3.7 Radiation Protection

Design Description

The ABWR design provides radiation protection features that will keep exposures for both plant personnel and the general public well below allowable limits. These low exposure conditions are achieved by an integrated approach that recognizes the contribution of both shielding provisions and ventilation system designs that control airborne contaminants. Monitoring of radiation levels is an integral part of the plant radiation protection strategy.

The plant design provides radiation shielding for rooms, corridors and operating areas commensurate with their occupancy requirements and thus maintains radiation exposures to plant personnel as low as reasonably achievable. Maintenance of plant components is achieved without significant radiation exposure from adjacent plant systems or equipment by use of shielded cubicles, labyrinth access and provisions for temporary shielding. Under accident conditions, plant shielding designs permit operators to perform required safety functions in vital areas of the plant. In addition to protection of operating personnel, the plant design provides radiation shielding which maintains radiation exposure to the general public as low as is reasonably achievable.

Plant ventilation systems insure that concentrations of airborne radionuclides are maintained at levels consistent with personnel access requirements. In addition, airborne radioactivity monitoring is provided for those normally occupied areas of the plant in which there exists a significant potential for airborne contamination.

Inspection, Test, Analyses and Acceptance Criteria

Tables 3.7a and 3.7b provide a definition of the inspections, tests, and/or analyses together with associated acceptance criteria which will be undertaken for the ABWR plant shielding, ventilation and airborne monitoring equipment.

Table 3.7a: Plant Shielding Design

Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The plant design shall provide radiation shielding for rooms, corridors and operating areas commensurate with their occupancy requirements to maintain radiation exposures to plant personnel as low as reasonably achievable.	1. An analysis of the expected radiation levels in each plant area will be performed to verify the adequacy of the shielding design. This analysis shall consider the following: a. Confirmatory calculations shall consider all significant radiation sources (greater than 5% contribution) for an area. Radiation source strength in plant systems and components will be determined based upon an assumed source term of 100,000 μCurie/second offgas release rate (after 30 minutes decay), a 200 μCurie/gram-steam N-16 source term at the vessel exit nozzle, and a core inventory commensurate with a 4005 MWT equilibrium core at 51.6 kwatt/liter. All source terms shall be adjusted for radiological decay and buildup of activated corrosion and wear products. b. Commonly accepted shielding codes, using nuclear properties derived from well known references (such as Vitamin C and ANSI/ANS-6.4) shall be used to model and evaluate plant radiation environments. 1) For non-complex geometries, point kernal shielding codes (such as QAD or GGG) shall be used. 2) For complex geometries, more sophisticated two or three dimensional transport codes (such as DORT or TORT) shall be used.	1. Maximum expected radiation levels are well within (25% or less) of the radiation zone designation, for each plant area, as indicated in Figures 3.7.a through 3.7.bb.

Table 3.7a: Plant Shielding Design (Continued)

Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
	1. (Cont.) c. In any calculation, a safety factor shall be applied based upon benchmark comparisons of the code and data collected from known and measured environments.	
2. The plant design shall provide shielded cubicles, labyrinth access, and space for temporary shielding to allow for maintenance of plant components without significant radiation exposure from adjacent plant systems or equipment.	2. Using the methods identified in (1) above, radiation levels present in areas where maintenance is performed shall be evaluated for the contribution from adjacent high radiation areas and equipment.	2. Shielding design (with temporary shielding installed, where appropriate) is such that radiation from adjacent areas shall contribute no more than a small fraction (10% or less) of the radiation field intensity or less than 0.06mrem/hr whichever is larger, in plant areas where maintenance is performed.
3. The plant radiation shielding design shall permit operators to perform required safety functions in vital areas of the plant (including access and egress of these areas) under accident conditions.	3. An analysis of the expected high radiation levels in each area which will or may require occupancy to permit an operator to aid in the mitigation of or recovery from an accident (vital area) shall be performed to verify the adequacy of the plant shielding design. This analysis shall use calculational methods consistent with (1.b) above and a radiation source term (adjusted for radioactive decay) based on the following: a. Liquid containing systems: 100% of the core equilibrium noble gas inventory, 50% of the core equilibrium halogen inventory and 1% of all others are assumed to be mixed in the reactor coolant and recirculation liquids recirculated by the residual heat removal system (RHR), the high	3. Under accident conditions, radiation shielding design allows access, occupancy and egress of vital areas such that personnel radiation exposures do not exceed 5 rem to the whole body, or its equivalent, for the duration of the accident (based on the required frequency of access to each vital area). For areas requiring continuous occupancy (such as the control room), local radiation hot spots shall not exceed 15 mrem/hr (averaged over 30 days).

Table 3.7a: Plant Shielding Design (Continued)

Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
	3. (Cont.) pressure core flooder (HPCF), and the reactor core isolation cooling (RCIC) systems. b. Gas containing systems: 100% of the core equilibrium noble gas inventory and 25% of the core equilibrium halogen activity are assumed to be mixed in the containment atmosphere. For vapor containing systems (such as the main steam lines) these core inventory fractions are assumed to be contained in the reactor coolant vapor space.	
4. The plant design shall provide radiation shielding to maintain radiation exposure to the general public as low as is reasonably achievable.	4. Using the methods identified in (1) above, the radiation dose to the maximally exposed member of the general public from direct and scattered shall be determined.	4. The radiation dose to the maximally exposed member of the public is a small fraction (10% or less) of the dose limit to a member of the public listed in 40CFR190.

Table 3.7b: Ventilation And Airborne Monitoring

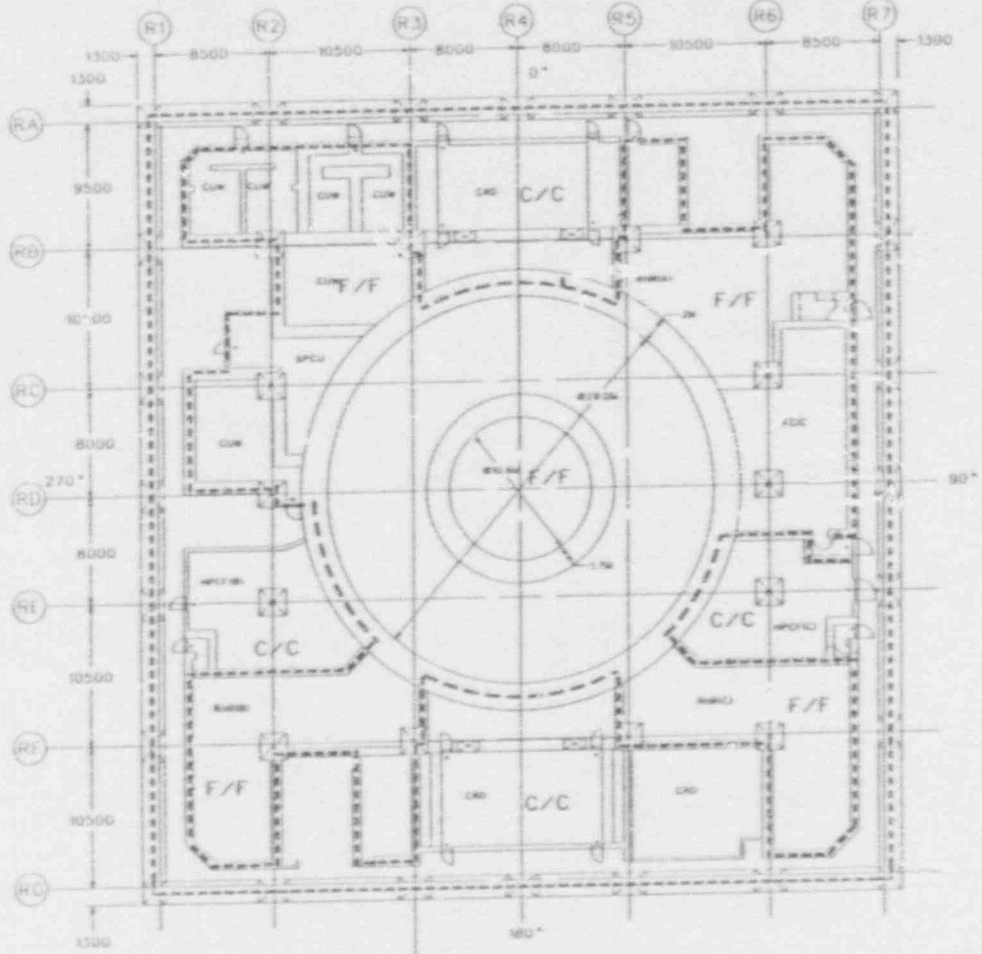
Inspections, Tests, Analyses and Acceptance Criteria

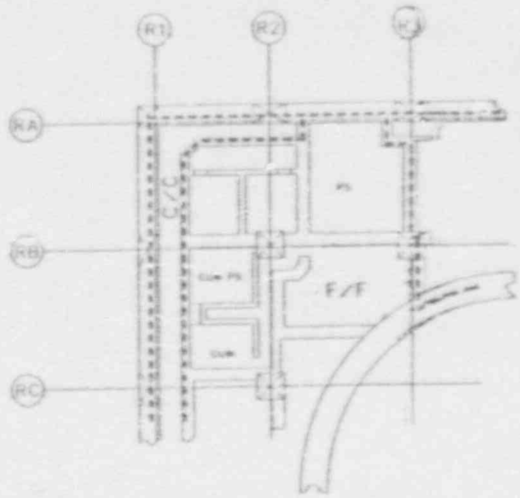
Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. Plant design shall provide adequate containment of airborne radioactive materials and the ventilation system will ensure that concentrations of airborne radionuclides are maintained at levels consistent with personnel access requirements.	1. Expected concentrations of airborne radioactive material shall be calculated by nuclide for normal plant operations, anticipated operational occurrences for each equipment cubicle, corridor, and operating area requiring personnel access. Calculations shall consider: a. Design ventilation flow rates for each area, b. Typical leakage characteristics for equipment located in each area, and c. A radiation source term in each fluid system shall be determined based upon an assumed offgas rate of 100,000 Curie/second (30 minute decay) appropriately adjusted for radiological decay and buildup of activated corrosion and wear products.	1. Calculation of radioactive airborne concentration shall demonstrate that: a. For normally occupied rooms and areas of the plant (i.e. those areas requiring routine access to operate and maintain the plant) equilibrium concentrations of airborne nuclides will be a small fraction (10% or less) of the occupational concentration limits listed in 10 CFR 20 Appendix B. b. For rooms that require infrequent access (such as for non-routine equipment maintenance), the ventilation system shall be capable of reducing radioactive airborne concentrations to (and maintaining them at) the occupational concentration limits listed in 10CFR20 Appendix B during the periods that occupancy is required. c. For rooms that seldom require access (such as tank rooms), plant design shall provide sufficient containment and ventilation to ensure airborne contamination does not spread to other areas.

Table 3.7b: Ventilation And Airborne Monitoring (Continued)

Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
2. Airborne radioactivity monitoring shall be provided for those normally occupied areas of the plant in which there exists as significant potential for airborne contamination (greater than 0.1 per year)	2. An analysis shall be performed to identify the plant areas that require airborne radioactivity monitoring.	2. Airborne radioactivity monitoring system shall: a. Have the capability of detecting the time integrated change in concentrations of the most limiting particulate and iodine radionuclides in each area equivalent to the occupational concentration limits in 10CFR20, Appendix B for 10hours. b. Provide a calibrated response, representatvie of the concentrations within the area (i.E. air sampling monitors in ventilation exhaust streams shall collect and isokinetic sample). c. Provide local audible alarms (visual alarms in high noise areas) with variable alarm set points, and readout/ annunciation capability in the control room.





FULL POWER/SHUTDOWN
RADIATION LEVELS IN
mRem/hour

A ≤ 0.6
B < 1
C < 5
D < 25
E < 100
F ≥ 100

FIGURE 3.7-2 REACTOR BUILDING
RADIATION ZONE MAP FOR
FULL POWER AND SHUTDOWN OPERATIONS
AT ELEVATION -8200 (B3F)

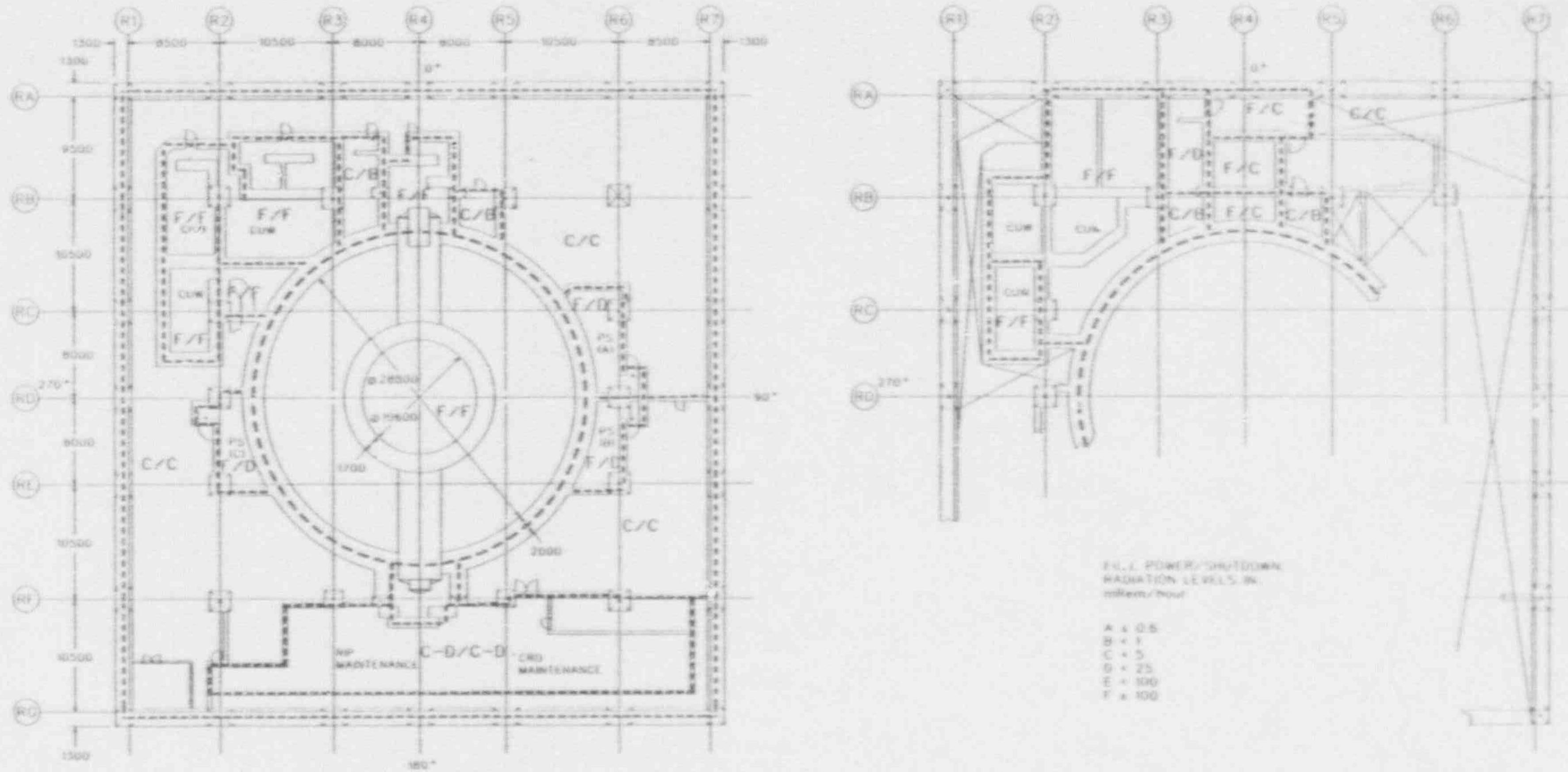
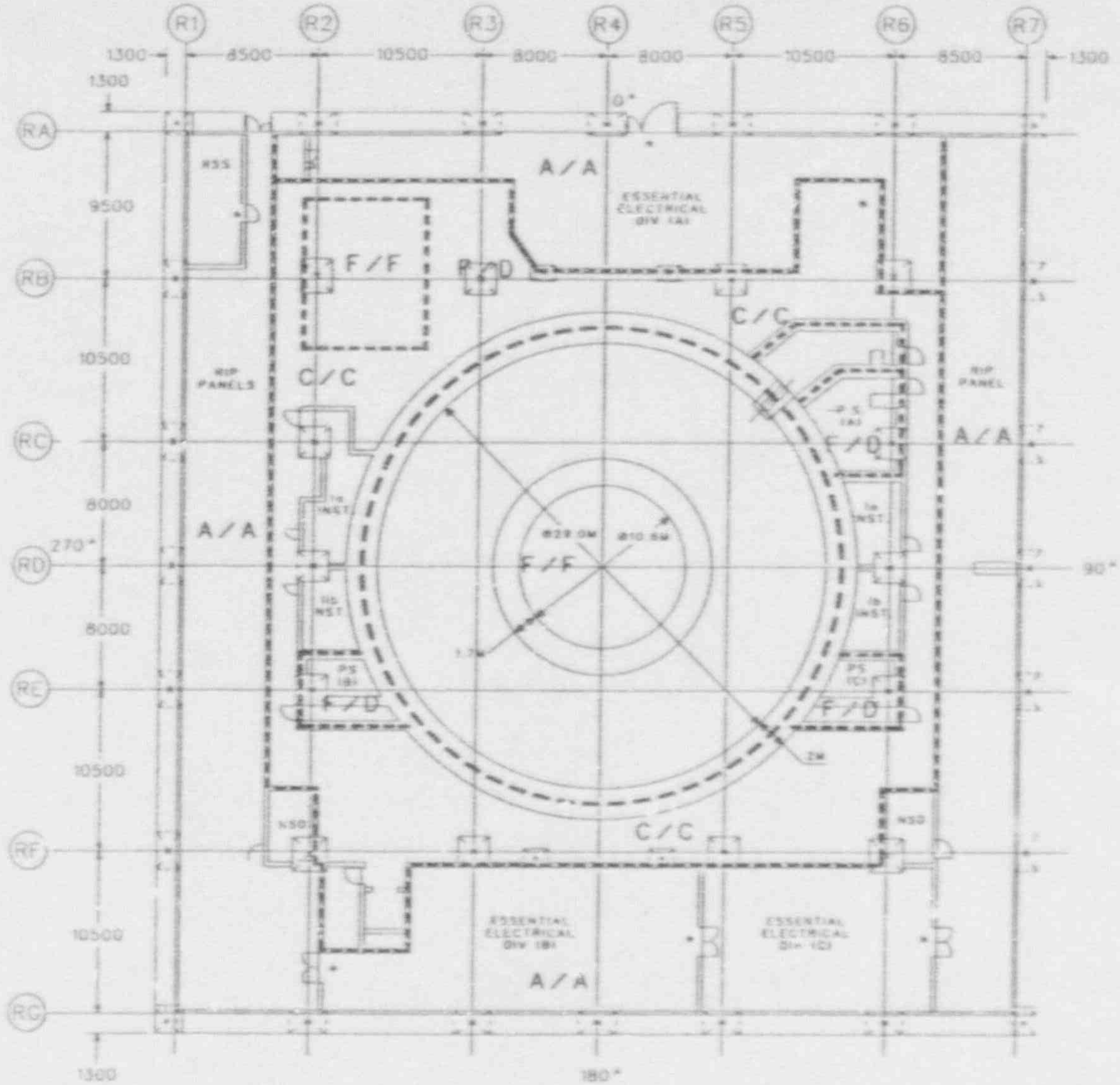


