Department of Energy
Washington, D.C. 20545
Docket No. 50-537
HQ:S:82:098

OCT 0 4 1982

Mr. Paul S. Check, Director
CRBR Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Check:

Reference: Longenecker to Check, Subject: Meeting Summary for Instrumentation (Chapter 7) Working Meeting, September 21 and 22, 1982, dated September 24, 1982

INSTRUMENTATION (CHAPTER 7) WORKING MEETING, SEPTEMBER 21 and 22, 1982 - ADDITIONAL INFORMATION

Enclosed is the additional information requested during the subject meeting for which response dates of October 4, 1982, were projected. The enclosures include a list of the items from the reference meeting summary indicating their resolution followed by question responses and marked up PSAR pages keyed to the item numbers. The marked up PSAR pages will be incorporated into a future PSAR revision. Item 43 (QR 421.42) from the reference meeting summary will be submitted as soon as possible.

Any questions regarding the information provided or further activities can be addressed to Mr. R. Rosecky (FTS 626-6149) or Mr. A. Meller (FTS 626-6355) of the Project Office Oak Ridge staff.

Sincerely,

John R. Longenecker
Acting Director, Office of the
Clinch River Breeder Reactor
Plant Project
Office of Nuclear Energy

Enclosure

cc: Service List
Standard Distribution
Licensing Distribution

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TABLE 12.1-1

PLANT RADIATION ZONE CLASSIFICATION

Zone	Area Type	Access	Design Dose Rate (mrem/hr)	Zone Dose Rate Specification (mrem/hr)	Type of Control
-	Unrestricted Area	Continuous	-	**	Uncontrolled
I	Restricted Area	Continuous Routinely Occupied	0.2	≤0.2	Administrative Control
II	Restricted Area	Continuous, Not Routinely Occupied	2.0	>0.2 to <5	Administrative Control
III	Radiation Area	Periodic Limited Access for Routine Tasks	10***	>5 to ≤100	Administrative Control
IV	High Radiation Area	Unoccupied* Limited Access for Non-routine or Infrequent Tasks	100	>100 to <5000	Special Work Permits, Locked Doors, Signs, Temporary Barricades, Health Physics Surveillance
V	Extremely High Radiation Area	Unoccupied*	Unlimited	>5000	Positive exclusion, Locked Doors, Special Work Permits, Continuous Health Physics Monitoring

* 10CFR20 criteria.
** Approaching background radiation.
*** 25 mrem/hr within HAA

Resolution of Items From the September 21 and 22, 1982 Instrumentation (Chapter 7) Working Meeting

Item		Comments	Resolution
1.	7.1 Listing of Safety Related Inst.	Define "Safety Related" in Table 7.1.1. Assure consistency with H. Denton Memo, and verify adequacy of Table 7.5-1. Differentiation between NSSS and BOP Supplier is not required.	Revised Table 7.1.1 attached. Consistency with H. Denton memo reviewed and Table 7.5-1 is adequate.
2.	I&C Design Criteria - Inst. error	Add note to Table 7.2-3 to clarify what's included in the response times, i.e. sensor to output of signal conditioner, and note 200 msec additional time for rod release.	Revised Table 7.2.3 attached.
3.		Review 15.1.4.1-4, 15.31.1.1.a and Table 1.3-3 for potential conflicts. Correct confusing discussions.	Table 1-3-3, paragraph 15.1.4.1.4, and paragraph 15.3.1.1.1 revised. See attached.
21.	- RSS bypass capability	Delete existing two loop operation I&C. Correct PSAR.	PSAR corrected. See PSAR page 7.2-1a, attached.
22.		Provide revised Figure 7.2- 2A. Place in PSAR.	Revised Figure 7.2-2A attached.
23.	- Diversity - RSS primary and secondary logic	Add additional discussion on diversity and figure on diveristy.	Discussion added in paragraph 7.1.2.1. Diversity Table 7.1-5 added. See attached.
25.	- Response Time	See Section 7.1 Item 2 and 3.	See Items 2 and 3.
31.	Q 421.9	Verify that there are no cases where a control system xmitter and a protection system xmitter are connected to a common sensor or input line - Revise Q 421.9 accordingly.	See revised QCS 421.9-1, attached.
33.	Correct Table 7.1-6 Error (page 3.1-20)	The error will be corrected. Check Table of Contents also.	See corrected page 3.1-20 and corrected List of Tables.
47.	Discuss Design of I&C for PHTS, IHTS & SGS	Confirm power supplies & I&C to pony motors is safety related.	See Revised Section 7.5.2.1.2 and new Section 7.4.3, attached.

71.	Pony Motor I&C	Q421.34 will answer questions.	See Q421.34 Response, attached.
80.	Radiation Monitoring System	Information in Ch. 11 & 12 is being revised. Draft copies provided. Update PSAR. Radiation Assessment Branch will review the Radiation Monitoring System.	Revised sections of Chapter 11 & 12 are attached.
87.	Fuel Handling and Storage Safety Interlock System	Review of auxiliary Systems Branch required also. Typographical error in introduction of PSAR 7.6 will be corrected. This is not a safety related system.	See revised Section 7.6, attached.
88.	Structural Concrete Cooling System	PSAR will be clarified regarding requirements for structural concrete cooling.	See revised Section 7.6, attached.

TABLE 7.1-1

SAFETY RELATED INSTRUMENTATION AND CONTROL SYSTEMS*

Reactor Shutdown Systems

Includes all RSS sensors, signal conditioning calculation units, comparators, buffers, 2/3 logic, scram actuators, scram breakers, scram solenoid
57 valve power sources, control rods, HTS shutdown logic, coolant pump breakers, and mechanical mounting hardware (equipment racks).

Containment Isolation System

Includes radiation monitoring sensors, signal conditioning, comparators, 2/3 logic, containment isolation valve actuators and valves.

57 Shutdown Heat Removal System Instrumentation and Control System

Includes initiating sensors, signal conditioning, calculation units, comparators, logic, auxiliary feedwater pump actuators and controls including feedwater turbine pump, PACC DHX actuators and controls, steam relief valve actuators and valves; sensors, signal conditioning, logic and
26 57 actuators related to shutdown heat removal functions of DHRS including control of sodium and NaK pumps and air blast heat exchangers; and sensors, signal conditioning, logic and actuators related to removal of heat from the EVST.

Other Safety Related Instrumentation and Control

Includes Instrumentation and Controls for portions of the following functions to assure the plant is maintained in a safe shutdown condition:

- Emergency Chilled Water System
- 33 Emergency Plant Service Water System
- Instrumentation necessary to assure plant is maintained in safe shutdown status (See Table 7.5-4)
- 59 49 Heating, Ventilating, and Air Conditioning System
- Recirculating Gas Cooling System 1

*The Clinch River Breeder Reactor Plant (CRBRP) safety-related structures, systems, and components ~~important to safety~~ are ~~to be~~ designed to remain functional ~~to~~ in the event of a Safe Shutdown Earthquake (SSE). ~~These plant features are also designated as safety related features in the SAR.~~ These include, but are not limited to, those structures, systems and components which are necessary:

a. To assure the integrity of the Reactor Coolant Boundary;
b. To shut down the reactor and maintain it in a safe shutdown condition;
c. To prevent or mitigate the consequences of accidents which could result in potential off-site exposures comparable to the guideline exposures of 10CFR100.

NOTE: Class IE equipment loads are identified in Chapter 8. 1

TABLE 7.2-3

ESSENTIAL PERFORMANCE REQUIREMENTS FOR PPS INSTRUMENTATION CHANNELS*

Plant Parameter	Accuracy (% of span)	Response Time (msec)
Neutron Flux		
Primary	±1.0	<10
Secondary	±1.0	<10
Reactor Inlet Plenum Pressure	±2.0	<150
Sodium HTS Pump Speeds	±2.0	<20
Sodium HTS Flow	±5.0	<500
Reactor Vessel Sodium Level	±5.0	<500
Undervoltage Relay	±1.0	<230
Steam Flow	±2.0	<500
Feedwater Flow	±2.5	<500
Evaporator Outlet Sodium Temperature	±2.0	<5000
Steam Drum Level	±1.0	<1000
IHX Primary Outlet Temperature	±2.0	<5000
Underfrequency Relay	±2.0	<200

* Note that these accuracy and response times relate to the performance of the instrumentation channels from the sensors up to the signal conditioning output.

In addition, as noted in Section 7.2.1.2.3, the reactor shutdown system logic, actuators and rod unlatch features require a further response time delay of 200 msecs.

	CRBRP - 975 Mwt	FFTF - 400 Mwt	MONJU-714 Mwt	PSAR Section
Reactor Trip Circuits				
No. Circuits Monitored For Trip Actuation	24-Pri. System 16-Sec. System	23-Pri. System 19-Sec. System	--	
Basic Signal and Trip Output Signal Logic	Pri.-2/3 Local Coincidence Logic	Pri.-2/3 Local Coincidence Logic	--	
	Sec.-2/3 General Coincidence Logic	Sec.-1/4 2/3 Hybrid General Local Coincidence Logic	--	
No. External Flux Monitors	3	3	--	
Max. PPS Response Time (From time PPS senses condition requiring trip to time when rods are released.) (Sec.)	0.200	0.200	--	
10. Containment				3.8
Type/Shape	Single steel vessel, cylindrical shell with flat bottom and hemi-ellipsoidal top. Concrete shielding inside, below operating floor. Steel containment surrounded by concrete confinement building. An Annulus space between containment and confinement maintained at negative pressure with respect to outside atmosphere.	Single steel vessel, cylindrical shell with hemi-ellipsoidal top and bottom heads. Concrete shielding below operating floor.	Single steel vessel, cylindrical shell with hemi-spherical top and hemi-ellipsoidal bottom. Concrete cylinder surrounds entire containment.	8

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(3) (25)

is an extremely unlikely event). As with the past analyses, the following conservative assumptions were made:

1) All full power cases are for the reactor operating at thermal hydraulic design conditions with a power generation of 975 MWt at three-loop operation. (Power uncertainties are discussed in Section 4.4.3.2.)

2) Since the smallest Doppler coefficient occurs at the beginning-of-equilibrium cycle, the transient reactor power calculation was made for this particular phase in core life. This results in the highest possible reactor power changes being calculated. For overpower transients, the smallest Doppler coefficient of all core cycles is used (see Section 4.3.2.3) and this value is reduced 30% to account for 3σ uncertainties.

3) The highest cladding and fuel temperature hot rod occurs at the beginning of the first cycle of operation (in F/A 52 and 101). The conservative reactor power calculation from Item 2 above was applied to this particular rod. With burnup, the power generation and steady-state temperatures decrease (flows are constant) in the hottest fuel assemblies, and consequently, the temperatures, due to the transients, would decrease after beginning of cycle.

4) As described in Chapter 7.0 and Section 4.2, the maximum allowable time delays for PPS logic and electrical/mechanical delays have been conservatively enveloped by using a 200 millisecond delay between the ~~physical conditions causing scram (e.g., P/Po = 1.15)~~ instrument channel output going beyond the trip level and the start of control rod insertion. *

5) Three sigma (3σ) hot channel factors were used for all the analyses and the cladding temperatures shown are the inner surface of the hot pin cladding at the highest temperature position, both axially and circumferentially on the fuel rods. (Position is under the wire wrap.)

6) The most rapid flow decay after de-energizing the primary pumps was used. (See Figure 5.3-22.)

7) Maximum decay heats were used for the hot rods considering 3σ uncertainties.

Results from FORE 2M analysis are given by Figures 15.1.4-1, 2 and 3 and Table 15.1.4-1 for a 60¢ step reactivity insertion occuring at the worst time during the SSE (see Section 15.2.3.3.1). Comparisons of the heterogeneous core results are made with data for a homogeneous core previously reported in this section. This previously reported data updated earlier data for the homogeneous core analyzed in Section 15.2.3.3. The figures show the

* In this instance the sensor delay has been encompassed by the 200 msec PPS logic and control rod unlatch delay. This is justified by the small magnitude of the flux sensor delay which is estimated at less than 10 msecs.

(3) (25)

15.3.1 Anticipated Events

15.3.1.1 Loss of Off-Site Electrical Power

15.3.1.1.1 Identification of Causes and Accident Description

The off-site power supply to the 13.8 KV buses is available from the generating switchyards and the reserve switchyard both of which are powered by outside sources as described in Chapter 8.0. Hence, the postulated loss of power would result only from simultaneous, multiple failures.

The loss of all off-site power trips all primary and intermediate sodium pumps, commencing a flow coastdown. It also initiates starting of the emergency diesel generators. Action of the Plant Protection System (PPS) trips the control rods thus limiting core over temperatures from reduced flow.
44 Either emergency diesel provides power to the primary and intermediate sodium pump pony motors and SGAHRS Auxiliary Feedwater Pumps for decay heat removal. Additionally, a third power supply (250 VDC Diverse Battery and Inverter)
44 provides power to the third loop pony motors. To provide conservatism in the analysis, the most rapid core flow coastdown was assured by using the minimum pump rotating kinetic energy and the maximum core flow resistance specified in the design.

The action of the Primary and Secondary Shutdown Systems (SDS) are as follows:

a. Primary trip - Loss of electrical [RSS logic and] power trip occurring in 0.5 seconds. The 0.5 second delay includes measurement and trip function lags. These lags include bus voltage decay and instrument delay but not the control rod unlatching delays.
b. Secondary trip - Flux-Total Flow trip occurring 2 seconds after loss of electrical pumping power. This lag includes time for the flow to coastdown as well as the measurement lags.

15.3.1.1.2 Analysis of Effects and Consequences

The loss of off-site electrical power event was analyzed with the DEMO computer code. The overall results of the analysis are summarized in Figures 15.3.1.1-1 and 15.3.1.1-2. As shown, the Primary PPS loss of electrical power trip limits the maximum core hot spot temperature to 1410°F.

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In the event the primary shutdown system does not operate, Figure 15.3.1.1-1 shows that the secondary shutdown system limits the worst case clad hot spot temperature to 1630°F. While the transient temperature exceeds the design basis emergency transiet envelope temperature by
51 30°F, the time above the normal operating temperature is only 6 second as

52

21

permissive condition goes out of the allowable range, the protective function is automatically reinstated. The trip function will remain reinstated until the permissive conditions are again satisfied and the operator again manually initiates the bypass. Operator manual bypass control is not effective unless the bypass comparator indicates that permissive conditions are satisfied. A functional diagram of the Primary and Secondary bypass permissive logic is shown in Figure 7.2-2AA.

Two loop bypasses are established under administrative control by changing the hardware configuration within the locked comparator cabinets. These bypasses are also under permissive control such that the plant must be shutdown to establish two loop operation and if the shutdown loop is
57 activated the bypass is automatically removed.

Bypass permissives are part of the Plant Protection System (PPS), and are designed according to the PPS requirements detailed elsewhere in this section of the PSAR.

Continuous local and remote indication of bypassed instrument channels will be provided in conformance with Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety 15
Systems".

Bypass features included within the Primary and Secondary RSS hardware for two loop operation will be deactivated during all three loop operating modes so that the three loop operating configuration can not be affected by these bypass features either by operator action or by two loop hardware failure.

new material to be inserted

Amend. 57
Nov. 1980

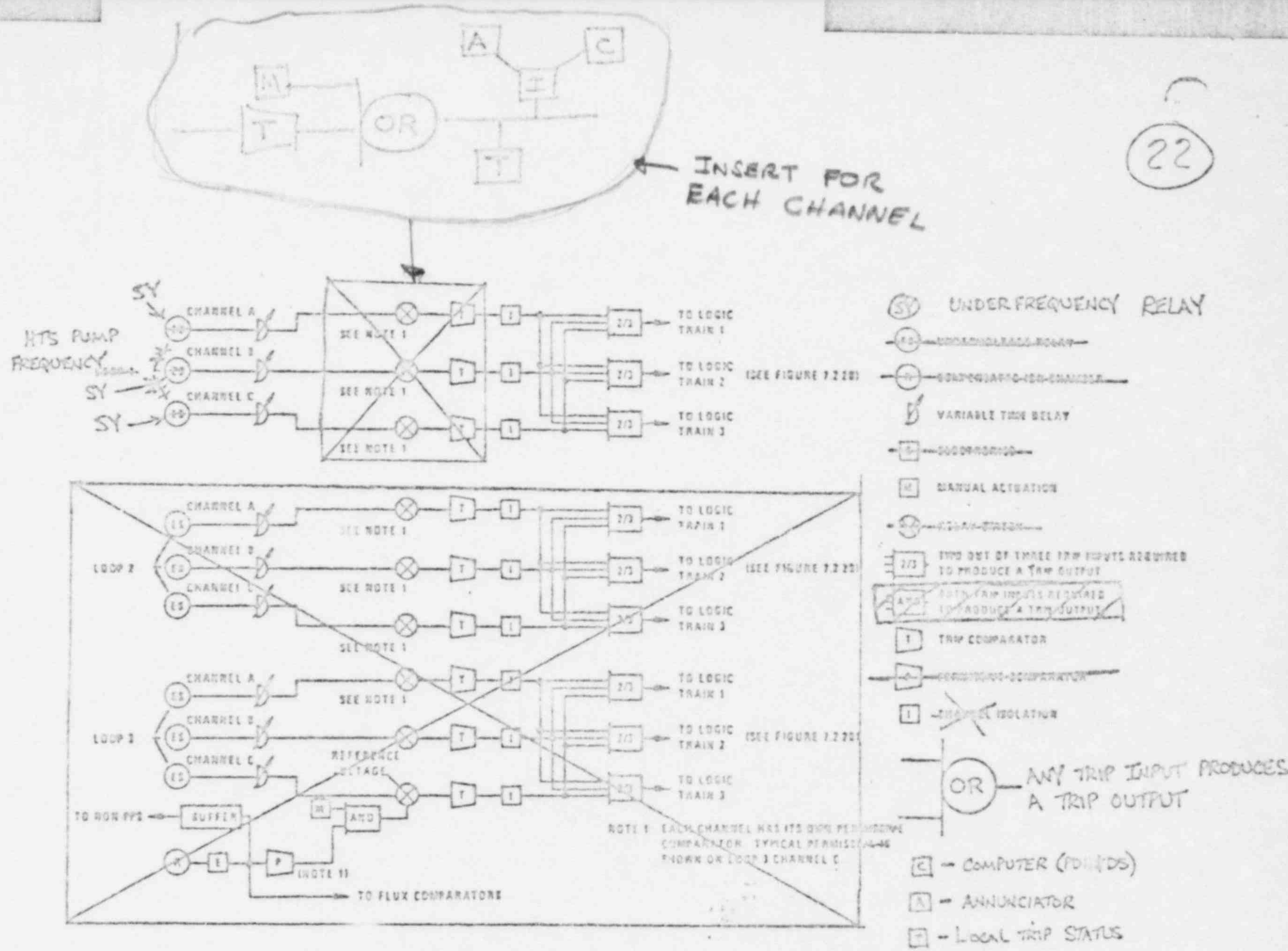

Figure 7.2-2A. Typical Primary ~~PPS~~ RSS Instrument Channel Logic Diagram (~~Pump Electrics~~ Subsystem Shown)
HTS PUMP FREQUENCY

(23)

Compliance with guides or standards applicable to specific I&C systems or equipment are described in the paragraphs related to those systems. In addition to meeting the requirements of the Regulatory Guides and IEEE Standards, the safety related equipment will be designed to meet the applicable requirements of the RDT Standards listed in Table 7.1-4. The instrument error and other performance consideration are addressed in the description of individual subsystems.

7.1.2.1 Design Basis

The Plant Protection System (PPS) includes the Reactor Shutdown System (RSS), the Containment Isolation System and the Shutdown Heat Removal Systems.

The Reactor Shutdown System consists of a Primary and a Secondary System either of which is designed to initiate and carry to completion trip of the control rods and sodium coolant pumps to prevent the results of postulated fault conditions from exceeding the allowable limits. Table
45 4.2-35 shows the basis for Primary and Secondary RSS performance for the defined fault categories. The performance limits for the fuel and cladding are identified in Section 4. The Reactor Shutdown Systems are described in Section 7.2.

INSERT 7.1-2

The Containment Isolation System (CIS) is designed to react automatically to prevent or limit the release of radioactive material to the outside environment. The system acts to isolate the interior of the containment by closing the containment isolation valves in the event that radioactive material is released within the containment. Radiation monitors within the containment boundary are used to activate the CIS. A description of this system is given in Section 7.3.

