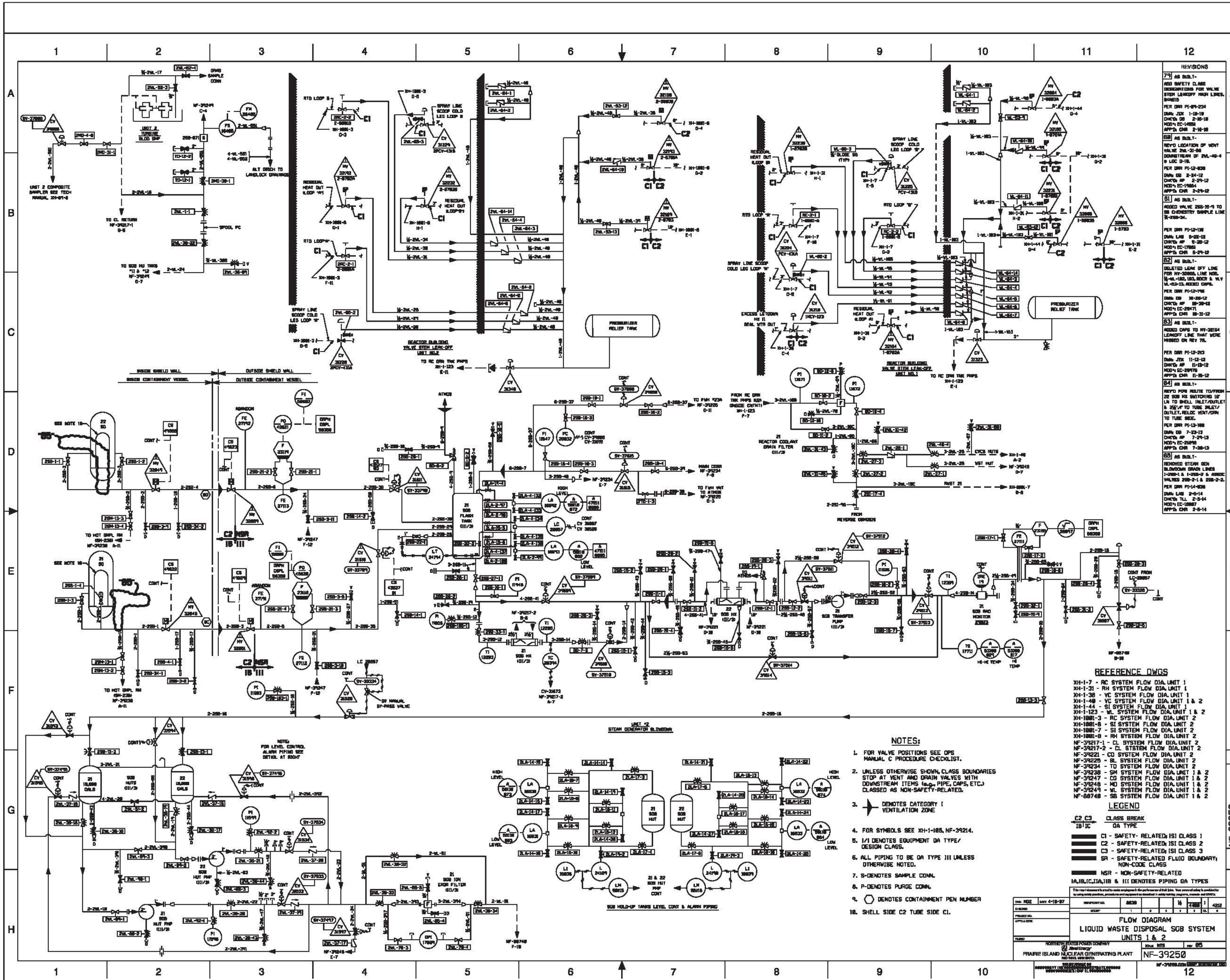



FIGURE 9.1-5 REV. 33

CAD FILE: U09105.DGN

01429088