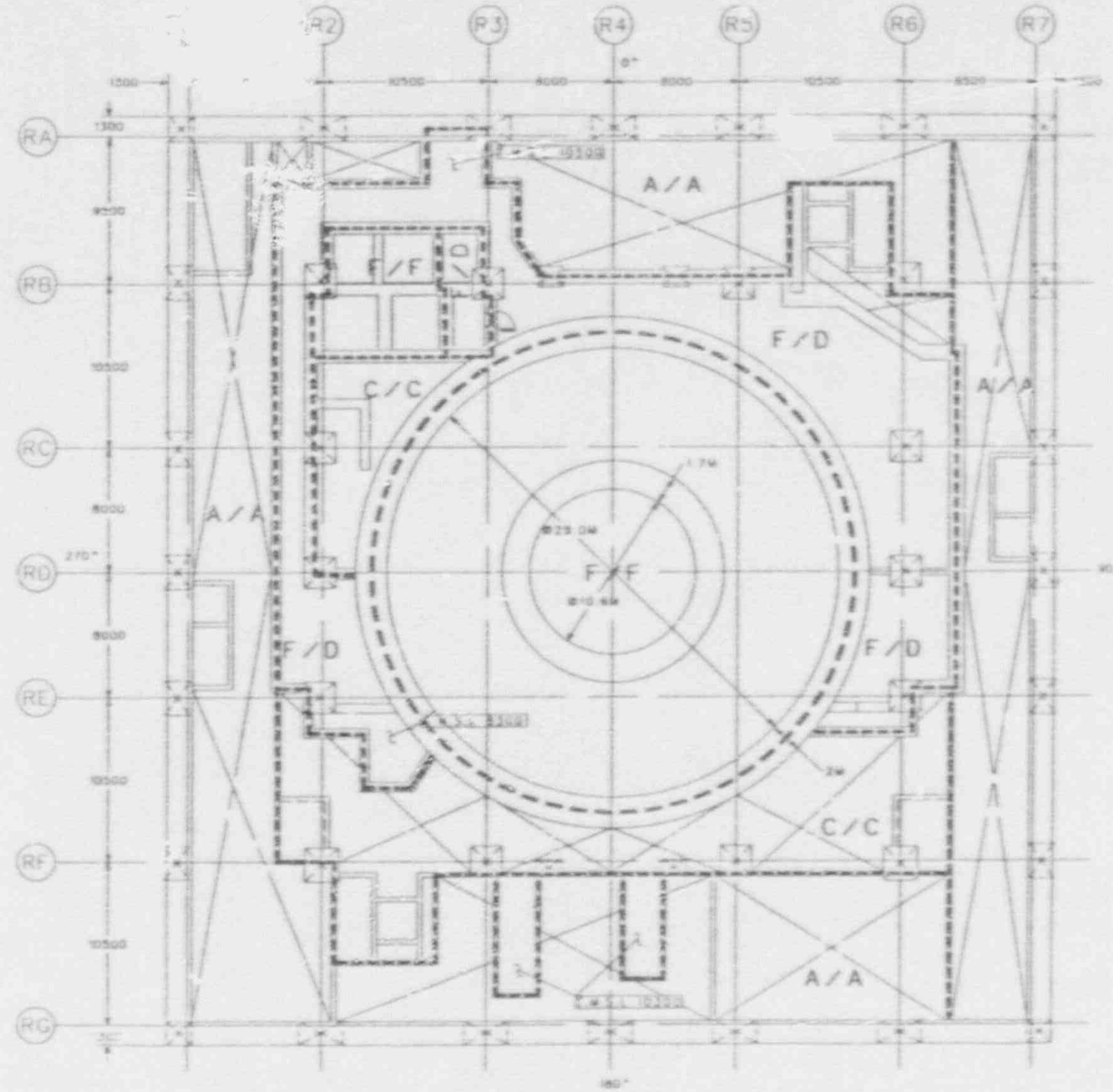
FIGURE 3.7b REACTOR BUILDING
RADIATION ZONE MAP FOR
FULL POWER AND SHUTDOWN OPERATIONS
AT ELEVATION 1700 (B2F)



FULL POWER/SHUTDOWN
RADIATION LEVELS IN
mRem/hour

A ≤ 0.6
B < 1
C < 5
D < 25
E < 100
F ≥ 100

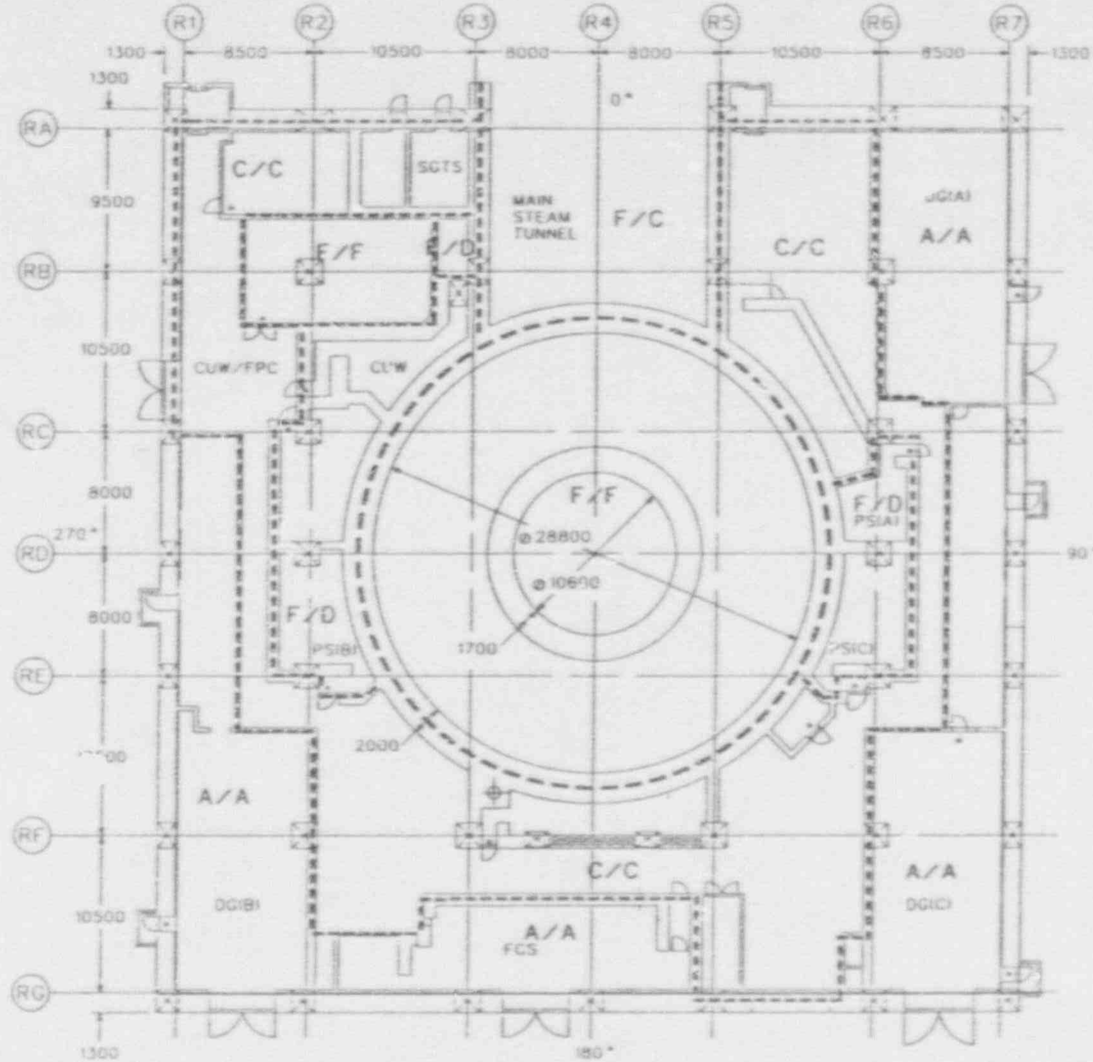
FIGURE 3.7c REACTOR BUILDING
RADIATION ZONE MAP FOR
FULL POWER AND SHUTDOWN OPERATIONS
AT ELEVATION -4800 (B1F)



FULL POWER/SHUTDOWN
RADIATION LEVELS IN
mRem/hour

A ≤ 0.6
B < 1
C < 5
D < 25
E < 100
F ≥ 100

FIGURE 3.7d REACTOR BUILDING
RADIATION ZONE MAP FOR
FULL POWER AND SHUTDOWN OPERAT
AT ELEVATION -8500 (B1F)



FULL POWER/SHUTDOWN
RADIATION LEVELS IN
mRem/hour

A ≤ 0.6
B < 1
C < 5
D < 25
E < 100
F ≥ 100

FIGURE 3.7e REACTOR BUILDING
RADIATION ZONE MAP FOR
FULL POWER AND SHUTDOWN OPERATIONS
AT ELEVATION 12300 (1F)

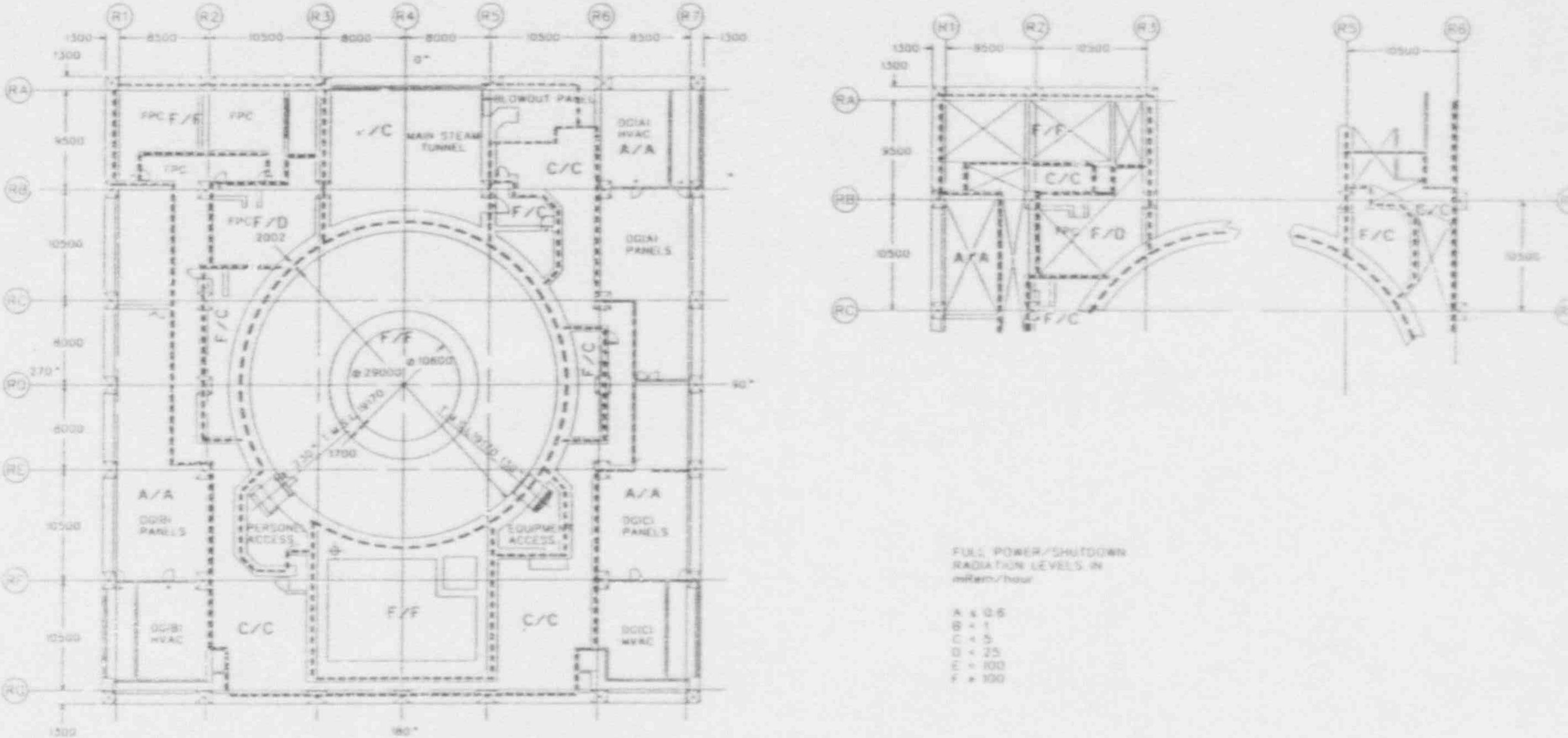
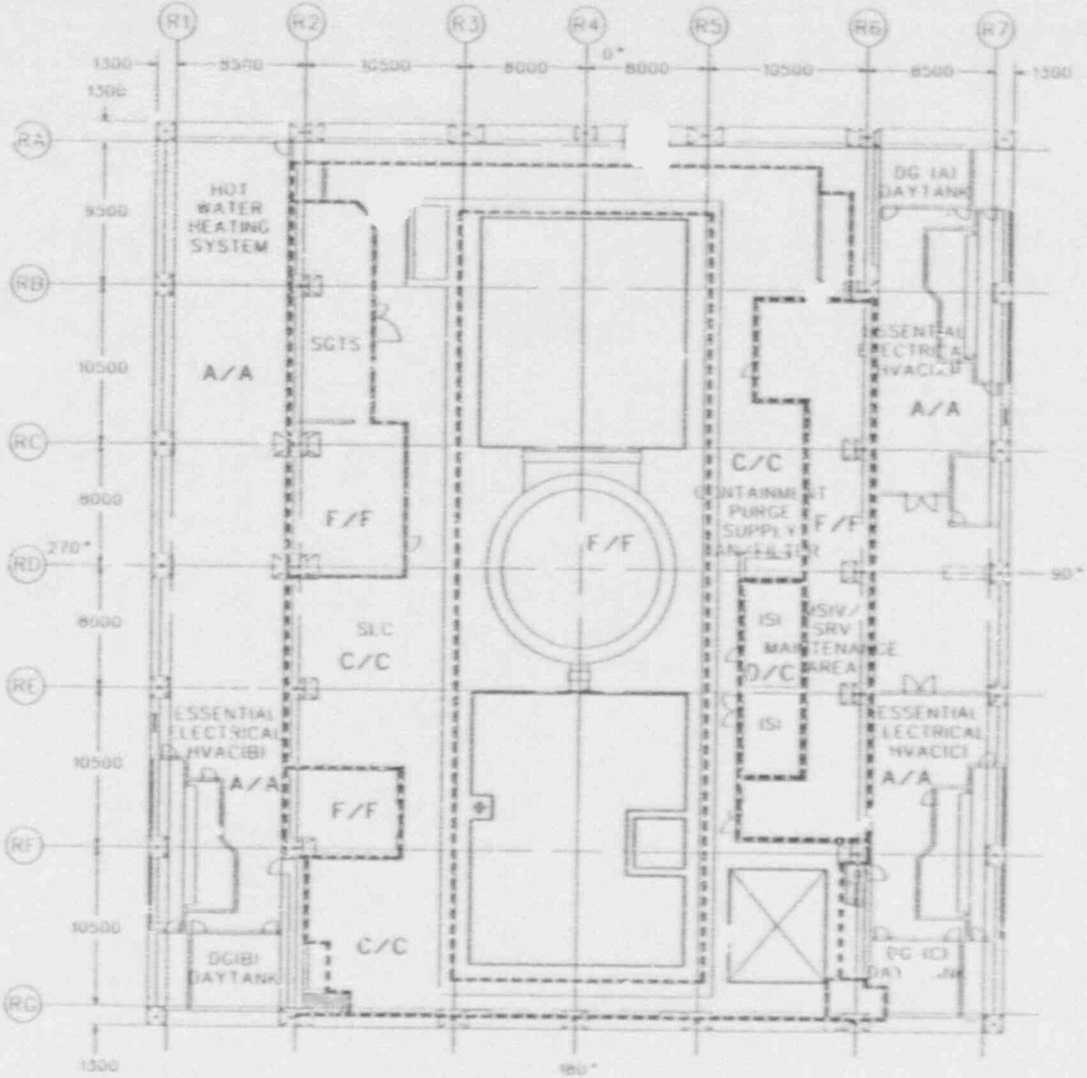