The Shutdown Heat Removal Instrumentation and Control System is designed to provide assurance against exceeding acceptable fuel and reactor coolant system damage limits following normal and emergency shutdowns. The description of this instrumentation and control is given in Section 7.4 for the removal through the auxiliary steam/water system (Steam Generator Auxiliary Heat Removal System (SGAHRS) and Outlet Steam Isolation System (OSIS)) and Section 7.6 for removal through the NaK to air system (Direct Heat Removal
26 57 System (DHRS)).

Sufficent instrumentation and associated display equipment will be provided to permit effective determination of the status of the reactor at any time. Section 7.5 provides a description of the instrumentation provided. In Section 7.9, a description of the control room, control room
57 layout, operator-control panel interface, instrument and display groupings and habitability are given.

INSERT 7.1-2

Two diverse Reactor Shutdown Systems have been provided for CRBRP to ensure that the reactor is protected from the consequences of all anticipated and unlikely events even if one of the Reactor Shutdown Systems fails. The two Reactor Shutdown Systems have been made diverse in order to reduce the probability that a common mode failure will prevent a reactor shutdown from taking place. This diversity extends from the sensors used as input to the two systems, through the logic utilized, to the actuation devices required to trip the two different control rod designs.

Table 7.1-5 lists the principal diverse design features present in the two systems. These different design features are discussed in more detail in Section 7.2.1.1. When combined with the separation, qualification and other design requirements arising from the Regulatory Guides listed in Tables 7.1-2 and 7.1-3, these designs provide protection against degradation of performance arising from common mode initiators.

(23)

TABLE 7.1-5

RSS DIVERSITY

	Primary	Secondary
Logic:	Local Coincidence	General Coincidence
Sensors:	Inlet Plenum Pressure	Primary Loop Flow
	Primary Pump Speed	Primary Loop Flow
	Intermediate Pump Speed	Intermediate Loop Flow
	HTS Bus Frequency	HTS Bus Voltage
	Steam Flow }	Steam Drum Level
	Feedwater Flow }	Reaction Products Flow
	IHX Primary Outlet Temperature	Evaporator Outlet Sodium Temperature
Logic Isolation ~~Separation~~:	Light Coupling ~~Emitting Diodes~~	Direct ~~DC~~. Coupled
Equipment:		
• Circuitry	Integrated Circuits	Discrete Components
• Power Supplies	Separate vendors utilized	
• Potentiometers	Separate vendors utilized	
• Buffers	Light Coupling	Magnetic Coupling
• Control Rod Release	Circuit Breakers in 2/3 Logic Arrangement	Solenoid Operated Pneumatic Valve in a 2/3 Logic Arrangement

Question CS 421.9

Identify where instrument sensors or transmitters supplying information to more than one protection channel, to both a protection channel and control channel, or to more than one control channel, are located in a common instrument line or connected to a common instrument tap. The intent of this item is to verify that a single failure in a common instrument line or tap (such as break or blockage) cannot defeat required protection system redundancy.

Response

Redundant protection channels, protection channels and control channels, or more than one control channel instrumentation sensors or transmitters are not located in common instrument lines or taps. Therefore, the required protection system redundancy will not be defeated by a blockage or breakage of an instrument line or tap.

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Criterion 11 - Instrumentation and Control

Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for postulated accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor-coolant boundary, and the containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges.

RESPONSE

Instrumentation and controls are provided to monitor and control neutron flux, control rod position, temperatures, pressures, flows, and levels as necessary to assure that adequate plant safety can be maintained. Instrumentation is provided in the Reactor System, Heat Transport System, Steam and Power Conversion System, the Engineered Safety Features Systems, Radwaste Systems and other auxiliaries. Parameters that must be provided for operator use under normal operating and accident conditions are indicated, in proximity with the controls for maintaining the indicated parameter in the proper range. ~~The specific instrumentation important to safety is identified in Table 7.1-6 which is a listing of safety-related electrical equipment.~~

The control room is provided as the focal point from which the plant can be operated safely during normal operation, anticipated operational occurrences, and for postulated accident conditions. The basic criteria for including instrumentation readout and control in the control room is as follows:

- The displays or controls necessary to support all normal plant operating conditions;
- The displays and controls necessary to respond to anticipated operational occurrences and accident conditions which impact on power operations capability;
- The displays or controls necessary to prevent potential radiological hazards to offsite personnel;
- The displays necessary to the operator for detection of fire hazards; or
- The display and controls necessary to prevent potential damage to the plant.

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Amend. 32
Dec 1976

LIST OF TABLES

(47)

29| 59|

Pony Motor Running

A signal is provided to the control room indicating that the pony motor is running.

INSERT A →

Diagnostic Instrumentation

In addition to the instrumentation described above, diagnostic instrumentation is provided.

7.5.2.1.3 Steam Generator

Sodium Flow

Venturi flowmeters are provided, one loop only, to accurately measure the sodium flow rate through each of the superheater outlet ports. The accurate flow data is used for determination of the performance characteristics typical of the superheaters and evaporators.

Sodium Temperature

The evaporator and superheater outlet temperature is monitored, on all three loops, by Resistance Temperature Detectors (RTD). The superheater inlet is monitored, on one loop only, also by an RTD for purposes of steam generator performance evaluation. These temperature sensors provide signals
59| for the PDH & DS. The evaporator bulk outlet temperature is measured with three thermocouples and are part of the Reactor Shutdown System.

Sodium Pressure

For the purpose of steam generator performance evaluation, pressure is measured, in one loop only, at the superheater inlet, superheater outlet (both legs) and evaporator outlet. The type of pressure sensor used is the same as the one for Intermediate pump inlet pressure. These pressure mea-
59| surements provide pressure signals to the PDH & DS.

Steam and Water Flow

- Feedwater Mass Flow - sensed by three differential pressure elements across one venturi in the inlet line to each steam drum.

INSERT A

The pony motors are Class 1E motors and are supplied power from the Class 1E 480 VAC busses.

Non-class 1E signals are provided to the main control room to indicate the pony motors are running. These signals are pony motor speed indicators which ~~is~~ are located in the main control panel and pony motor current which is available through the PDH & DS. Also start and stop lights are on the main control room panel which are from the pony motor starters.

During pony motor operation indication is available on the main control room panel from sodium flow.

NEW PSAR SECTION

7.4.3 Pony Motors and Controls

There are six pony motors, one in each primary and intermediate heat transport loop to provide sodium flow for decay heat removal. These motors through the use of a gear box are capable of providing five to ten percent sodium flow in five discrete steps by gear changes. Section 5.6 describes the interaction of the primary and intermediate heat transport loops with the SGAHRS to provide decay heat removal.

7.4.3.1 Design Description

The pony motors are 75 horsepower, 480 VAC, 3 ø, 60 Hz, totally enclosed fan cooled Class 1E motors. These motors are mounted on top of the sodium pump vertical drive motor. They are 1800 rpm motors which deliver power to the sodium pump via a reducing gear, an overrunning clutch, and the vertical motor shaft.

The overrunning clutch allows the pony motor to run continuously during all modes of plant operation and automatically drives the pump when the vertical motor speed decreases below the output speed of the reducing gear. Thus, after a reactor trip and pump (vertical drive motor) trip sodium flow does not decrease below pony motor flow.

During normal operation at pony motor speeds the external oil cooling system is in operation. However, the vertical drive motor bearings are designed to start and operate continuously at pony motor speed without the external oil cooling system or high pressure lift pump.

The pony motor is controlled using both ~~via a~~ Non-class 1E and Class 1E circuit. The Non-class 1E circuit is isolated from the Class 1E circuit and is overridden by the Class 1E circuit.

Normal pony motor start is through a Non-1E permissive sequence circuit which first starts the vertical drive motor external lubricating oil cooling system and high pressure lube oil pump. ~~and~~ When the oil system achieves flow and pressure the pony motor starts. Once started the Class 1E circuit takes over and the loss of the external lubricating oil system will not result in a pony motor trip. This method of starting is not classified as safety-related and is used for starting the pony motor during reactor shutdown periods after maintenance which requires the pony motor to be off.

The Class 1E controls start the pony motors without the use of the external lubricating oil cooling system or high presure lube oil pump. This function is carried out by a start-stop switch on the main control panel in the control room. Once started by either the Class 1E or Non-class 1E control the pony motor will automatically restart following the loss of off-site power on the Class 1E diesels.

7.4.3.2 Initiating Circuits

The pony motor runs continuously during all modes of plant operations except during reactor shutdown for maintenance. Therefore, there is no need for automatic or manual initiation circuits. However, the Class 1E start-stop switch is located on the main control panel.

(DURING MAINTENANCE ONLY ONE LOOP IS permitted to be out of service.)

7.4.3.3 Bypasses and Interlocks

There are no bypasses in the Class 1E control circuit.

The only condition which results in an interlock/automatic pony motor trip is a sodium-to-water leak in the steam generator modules. This results in an automatic trip of the affected intermediate heat transport loop pony motor only. The sodium-to-water leak trip is describe in 7.5.6.

7.4.3.4 Analysis

The pony motor and the Class 1E control circuit is designed to the IEEE Standards listed in Table ~~9~~ and is qualified ~~per~~ in accordance ~~WARD-D-0165~~. with Section 1.6 Reference 9

(A TABLE ~~LISTED~~ WILL BE PROVIDED IN PSAR update)

(71)

Question CS421.34

PSAR Section 7.5.2.1.2 states in part that a signal is provided to the control room indicating that the pony motor is running. The staff requires more information with regard to the CRBR pony motor instrumentation and control system. In particular, the initiation signals for the pony motors, manual initiation capability, qualifications for the system, and the design criteria for the system should be discussed. PSAR Section 7.5.6.1.1 states in part that the sodium pony motor is tripped upon a large leak detection. Discuss the safety aspects of this trip and provide the staff information on other signals that will trip the pony motors.

Response:

The pony motor runs continuously during all modes of plant operation except during sodium pump or drive system maintenance. Therefore, there is no need for automatic or manual initiation signals except for the start-stop switch.

Normal pony motor start is through a permissive sequence circuit which starts the external lubricating oil cooling system and high pressure lube oil pump, and when the oil system achieved flow and pressure the pony motor starts. Once started the loss of flow or pressure will not result in a pony motor trip. This method of starting is not classified as safety-related.

In the safety-related mode, pony motor operation does not require the use of the external lubricating oil cooling system or high pressure lube oil pump. This function is carried out by a start-stop switch on the main control panel in the control room.

The non-safety permissive sequence starting circuit is isolated from the safety circuit and will not prevent the operation of the safety function. The safety circuit will be qualified per WARD-D-0165 (Ref. 13 of PSAR Section 1.6).

There is available in the control room, pony motor speed and current indications. Pony motor current indication is provided via the PDH&DS. These circuits are non-safety related.

The only condition which results in an automatic IHTS pony motor trip (the PHTS pony motor is not tripped) is a large sodium/water reaction which results in a rupture disc rupturing. The safety aspects of this trip are specifically addressed in the response to Question CS421.27.

(80)

11.4 PROCESS AND EFFLUENT RADIOLOGICAL MONITORING SYSTEM

11.4.1 Design Objectives

Process radiation monitors are provided to allow the evaluation of plant equipment performance and to measure, indicate and record the radioactive concentration in plant process and effluent streams during normal operation and anticipated operational occurrences. The monitors are provided in accordance with CRBRP (Section 3.1) Design Criterion 56.

Radiation monitoring of process systems provides early warning of equipment malfunctions, indicative of potential radiological hazards, and prevents release of activity to the environment in excess of 10CFR 20 limits. Each monitor will be equipped with a loss-of-signal instrument failure alarm and a high level alarm, (a high-high level alarm is also provided when required). These alarms alert operating personnel to channel malfunction and excessive radioactivity. Corrective action will then be manually or automatically performed.

Monitoring of liquid and gaseous effluents under normal operating conditions will be in accordance with NRC Regulatory Guide 1.21 and any activity released will be within limits established in 10CFR20.

The number, sensitivities, ranges, and locations of the radiation detectors will be determined by requirements of the specific monitored process during normal and postulated abnormal (accident) conditions. All monitors will be designed so that saturation of detectors during a severe accident condition will not cause erroneously low readings. Monitoring during severe post accident conditions will be accomplished by the high-range gamma area monitors discussed in Section 12.1.4, in conjunction with the sampling lines described in Section 11.4.2.2.1.

Radioactivity in the low level waste releases will be integrated and recorded. Control signals will be provided by the radiation monitor(s) to terminate liquid or gaseous effluent if an out-of-limit signal is recorded. The monitoring and control exerted by the process radiation monitoring equipment and the operator during any release will also be verified by periodic manual sampling and laboratory analysis in accordance with Technical Specifications. For tritiated process liquids, tritium surveillance will be by sampling and lab analysis.

All detectors will be shielded against ambient background radiation levels so that required activity measurements can be maintained. Monitors associated with accident conditions are also discussed in 3.A.3.1. Area monitors and airborne radioactivity monitors are discussed in 12.1.4 and 12.2.4, respectively. The radiological effluent sampling program is discussed in Section 11.4.3 and meets the reporting requirements of Regulatory Guide 1.21.

11.4.2 Continuous Monitoring/Sampling

11.4.2.1 General Description

The descriptive tabulation of the various continuous monitors/samplers for process and effluent radioactivity monitoring, which includes those gas and liquid monitoring devices in or associated with liquid or gas process streams considered in this discussion, is found in Table 11.4-1. The basis for selecting the locations as well as the control functions associated with the monitor, are described below.

Each continuous monitor will be equipped with power supplies, micro-processor and accessories, indication and local alarm indicator lights. Each monitor will transmit radioactivity level and alarm status information for display and logging by Radiation Monitoring equipment located in the Control Room with redundant display and logging equipment located in the Health Physics Area of the Plant Service Building. The alarms are provided to indicate instrument malfunctions or a radioactivity level in excess of the monitor's alarm setpoint. Each continuous monitor has a local indicator at the detector location to facilitate the testing and/or calibration of the equipment.

The lowest scale division of each continuous monitor's range is the maximum detector sensitivity deemed appropriate for the intended service. The range of the monitor will be a minimum of five decades above the maximum sensitivity level; and will allow for a minimum of one decade span above the monitor high-high setpoint (when high-high setpoints are employed). The effluent alarm setpoint corresponds to the alarm annunciation level dictated by the CRBRP Technical Specifications (Chapter 16.) For each monitor, a sample chamber and/or detector is selected and will be installed in such a way as to minimize sampling losses and electromagnetic and background interferences. The output of all effluent monitors will be continuously sampled and recorded by the CRBRP Plant Data Handling and Display System. The Reactor Containment Isolation Monitors (PPS), Control Room Air Intake monitors and other safety-related monitors will be powered by Class IE, redundant 120 VAC power.

11.4.2.2 Gaseous System Description

11.4.2.2.1 Post-Accident Containment Atmosphere Monitors

The capability to monitor the containment atmosphere radioactivity level following containment isolation during an accident condition shall be provided. Three pair of penetrations, located 120° apart around the containment structure will allow air samples to be taken by mobile or portable monitors and sampling equipment. The penetrations design and locations will consider the following criteria:

1. The penetration opening on the inside of containment will be positioned to obtain a representative sample.

2. The penetration opening on the outside of containment will be positioned in an accessible area to enable connection of the monitoring and/or sampling equipment.

3. Each penetration will have two isolation valves; a remote manual controlled valve inside containment and a manual, locked valve outside containment with a blind flange.

4. The penetration design will comply with CRBRP Design Criteria Numbers 45 and 47 (Section 3.1)

Each pair of penetrations can be connected to a mobile monitor which will be utilized for continuous monitoring of the containment atmosphere. The sample is withdrawn from containment, passes through the monitor for radiation detection and returned to containment. Grab samples will also be obtained for further laboratory analysis.

11.4.2.2.2 Reactor Containment Isolation Monitors

The radiation level in the head access area will be monitored by three detectors for direct gamma activity. The output of these detectors is routed to the plant protection system to initiate closure of containment isolation valves if a preset limit is reached by two out of three of the detectors.

In addition, the radiation level in containment exhaust, upstream of the isolation valves will be isokinetically monitored for gaseous activity by three gas monitors. Their output will also be provided to the PPS for initiation of containment isolation when a preset radiation level is reached by two of the three detectors.

The monitoring system will be designed to comply with IEEE 279-1971. The overall containment isolation system design and protection logic is discussed in Section 7.3. Figure 12.2-1 shows a typical block diagram of these channels and Figure 7.3-1 shows the trip logic configuration.

11.4.2.2.3 Building Ventilation Exhaust Monitors

The number and location of building exhaust plenums from which potentially radioactive plant gaseous release may emanate are: One located in the Intermediate Bay (SGB-IB), nine located near the top of the RCB dome, two located in the Reactor Service Building (RSB), one located in the Radwaste Area (Bay), one located in the Plant Service Building (PSB), fourteen in the Turbine Generator Building (TGB), and three located in the Steam Generator Building (SGB). Continuous monitoring will be performed at those exhausts which could conceivably undergo a significant increase in detectable levels in radioactivity. The remaining exhausts will be sampled periodically.

The exhaust plenum located in the IB receives ventilation exhaust air from the Intermediate Bay area. A continuous air monitor (CAM) will be provided to detect particulate, radioiodine and gaseous activity in the effluent stream. The air sample will be obtained isokinetically from the exhaust, on a continuous basis. The operation of the three-channel CAM unit is described in Section 12.2.4.2.1.

The exhaust plenum located on the Radwaste Building receives ventilation exhaust air from the radwaste area. A Continuous Air Monitor (CAM) will be provided to detect particulate, iodine and gaseous activity in the effluent stream. The air sample will be obtained isokinetically from the exhaust, on a continuous basis. The operation of the three channel CAM unit is described in Section 12.2.4.2.1.

The two RSB exhausts will be continuously monitored for radioactivity releases. The first exhaust plenum located on the RSB roof which receives ventilation exhaust from the RCB will be continuously monitored for particulates, radio gases, and radioiodine activity in the effluent stream. The second exhaust plenum located on the RSB which receives ventilation exhaust from the RSB via the RSB clean-up filtration units will also be continuously monitored for particulate, gaseous and radioiodine activity.

The exhaust plenum located near the top of the RCB dome, which receives exhaust from the Containment Clean-up and Annulus Pressure Maintenance and Filtration System will be continuously monitored for particulate, radioiodine, radiogas, and plutonium activity in the effluent stream.

The 8 exhausts located at the top of the RCB dome for the Annulus Cooling Air become potential radioactivity release points only in the event of very low probability accidents beyond the design basis (e.g., Thermal Margin Beyond the Design Base). On line monitoring for particulates, radioiodines and radiogases have been provided for these exhausts in the event of such an accident.

TGB areas will be periodically grab sampled and samples will be analyzed for tritium activity.

The exhaust in the PSB receives ventilation from the combined laboratory. Samples will be collected isokinetically by a particulate (and iodine, if required) filter and analyzed for isotopic content in the Counting Room.

Certain effluent radiation monitors are identified as Accident Monitoring Instrumentation in Table 11.4-1. As such, these monitors will meet the requirements of Section 7.5.11 of the PSAR.

The reporting of effluent radioactivity released from the CRBRP will be consistent with the guidelines established in Regulatory Guide 1.21. This reporting will be based upon the results of Counting Room analysis of effluent samples obtained at each location listed above.

11.4.2.2.4 Condenser Vacuum Pump Exhaust, Deaerator Continuous Vents and Turbine Steam Packing Exhauster Tritium Samplers

A gas sample will be continuously withdrawn from each one of the condenser vacuum pump air, deaerator exhaust, and turbine steam packing exhauster air into tritium samplers comprised of silica gel dessicant column to enable determination of tritium activity to indicate unacceptable tritium diffusion in the steam generators. The sample will be analyzed using liquid scintillation techniques in the counting room.

11.4.2.2.5 Control Room Inlet Air Monitors

The main and remote Control Room air intakes will each be continuously monitored by two redundant monitors. These three channel (particulate/radioiodine/radiogas) CAMs will detect radioactivity in the air intakes and will determine which intake should be used during the Control Room isolation condition. Details concerning the sequence of operation during Control Room isolation are given in Section 9.6.1.3.4.13. A fifth three channel CAM will be installed downstream of the parallel HVAC make-up air filters to monitor the performance of the HEPA filter trains. A detailed description of the operation of each of these CAM units is given in Section 12.2.4.2.1.