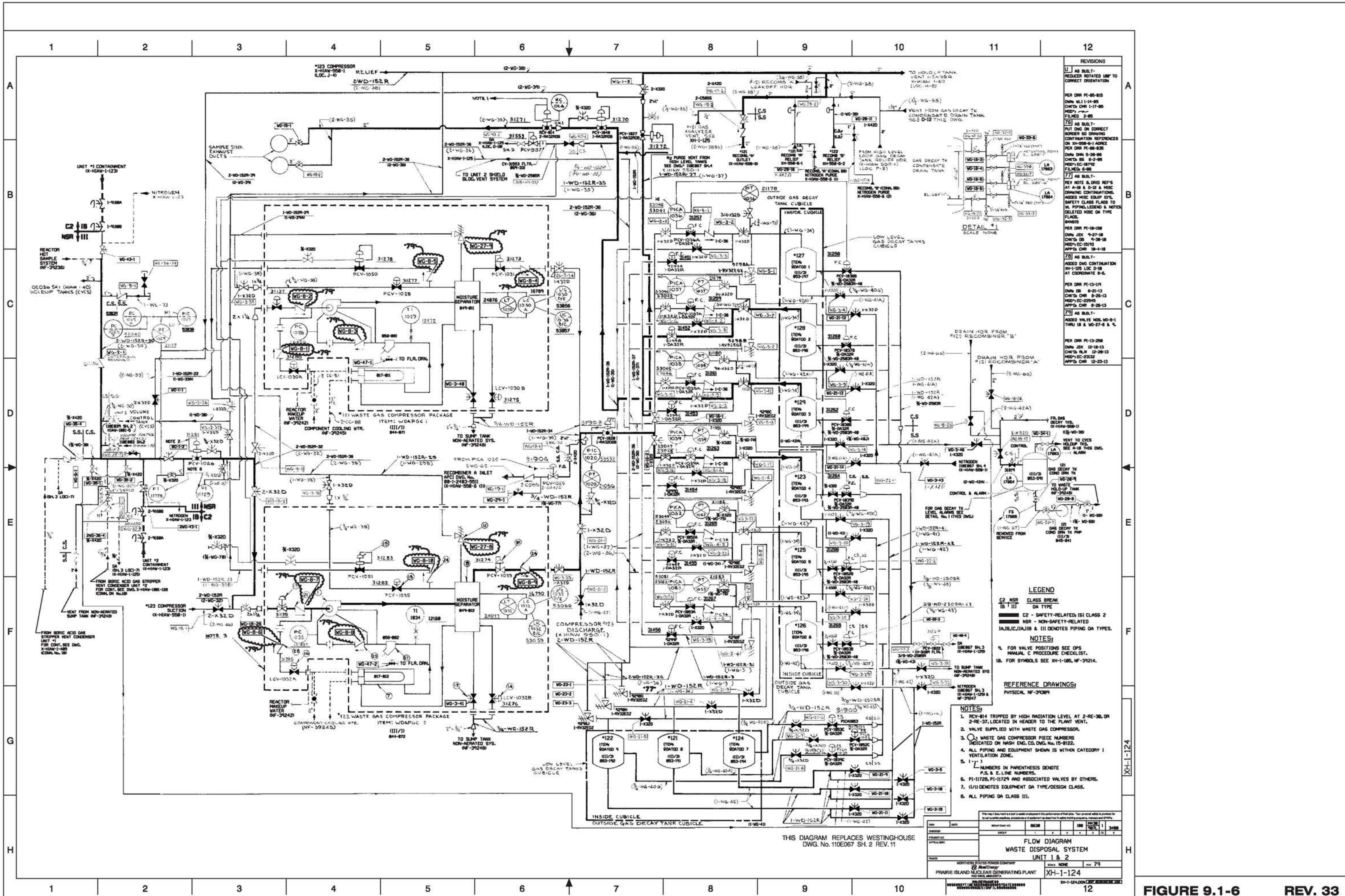



**FIGURE 9.1-6** **REV. 33**

01429088

CAD FILE: U09106.DGN