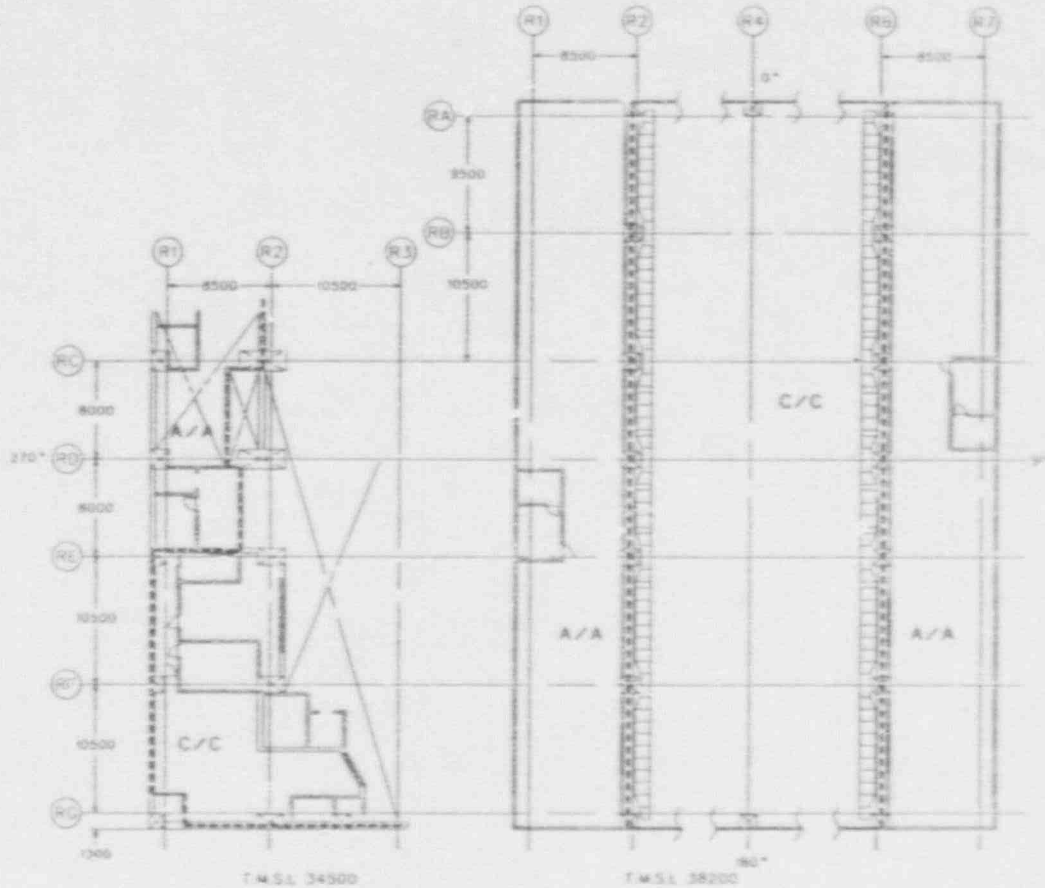
FIGURE 3.7 REACTOR BUILDING
RADIATION ZONE MAP FOR
FULL POWER AND SHUTDOWN OPERATIONS
AT ELEVATION 18100 (2F)



FULL POWER/SHUTDOWN
RADIATION LEVELS IN
mRem/hour

A ≤ 0.6
B < 1
C < 5
D < 25
E < 100
F ≥ 100

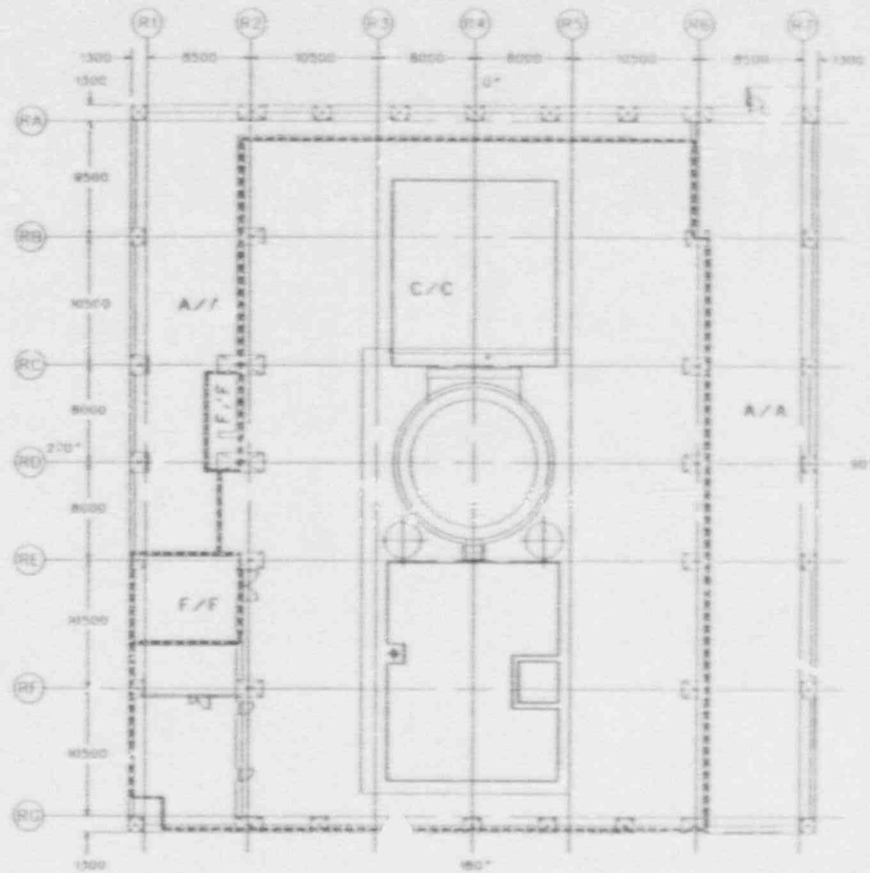
FIGURE 3.7g REACTOR BUILDING
RADIATION ZONE MAP FOR
FULL POWER AND SHUTDOWN OPERATIONS
AT ELEVATION -23500 (B3F)



FULL POWER/SHUTDOWN
RADIATION LEVELS IN
mRem/hour

A ≤ 0.6
B < 1
C < 5
D < 25
E < 100
F ≥ 100

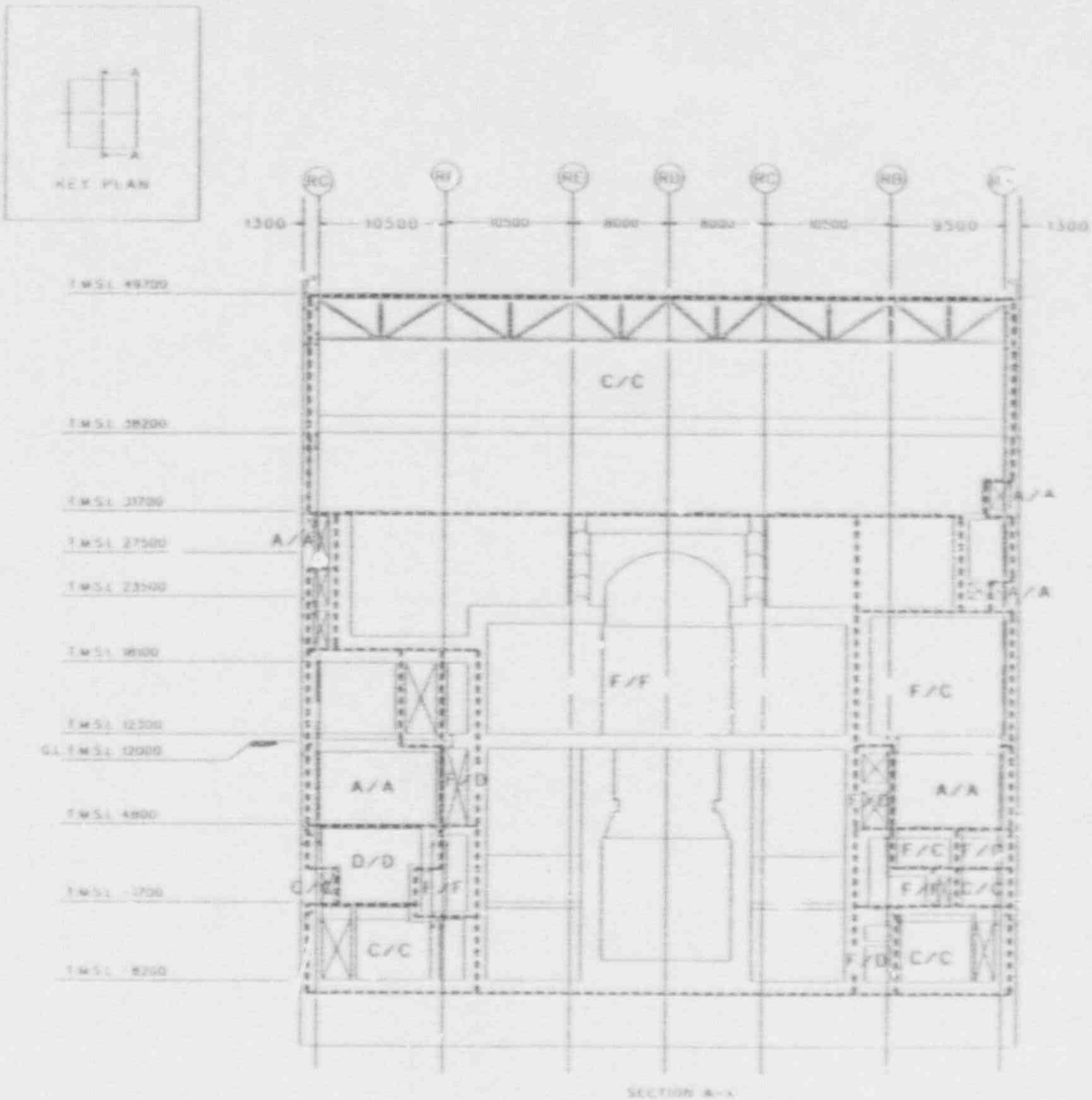
FIGURE 3.7h REACTOR BUILDING
RADIATION ZONE MAP FOR
FULL POWER AND SHUTDOWN OPERATIONS
AT ELEVATION 34500



FULL POWER/SHUTDOWN RADIATION LEVELS IN mRem/hour

A ≤ 0.6
B ≤ 1
C ≤ 5
D ≤ 25
E ≤ 100
F > 100

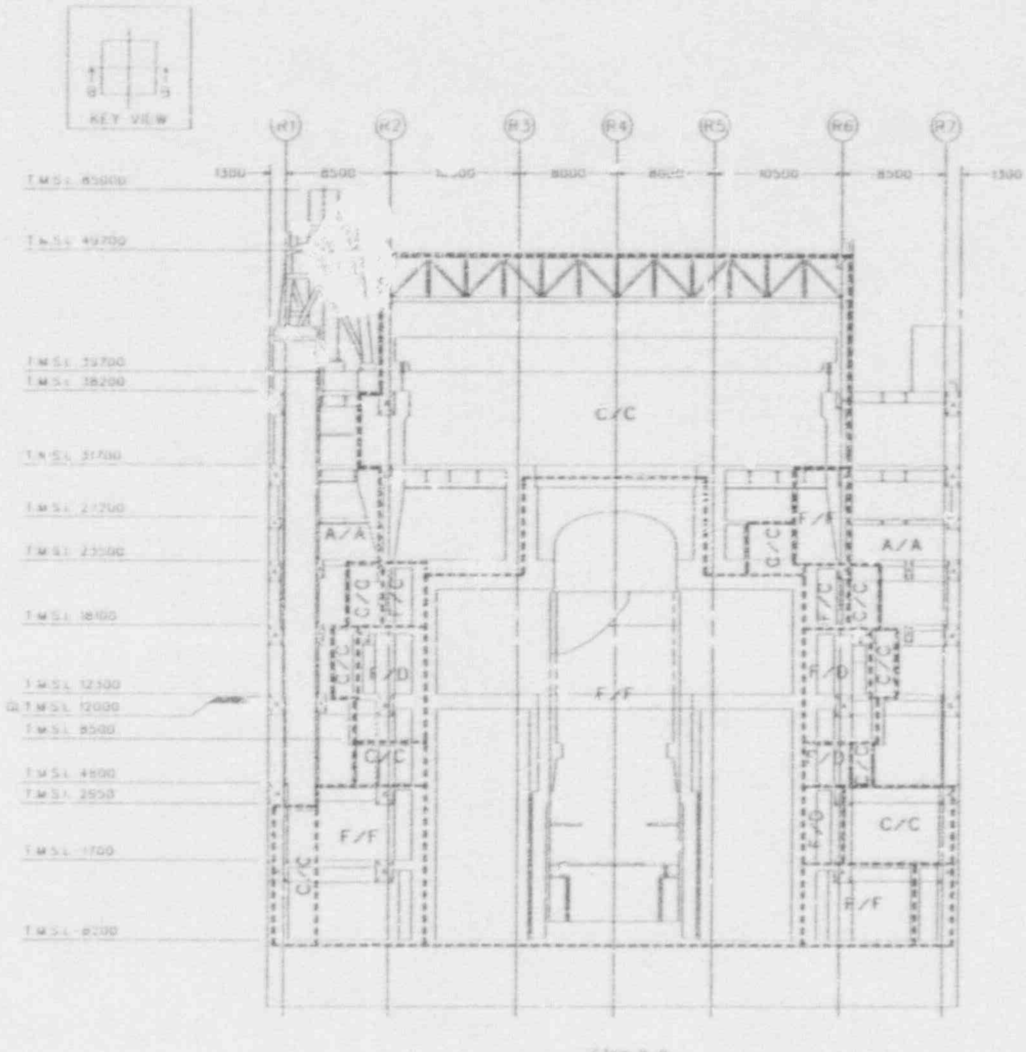
FIGURE 3.7-[illegible] REACTOR BUILDING RADIATION ZONE MAP FOR FULL POWER AND SHUTDOWN OPERATIONS AT ELEVATION [illegible]