11.4.2.2.6 Inerted Cell Atmosphere Monitors

The capability for monitoring the atmosphere of each individual inerted cell for high radioactivity will be accomplished by three methods. One method is the sequential sampling of groups of cells with on-line gas monitors as described in 3.A.1.4.2. Each monitor shall have a trip signal determined by the process system to initiate activation of cell purging equipment. In addition, mobile particulate, iodine and gas monitors are provided to sample any individual inerted cells atmosphere, as described in 12.2.4.

Finally to provide a sensitive method of sodium leak detection, particulate monitors are provided for continuous monitoring of inerted cells within the RCB containing components contacting radioactive sodium. These monitors will alarm for activated sodium present in the cells atmosphere. The individual inerted cells that are continuously monitored for sodium leak detection are listed in Table 3.A.1-3.

11.4.2.2.7 RAPS and CAPS Monitoring

Gas monitors will be provided for the Radioactive Argon Processing System (RAPS) and Cell Atmosphere Processing System (CAPS). A monitor will be located at the CAPS inlet for controlling the rate of radioactivity input. Monitors will also be located at the output of these systems to ascertain that the radionuclide activity of the processed gas is within limits for reuse in RAPS or within 10 CFR 50, App. I and ALARA limits for those gases exhausted to the H&V system by CAPS.

11.4.2.2.8 Safety-Related Monitors

Certain monitors which provide control signals to safety related process systems or are used to monitor safety related systems are classified as safety related monitors. These monitors will be supplied with Class 1E power from redundant vital AC buses and will meet the requirements described in Section 7.1. Safety related monitors are identified in Table 11.4-1.

These monitors will each have a dedicated Display and Control Unit (DCU) in the Control Room. The DCU will also meet the requirements described in Section 7.1 and will be supplied with Class 1E power. The DCU's will be located in the back panel area of the Control Room adjacent to the Radiation Monitor Console (computer).

11.4.3.1 Process Sampling

Periodic sampling is conducted to alert the operator of any abnormal condition that may be developing. Both local and remote liquid samples are taken. Gaseous samples are taken directly at the sample station adjacent to the gas analyzer. The locations for gaseous sample instrumentation are given in Section 11.3.3.3. Operating procedures and performance tests of gaseous samples are discussed in Section 11.3.4. Sampling of primary sodium, secondary sodium, ex-vessel sodium and cover gas is discussed in detail in Section 9.8, entitled "Impurity Monitoring System". This section also discusses the location of samples, expected composition and concentration, sampling frequency and procedures.

The basis for selecting the locations for sample stations is to provide an indication of the effectiveness of key process operations. Analyses of these samples are related to the process sequence from which they were obtained to evaluate specific equipment performance.

Gaseous samples are monitored for gross activity and periodically analyzed for isotopic content. Tables 11.3-1 through 11.3-15 list inventories of the expected concentration and composition of the effluent gas samples.

Sections 11.4.3.1.1 through 11.4.3.1.5 describe in detail each of the liquid sampling points in the Radioactive Waste Systems. Sampling procedure, analytical procedure, and sensitivity for each sample point are the same and are discussed in detail in the following paragraphs.

Sampling Procedure: Samples are collected in a sampling station located on the operating floor of the radwaste building. Sample circulating lines run through this sampling station. The upstream side of the sample lines are connected to the discharge of the pumps serving the tanks. After passing through the sampling station, the circulating sample fluid is returned to the tank from which it was drawn.

Analytical Procedure and Sensitivity: The quantity of sample to be counted for gross beta-gamma is pipetted onto a planchet. The planchet is placed on a turntable and evaporated to dryness under an infrared bulb. The rotation insures a uniformly distributed dried sample for reproducible counting. The height of the infrared bulb is adjustable to obtain a moderate rate of evaporation. Counting is done by means of an internal proportional counter.

The isotopic analysis is performed by a completely automated Pulse Height Analysis System. A shielded Ge (Li) detector is used with a computer-based pulse height analysis system. The system satisfies the reporting requirements of Regulatory Guide 1.21.

Provisions will also be made for alpha and tritium assay.

11.4.3.1.1 Intermediate Level Activity Liquid Waste Collection Tanks

These tanks receive decontamination waste from the Large Component Cleaning Cell. The analysis of this waste provides a check on the decontamination procedure.

The composition is expected to be sodium hydroxide solution, nitric acid solution and water rinses. After neutralization a solution of sodium sulfate or sodium nitrate results. Activity will be ~1 μCi/cc.

The quantity to be measured is the gross β-γ activity.

Additional rinses would be required if the activity of the component is higher than expected. Additional passes through the purification equipment would be required if the activity of the product from the evaporator is too high. Corrective action would be taken if the DF is lower than the expected value. The expected recirculation flow through the sample line is 10 gpm.

11.4.3.1.2 Process Distillate Storage Tanks

These tanks receive the distillate from the Process Waste Evaporator. The sample provides the check on the DF of the evaporator and purity of the product to be recycled for plant uses or released to the environment after dilution with cooling tower blowdown. The composition is expected to be very dilute sodium sulfate or sodium nitrate with an activity ~ 10^{-6} μCi/cc.

The quantity to be measured is the gross β-γ activity, if no excess inventory exists. If excess inventory exists and a portion of the content is to be released to the low activity liquid system, an isotopic analysis will be performed consistent with reporting requirements of Regulatory Guide 1.21. If the activity of the sample is unacceptably high, the contents of the tank are reprocessed through another evaporator-ion exchange cycle. Corrective measures would be taken if the DF is much lower than the expected value.

The expected recirculation flow through the sampling line is 10 gpm.

11.4.3.1.3 Low Level Activity Liquid Waste Collection Tanks

These tanks receive laboratory drains, floor drains, lavatory drains, and shower drains from areas that may contain radioactivity. An activity check at these points determines the possibility of the need for further processing. It also permits a check on the DF of the purification equipment by comparing it with the activity of the purified waste.

These tanks receive waste from several sources, hence the composition is not well defined. The conductivity will be measured to determine impurity level. The expected activity is 10^{-4} μCi/cc. The quantity to be measured is the gross β-γ activity.

The sampling frequency will be in accordance with reporting requirements of Regulatory Guide 1.21.

Higher sample activity indicates abnormal operations elsewhere in the plant. Corrective measures at those locations would be taken. Also, higher activity indicates that a second pass through the equipment would be required.

The expected recirculation flow of the sampling line is 10 gpm.

11.4.3.1.4 Low Level Activity Distillate Monitoring Tanks

Since these tanks are holding tanks for the purified product from the low level waste evaporator, pending release to the discharge canal, sample analysis is mandatory. The composition is expected to be equivalent to grade C water or comply with federal and state regulations and have an average activity of 10^{-8} μCi/cc.

A gross β-γ-α count is made before releasing to the environment. Tritium content will also be sampled. An isotopic analysis is performed for record purposes as required by Regulatory Guide 1.21. Sampling frequency will be determined by reporting requirements of Regulatory Guide 1.21.

High sample activity indicates the need for reprocessing the batch. Corrective measures would be taken if DF is lower than the expected level. No particular process flow is associated with this sample point.

11.4.3.1.5 Concentrated Waste Collection Tank

The material in this tank is intended to be solidified and shipped to the disposal site. To determine the type of packaging and degree of shielding required to meet the shipping regulation CFR Title 49, the analysis of sample is necessary. The composition is expected to be a solution of sodium sulfate or sodium nitrate and an activity of $\sim$50 μCi/cc. The quantity to be measured is the gross β-γ activity.

The sampling frequency will be determined in the FSAR. No process flow is associated with this sampling procedure.

11.4.3.2 Effluent Sampling

The radioactive effluents are continuously monitored or sampled as indicated in Section 11.4.2.2.3 by activity and by flow. The sampling system is designed to obtain a representative effluent sample to establish concentrations of radioactivity and to facilitate radioisotopic analysis to assure compliance with recognized codes and standards for radiation protection. The samples are taken before the effluent release to the environment. The gaseous effluents are discussed in detail in Section 11.3 and liquid effluents are discussed in Section 11.2.

The Cooling Tower blowdown, wastes and drains and other normally non-radioactive liquid effluent streams will be sampled for suspended/dissolved activity including tritium. The problem associated with continuous monitoring of low level β activity in tritium is recognized and therefore, periodic batch samples from each liquid effluent stream will be taken and analyzed in the laboratory.

Building Storm drains and Plant Service Building liquid effluents are normally non-radioactive and will not be monitored, but will be periodically sampled for radioisotopic analysis as necessary.

To satisfy Regulatory Guide 1.21 requirements for gamma spectroscopy and sensitivity, a high resolution automated radioisotopic analysis system will be provided at the plant site to facilitate precise identification and analysis of complex radionuclide concentrations.

11.4.4 Reporting

An automated Report Processor will be provided which will generate the Effluent Radioactivity Release Reports in accordance with Appendix B of NRC Regulatory Guide 1.21. This computer based processor will be interfaced with the Radiation Monitoring System Controllers and the CRBRP Environmental Computer. The Report Processor will also accept manual entry of analyses performed by the Health Physicist.

TABLE 11.4-1 PROCESS & EFFLUENT MONITORING AND SAMPLING

Description	Bldg.	Elev.	Sample or Cont.	Range (μCi/cc) UOS	Expected Concent.	Quant. Meas.	Remarks
Reactor Containment Isolation Monitors (PPS):							
-Containment Ventilation (3) Exhaust (Gaseous) CAM	RCB	842	Continuous	10^{-7}-10^{-2} Cs^{137}	See Section 11.3.2.6	Gross Concent.	Safety-related Class 1E PPS Related
-Head Access Area (3) Direct Gamma	RCB	802	Continuous	10^{-1}-10^{-4} mR/hr		Direct Gamma	See Section 7.3.1.2
Radwaste Monitor:							
-IALL Evaporator, Heating Element; Heating Water Out (Liquid)	RWA	775	Continuous	$4x10^{-7}$$4x10^{-2}$ Cs^{137}		Gross Concent.	
-LALL Evaporator, Heating Element; Heating Water Out (Liquid)	RWA	775	Continuous	$4x10^{-7}$$4x10^{-2}$ Cs^{137}		Gross Concent.	
-IALL Evaporator, Distill. Cooler; Cooling Water Out (Liquid)	RWA	775	Continuous	$4x10^{-7}$$4x10^{-2}$ Cs^{137}		Gross Concent.	
-LALL Evaporator, Distill Cooler; Cooling Water Out (Liquid)	RWA	775	Continuous	$4x10^{-7}$$4x10^{-2}$ Cs^{137}		Gross Concent.	
-LALL Effluent	RWA	795	Continuous	$4x10^{-7}$$4x10^{-2}$ Cs^{137}		Gross Concent.	
RAPS & CAPS Process Monitors:							
-Gas Entering RAPS Cold Box (Gaseous)	RCB	733	Continuous	2.7-$2.7x10^{5}$ Kr^{85}		Gross Concent.	
-Coolant Leaving RAPS Cold Box (Gaseous) (2)	RSB	779	Continuous	$2.7x10^{-6}$-$2.7x10^{-1}$ Kr^{85}		Gross Concent.	In-Line Monitoring
-Gas Leaving RAPS Cold Box (Gaseous)	RCB	733	Continuous	$2.7x10^{-3}$-$2.7x10^{+2}$ Kr^{85}		Gross Concent.	
-Gas Leaving CAPS Surge Vessel (Gaseous Iodine)	RSB	779	Continuous	$2.7x10^{-4}$-$2.7x10^{+1}$ Kr^{85} 10^{-5}-10^{0} I^{131}		Gross Concent.	
-CAPS Header Serving RCB Cells (Gaseous)	RCB		Continuous	$2.7x10^{-6}$-$2.7x10^{-1}$ Kr^{85}		Gross Concent.	

TABLE 11.4-1 PROCESS & EFFLUENT MONITORING AND SAMPLING

Description	Bldg.	Elev.	Sample or Cont.	Range (μCi/cc) UOS	Expected Concent.	Quant. Meas.	Remarks
-Gas From Nitrogen Cell Atmosphere Sampling Unit (Gaseous)	RSB	755	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	
-Gas From Nitrogen Cell Atmosphere Sampling Unit (Gaseous)	RCB	752	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	
CAPS Process Gas Effluent to HVAC (Gaseous) (2) (Iodine)	RSB	779	Continuous	2.7×10^{-5}-2.7×10^{0} Kr^{85} 10^{-10}-10^{-5} I^{131}		Gross Concent.	
Effluent Gas From (2) Inerted Cells to HVAC (Gaseous)	RSB	800	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	
HVAC Duct Monitoring (CAM of RAPS/CAPS Cells:							
-RAPS Cold Box & Valve Gallery Cells (Gaseous)	RCB	733	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	In-line Monitoring & Cell Isolation
-RAPS Noble Gas Storage Vessel Cell (Gaseous)	RCB	733	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	In-line Monitoring & Cell Isolation
-RAPS Compressor and Aftercooler Cells (2) (Gaseous)	RCB	733	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-RAPS Vessels (Gaseous)	RCB	733	Continuous	2.7×10^{-6}-27×10^{-1} Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-RAPS/CAPS Pipeway (Gaseous)	RCB	780	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-CAPS Cold Box Cell (Gaseous)	RSB	792	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-CAPS Vessel Cells & Gallery (Gaseous)	RSB	755	Continuous	2.7×10^{-6}-27×10^{-1} Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation

TABLE 11.4-1 PROCESS & EFFLUENT MONITORING AND SAMPLING

Description	Bldg.	Elev.	Sample or Cont.	Range (μCi/cc) UOS	Expected Concent.	Quant. Meas.	Remarks
-CAPS Compressor & (2) After Cooler Cells (Gaseous)			Continuous	$2.7\times10^{-6}-27\times10^{-1}$ Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-RAD Water Holding Vessel & Pump Cell (Gaseous)			Continuous	$2.7\times10^{-6}-27\times10^{-1}$ Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-Access Areas (4) (Gaseous)			Continuous	$2.7\times10^{-6}-27\times10^{-1}$ Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-Cover Gas Monitoring Cells (Gaseous)			Continuous	$2.7\times10^{-6}-27\times10^{-1}$ Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-Pipe Chase & Vapor Trap Cell (Gaseous)	RSB	772	Continuous	$2.7\times10^{-6}-27\times10^{-1}$ Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-HVAC Common Header For Various Cells (Gaseous)	RCB	766	Continuous	$2.7\times10^{-6}-27\times10^{-1}$ Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
Main HVAC Duct From All RAPS/CAPS Cells (Gaseous) CAM (Iodine)	RSB	779	Continuous	$2.7\times10^{-6}-2.7\times10^{-1}$ Kr^{85} $10^{-10}-10^{-5}$ I^{131}		Gross Concent.	
Sodium Leak Detection For Following Recirc. Gas Cooling Subsystems: (All Particulate)							
Reactor Cavity	RCB	733	Continuous	$2.94\times10^{-13}-2.94\times10^{-5}$ Na^{24}		Gross Concent.	Alarm Only
PHTS Loop 1	RCB	766	Continuous	$2.94\times10^{-13}-2.94\times10^{-5}$ Na^{24}		Gross Concent.	Alarm Only
PHTS Loop 2	RCB	766	Continuous	$2.94\times10^{-13}-2.94\times10^{-5}$ Na^{24}		Gross Concent.	Alarm Only
PHTS Loop 3	RCB	766	Continuous	$2.94\times10^{-13}-2.94\times10^{-5}$ Na^{24}		Gross Concent.	Alarm Only
Na Makeup Pump & Vessels	RCB	752	Continuous	$2.94\times10^{-13}-2.94\times10^{-5}$ Na^{24}		Gross Concent.	Alarm Only
Na Makeup Pump & Pipeway	RCB	752	Continuous	$2.94\times10^{-13}-2.94\times10^{-5}$ Na^{24}		Gross Concent.	Alarm Only

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TABLE 11.4-1 PROCESS & EFFLUENT MONITORING AND SAMPLING

Description	Bldg.	Elev.	Sample or Cont.	Range (µCi/cc) UOS	Expected Concent.	Quant. Meas.	Remarks
Cold Trap, Nak Cells	RCB	794	Continuous	2.94×10^{-13}-2.94×10^{-5} Na^{24}		Gross Concent.	Alarm Only
Control Room Main (2) Air Intake (Gaseous) CAM (Iodine) (Particulate)	CB	863	Continuous	3×10^{-7}-3×10^{-2} Kr^{85} 4×10^{-12}-4×10^{-7} I^{131} 2×10^{-10}-2×10^{-5} Cs^{137}	See Section 12.2	Gross Concent.	Initiate C/R Isolation, see Sec. 7.6.4.5.6 Safety-Related (1E)
Control Room Remote (2) Air Intake (Gaseous) CAM (Iodine) (Particulate)	SGB	851	Continuous	3×10^{-7}-3×10^{-2} Kr^{85} 4×10^{-12}-4×10^{-7} I^{131} 2×10^{-10}-2×10^{-5} Cs^{137}	See Section 12.2	Gross Concent.	Initiate C/R Isolation, see Sec. 7.6.4.5.7 Safety-Related (1E)
Control Room Common Duck Downstream of Filter Units (Gaseous) CAM (Iodine) (Particulate)	CB	847	Continuous	3×10^{-7}-3×10^{-2} Kr^{85} 4×10^{-12}-4×10^{-7} I^{137} 5×10^{-10}-5×10^{-5} Cs^{137}	See Section 12.2	Gross Concent.	Monitor Only
IHTS Loop 1 (Direct Gamma)	SGB	765	Continuous	10^{-2}-10^{3} mR/hr		Gross Activity	
IHTS Loop 2 (Direct Gamma)	SGB	765	Continuous	10^{-2}-10^{3} mR/hr		Gross Activity	
IHTS Loop 3 (Direct Gamma)	SGB	765	Continuous	10^{-2}-10^{3} mR/hr		Gross Activity	
Large Component Cleaning Cell (LCCC)	RCB	756	Continuous	10^{-1}-10^{4} mR/hr		Gross Activity	
LCCC Cooling Water (Liquid)	RCB	733	Continuous	4×10^{-7}-4×10^{-2} Cs^{137}		Gross Concent.	
LCCC Process Gas Effluent (Gaseous)	RCB		Continuous	10^{-6}-10^{-1} Kr^{85}		Gross Concent.	
Fuel Handling Cell (FHC) Argon Gas (Gaseous) (Iodine) (Particulate)	RSB	779	Continuous	10^{-6}-10^{-1} Kr^{85} 10^{-10}-10^{-5} I^{131} 10^{-10}-10^{-5} Cs^{137}		Gross Concent.	
EVST Argon Cover Gas (Gaseous)	RSB	842	Continuous	10^{0}-10^{4} Kr^{85}		Gross Concent.	