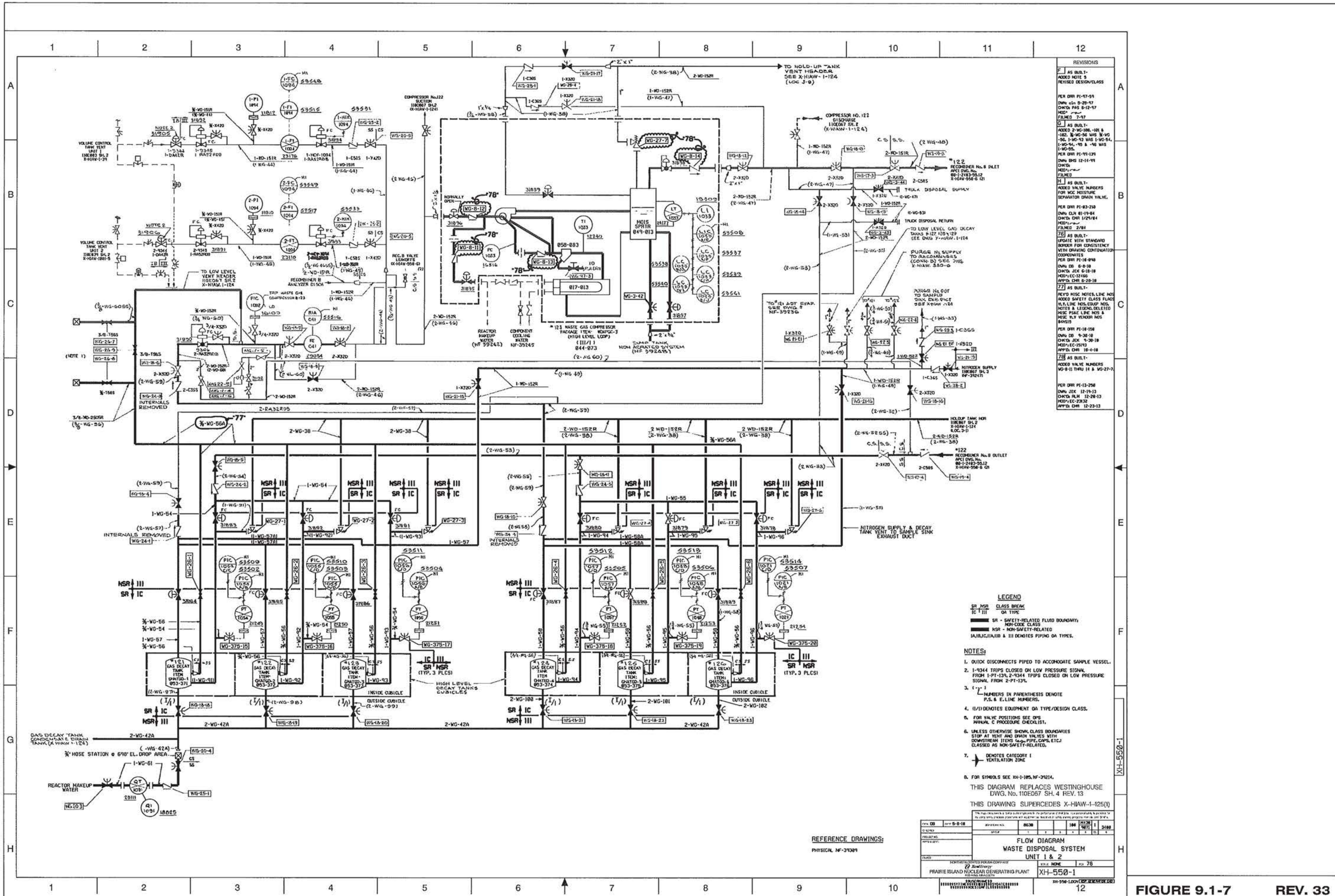



**FIGURE 9.1-7** **REV. 33**

CAD FILE: U09107.DGN