Full Power/Shutdown Radiation Levels in mRem/hr

A ≤ 0.6
B ≤ 1
C ≤ 5
D ≤ 25
E ≤ 100
F ≥ 100

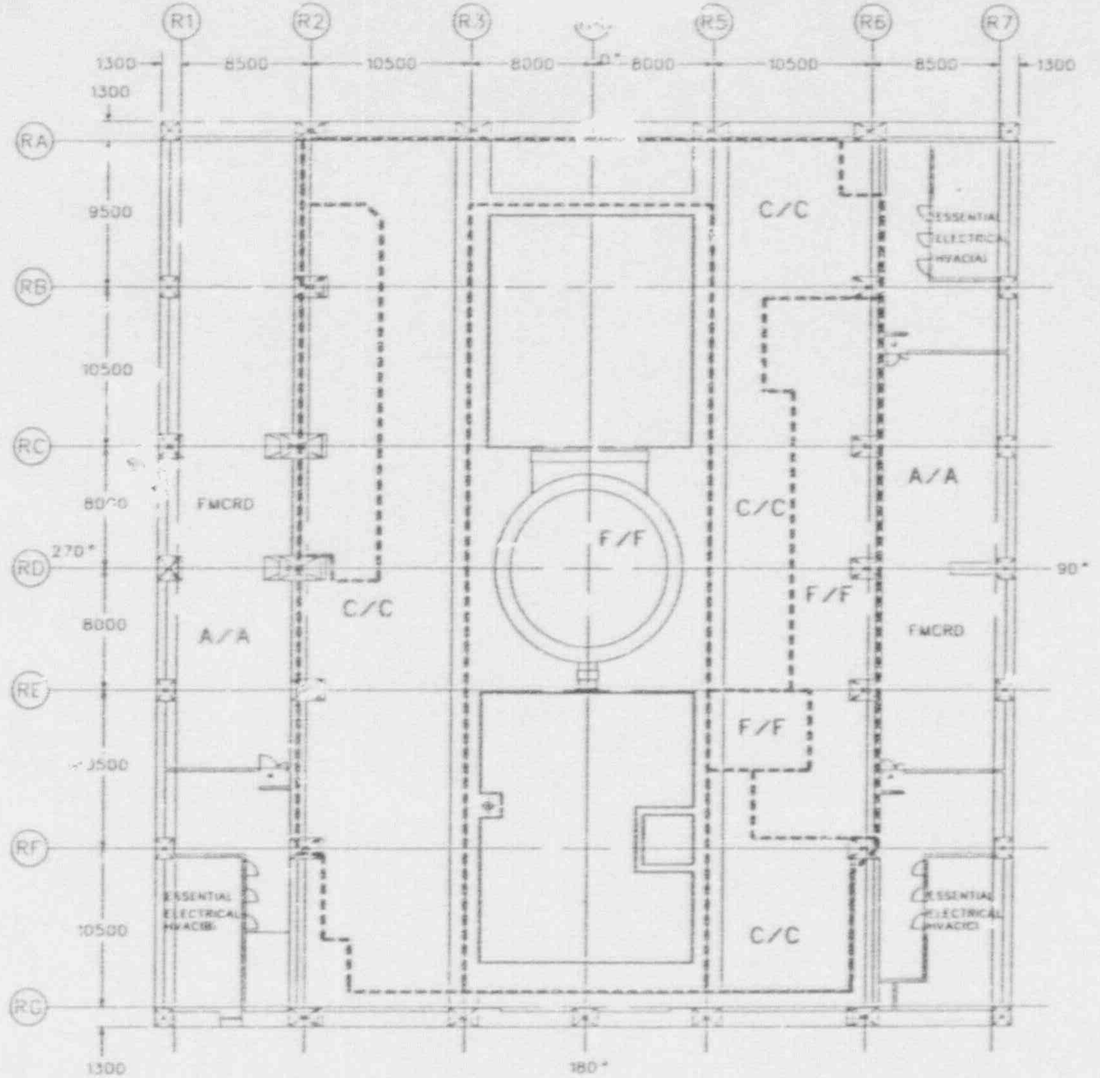
FIGURE 3.7j REACTOR BUILDING
RADIATION ZONE MAP FOR
FULL POWER AND SHUTDOWN OPERATIONS
CROSS SECTION VIEW A-A



FULL POWER/SHUTDOWN
RADIATION LEVELS IN
mRem/hour

A ≤ 0.6
B < 1
C < 5
D < 25
E < 100
F ≥ 100

FIGURE 3.7k REACTOR BUILDING
RADIATION ZONE MAP FOR
FULL POWER / SHUTDOWN OPERATIONS
CROSS SECTION VIEW B-B



FULL POWER/SHUTDOWN
RADIATION LEVELS IN
mRem/hour

A ≤ 0.6
B < 1
C < 5
D < 25
E < 100
F ≥ 100

FIGURE 3.7R REACTOR BUILDING
RADIATION ZONE MAP FOR
FULL POWER AND SHUTDOWN OPERATIONS
AT ELEVATION 27200 (4F)

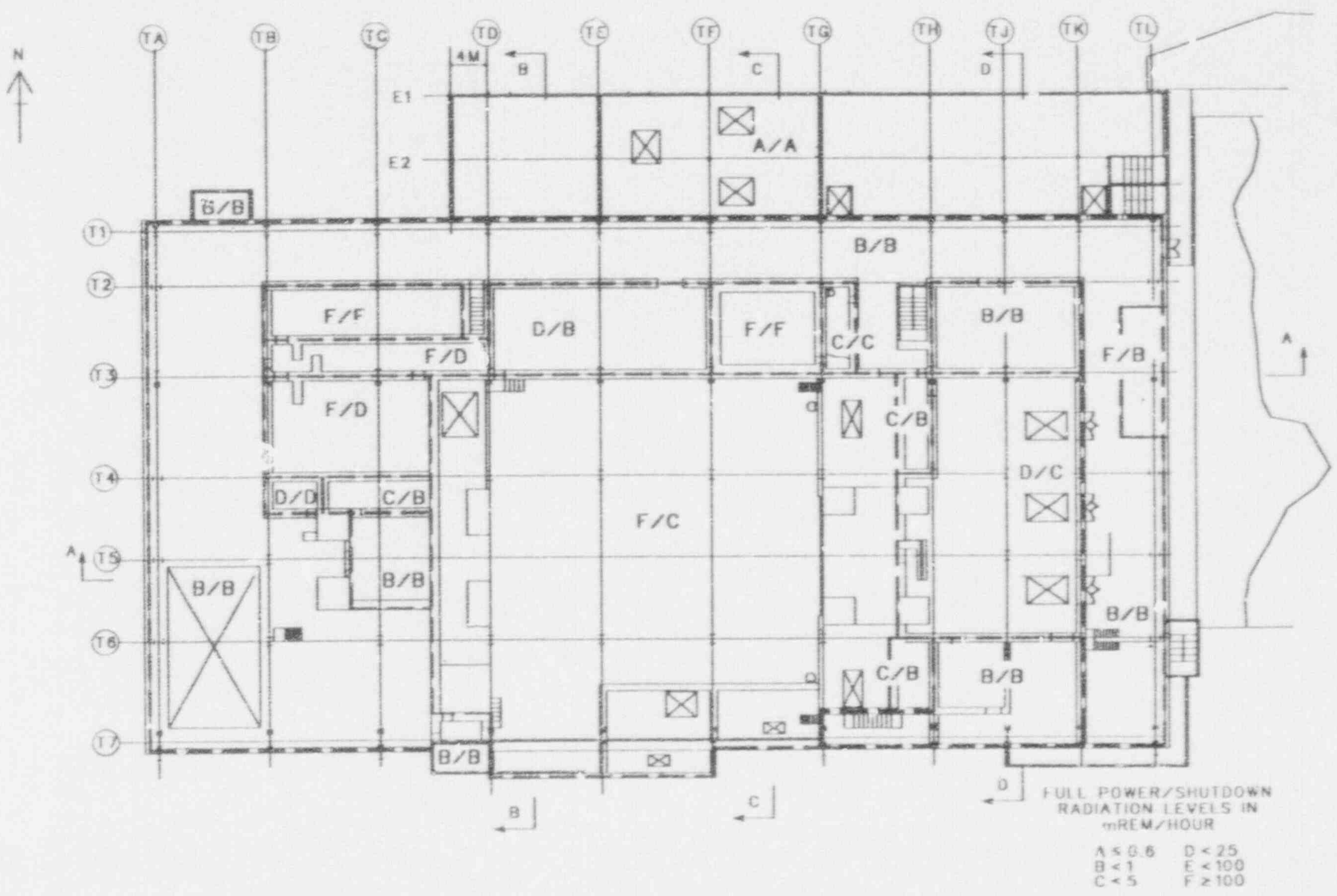


FIGURE 3.7m TURBINE BUILDING RADIATION ZONE AT ELEVATION TMSL 12.3M

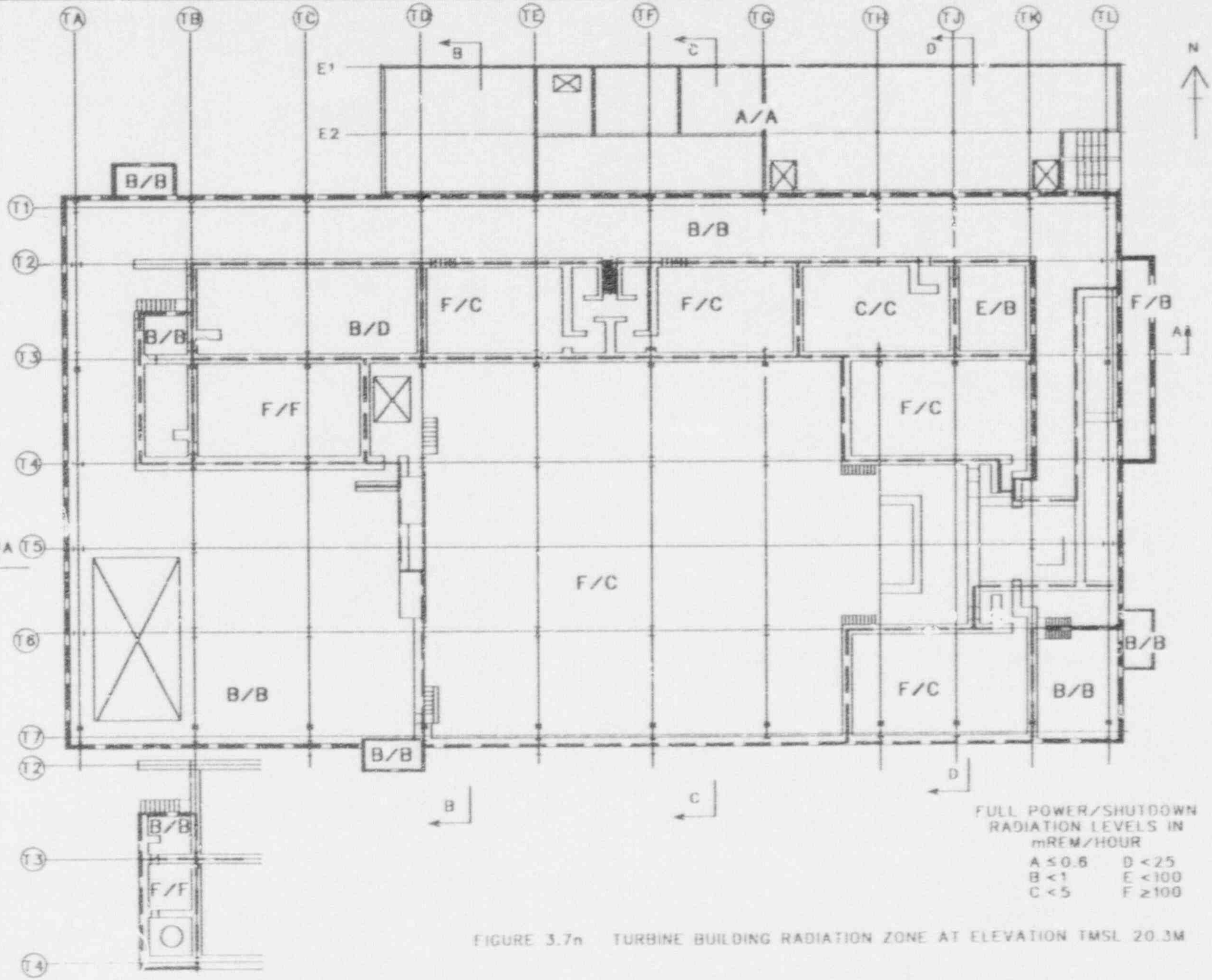
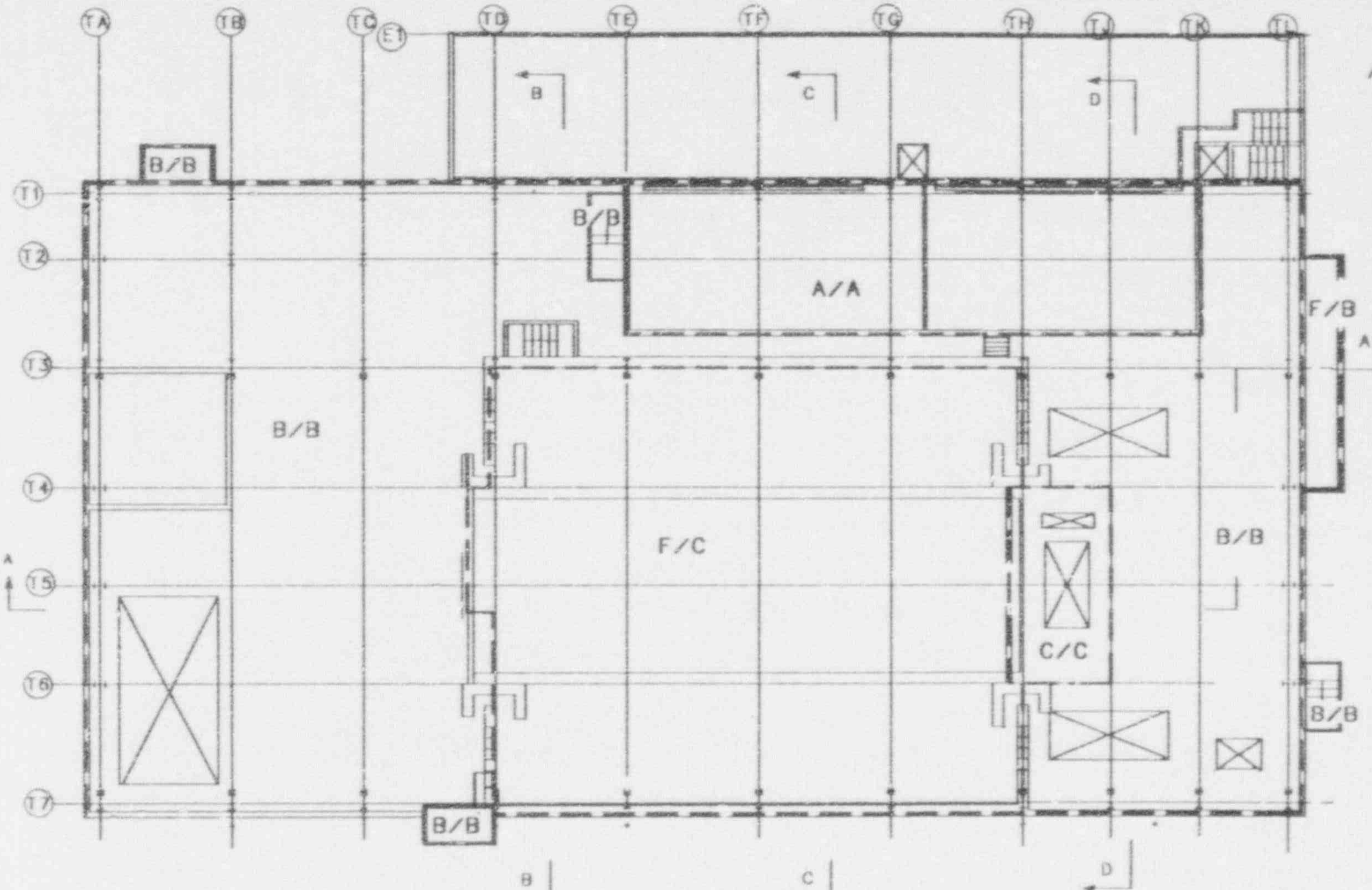