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TABLE 11.4-1 PROCESS & EFFLUENT MONITORING AND SAMPLING

Description	Bldg.	Elev.	Sample or Cont.	Range (μCi/cc) UOS	Expected Concent.	Quant. Meas.	Remarks
FHC Utility Monitor (Direct Gamma)	RSB	779	Continuous	10^{-1}-10^{7} mR/hr		Gross Activity	
Radwaste Building Exhaust (Gaseous) CAM (Iodine) (Particulate)	RWB	867	Continuous	3×10^{-7}-10^{3} Kr^{85} 10^{-10}-10^{2} I^{131} 10^{-10}-10^{2} Cs^{131}		Gross Concent.	Initiate Filtering of Effluent from RWB
RSB Operating Floor (2) HVAC Exhaust (Gaseous) CAM (Iodine) (Particulate)	RSB	816	Continuous	3×10^{-7}-3×10^{-2} Kr^{85} 4×10^{-12}-4×10^{-7} I^{131} 10^{-6}-10^{-1} Cs^{137}		Gross concent.	Initiate RSB Confinement see Section 7.6.4.3.3 (4) Safety related (1E)
Fuel Handling Cell (2) HVAC Exhaust (Gaseous) (Iodine) (Particulate)	RSB	779	Continuous	3×10^{-7}-3×10^{-2} Kr^{85} 4×10^{-12}-4×10^{-7} I^{131} 10^{-6}-10^{-1} Cs^{137}		Gross Concent.	- same -
Annulus Filter (2) Discharge (Gaseous) (Iodine) (Particulate)	RSB	840 861	Continuous	4.4×10^{-6}-$4\times4\times10^{-1}$ Kr^{85} 1.1×10^{-7}-1.1×10^{-2} I^{131} 1.2×10^{-10}-1.2×10^{-5} Cs^{137}		Gross Concent.	Select Filter train Section 7.6.4.2.2 (1) Safety Related (1E)
Annulus Filter Inlet/(2) Annulus Cooling Exhaust CAM (Gaseous) (Iodine) (Particular)	RSB	840 861	Continuous	3×10^{-7}-1×10^{4} Kr^{85} 1×10^{-10}-1×10^{2} I^{131} 1×10^{-6}-1×10^{2} Cs^{137}		Gross Concent.	1) Start Filter see 7.6.4.2.2 (6) 2) Monitor Exhaust see 11.4.2.2.3 (Accident (Monitor)
RSB Clean Up Filter Discharge (Gaseous) (Iodine) (Particulate)	RSB	816 794	Continuous	3×10^{-7}-3×10^{-2} Kr^{85} 1×10^{-10}-1×10^{-5} I^{131} 1×10^{-6}-1×10^{-1} Cs^{137}		Gross Concent.	Select Filter Train See Section 7.6.4.3.3(1) Safety Related (1E)
Radwaste Ventilation Exhaust Effluent (Gaseous) (Iodine) (Particulate)	RSB	867	Continuous	1×10^{-6}-1×10^{3} Kr^{85} 1×10^{-10}-1×10^{2} I^{131} 1×10^{-10}-1×10^{2} Cs^{137}	See Section 11.3.6	Gross Concent.	Effluent, Accident Monitor

TABLE 11.4-1 PROCESS & EFFLUENT MONITORING AND SAMPLING

Description	Bldg.	Elev.	Sample or Cont.	Range (μCi/cc) UOS	Expected Concent.	Quant. Meas.	Remarks
RCB Ventilation Exhaust Effluent (Gaseous) (Iodine) (Particulate)	RSB	861	Continuous	$1\times10^{-6}-1\times10^{-1}$ Kr^{85} $1\times10^{-10}-1\times10^{-5}$ I^{131} 1×10^{-10} 1×10^{-5} Cs^{137}	See Section 11.3.2.6	Gross Concent.	
RCB Annulus/TMBDB (2) Effluent (Gaseous) (Iodine) (Particulate) (Plutonium/Alpha)	RSB	840 861	Continuous	$1\times10^{-6}-1\times10^{5}$ Kr^{85} $1\times10^{-10}-1\times10^{2}$ I^{131} $1\times10^{-10}-1\times10^{2}$ Cs^{137} $1\times10^{-12}-1\times10^{-7}$ Pu^{239}			Accident Monitor Safety Related (1E)
RSB Exhaust Effluent (Gaseous) (Iodine) (Particulate)	RSB	816	Continuous	$1\times10^{-6}-1\times10$ Kr^{85} $1\times10^{-10}-1\times10^{2}$ I^{131} $1\times10^{-10}-1\times10^{2}$ ^{137}			Accident Monitoring
SGB-IB Exhaust Effluent (Gaseous) (Iodine) (Particulate)	SGB	836	Continuous	$1\times10^{-6}-1\times10^{3}$ Kr^{85} $1\times10^{-10}-1\times10^{2}$ I^{131} $1\times10^{-10}-1\times10^{2}$ Cs^{137}	See Section 11.3.2.6		Accident Monitoring
Hot Laboratory, Counting Room, and Decontamination Area Ventilation Exhaust Particulate Sampler	PSB		Sample**			Gross Concent.	
Plant Discharge Canal Liquid Sampler	YARD	-	Sample ***		See Section 11.2.5	Concent.	

** Particulate collection on filter, analysis by proportional counters and spectroscopy system.
*** Liquid Samples collected in container. Analysis by proportional and liquid scintillation counters and spectroscopy system.

12.1.4 Area Radiation Monitoring

12.1.4.1 Design Criteria

Area monitors are provided in selected building locations to continuously detect, measure, and indicate the radiation level and to initiate alarms (audible and visual) for radiation levels above preset values. In high or varied noise level areas ($\geq$95db) strobe lights are also provided in addition to the audible alarms. These monitors advise plant personnel of existing radiation levels during normal operation and warn them of potential radiation hazards that may cause higher exposure levels than expected.

The detector ranges of these monitors are chosen to provide continuous monitoring of gamma radiation levels ranging from one decade below to three decades above the design background level at each monitor location.

The basis for location of the various personnel protection monitors shall consider the following factors:

1. The anticipated radiation level under operation, shutdown maintenance, and abnormal conditions.

2. The frequency and duration of occupancy, and the flow of traffic under normal and accident conditions.

3. The proximity of high radiation sources.

4. The consequence of an undetected increase in radiation level.

In addition to the personnel protection monitoring utilized during normal plant conditions, accident area monitoring will also be provided. Area monitoring for range 10^{-1} to 10^{4} R/hr will be provided in the following areas:

1. Inside buildings or areas which are in direct contact with primary containment where penetrations and hatches are located.

2. Inside buildings or areas where access is required to service equipment important to safety and the threat of radiation contamination exists.

Three high-range monitors of range 1 to 10^{7} R/hr will be provided to monitor the levels of gamma radiation in the Containment Area. The detectors for these monitors will be located approximately 120° apart around the Containment vessel periphery in the Annulus space so as to allow a measurement of gamma activity being radiated from containment. The location of these monitors is in the more benign environment of the Annulus rather than in containment to avoid the severe temperature transient and direct sodium aerosol which may occur during and following an acident. These monitors are safety-related and each is supplied which a separate division of Class 1E power.

The Accident Monitors as identified in Table 12.3-5, will meet the requirements of Section 7.5.11 of the PSAR

The locations of the area monitors provided for the CRBRP are shown on Figs. 12.1-1 to 12.1-19d and are listed in Table 12.3-5.

12.1.4.2 <u>Monitoring System Description</u>

Each area monitoring channel consists of a gamma detector, microprocessor and accessories, local indicators, alarms, and Control Room indication. The gamma detector energy dependence will be flat within ±20% for incident radiation above 100 Kev. Local monitor display includes loss-of-signal, high and high-high radiation indicator lights, high and high-high radiation audible alarms and mR/hr rate meter. Also, an essential feature of each monitoring channel will be its ability to avoid "foldover" following saturation in high radiation fields.

The detector signal is also displayed on redundant Radiation Monitoring System CRTs located in the Control Room and Health Physics Area of the Plant Service Building via their respective Central Processing Units and Mini-Computers(System Controllers). The indicating analog meter in each local monitor indicates exposure levels on a suitable multi-decade logarithmic scale. The alarm signals are also permanently recorded by the redundant Radiation Monitoring System Line-Printers located in the Control Room and Health Physics Area.

Group annunciation is also provided on the Main Control Board.

Each area monitor will contain a built-in solenoid actuated shielded check source which can be actuated from the remote process station in the vicinity. All monitor components will be modular, commercially available units designed for rapid replacement upon failure. Electronic components will be exclusively solid-state, as available; and power will be supplied from the instrument AC (120V, $60H_z$) busses for the non-safety monitors. Area monitors performing containment isolation functions (PPS) will be supplied with Class 1E power from redundant vital AC busses.

The high radiation alarms of all area monitors are transmitted from the local monitors to the Remote Data Aquisition Terminal units in the vicinity. The Plant Data Handling and Display system will display and log all high alarms.

Figure 12.1-21 shows a functional block diagram of an area radiation monitor. Locations, design dose rates and ranges of sensitivities of the monitors are provided in Table 12.3-5.

12.1.4.3 Maintenance and Calibration

On completion of the monitoring system installation, each area monitor will be checked for proper operation and calibrated against a radiation checksource traceable to the National Bureau of Standards or from an equally acceptable source. The initial calibration and subsequent calibrations at six month intervals will utilize a minimum of two source strengths to verify the linearity of detector output. In addition, each monitor is supplied with a built-in check source to provide a rapid functional test at periodic intervals.

12.1.5 Estimates of Exposure

Peak External Dose Rates and Annual Doses at Unrestricted Locations

The peak dose rates and annual doses at the site boundary and control room due to direct plant radiation are low and considered small relative to the natural background radiation. These doses have been estimated and are shown in Table 12.1-49, Parts I, II, and III.

TABLE 12.1-48 HAS BEEN INTENTIONALLY DELETED

3. Low-volume (integrating) air sampling is performed in infrequently occupied operating areas within the Nuclear Island. Infrequently occupied areas include radiation zone II and III cells where routine tasks are performed on a limited access basis.

4. High-volume grab sampling is performed (with accompanying Counting Room analysis) prior to personnel entry into Zone IV radiation zones; and whenever a gross determination of short-lived airborne radioactivity in lower radiation zoned areas is desired.

Fixed CAM's are provided as effluent and process monitors (described in Section 11.4) at locations which could conceiveably be subject to increases in radioactivity levels during various plant evolutions. The process monitors are used to monitor the ventilation exhaust from a particular cell or group of cells. Upon detection of radioactivity above desired levels the radiation monitor will produce an alarm at the process system local panel (in addition to the Control Room) and some monitors will initiate a signal to automatically isolate the affected area. The effluent monitors perform surveillance functions and provide (in the Control Room) indication of an abnormal occurrence warranting investigation by Health Physics personnel. Since the effluent monitors don't perform initiation of isolation the ranges have been selected to provide monitoring during normal and accident conditions. These monitors are included in Table 11.4-1. Fixed CAMs, except those downstream of HEPA filters will withdraw the samples isokinectically in accordance with ANSI N13.1. In addition, the monitors will be located as close as practical to the sample point, and sample line bends are minimized to avoid plate out.

Fixed CAM's are also provided to ensure adequate protection against contamination of the Control Room atmosphere due to airborne radioactivity following an accident condition. This monitoring arrangement is described in Section 11.4. Fixed radiogas monitors (PPS) are also used to initiate Reactor Containment Isolation as discussed in Section 7.3.1.

Mobile CAM's will be provided in select locations throughout the CRBRP to perform the following functions:

1. Continuously monitor the atmosphere at any specific location where maintenance is performed.

2. Continuously monitor the atmosphere at any specific location where a process system failure is suspected of causing airborne radioactivity leakage.

3. Continuously monitor individual inerted cell purging activities as required by the Heating, Ventilating and Air Conditioning System.

4. Continuously monitor the RCB atmosphere following containment isolation, after connection to the post-accident containment sampling penetrations discussed in Section 11.4.2.2.1.

5. Provide backup support to inoperative stationary airborne radioactive monitors.

The mobile CAM's will provide local audible and visual alarm indication of airborne radioactivity levels which exceed the monitor setpoint(s). Locations and design parameters of the various mobile airborne activity monitors are given in Table 12.2-3.

High and low volume portable air samplers will be employed to obtain representative samples of breathing air at infrequently occupied operating areas of the CRBRP. Samples obtained will be analyzed in the Counting Room for gross activity and radioisotopic identification, as required. The portable air samplers will be supplied as health physics equipment, and their frequency of use will be governed by the operational procedures of the CRBRP Health Physics Program.

12.2.4.2 Monitoring System Description

12.2.4.2.1 Continuous Air Monitors

Continuous air monitors (CAM) are used to provide detection of radiogas, particulate, radioiodine and alpha (Pu) activity as indicated in Table 12.2-3. A combination of single and multichannel instruments are used to perform the required monitoring functions. The following is a description of each type of monitor provided:

Gaseous Radioactivity Monitors

Each radiogas CAM continuously draws gas/air samples through a particulate filter into a shielded 4-Pi sample chamber where the gas is viewed by a beta detector, and then returns the gas/air back to the original source. A regulated vacuum pump is used to maintain desired flow rate through the monitor. Samples withdrawn from process or effluent flow will be obtained isokinetically from the source stream. Each monitor consists of a radiogas detector, vacuum pump, microprocessor and accessories, local indicator and alarms. The detector will have a minimum sensitivity of 3×10^{-7} μCi/cc for Kr-85, at the 95% confidence level. Each monitor cabinet will include local loss-of-signal, high and high-high radiation indicator lights, gas/air sample flowmeter and count-rate meter. Taps will be provided to allow samples to be withdrawn for analysis in the Counting Room. For stationary monitors, the detection signal is continuously provided for display on redundant Radiation Monitoring System CRTs located in the Control Room and the Health Physics Area of the Plant Service Building, via their respective Central Processing Units and Mini-Computers (System Controllers). All control signals from monitors which are transmitted to interfacing systems will originate from Remote Process Stations which are part of the local monitor cabinet. The alarm signals are permanently recorded by the redundant Radiation Monitoring System Line Printers located in the Control Room and Health Physics Area.

Iodine and Gaseous Radioactivity Monitors

Radioiodine and radiogas CAM's provide two distinct detection channels within a single monitor housing. A regulated vacuum pump continuously draws a gas/air sample at a measured flow rate into the monitor assembly.

The sampled gas/air flows through a fixed iodine filter, where a gamma detector observes radioiodine activity through a discriminator window. The minimum radioiodine sinsitivity is 10^{-10} μCi/cc for I-131 at the 95% confidence level.

From the iodine filter the air sample passes into a 4-Pi shielded chamber where a beta detector observes gaseous activity with a minimum sensitivity of 10^{-6} μCi/cc for Kr-85 at the 95% confidence level. The gas/air sample is then exhausted to the original source.

Each monitor contains the detectors, vacuum pump, microprocessor and accessories, and indicators. Display provisions at each monitor cabinet include (common for each detection channel) loss-of-signal, high and high-high radiation indicator lights, and (separate for each detection channel) count-rate meters. A sample flow rate gauge is also provided.

The detection signal is continuously provided for display on redundant Radiation Monitoring system CRTs located in the Control Room and the Health Physics Area of the Plant Service Building, via their respective Central Processing Units and Mini-Computers (system Controllers). All Control signals from monitors which are transmitted to interfacing systems will originate from Remote Process Stations which are part of the local monitor cabinet. The alarm signals are permanently recorded by the redundant Radiation Monitoring System Line Printers located in the Control Room and Health Physics Area.

Particulate, Iodine and Gaseous Radioactivity Monitors

Particulate, radioiodine and radiogas CAM's provide three distinct detection channels within a single monitor housing. A regulated vacuum pump continuously draws a gas/air sample at a measured flow rate into the monitor assembly. If process or effluent flow is being monitored, the sample is obtained isokinetically from the source stream. Particulates are collected on a filter paper having an efficiency of 99.0% for 0.3 microns particle sizes and viewed by a beta detector of minimum sensitivity of 10^{-10} μCi/cc for Cs-137 at the 95% confidence level, during an integrating time determined by sample flow rate. From the particulate filter, the sampled gas/air flows through a fixed iodine filter, where a gamma detector observes radioiodine activity through a discriminator window. The minimum radioiodine sensitivity is 4×10^{-12} μCi/cc for I-131 at the 95% confidence level.

From the iodine filter the air sample passes into a 4-Pi shielded chamber where a beta detector observes gaseous activity with a minimum sensitivity of 3×10^{-7} μCi/cc for Kr-85 at the 95% confidence level. The gas/air sample is then exhausted to the original source.

Each monitor contains the detectors, vacuum pump, microprocessor and accessories, and indicators. Display provisions at each monitor cabinet include (common for each detection channel) loss-of-signal, high and high-high radiation indicator lights, and (separate for each detection channel) count-rate indicators. Mobile monitors are provided with a multipoint strip-chart recorder and audible and visual alarms for high and high-high radiation conditions.

For stationary monitors, the detection signal is continuously provided for display on redundant Radiation Monitoring System CRTs located in the Control Room and the Health Physics Area of the Plant Service Building, via their respective Central Processing Units and Mini-Computers (System Controllers). All control signals from monitors which are transmitted to interfacing systems will originate from Remote Process Stations which are part of the local monitor cabinet. The indicating analog meter in the Remote Process Station will indicate counts per minute on a five decade logarithmic scale. The alarm signals are permanently recorded by the redundant Radiation Monitoring System Line Printers located in the Control Room and Health Physics Area.

Gaseous In-Line Monitors

Gaseous in-line monitors provided to monitor radioactivity in some process systems including HVAC. The Monitor consists of a shielded section of pipe which is mounted by end flanges in the process line. A penetration through the pipe wall allows a beta scintillation detector to be placed in the process system flow. The detector will have a minimum sensitivity of 10^{-6} μCi/cc for Kr-85, at the 95% confidence level. Each monitor will have a local microprocessor with local indicator and alarms.

The detection signal is continuously provided for display on redundant Radiation Monitoring System CRTs located in the Control Room and the Health Physics Area of the Plant Service Building, via their respective Central Processing Units and Mini-Computers (System Controllers). All control signals from monitors which are transmitted to interfacing systems will originate from Remote Process Stations which are part of the local monitor cabinet. The alarm signals are permanently recorded by the redundant Radiation Monitoring System Line Printers located in the Control Room and Health Physics Area.

Alpha Radioactivity Monitors

Each alpha CAM (mobile units) provided will have the capability to differentiate plutonium alpha readings from the natural radon thoron alpha background through delayed detection techniques. Each alpha CAM continuously draws air samples into a shielded chamber where particulates greater than 0.3 microns are deposited on a filter with an efficiency of 99.0% and viewed by α detector(s). A regulated vacuum pump will be used to maintain desired flow rate through the monitor arrangement, and return the air sample back to the original source. Each monitor contains the alpha detector(s), vacuum pump, microprocessor and accessories and indicators. The detector(s) will have a minimum sensitivity of 10^{-12} μCi/cc for Pu-239 at the 95% confidence level for a collection time of 8 hours. Display provisions at each monitor cabinet include loss-of-signal, loss-of-sample flow, high and high-high radiation indicator lights, sample flow-meter, count-rate meter, strip-chart recorder and audible alarms for high and high-high radiation conditions. These monitors shall have the capability to transmit data to the radiation monitoring consoles in the control room and health physics area when linked to the communication loop at the option of plant operators.

Figures 12.2-1 and 12.2-2 show typical block diagrams of the containment exhaust (PPS) and typical fixed (non-PPS) continuous air radiation monitoring channels. The PPS radiogas monitors used for Containment Isolation differ from the radiogas CAM described previously in the following manner:

1. Each Class 1E Monitor is individually wired to a dedicated Display and Control Unit (DCU) in the Control Room.

2. An analog output is provided by each monitor to the Plant Protection System (Containment Isolation System) Comparators, Logic and Safety Circuits.

3. The buffered output of each monitor is available for display on the Radiation Monitoring System CRTs and logging on Line Printers.

All CAM components will be modular, commercially available units designed for rapid replacement upon failure. Electric components will be exclusively solid-state, as available, and power will be supplied from the instrument AC busses (120V, 60Hz), with the exception of Class 1E monitors. These latter CAM's will receive Class 1E power (120 Vac, 60Hz) from redundant vital instrument AC busses. Certain design parameters, as well as locations of the various airborne activity monitors are given in Table 12.2-3.

12.2.4.2.2 Portable Air Samplers

Portable air samplers will be used to obtain representative samples of both long and short-lived airborne radioactive contaminants in operating areas of the plant. Their use and placement will be under the direction of the CRBRP site Health Physicist.

Low Volume Samplers

Each sampling station consists of a regulated air pump and filter arrangement to deposit particulates greater than 0.3 microns in size, and/or radioiodine, as required. The sample flow rate is set locally and recorded to enable an accurate determination of activity. The filters will be collected after a suitable integrating time interval, and brought to the Counting Room for analysis. The only local output from the sampler unit is the pump flow signal. The complete pump and filter(s) arrangement are standard, commercially available units designed for ease of maintenance and interchangeability of components.

High Volume Samplers

High volume samplers will employ high speed air blowers to enable grab samples to be obtained in the 20-35 cfm range. Particulate and/or charcoal filters will be used for sample collection, and analysis in the Counting Room will be performed. This type of sampler will be used to determine the airborne radioactivity contribution due to shorter lived isotopes.

12.2.4.3 Maintenance and Calibration

On completion of the monitoring system installation, each CAM will be checked for proper operation and calibrated against a radiation check source(s) traceable back to the National Bureau of Standards or from an equally acceptable source. This initial calibration, and subsequent calibration at six month intervals will verify the electronic operation of both local and Control Room ratemeters and also all annunciation points (loss-of-signal, high radiation, etc.). In addition, each monitor is supplied with a built-in check source to provide rapid functional tests at periodic intervals.

12.2.5 Inhalation Doses

Inhalation doses to plant personnel will be limited and controlled consistent with 10CFR20 requirements via the heating and ventilation system design. Resulting doses will be kept as low as practicable during operation and maintenance and exposures will be compatible with existing regulations (10CFR20).

The expected annual inhalation doses to plant personnel in normally accessible cells can be determined from the leakage rates given in Table 12.2-1 and the design flow rates for ventilation air in the Heat Access Area and Intermediate Sodium Piping cells.