01429088

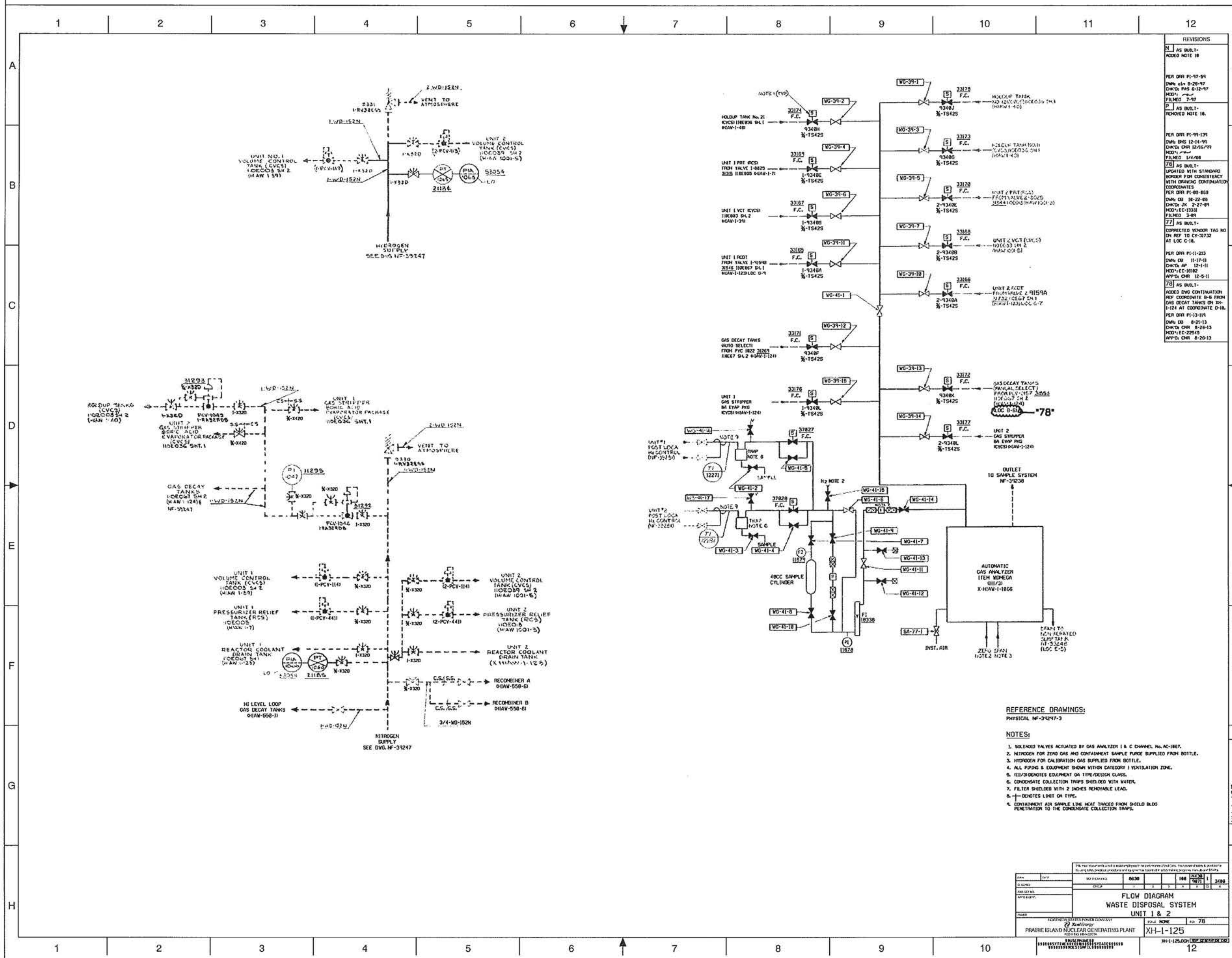



FIGURE 9.1-8 REV. 33

01429088

CAD FILE: U09108.DGN