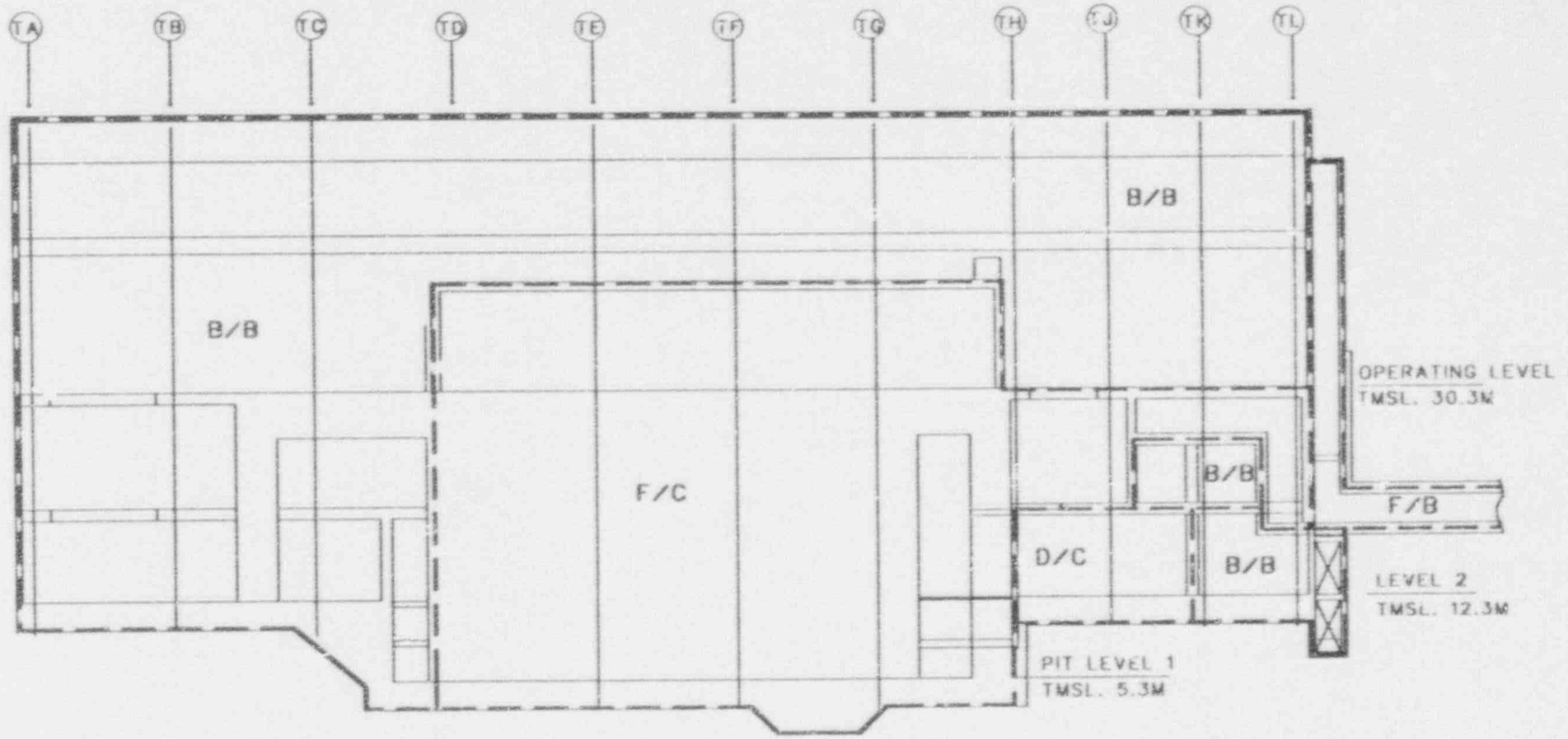
FIGURE 3.7n TURBINE BUILDING RADIATION ZONE AT ELEVATION TMSL 20.3M



FULL POWER/SHUTDOWN
RADIATION LEVELS IN
mREM/HOUR

A ≤ 0.6 D < 25
B < 1 E < 100
C < 5 F ≥ 100

FIGURE 3.7a TURBINE BUILDING RADIATION ZONE AT ELEVATION TMSL 30.3M



FULL POWER/SHUTDOWN
RADIATION LEVELS IN
mREM/HOUR

A ≤ 0.6	D < 25
B < 1	E < 100
C < 5	F ≥ 100

FIGURE 3.7p TURBINE BUILDING RADIATION ZONE AT NORMAL OPERATION LONGITUDINAL SECTION AA

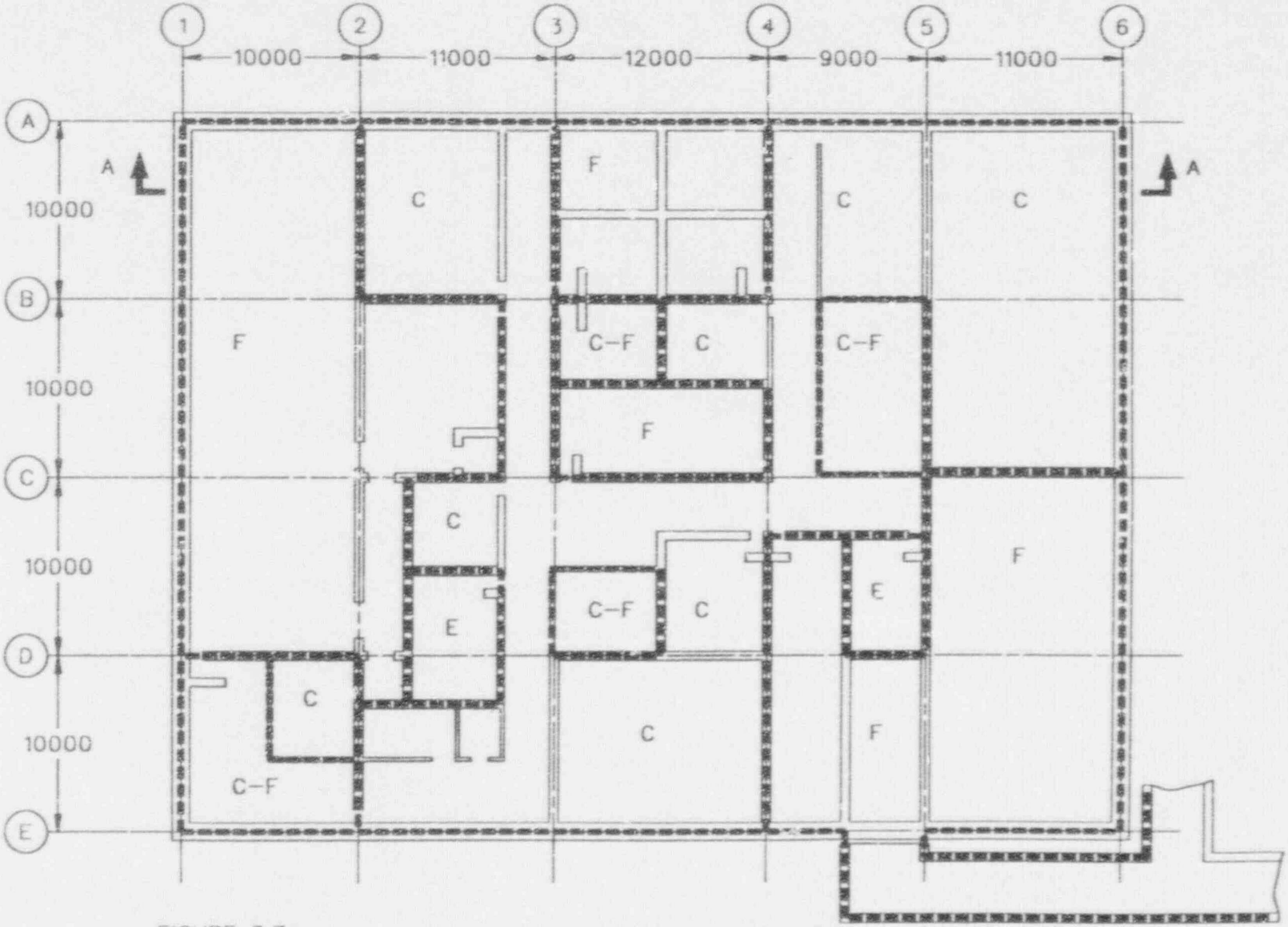


FIGURE 3.7q

RADWASTE BUILDING, RADIATION ZONE MAP, NORMAL OPERATION AT ELEVATION (-) 6500mm

A ≤ 0.6mrem/hr
B < 1.0mrem/hr
C < 5.0mrem/hr
D < 25.0mrem/hr
E < 100mrem/hr
F ≥ 100mrem/hr

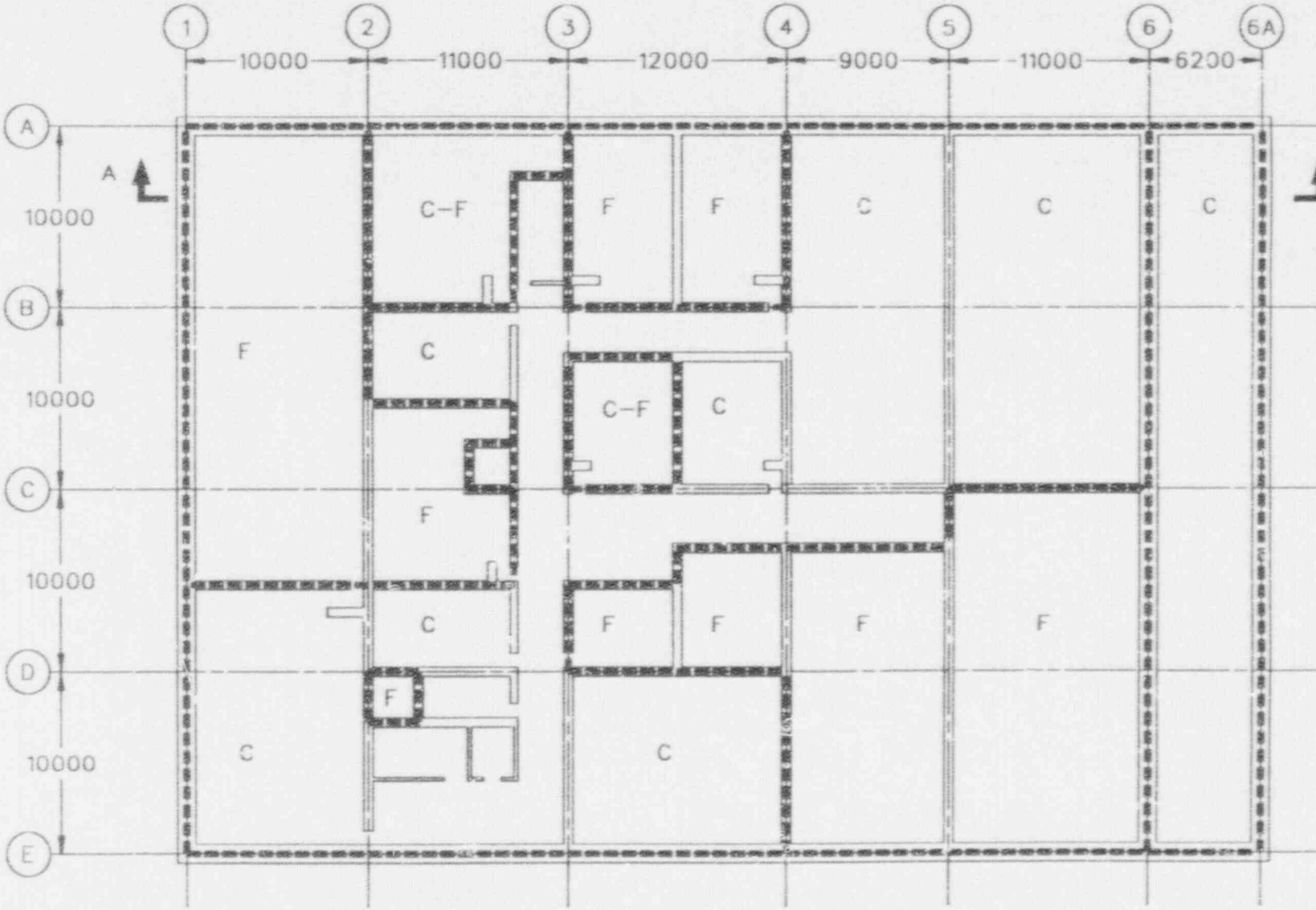


FIGURE 3.7r

RADWASTE BUILDING, RADIATION ZONE MAP, NORMAL OPERATION AT ELEVATION (–) 200mm

A ≤ 0.6mrem/hr D < 25.0mrem/hr
B < 1.0mrem/hr E < 100mrem/hr
C < 5.0mrem/hr F ≥ 100mrem/hr