The concentration in these cells, for the expected leakage rates, is estimated by assuming that there is a uniform concentration in the cell atmosphere and the ventilation air stream. Thus, an equilibrium concentration will exist when the curie content discharged per day is equal to the leakage into the cell. The expected concentrations in the accessible cells are given in Table 12.2-4. The doses from the expected concentration can be estimated by assuming the ratio of the concentration to MPC occupational limits for each isotope present and multiplying this by 5 rem, the annual dose which would result from exposure to the MPC for 40 hours per week for 50 weeks of the year.

As shown in Table 12.2-4, the combined expected activity level for the isotopes present is about 0.01 MPC (occupational) in the Head Access Area. Thus, the corresponding annual dose would be about 5mrem/year.

The release to the Intermediate Sodium Piping cells is tritium and the resulting equilibrium concentration is 0.0008 MPC. The resulting expected yearly dose would be about 4mrem/year.

Both of the above annual dose estimates are conservative since each assumes occupancy in the cells by an individual of 40 hours per week for 50 weeks of the year. The expected occupancy is considerably less.

The control room will be designed to assure continued occupancy during postulated accident conditions. The expected radioactivity in the control room during normal plant operations is background level. Additional discussion is provided in Section 12.1.5.

TABLE 12.2-3

LOCATION OF CONTINUOUS AIR MONITORS

LOCATION BLDG.	ELEV.	CELL NO.	TYPE OF MONITOR	MONITOR AREA DESCRIPTION	BASIS FOR LOCATION/FUNCTION	REMARKS
RCB	B16	161A	Particulate/Radio-iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of work areas within containment	See Figure 12.2-2, See Sections 12.2.4.1 & 12.2.4.2.1. This locations is the normal storage position of the mobile monitor.
RCB	B16	161A	Particulate/Radio-iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of work areas and inerted cells in the containment	See Figure 12.1-2, See Sections 12.2.4.1 & 12.2.4.2.1. This location is the normal storage position of the mobile monitor.
RCB	B16	161A	Alpha	Operating Floor	Mobile monitor to provide monitoring of work areas within containment	See Figure 12.1-2, See Sections 12.2.4.1 & 12.2.4.2.1. This location is the normal storage position of the mobile monitor.
RCB	766	105M	Particulate/Radio-iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of work areas and inerted cells in the containment	See Figure 12.2-5, See Sections 12.2.4.1 & 12.2.4.2.1.. This location is the normal storage position of the mobile monitoring.

TABLE 12.2-3 (Cont'd)

LOCATION BLDG.	ELEV.	CELL NO.	TYPE OF MONITOR	MONITOR AREA DESCRIPTION	BASIS FOR LOCATION/FUNCTION	REMARKS
RSB	779	307B	Particulate/Radio-iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of local work areas and post-accident monitoring of containment atmosphere	See Figure 13.1-11, See Sections 12.2.4.1, 12.2.4.2.1 & 11.4.2.2.1. This location is the normal storage position of the mobile monitor.
RSB	816	308A	Alpha	Operating Floor	Mobile monitor to provide monitoring of local work areas and post-accident monitoring of containment atmosphere	See Figure 12.1-9, See Sections 12.2.4.1, 12.2.4.2.1, & 11.4.2.2.1. This location is the normal storage position of the mobile monitor.
RSB	816	308B	Particulate/Radio-iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of local work areas	See Figure 12.1-9, See Sections 12.2.4.1 & 12.2.4.2.1. This location is the normal storage position of the mobile monitor.
SGB-IB	816	262	Particulate/Radio-iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of SGB-IB local work areas and post-	See Figure 12.1-19a, See accident monitoring of containment Sections 12.2.4.1, atmosphere12.2.4.2.1 & 11.4.2.2.1. This location is the normal storage position of the mobile monitor.

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TABLE 12.2-3 (Cont'd)

LOCATION BLDG.	ELEV.	CELL NO.	TYPE OF MONITOR	MONITOR AREA DESCRIPTION	BASIS FOR LOCATION/FUNCTION	REMARKS
CB	816	431	Particulate/Radio-iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of control room and local work areas	See Section 12.2.4.1 & 12.2.4.2.1. This location is the normal storage position of the mobile monitor.

TABLE 12.3-5

PERSONNEL PROTECTION MONITOR - AREA MONITORS

LOCATION BLDG.	ELEV.	CELL	AREA AND/OR PROCESS MONITORED	MONITOR TYPE	METER RANGE mR/hr	OPERATIONAL BACKGROUND (mR/hr)	MONITOR OUTPUT**	BASIS FOR LOCATION*
RCB	824'	162	I&C Cubicle	Direct Gamma	$0.01-10^3$	0.2	A	1.
RCB	824'	163	I&C Cubicle	Direct Gamma	$0.01-10^7$	0.2	A	1,5
RCB	824'	164	I&C Cubicle	Direct Gamma	$0.01-10^7$	0.2	A	1.,4,3
RCB	780'	105U	Primary PTI Operating Area	Direct Gamma	$0.1-10^4$	2.0	A	1.,2
RCB	766'	105S	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2.,5
RCB	780'	161G	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2.
RCB	794'	152	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2.
RCB	752'	105H	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2.
RCB	766'	105Q	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2
RCB	733'	105A	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2,5
RSB	842'6"	311	Refuel. Comm. Center	Direct Gamma	$0.01-10^3$	0.2	B	1.,3
RCB	802'	151	Head Access Area	Direct Gamma	$0.1-10^7$	25.0	A	1.,2.,4.
RSB	816'	308A	Operating Floor	Direct Gamma	$0.01-10^3$	0.2	B	1.,2.,3,6
RSB	816'	308A	Operating Floor	Direct Gamma	$0.01-10^3$	0.2	B	1.,3,6
RWB	816'	643	Decontamination Bay	Direct Gamma	$0.1-10^4$	2.0	B	1.,2
RCB	794'	105V	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2,5
RSB	779'	307A	Ex-Vessel SSP Operating Area	Direct Gamma	$0.1-10^4$	2.0	A	1.
RCB	752'	105K	Operating Area	Direct Gamma	$0.1-10^4$	2.0	A	1.
RSB	755'	306A	Ex-Vessel PTI Operating Area	Direct Gamma	$0.1-10^4$	2.0	A	1.
SGB	836'	271	SGB(IB) Remote Shutdown Panels Area	Direct Gamma	$0.01-10^7$	Unrestricted (See NOTE 2)	A	1.

TABLE 12.3-5 (Cont'd)

LOCATION			AREA AND/OR PROCESS	MONITOR	METER RANGE	OPERATIONAL BACKGROUND	MONITOR	BASIS FOR
BLDG.	ELEV.	CELL	MONITORED	TYPE	mR/hr	(mR/hr)	OUTPUT**	LOCATION*
RCB	733'	105F	Make-up Pump Valve Operating Gallery	Direct Gamma	$0.1\text{-}10^4$	2.0	A	1,5
RCB	733'	105D	Operating Area	Direct Gamma	$0.1\text{-}10^4$	2.0	A	1.
RCB	766'	105M	Primary SSP Operating Area	Direct Gamma	$0.1\text{-}10^4$	2.0	A	1.,2.
RWB	795'	605C	IALL Distillate Storage Tank Area	Direct Gamma	$0.1\text{-}10^4$	2.0	A	1
RWB	795'	620	Filter Handling Room	Direct Gamma	$0.1\text{-}10^4$	2.0	A	1
RSB	733'	305B	Operating Areas	Direct Gamma	$0.1\text{-}10^4$	2.0	A	1
RSB	779'	307A	Operating Floor	Direct Gamma	$0.1\text{-}10^4$	2.0	B	1.,2
RSB	781'	341	Fuel Handling Cell	Direct Gamma	$0.01\text{-}10^8$	2.0×10^8	B	3.
RSB	779'	339A	FHC Operating Gallery	Direct Gamma	$0.01\text{-}10^3$	0.2	B	1.,2.
RSB	749'	336	Spent Fuel Cask Corridor and Shaft	Direct Gamma	$0.01\text{-}10^8$	5.0×10^4	B	3.
RSB	755'	306AA	Operating Areas	Direct Gamma	$0.1\text{-}10^4$	2.0	A	1.,2.
RSB	733'	335	SFSC Service Station Equipment	Direct Gamma	$0.1\text{-}10^4$	10.0	B	1.,2.,3
SGB	816'	262	Operating Areas	Direct Gamma	$0.1\text{-}10^7$	Unrestricted (See NOTE 2)	A	1.,4
SGB	794'	253	Emerg. Airlock/Analysis Operating Area	Direct Gamma	$0.1\text{-}10^4$	Unrestricted (See NOTE 2)	A	1.,4,6
CB	816'	431	Control Room	Direct Gamma	$0.1\text{-}10^7$	Unrestricted (See NOTE 2)	A	1.
PSB	816'	146	Combined Lab	Direct Gamma	$0.01\text{-}10^3$	Unrestricted (See NOTE 2)	A	1.
RWB	775'	605A	IALL Distillate Storage Tank Area	Direct Gamma	$0.01\text{-}10^7$	2.0	A	1.

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TABLE 12.3-5 (Cont'd)

LOCATION BLDG.	ELEV.	CELL	AREA AND/OR PROCESS MONITORED	MONITOR TYPE	METER RANGE mR/hr	OPERATIONAL BACKGROUND (mR/hr)	MONITOR OUTPUT**	BASIS FOR LOCATION*
RCB	816'	161A	Equipment/Personnel Airlock Area	Direct Gamma	$0.01-10^3$	0.2	A	1.
RCB	816'	169A	RCB Annulus	Direct Gamma	10^0-10^7	0.2	A	4
RCB	816'	169A	RCB Annulus	Direct Gamma	$10^{[illegible]}-10^7$	0.2	A	4
RCB	816'	169A	RCB Annulus	Direct Gamma	10^0-10^7	0.2	A	4
RCB	794'	161E	Primary Pump Drive	Direct Gamma	$10^{-1}-10^4$	2.0	A	5
RCB	794'	161D	Primary Pump Drive	Direct Gamma	$10^{-1}-10^4$	2.0	A	5
RCB	794'	161C	Primary Pump Drive	Direct Gamma	$10^{-1}-10^4$	2.0	A	5
RCB	766'	105Y	Valve Operating Gallery	Direct Gamma	$10^{-1}-10^4$	2.0	A	5
RCB	733'	111	Stairwell	Direct Gamma	$10^{-1}-10^4$	2.0	A	5
RCB	733'	105E	Access Area	Direct Gamma	$10^{-1}-10^4$	10.0	A	5
RCB	825'	106	Polar Crane Operating	Direct Gamma	$10^{-1}-10^4$	0.2	A	5
RCB	842'	165	EI&C Cubicle	Direct Gamma	$10^{-1}-10^4$	0.2	A	5
RCB	842'	167	EI&C Cubicle	Direct Gamma	$10^{-1}-10^{[illegible]}$	0.2	A	5
SGB	794'	247	Power Distrib. Panel Area	Direct Gamma	$10^{-1}-10^4$	Unrestricted	A	5,6
SGB	794'	271	Operating Area	Direct Gamma	$10^{-1}-10^4$	Unrestricted	A	5,6
SGB	794'	271	Operating Area	Direct Gamma	$10^{-1}-10^4$	Unrestricted	A	5,6
SGB	794'	262	Operating Area	Direct Gamma	$10^{-1}-10^4$	[illegible]restricted	A	5,6
SGB	794'	262	Operating Area	Direct Gamma	$10^{-1}-10^4$	Unrestricted	A	5,6
SGB	794'	211A	Valve Gallery	Direct Gamma	$10^{-1}-10^4$	$5x10^2$	A	6
SGB	794'	248	IHTS Pipe Chase	Direct Gamma	$10^{-1}-10^4$	$1x10^4$	A	6
SGB	794'	251	IHTS Pipe Chase	Direct Gamma	$10^{-1}-10^4$	$1x10^4$	A	6
SGB	794'	252	IHTS Pipe Chase	Direct Gamma	$10^{-1}-10^4$	$1x10^4$	A	6

TABLE 12.3-5 (Cont'd)

LOCATION BLDG.	ELEV.	CELL	AREA AND/OR PROCESS MONITORED	MONITOR TYPE	METER RANGE mR/hr	OPERATIONAL BACKGROUND (mR/hr)	MONITOR OUTPUT**	BASIS FOR LOCATION*
RSB	785'	348	Cont. Cleanup Scrubber	Direct Gamma	10^{-1}-10^{4}	0.2	A	6
RSB	785'	349	Cont. Cleanup & HVAC Duct	Direct Gamma	10^{-1}-10^{4}	0.2	A	6
RSB	840'	332	NDHX 3rd Loop Cell	Direct Gamma	10^{-1}-10^{4}	0.2	A	5
RSB	864'	395A	Annulus Filter	Direct Gamma	10^{-1}-10^{4}	0.2	A	6
RSB	733'	350	NAP Storage Vessel Cell	Direct Gamma	10^{-1}-10^{4}	2.0	A	6
RSB	733'	305M	Access Area	Direct Gamma	10^{-1}-10^{4}	2.0	A	6
RSB	733'	305C	RSB/SGB Passageway	Direct Gamma	10^{-1}-10^{4}	2.0	A	6
RSB	743'	311	SDD 82, 85 & 94 Area	Direct Gamma	10^{-1}-10^{4}	$1x10^{2}$	A	6
RSB	797'	314	SDD 23 Instru. Area	Direct Gamma	10^{-1}-10^{4}	0.2	A	5
RSB	755'	359	Cont. Cleanup Filter Cell	Direct Gamma	10^{-1}-10^{4}	0.2	A	6
RSB	779'	376	RAPS Pipe Gallery	Direct Gamma	10^{-1}-10^{4}	$5x10^{3}$	A	6
RSB	775'	3511	EVS Cooling Pipeway	Direct Gamma	10^{-1}-10^{4}	$2x10^{3}$	A	6

LEGEND

RCB - Reactor Containment Bldg.
RSB - Reactor Service Bldg.
SGB - Steam Generator Bldg.
CB - Control Bldg.
PSB - Plant Service Bldg.
RWB - Radwaste Area (Bay)

*BASIS FOR LOCATION

1. Provide personnel protection in trafficked area.
2. Monitor adjacent high radio-activity area.
3. Monitor refueling operations.
4. High level reactor containment radiation monitor (Accident Monitor).
5. Monitor areas conntaining safety-related equipment (Accident Monitor).
6. Monitor areas with hatches or penetrations from containment (Accident Monitor).

**MONITOR OUTPUT

A. Local and Control Room: Loss of signal indicator light, high level radiation alarm, high-high level radiation alarm, exposure meter (mR/hr).
B. Local, Control Room and Refueling Communication Center: (same as above).

NOTES:
Unrestricted: Defined by 10 CFR 20, Paragraph 20.105.
Background specified in table is maximum design background value during operation, based on Na-24 gamma field.

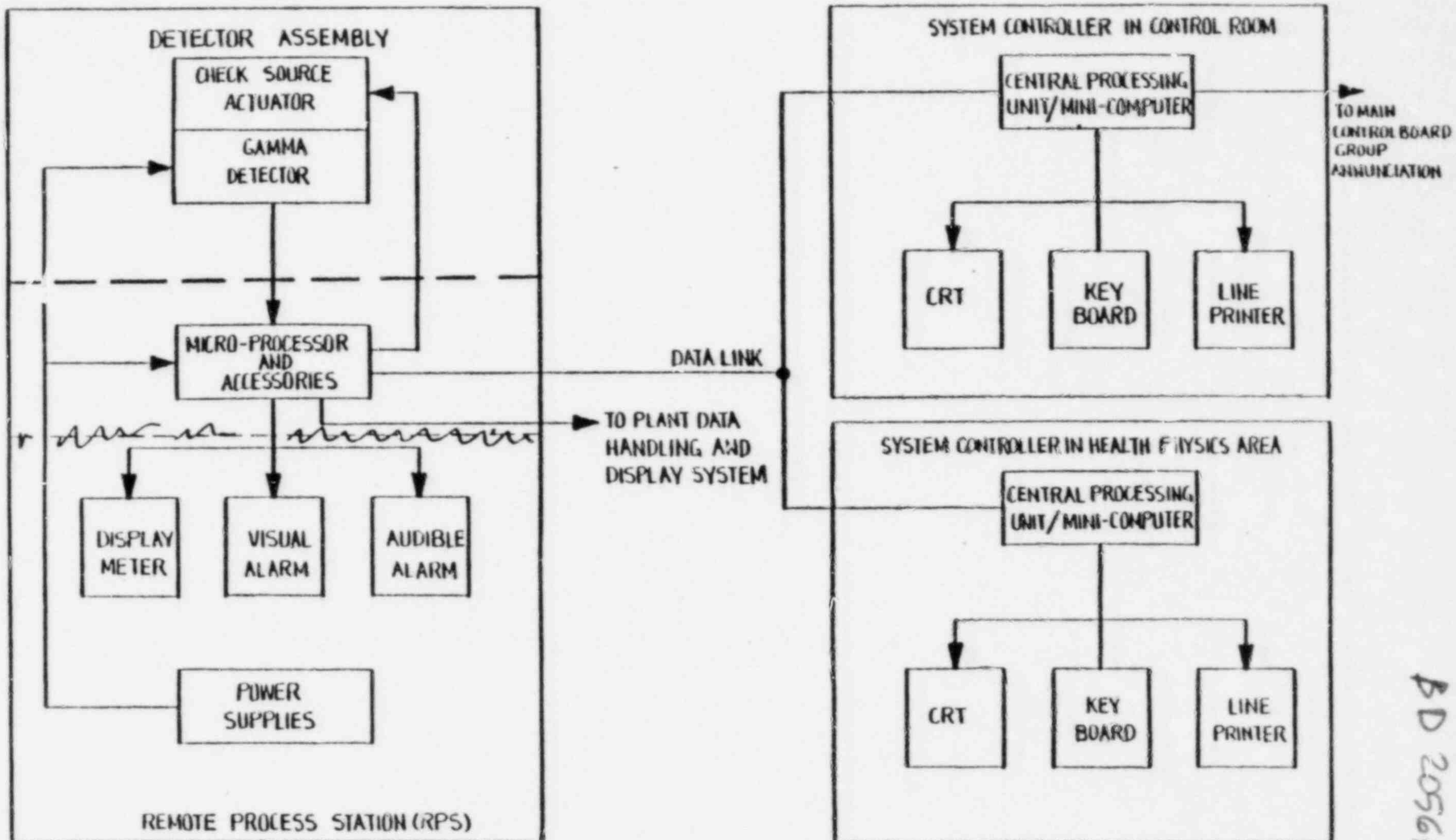

FIGURE 12.1-21 FUNCTIONAL BLOCK DIAGRAM OF AN AREA RADIATION MONITOR

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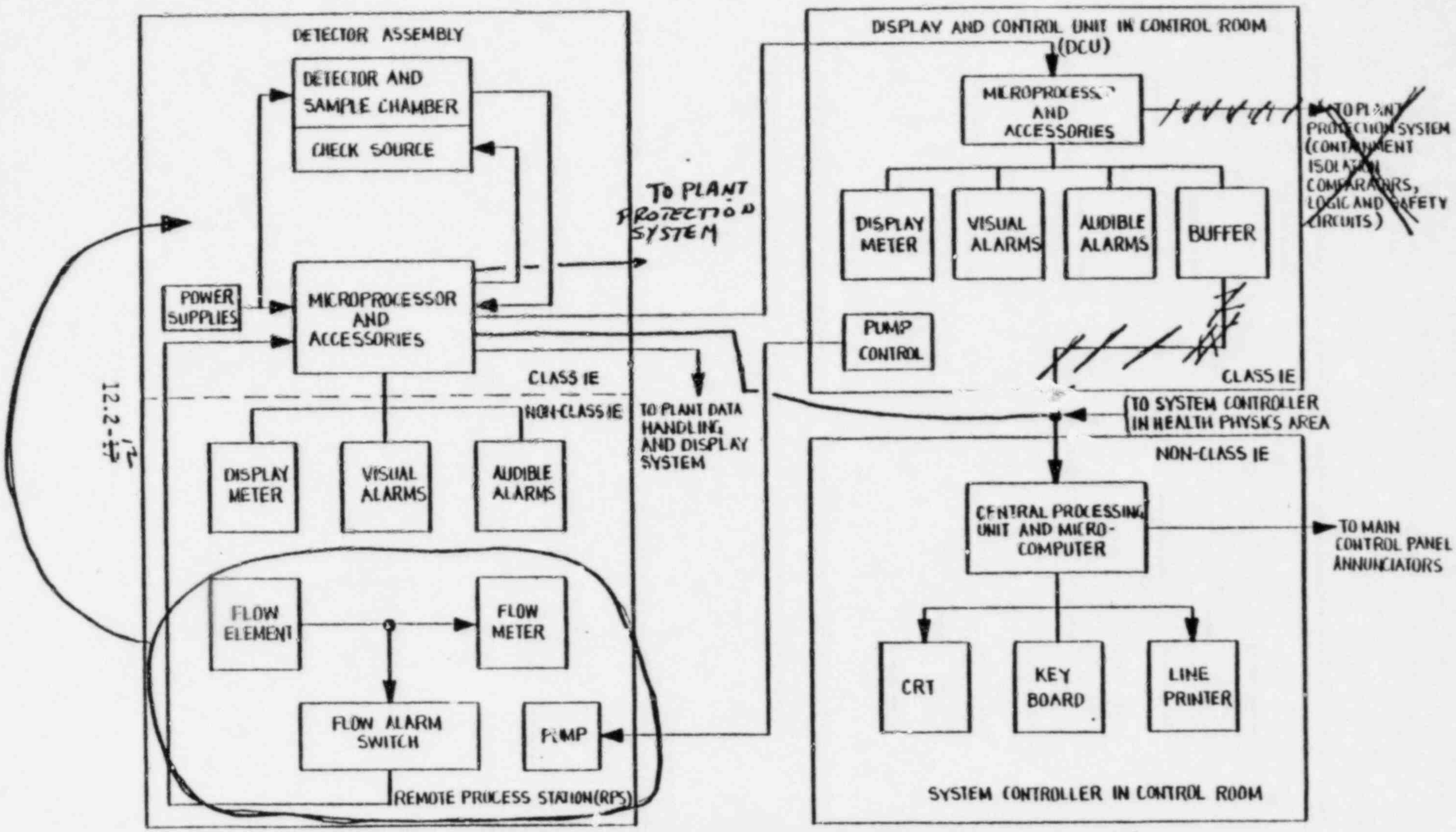