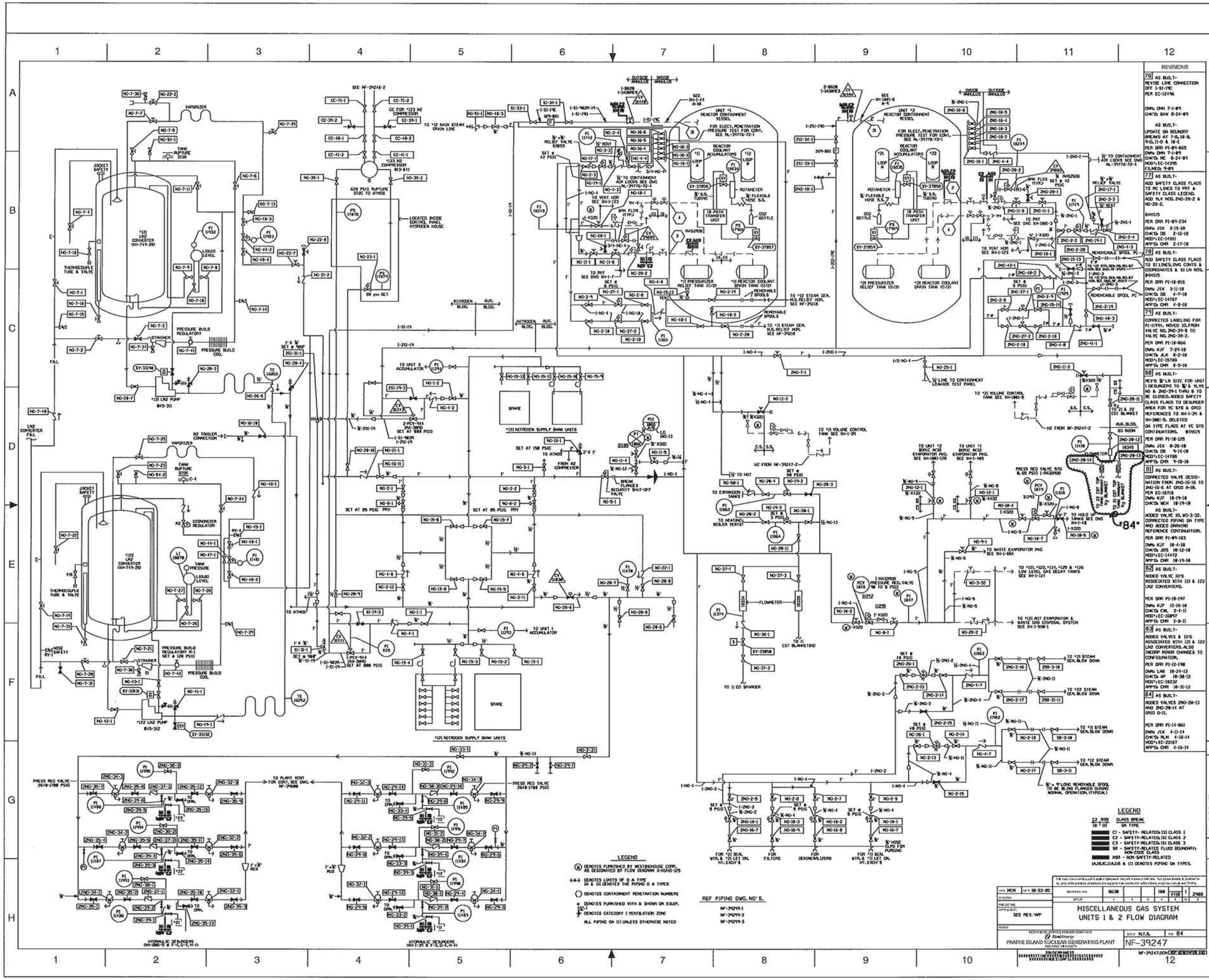



FIGURE 9.1-9 REV. 33

01429088

CAD FILE: U09109.DGN