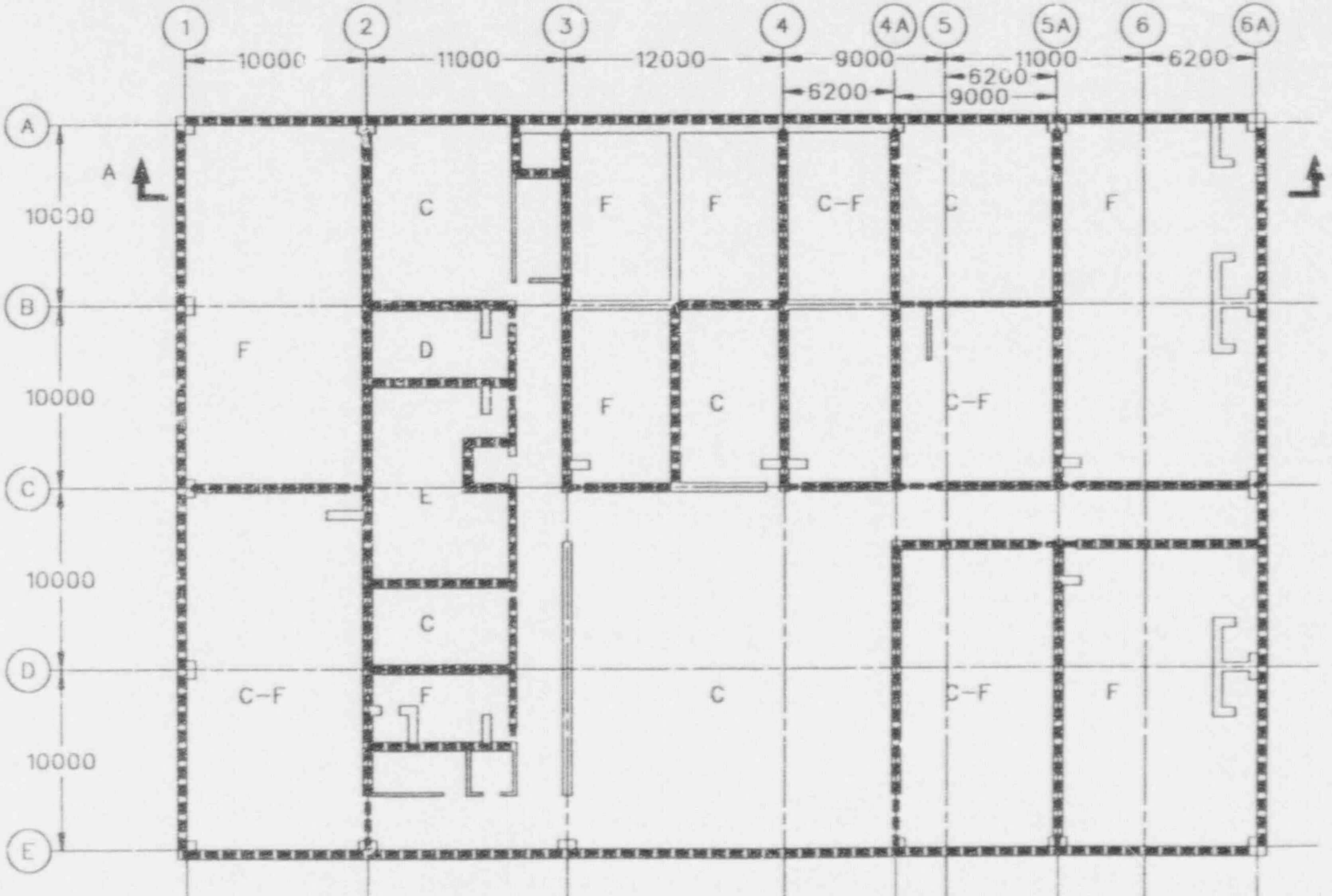


FIGURE 3.7s

RADWASTE BUILDING, RADIATION ZONE MAP, NORMAL OPERATION AT ELEVATION 7300mm

A ≤ 0.6mrem/hr	D < 25.0mrem/hr
B ≤ 1.0mrem/hr	E < 100mrem/hr
C < 5.0mrem/hr	F ≥ 100mrem/hr

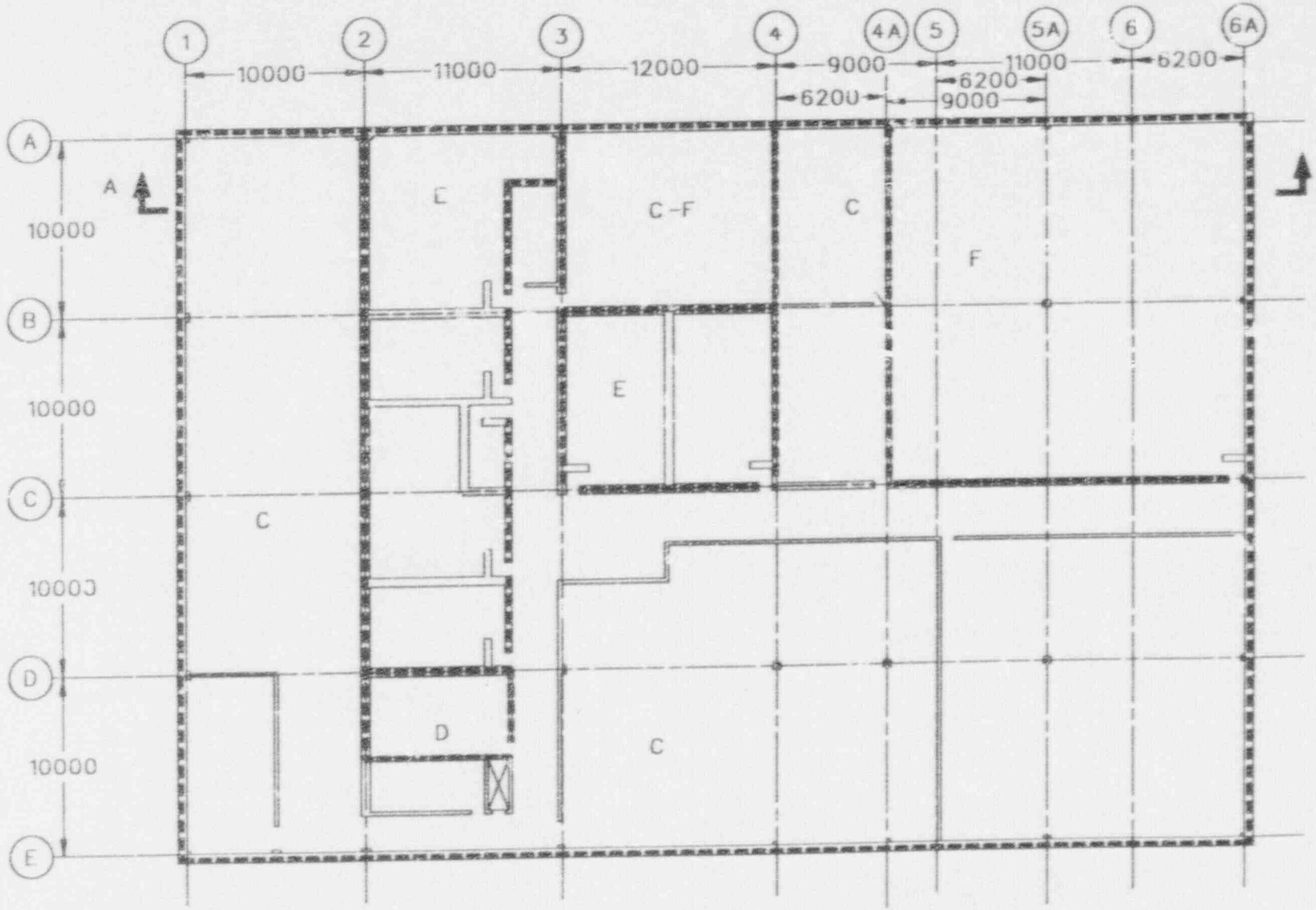


FIGURE 3.7t

RADWASTE BUILDING, RADIATION ZONE MAP, NORMAL OPERATION AT ELEVATION 16000mm

A ≤ 0.6mrem/hr D < 25.0mrem/hr
B < 1.0mrem/hr E < 100mrem/hr
C < 5.0mrem/hr F ≥ 100mrem/hr

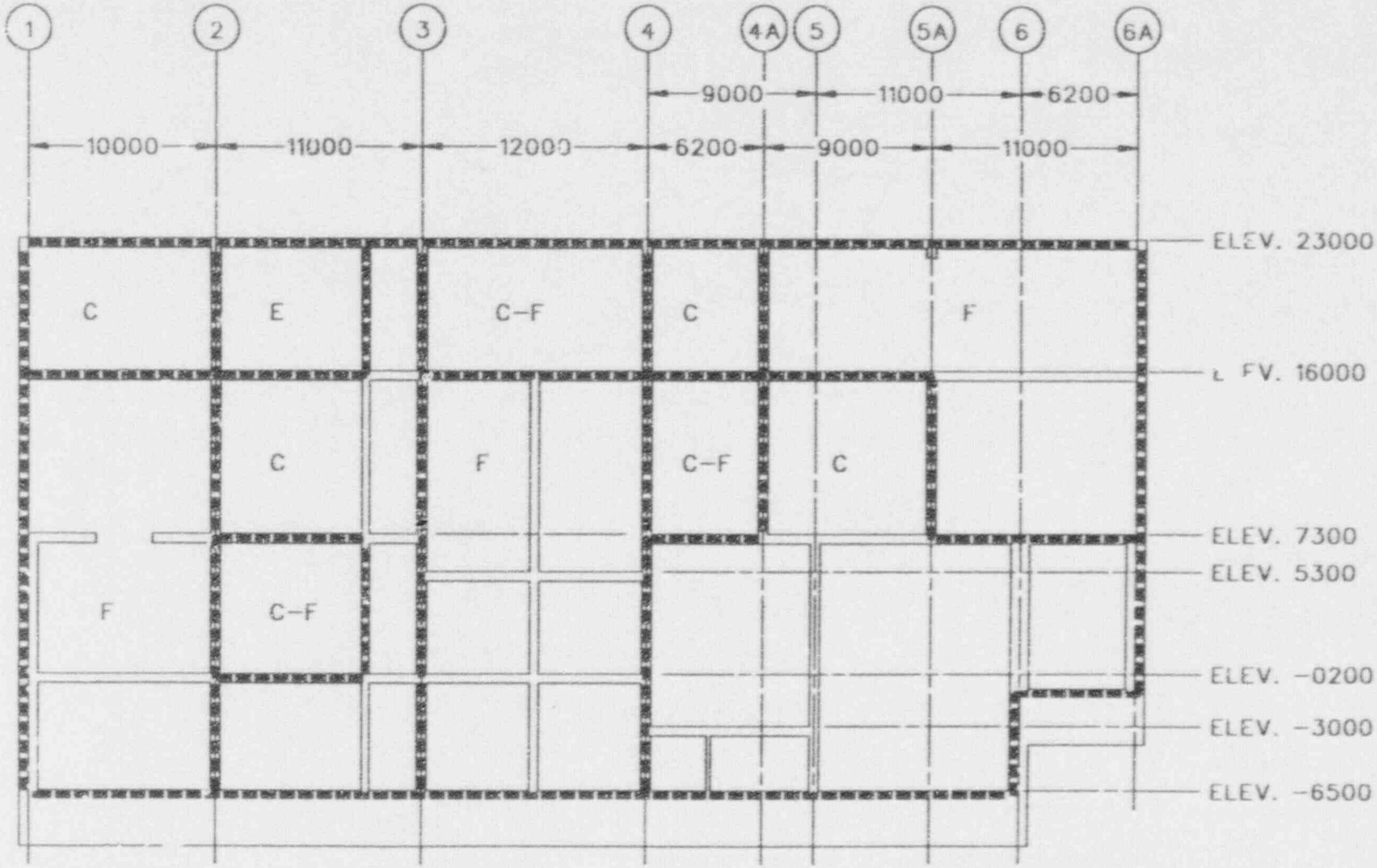
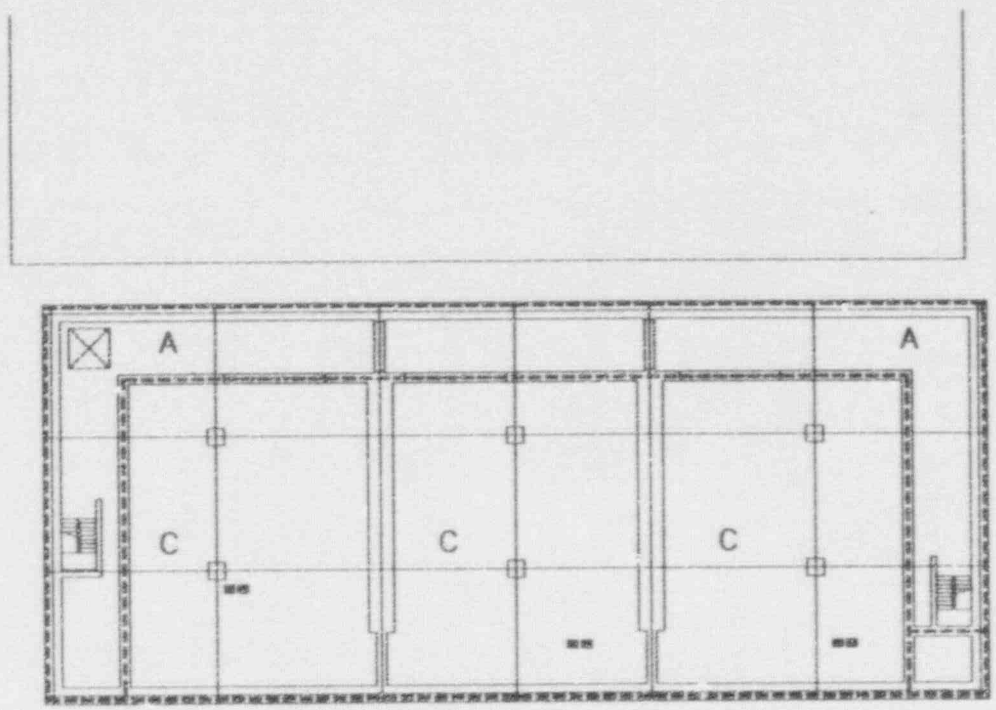


FIGURE 3.7u

RADWASTE BUILDING, RADIATION ZONE MAP, NORMAL OPERATION AT CROSS SECTION A-A

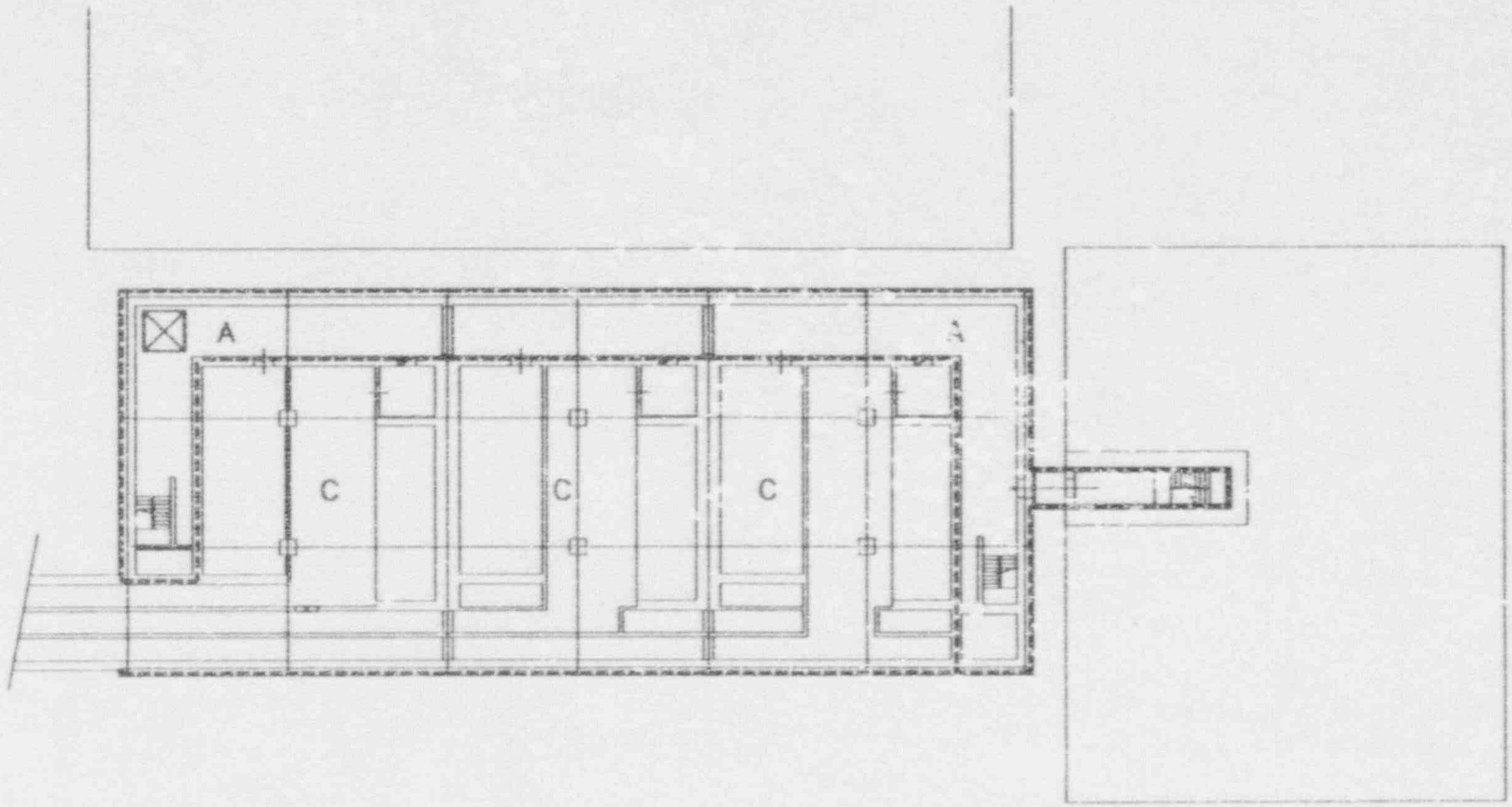
A ≤ 0.6mrem/hr D < 25.0mrem/hr
B < 1.0mrem/hr E < 100mrem/hr
C < 5.0mrem/hr F ≥ 100mrem/hr