FIGURE 12.2-1 PPS CONTAINMENT EXHAUST RADIATION MONITORING CHANNEL (CLASS IE)

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~~May 1980~~ MARCH 1982

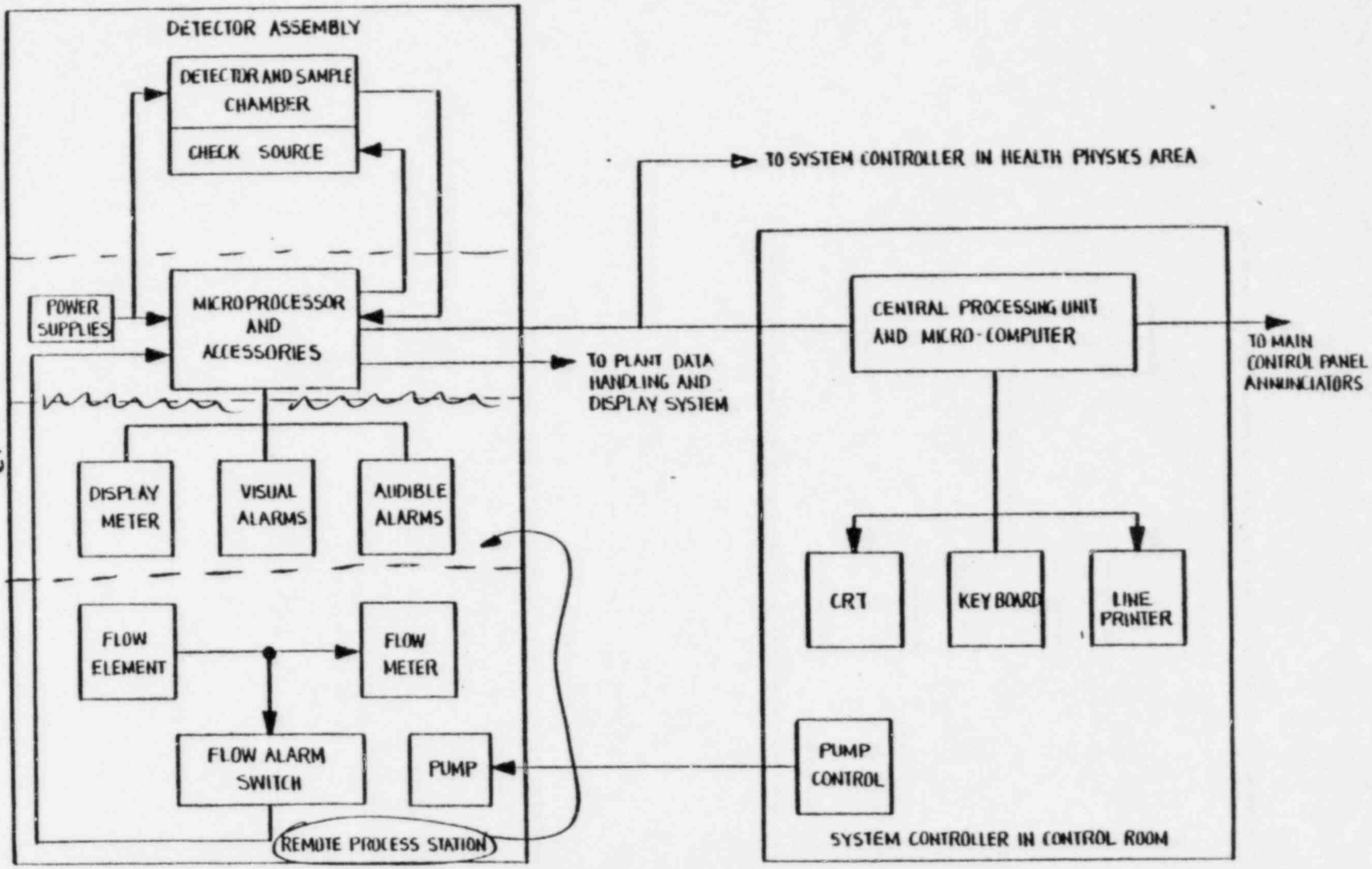

FIGURE 12.2-2 NON PPS AIR RADIATION MONITORING CHANNEL

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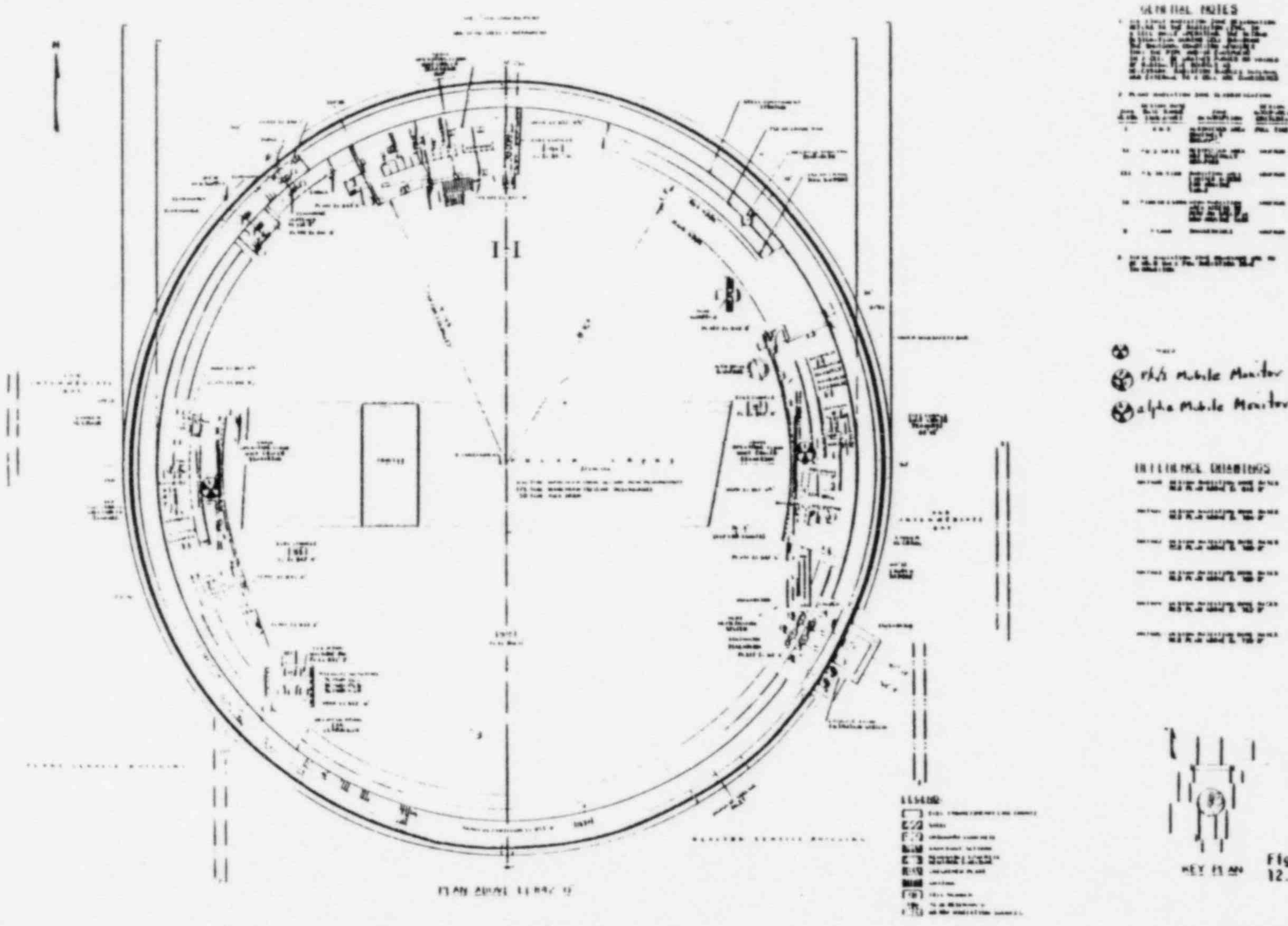