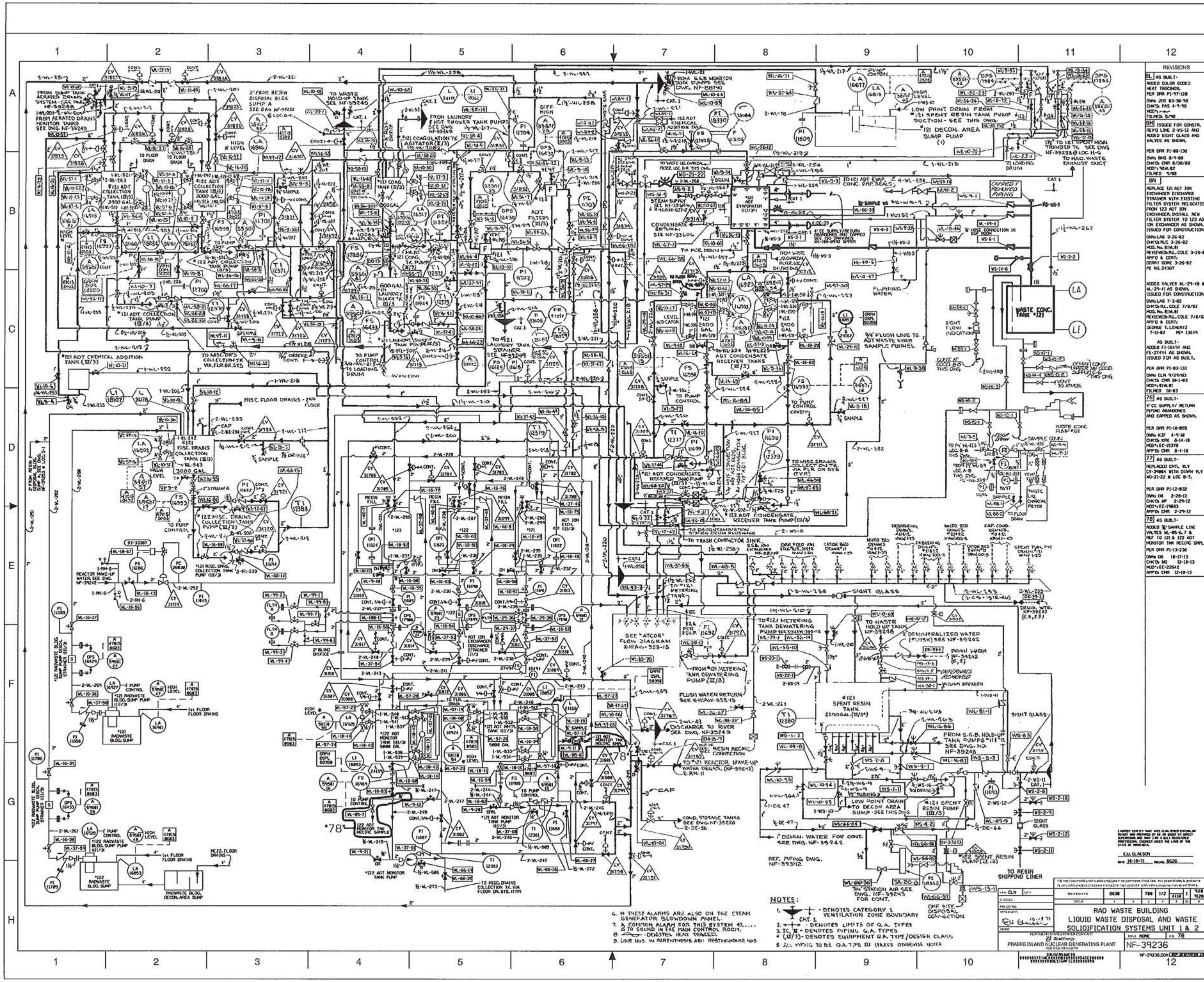



**FIGURE 9.1-10 REV. 33**

CAD FILE: U09110.DGN

0142908B