3/30/92



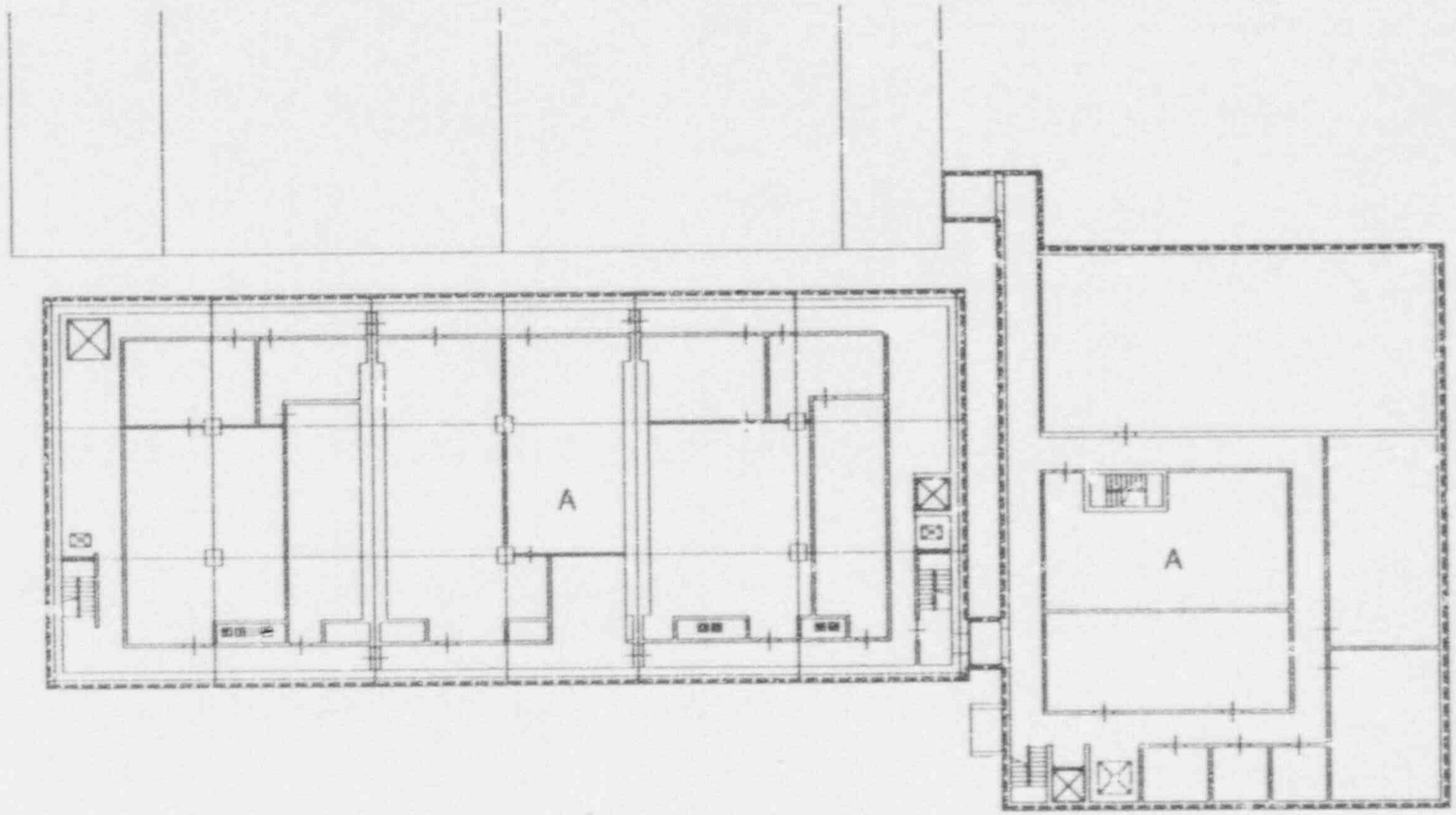
A ≤ 0.6 mREM/HOUR
B < 1.0 mREM/HOUR
C < 5.0 mREM/HOUR
D < 25.0 mREM/HOUR
E < 100.0 mREM/HOUR
F ≥ 100.0 mREM/HOUR

FIGURE 3.7v CONTROL BUILDING RADIATION ZONE, NORMAL OPERATION AT FLOOR LEVEL TMSL (-)8200MM



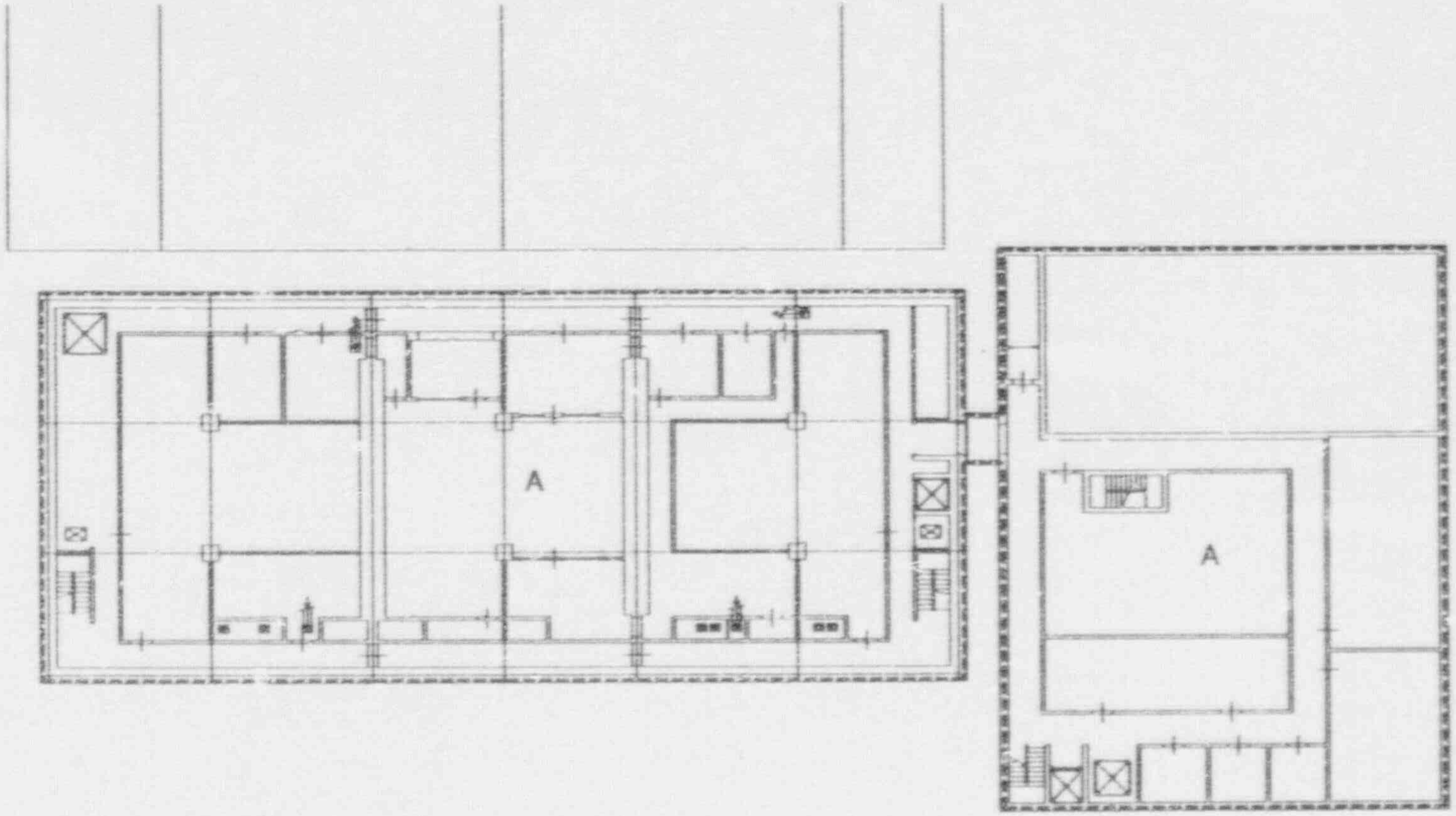
A ≤ 0.6 mREM/HOUR
B < 1.0 mREM/HOUR
C < 5.0 mREM/HOUR
D < 25.0 mREM/HOUR
E < 100.0 mREM/HOUR
F ≥ 100.0 mREM/HOUR

FIGURE 3.7w CONTROL BUILDING RADIATION ZONE, NORMAL OPERATION AT FLOOR LEVEL TMSL (−)12150MM



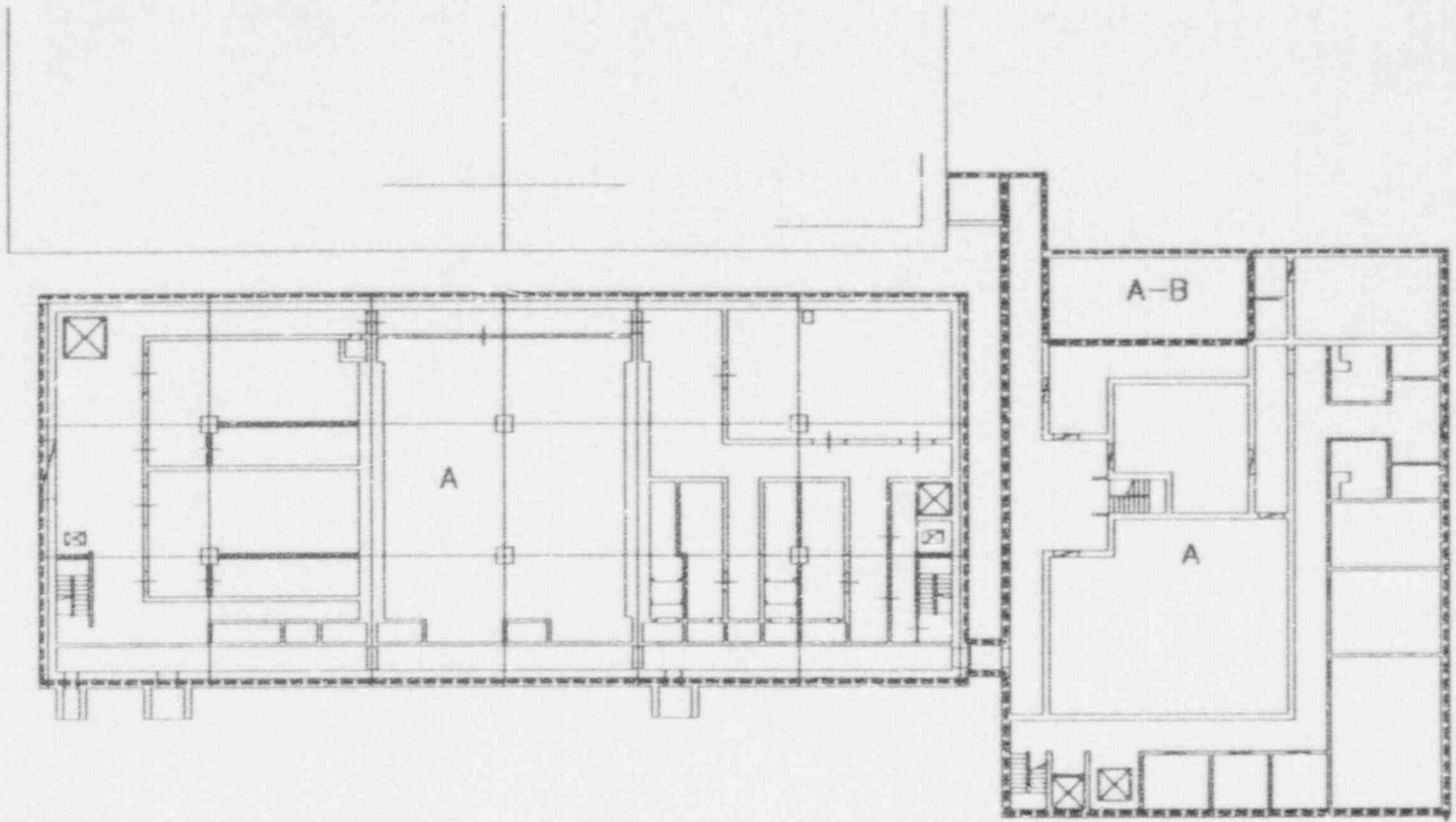
A ≤ 0.6 mREM/HOUR
B < 1.0 mREM/HOUR
C < 5.0 mREM/HOUR
D < 25.0 mREM/HOUR
E < 100.0 mREM/HOUR
F ≥ 100.0 mREM/HOUR

FIGURE 3.7x CONTROL BUILDING RADIATION ZONE, NORMAL OPERATION AT FLOOR LEVEL TMSL 3500MM



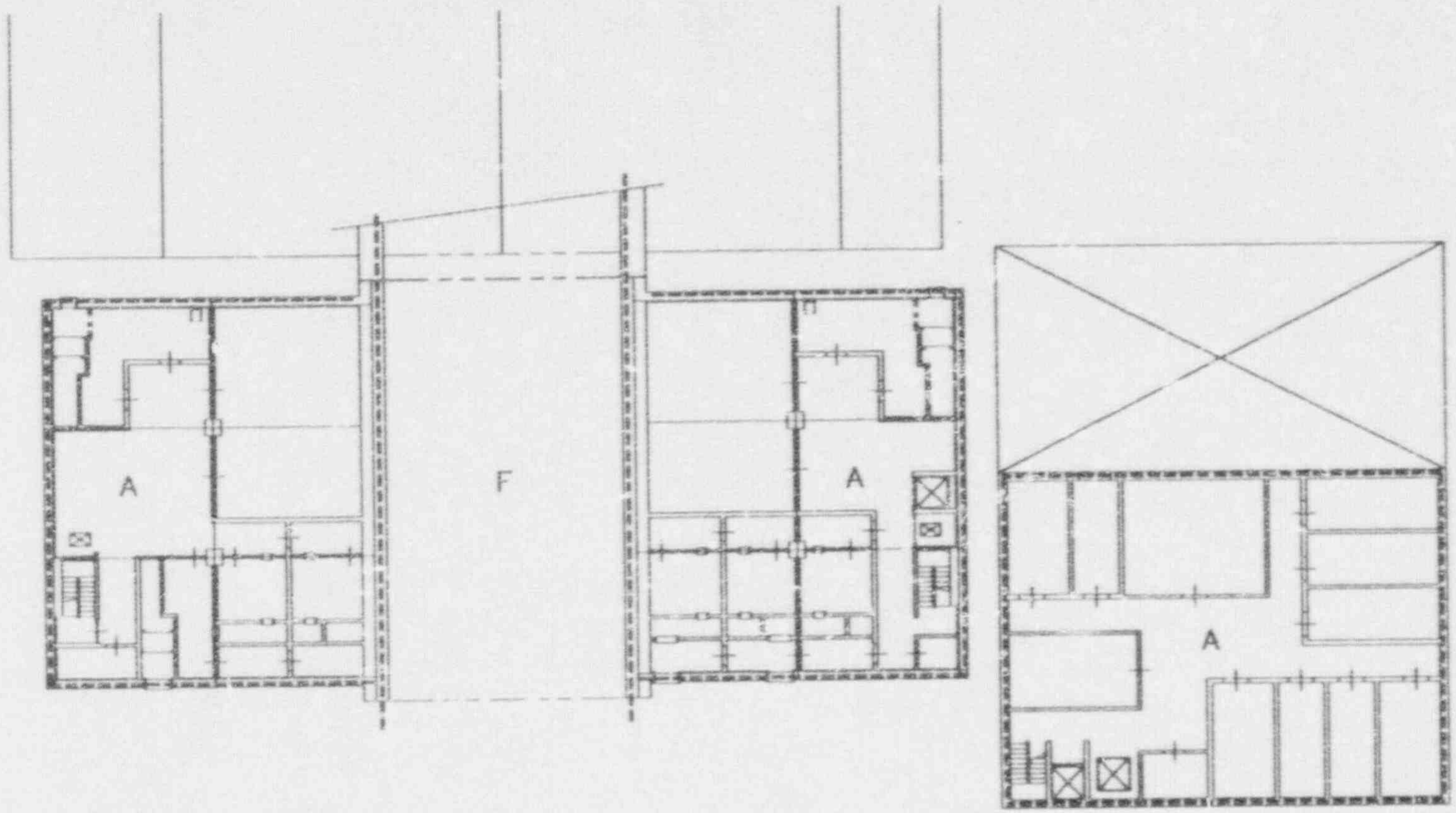
A ≤ 0.6 mREM/HOUR
B < 1.0 mREM/HOUR
C < 5.0 mREM/HOUR
D < 25.0 mREM/HOUR
E < 100.0 mREM/HOUR
F ≥ 100.0 mREM/HOUR