Figure 12.1-1 Plant Radiation Protection 12.1-81

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NN7399-0

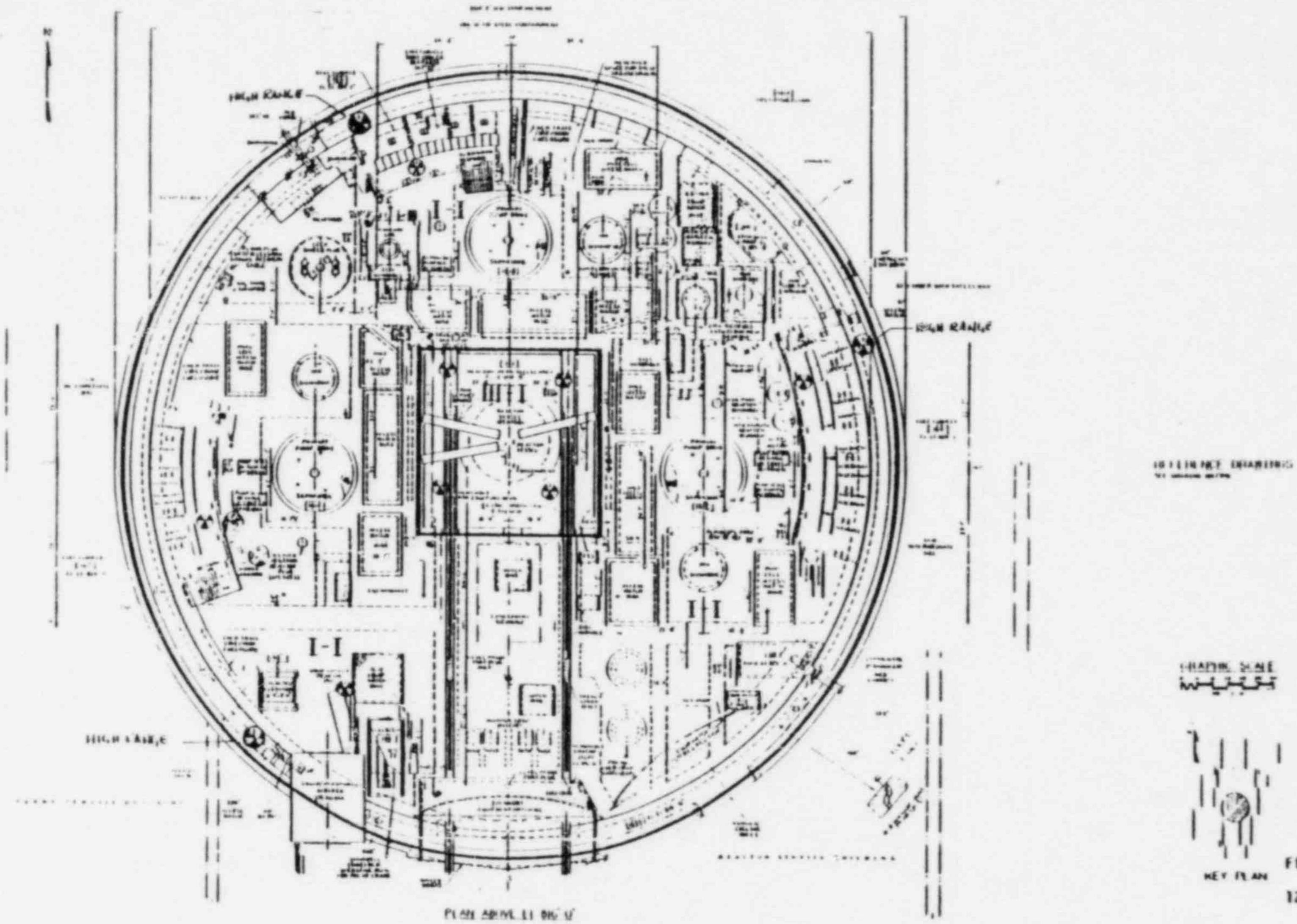

Figure 12.1-2 Plant Radiation Protection

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April 197

NN7400-1

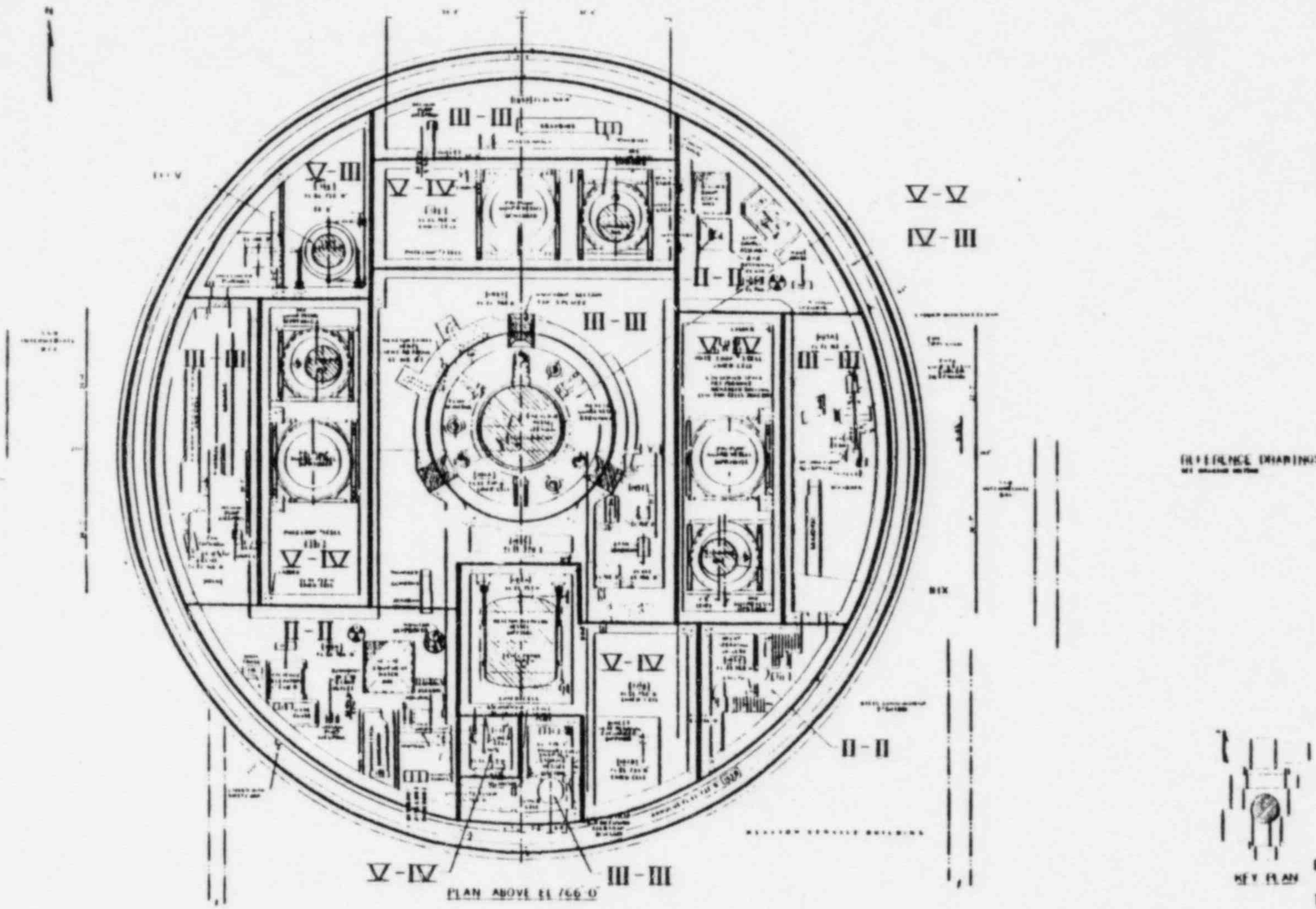

Figure 12.1-5 Plant Radiation Protection

12.1-85

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NN7403-2

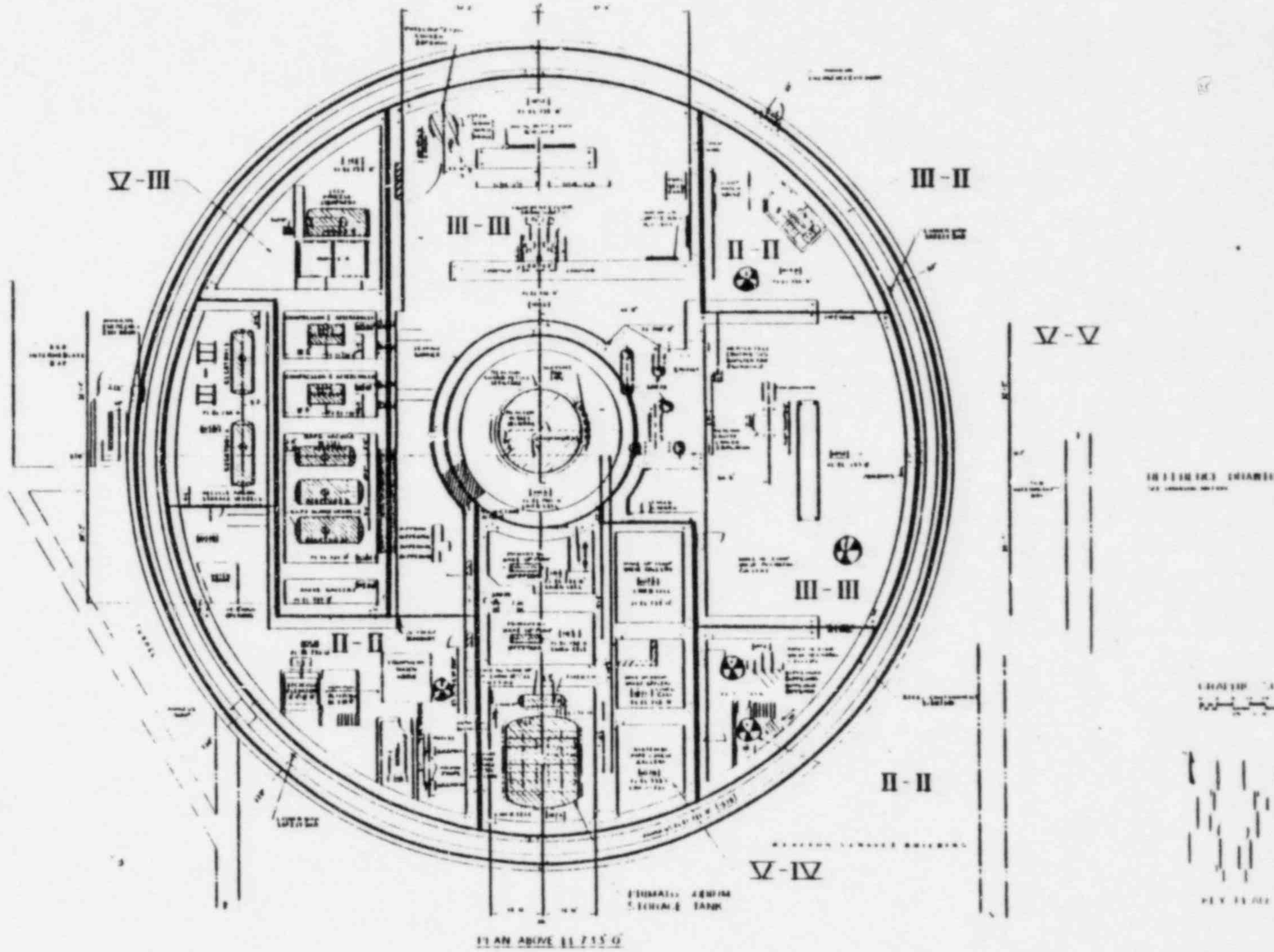

Figure 12.1-7 Plant Radiation Protection

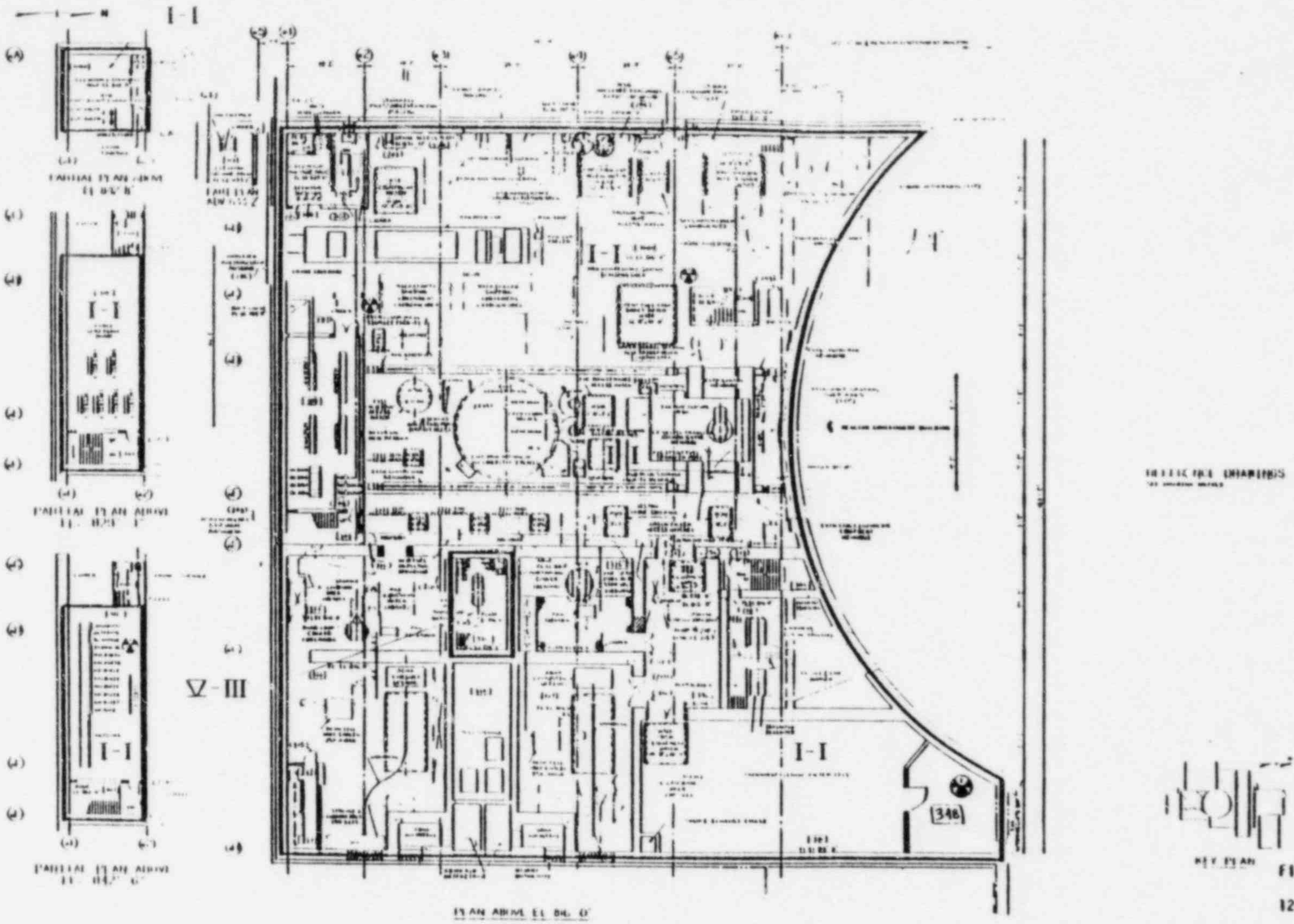

Figure 12.1-9 Plant Radiation Protection

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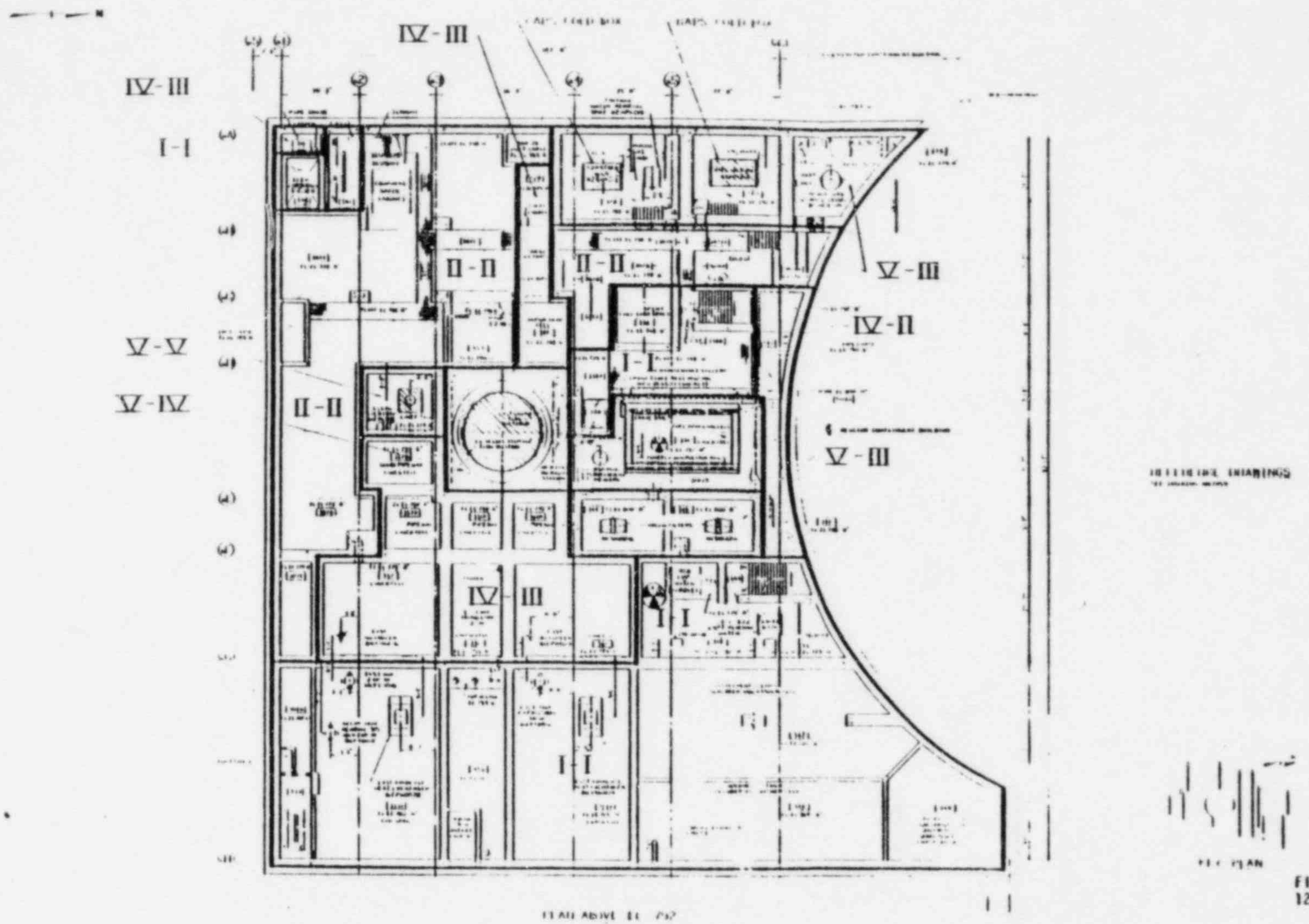

Figure 12.1-10 Plant Radiation Protection
12.1-90

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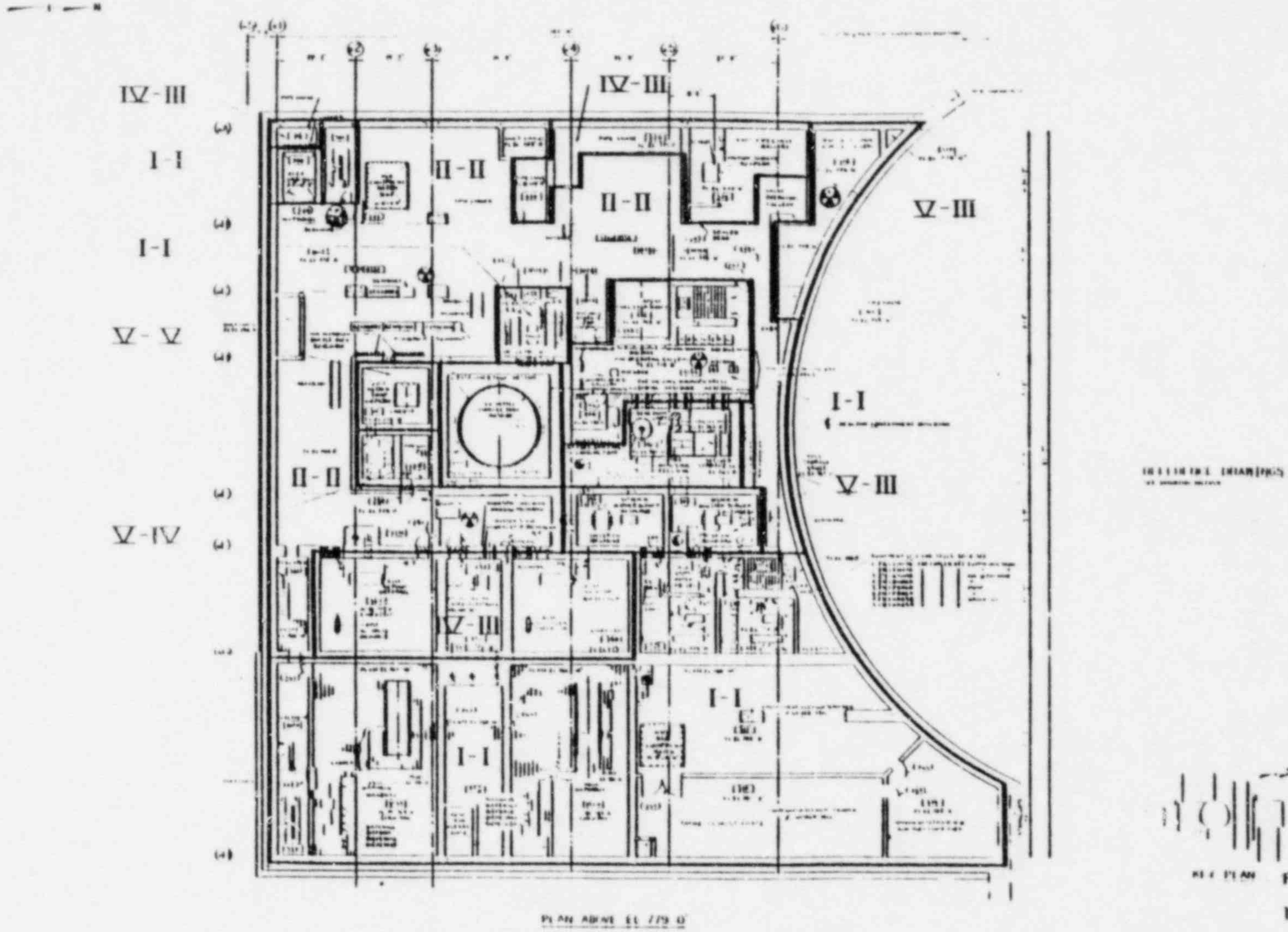

Figure 12.1-11 Plant Radiation Protection

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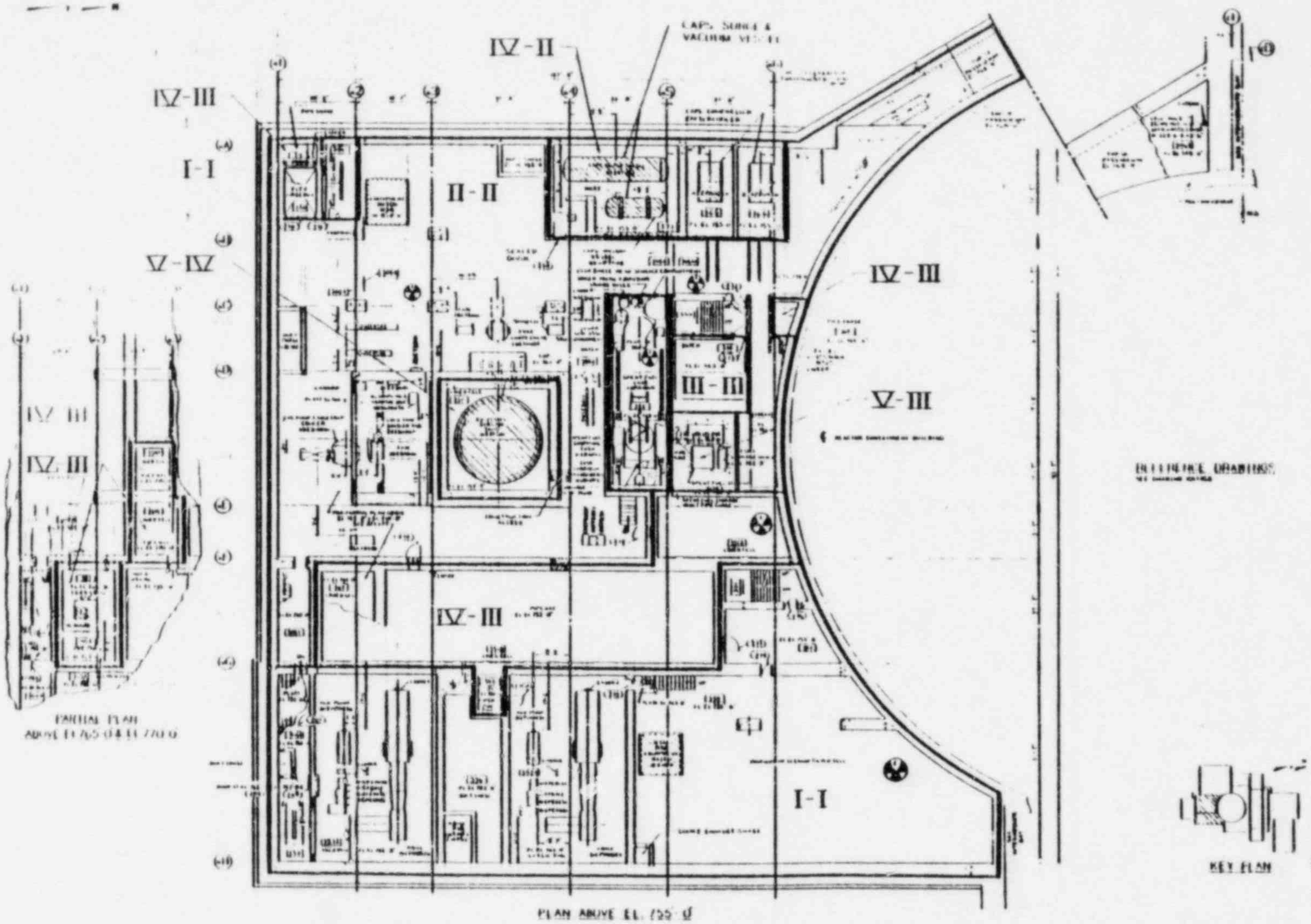

Figure 12.1-12 Plant Radiation Protect

12.1-92

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April 197

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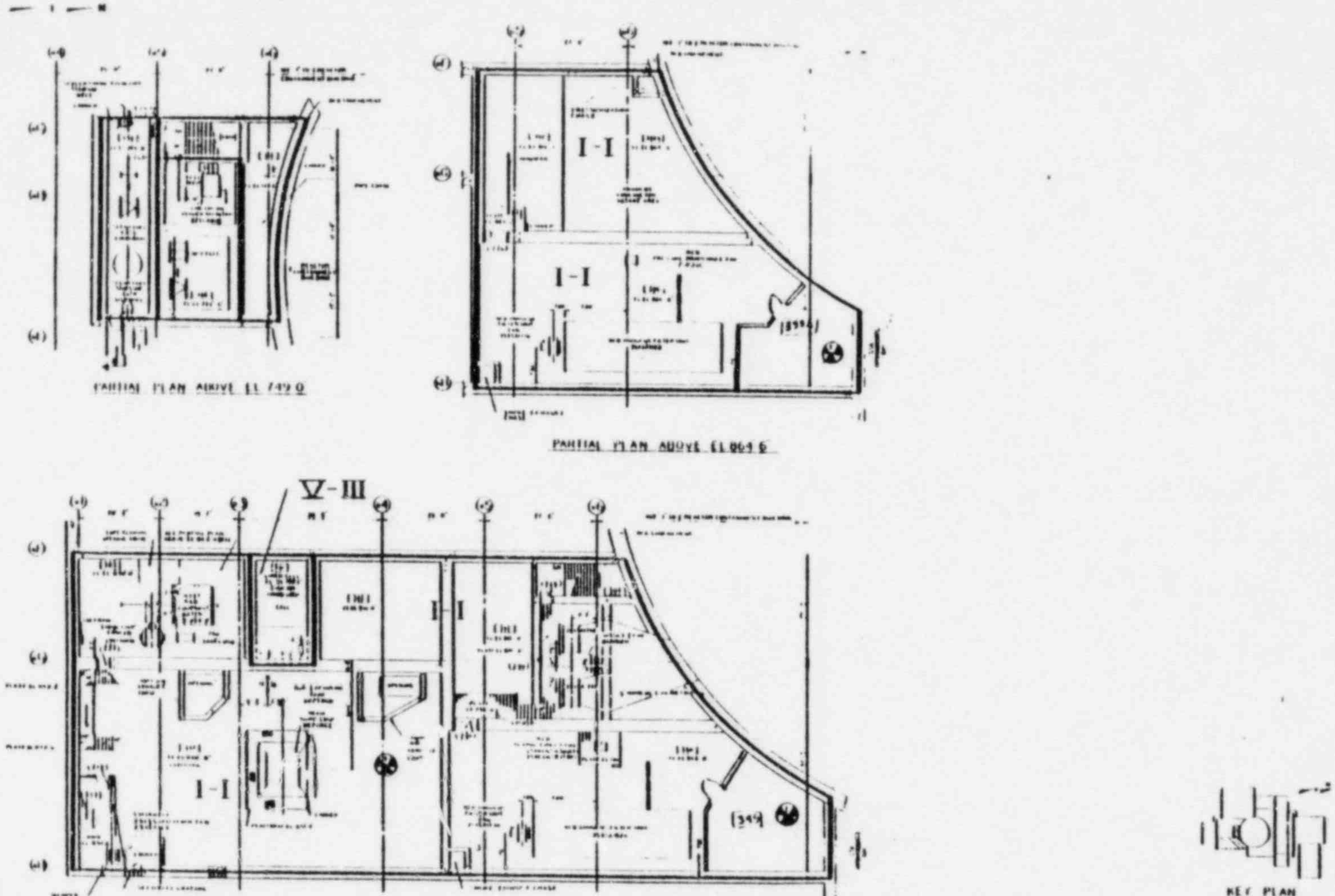

Figure 12.1-13 Plant Radiation Protectic

12.1-93

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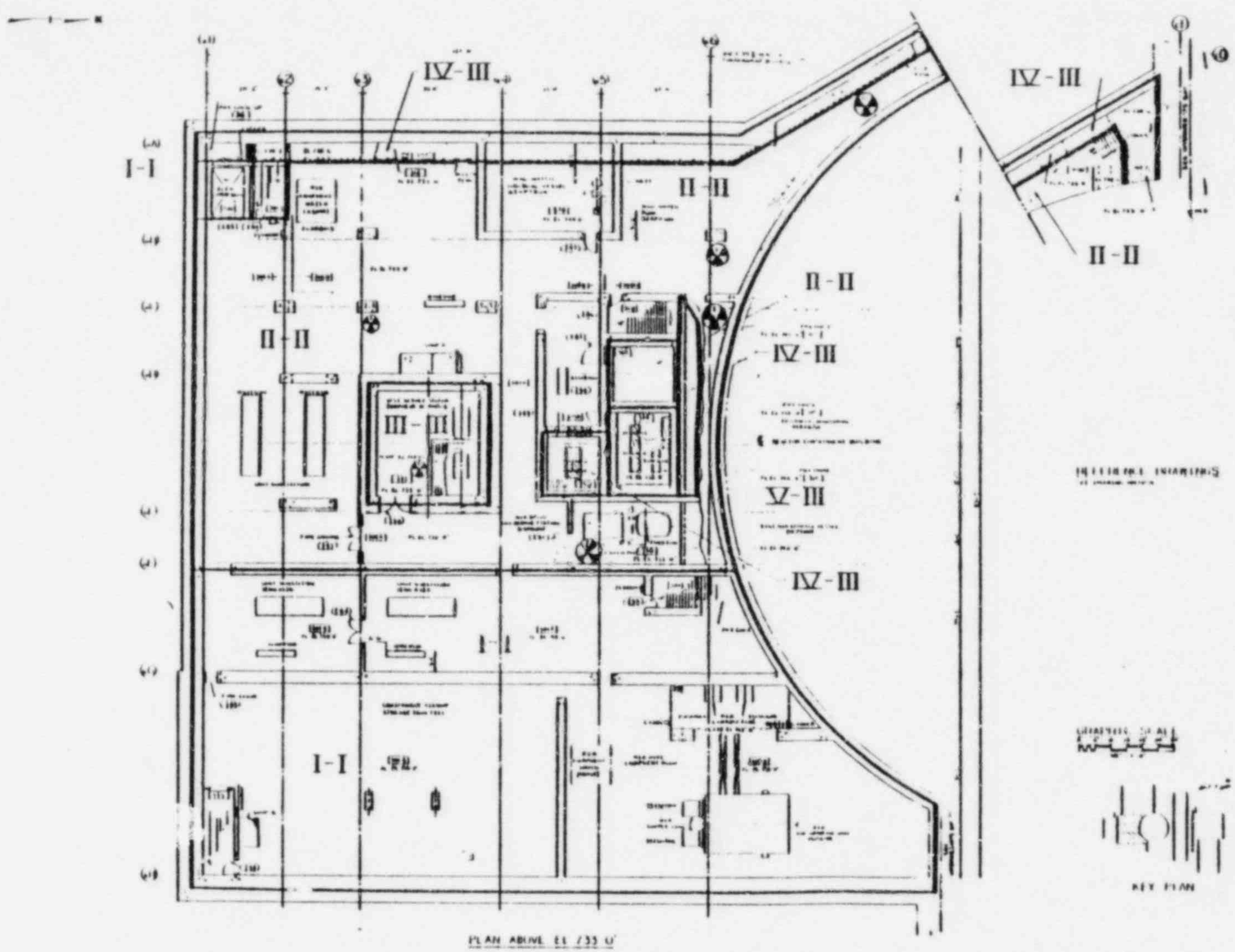

Figure 12.1-14 Plant Radiation Protection

12.1-94

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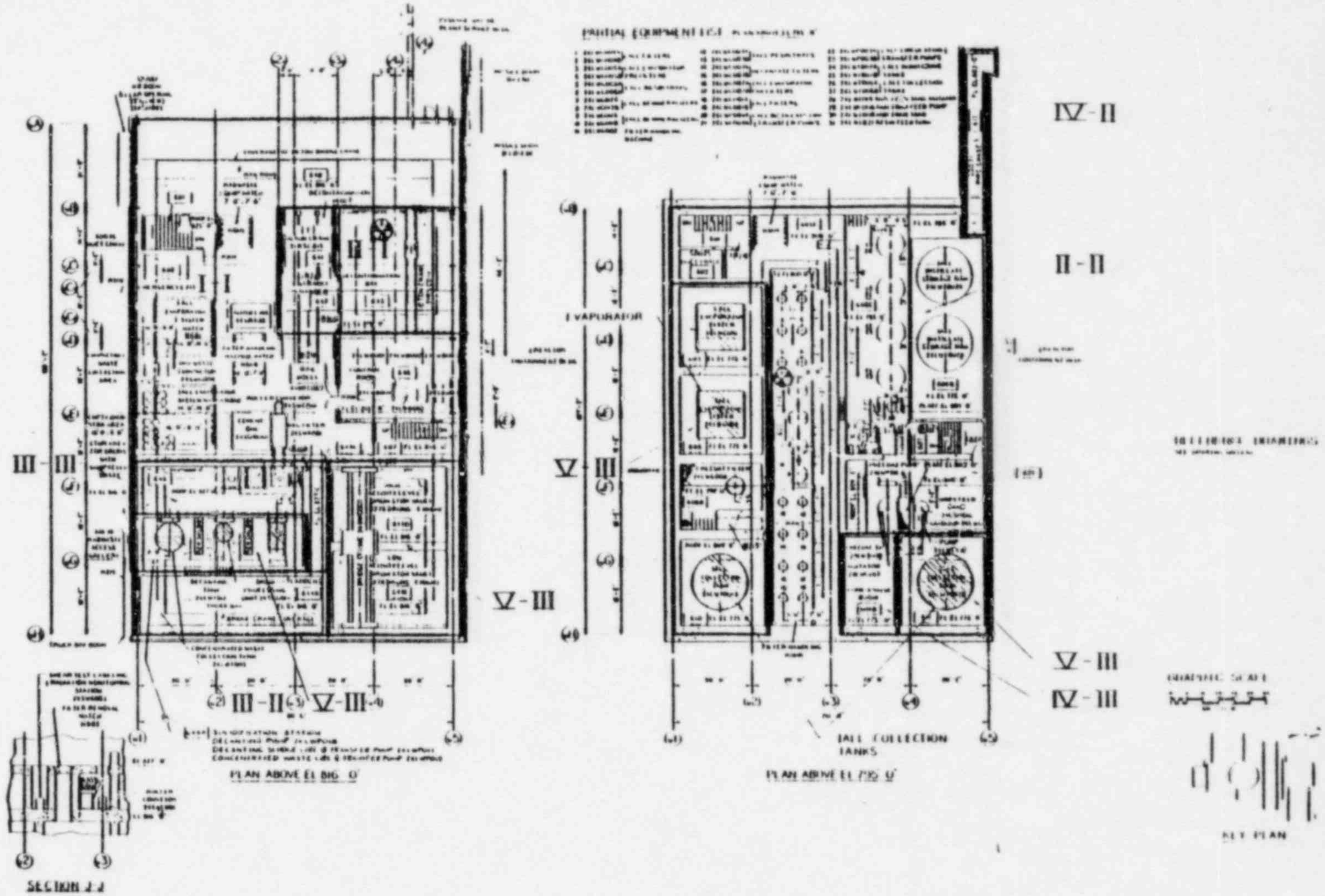

Figure 12.1-16 Plant Radiation Protection

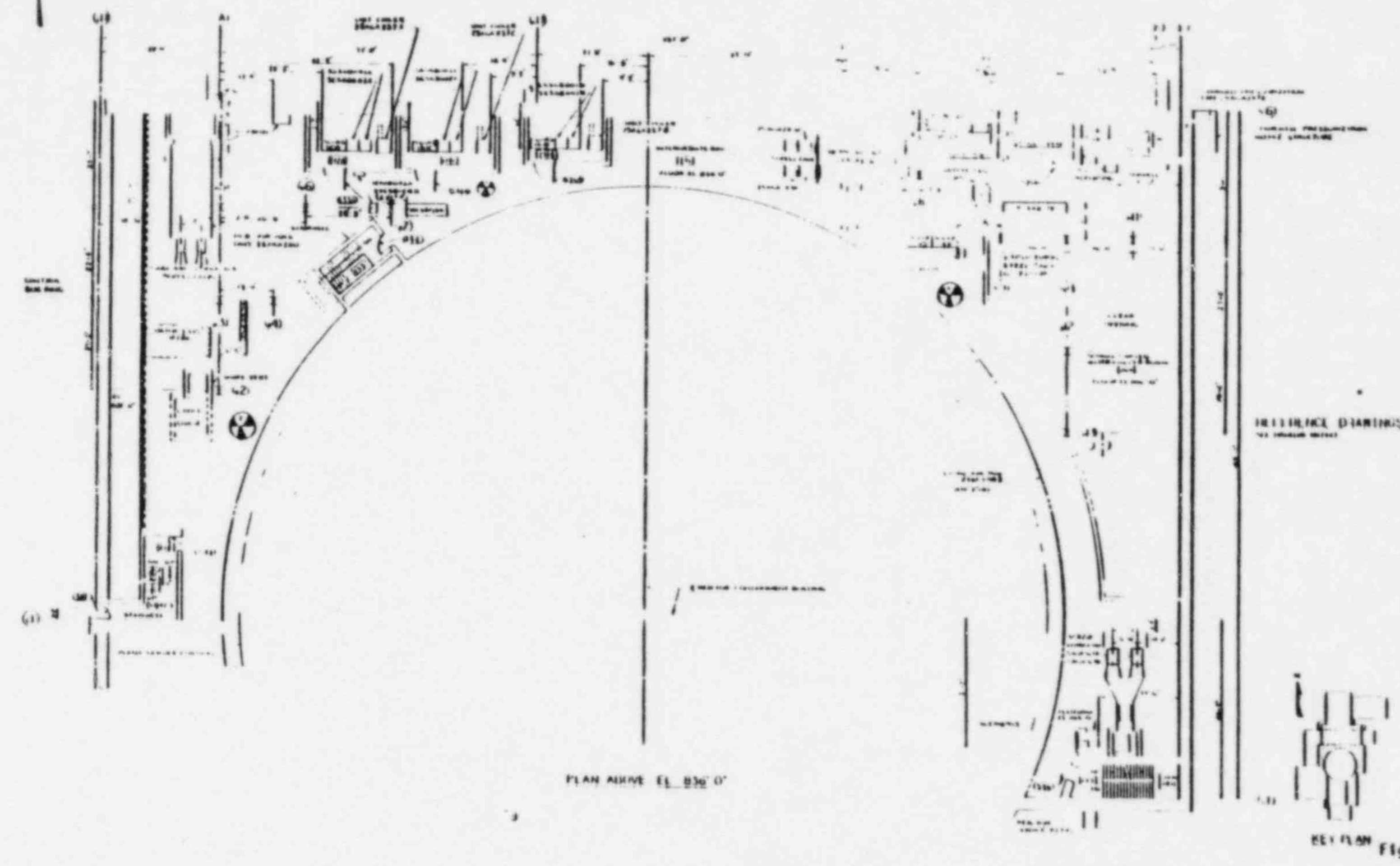

Figure 12.1-19 Plant Radiation Protection

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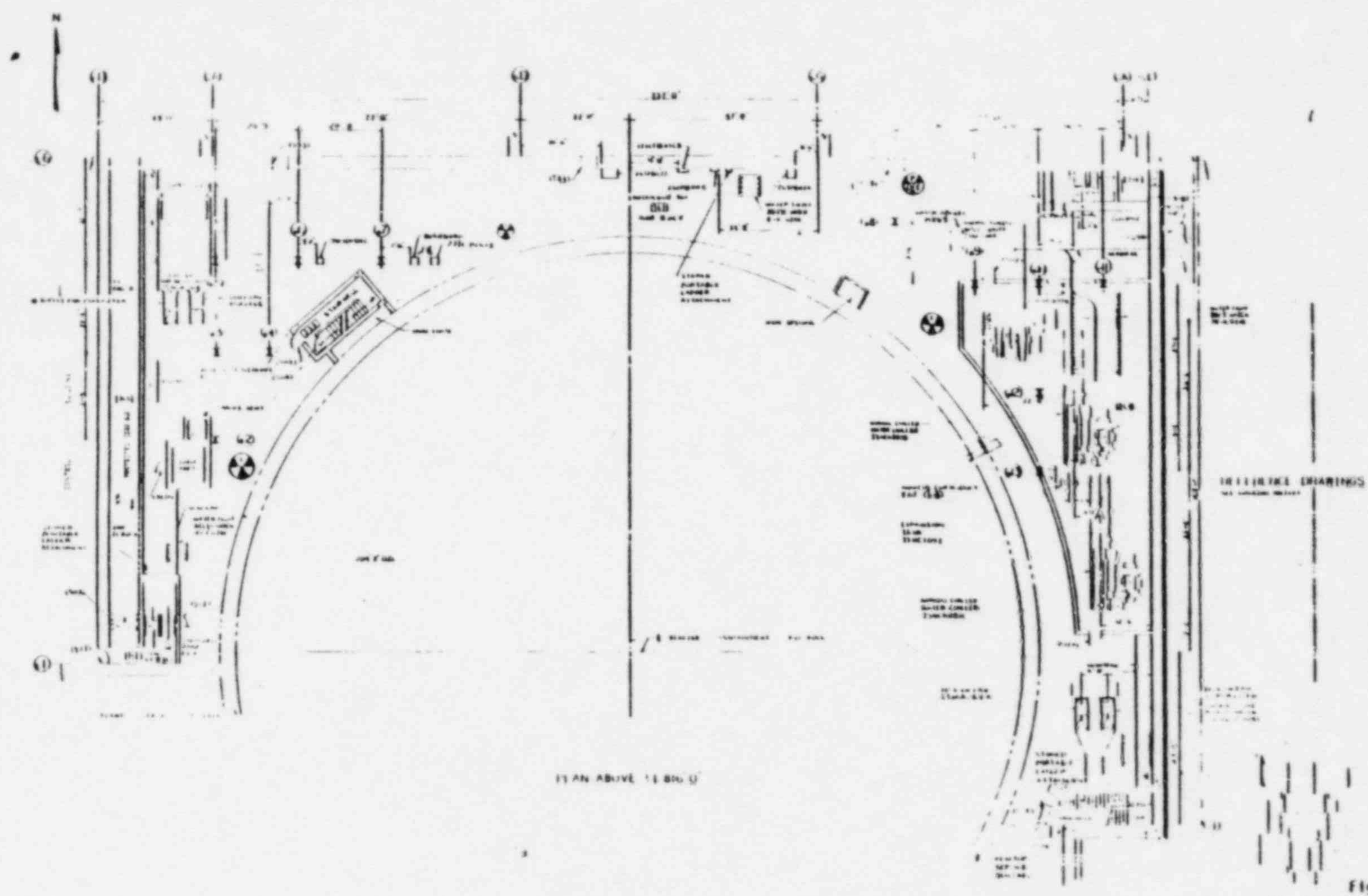

Figure 12.1-19a Plant Radiation Protection

12.1-99a

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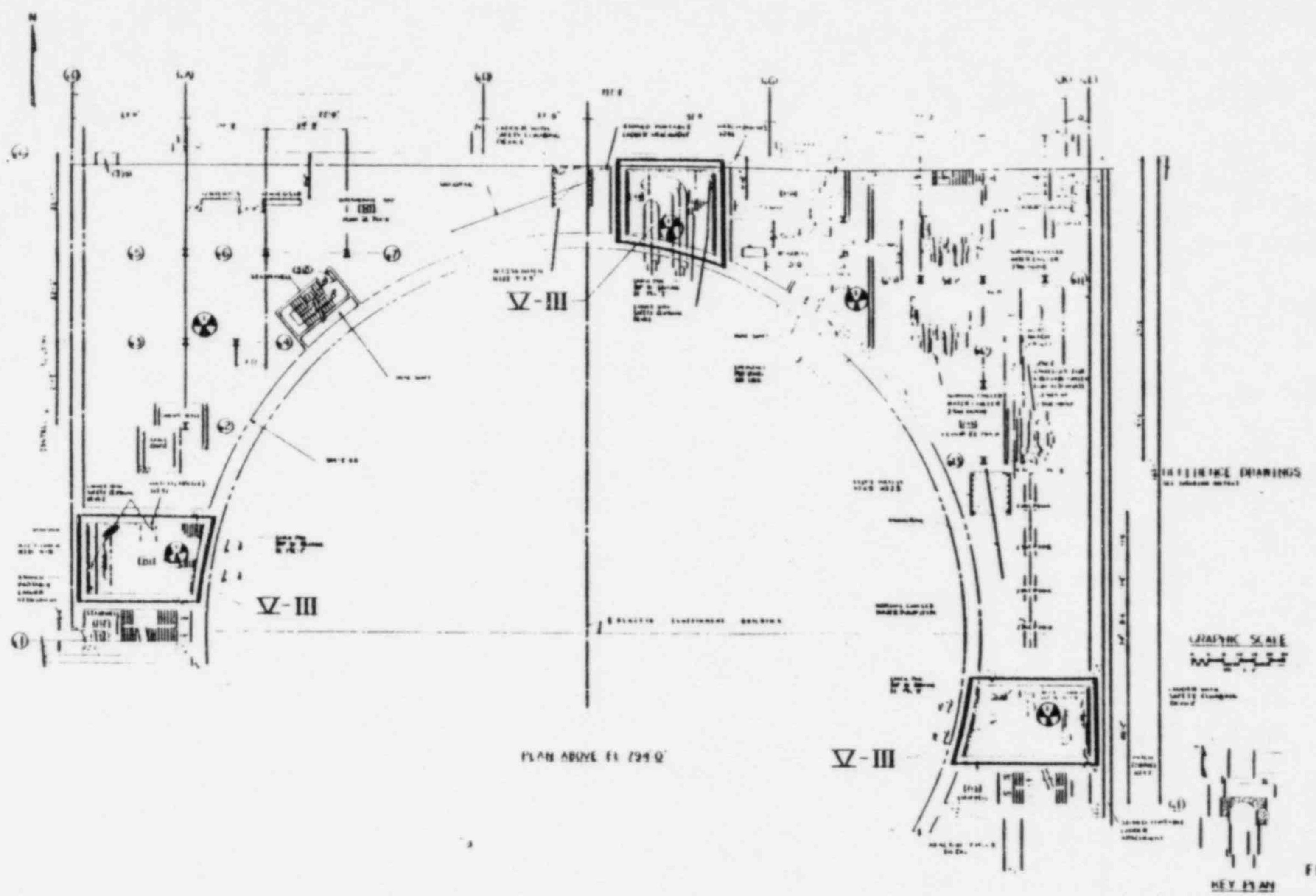

Figure 12.1-19b Plant Radiation Protecti

12.1-99b

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7.6 OTHER INSTRUMENTATION AND CONTROL SYSTEMS REQUIRED FOR SAFETY

The additional instrumentation and control systems required for safety which have not been discussed earlier in Chapter 7 are identified as the Plant Service Water and Chilled Water Instrumentation and Control Systems, ~~(the Fuel Handling and Storage Safety Interlock System)~~, and the Direct Heat Removal Service Instrumentation and Control. The Radiation Monitoring System also contains safety related components which are discussed in Chap-
33 ter 11. ~~(The Cooling of Structural Concrete is addressed in Chapter 3A)~~ The Normal and Emergency Plant Service Water and Chilled Water Systems, Fuel
26 Handling, and DHRS I and C are discussed in this Section.

7.6.1 Plant Service Water and Chilled Water Instrumentation and Control Systems

7.6.1.1 Description

Those portions of the Plant Service Water and Chilled Water Systems which are required for safety, include the Emergency Chilled Water System, and the Emergency Plant Service Water System (see Sections 9.7.2, 9.9.2).
33 15 Instrumentation and control for these systems will include the necessary redundant instrumentation, control and indicating circuits and devices required for operation of the system.

7.6.1.2 Analysis

As required by IEEE Standard 279-1971, redundant monitoring and control equipment will be provided to ensure that a single failure will not impair the capability of the Emergency Plant Service Water and Chilled Water Instrumentation and Control Systems to perform their intended safety functions. The systems will be designed for fail safe operation and control equipment, were practical, will assume a failed position consistent with its intended safety function.

To comply with CRBRP General Design Criterion 19, adequate instrumentation and control in the control room and locally, will be provided for those portions of these systems which are required for safety.

7.6.2 DELETED

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