FIGURE 3.7y CONTROL BUILDING RADIATION ZONE, NORMAL OPERATION AT FLOOR LEVEL TMSL 7900MM



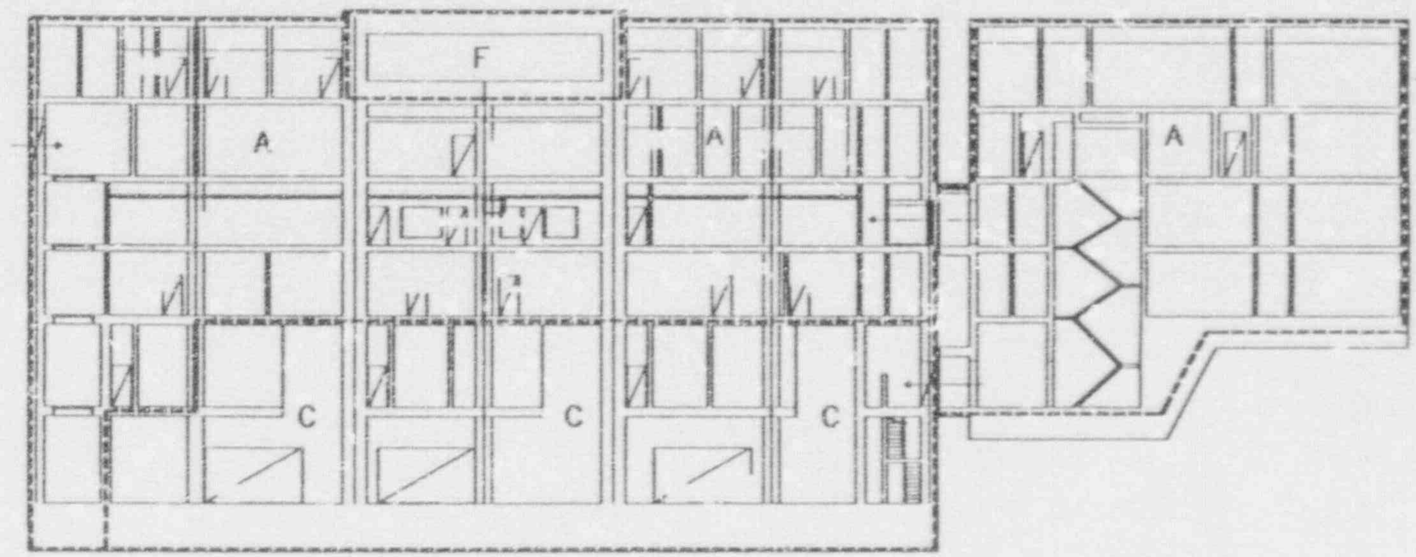
A ≤ 0.6 mREM/HOUR
B $<$ 1.0 mREM/HOUR
C $<$ 5.0 mREM/HOUR
D $<$ 25.0 mREM/HOUR
E $<$ 100.0 mREM/HOUR
F ≥ 100.0 mREM/HOUR

FIGURE 3.7z CONTROL BUILDING RADIATION ZONE, NORMAL OPERATION AT FLOOR LEVEL TMSL 12,300MM



A ≤ 0.6 mREM/HOUR
B < 1.0 mREM/HOUR
C < 5.0 mREM/HOUR
D < 25.0 mREM/HOUR
E < 100.0 mREM/HOUR
F ≥ 100.0 mREM/HOUR

FIGURE 3.7aa CONTROL BUILDING RADIATION ZONE, NORMAL OPERATION AT FLOOR LEVEL TMSL 17,150MM



A ≤ 0.6 mREM/HOUR
B < 1.0 mREM/HOUR
C < 5.0 mREM/HOUR
D < 25.0 mREM/HOUR
E < 100.0 mREM/HOUR
F ≥ 100.0 mREM/HOUR

FIGURE 3.7bb CONTROL BUILDING RADIATION ZONE, NORMAL OPERATION, SIDE VIEW

SECTION 12.3

CONTENTS

SECTION 12.3

CONTENTS (Continued)

TABLES

SECTION 12.3

ILLUSTRATIONS

SECTION 12.3

ILLUSTRATIONS (continued)

SECTION 12.3

ILLUSTRATIONS (continued)

SECTION 12.3

ILLUSTRATIONS (continued)

SECTION 12.3

ILLUSTRATIONS (continued)

SECTION 12.3

ILLUSTRATIONS (continued)

12.3 RADIATION PROTECTION DESIGN FEATURES

12.3.1 Facility Design Features

The ABWR Standard Plant is designed to meet the intent of Regulatory Guide 8.8 (i.e., to keep radiation exposures to plant personnel as low as reasonably achievable (ALARA)). This section describes the component and system designs in addition to the equipment layout employed to maintain radiation exposures ALARA. Consideration of individual systems is provided to illustrate the application of these principles.

Material application for primary coolant piping, tubing, vessel internal surfaces, and other components in contact with the primary coolant is discussed in the following pages. Typical nickel and cobalt contents of the principal materials applied are given in Table 12.3-2.

Carbon steel is used in a large portion of the system piping and equipment outside of the nuclear steam supply system. Carbon steel is typically low in nickel content and contains a very small amount of cobalt impurity.

Stainless steel is used in portions of the system such as the reactor internal components and heat exchanger tubes where high corrosion resistance is required. The nickel content of the stainless steels is in the 9 to 10.5% range and is controlled in accordance with applicable ASME material specifications. Cobalt content is controlled to less than 0.05% in the XM-19 alloy used in the control rod drives.

A previous review of materials certifications indicated an average cobalt content of only 0.15% in austenitic stainless steels.

Ni-Cr-Fe alloys such as Inconel 600 and Inconel X750, which have high nickel content, are used in some reactor vessel internal components. These materials are used in applications for which there are special requirements to be satisfied (such as possessing specific thermal expansion characteristics along with adequate corrosion resistance) and for which no suitable alternative low-nickel material is available. Cobalt content in the Inconel X750 used in the fuel assemblies is limited to 0.05%.

Stellite is used for hard facing of components which must be extremely wear resistant. Use of high cobalt alloys such as Stellite is restricted to those applications where no satisfactory alternative material is available. An alternative material (Colmonoy) has been used for some hard facings in the core area.

12.3.1.1 Equipment Design for Maintaining Exposure ALARA

This subsection describes specific components as well as system design features that aid in maintaining the exposure of plant personnel during system operation and maintenance ALARA. Equipment layout to provide ALARA exposures of plant personnel are discussed in Subsection 12.3.1.2.

(1) Pumps

Pumps located in radiation areas are designed to minimize the time required for maintenance. Quick change cartridge-type seals on pumps, and pumps with back pullout features that permit removal of the pump impeller or mechanical seals without disassembly of attached piping, are employed to minimize exposure time during pump maintenance. The configuration of piping about pumps is designed to provide sufficient space for efficient pump maintenance. Provisions are made for slushing and in certain cases chemically cleaning pumps prior to maintenance. Pump casing drains provide a means for draining pumps to the sumps prior to disassembly, thus reducing the exposure of personnel and decreasing the potential for contamination. Where two or more pumps conveying highly radioactive fluids are required for operational reasons to be located adjacent to each other, shielding is provided between the pumps to maintain exposure levels

ALARA. An example of this situation is the RWCS circulation pumps. Pumps adjacent to other highly radioactive equipment are also shielded to reduce the maintenance exposure, for example, in the radwaste system.

Whenever possible, operation of the pumps and associated valving for radioactive systems is accomplished remotely. Pump control instrumentation is located outside high radiation areas, and motor- or pneumatic-operated valves and valve extension stems are employed to allow operation from outside these areas.

(2) Instrumentation

Instruments are located in low radiation areas such as shielded valve galleries, corridors, or control rooms, whenever possible. Shielded valve galleries provided for this purpose include those for the RWCS, FPCC, and radwaste (cleanup phase separator, spent resin tank, and waste evaporator) systems. Instruments required to be located in high radiation areas due to operations requirements are designed such that removal of these instruments to low radiation areas for maintenance is possible. Sensing lines are routed from taps on the primary system in order to avoid placing the transmitters or readout devices in high radiation areas. For example, reactor water level as well as recirculation system pressure sensing instruments are located outside the drywell.

Liquid service equipment for systems containing radioactive fluids are provided with vent and backflush provisions. Instrument lines, except those for the reactor vessel, are designed with provisions for backflushing and maintaining a clean fill in the sensing lines. The reactor vessel sensing lines may be flushed with condensate following reactor blowdown.

(3) Heat Exchangers

Heat exchangers are constructed of stainless steel or Cu/Ni tubes to minimize the possibility of failure and reduce maintenance requirements. The heat exchanger design allows for the complete drainage of fluids from the exchanger, avoiding pooling effects that could lead to radioactive crud deposition. Connections are available for condensate or demineralized water flushing of the heat exchangers. For the reactor water clean up (CUW) system, separate connections are provided to chemically decontaminate both the heat exchangers (both regenerative and non-regenerative) and the pumps. The other main heat exchangers (RHR and RIP) are provided connections by which the exchangers can be flushed with clean water. The last main heat exchanger, the fuel pool heat exchanger, is downstream of the filter demineralizer and is therefore not subjected to flows containing significant amounts of fission or activation products. In all cases, the pumps directly involved with the heat exchangers are also inline for decontamination with the exchangers.. Instrumentation and valves are remotely operable to the maximum extent possible in the shielded heat exchanger cubicles, to reduce the need for entering these high radiation areas.

(4) Valves

Valve packing and gasket material are selected on a conservative basis, accounting for environmental conditions such as temperature, pressure, and radiation tolerance requirements to provide a long operating life. Valves have back seats to minimize the leakage through the packing. Straight-through valve configurations were selected where practical, over those which exhibit flow discontinuities or internal crevices to minimize crud trapping. Teflon gaskets are not used.

Wherever possible, valves in systems containing radioactive fluids are separated from those for "clean" services to reduce the radiation exposure from adjacent valves and piping during maintenance.

Pneumatic or mechanically operated valves are employed in high radiation areas, whenever practical, to minimize the need for entering these areas. For certain situations, manually operated valves are required, and in such cases extension valve stems are provided which are operated from a shielded area. Flushing and drain provi-

sions are employed in radioactive systems to reduce exposure to personnel during maintenance.

For areas in which especially high radiation levels are encountered, valving is reduced to the maximum extent possible with the bulk of the valve and piping located in an adjacent valve gallery where the radiation levels are lower.

(5) Piping

Piping was selected to provide a service life equivalent to the design life of the plant, with consideration given to corrosion allowances and environmental conditions. Piping for service in radioactive systems such as the RWC system have butt-welded connections, rather than socket welds, to reduce crud traps. Distinction is made between piping conveying radioactive and nonradioactive fluids, and separate routing is provided whenever possible. Piping conveying highly radioactive fluids is usually routed through shielded pipe chases and shielded cubicles. However, when these options are not feasible, the radioactive piping is embedded in concrete walls and floors.

(6) Lighting

Lighting is designed to provided sufficient illumination in radiation areas to allow quick and efficient surveillance and maintenance operations. To reduce the need for immediate replacement of defective bulbs, multiple lighting fixtures are provided in shielded cubicles. Consideration is also given to locating lighting fixtures in easily accessible locations, thus reducing the exposure time for bulb replacement.

(7) Floor Drains

Floor drains with appropriately sloped floors are provided in shielded cubicles where the potential for spills exist. These drain lines having a potential for containing highly radioactive fluids are routed through pipe chases, shielded cubicles, or are embedded in concrete walls and floors. Smooth epoxy-type coatings are employed to facilitate decontamination when a spill does occur.

(8) SGTS Filters

The SGTS filter is located in a separate shielded cubicle and is separated by a shield wall from the exhaust fans to reduce the radiation exposure of personnel during maintenance. The dampers located in the cubicles are remotely operated, thus requiring no access to the cubicle during operation. A pneumatic transfer system is employed to remove the radioactive charcoal from the filter, requiring entry into the shielded cubicle only during the connection of the hoses to the SGTS filter unit.

12.3.1.2 Plant Design for Maintaining Exposure (ALARA)

This subsection describes features of equipment layout and design which are employed to maintain personnel exposures ALARA.

(1) Penetrations

Penetrations through shield walls are avoided whenever possible to reduce the number of streaming paths provided by these penetrations. Whenever penetrations are required through shield walls, however, they are located to minimize the impact on surrounding areas. Penetrations are located so that the radiation source cannot "see" through the penetration. When this is not possible, or to provide an added order of reduction, penetrations are located to exit far above floor level in open corridors or in other relatively inaccessible areas. Penetrations which are offset through a shield wall are frequently employed for electrical penetrations to reduce the streaming of radiation through these penetrations.

Where permitted, the annular region between pipe and penetration sleeves, as well as electrical penetrations, are filled with shielding material to reduce the streaming area presented by these penetrations. The shielding materials used in these applications include a lead-loaded silicone foam, with a density comparable to concrete, and a boron-loaded refractory-type material for applications requiring neutron as well as gamma shielding. There are certain penetrations where these two approaches are not feasible or are not sufficiently

effective. In those cases, a shielded enclosure about the penetration as it exits in the shield wall, with a 90 degree bend of the process pipe as it exits the penetration, is employed.

(2) Sample Stations

Sample stations in the plant provide for the routine surveillance of reactor water quality. These sample stations are located in low radiation areas to reduce the exposure to operating personnel. Flushing provisions are included using demineralized water, and pipe drains to plant sumps are provided to minimize the possibility of spills. Fume hoods are employed for airborne contamination control. Both working areas and fume hoods are constructed of polished stainless steel to ease decontamination if a spill does occur. Grab spouts are located above the sink to reduce the possibility of contaminating surrounding areas during the sampling process.

(3) HVAC Systems

Major HVAC equipment (blowers, coolers, and the like) is located in dedicated low radiation areas to maintain exposures to personnel maintaining these equipment ALARA. HVAC ducting is routed outside pipe chases and does not penetrate pipe chase walls, which could compromise the shielding. HVAC ducting penetrations through walls of shielded cubicles are located to minimize the impact of the streaming radiation levels in adjoining areas. Additional HVAC design considerations are addressed in Subsection 12.3.3.

(4) Piping

Piping containing radioactive fluids is routed through shielded pipe chases, shielded equipment cubicles, or embedded in concrete walls and floors, whenever possible. "Clean" services such as compressed air and demineralized water are not routed through shielded pipe chases. For situations in which radioactive piping must be routed through corridors or other low radiation areas, an analysis is conducted to ensure that this routing does not compromise the existing radiation zoning.

Radioactive services are routed separately from piping containing nonradioactive fluids, whenever possible, to minimize the exposure to personnel during maintenance. When such routing combinations are required, however, drain provisions are provided to remove the radioactive fluid contained in equipment and piping. "Clean" services and radioactive piping are required at times to be routed together in shielded cubicles. In such situations, provisions are made for the valves required for process operation to be controlled remotely, without need for entering the cubicle.

Penetrations for piping through shield walls are designed to minimize the impact on surrounding areas. Approaches used to accomplish this objective are described in Subsection 12.3.1.2.1.

Piping configurations are designed to minimize the number of "dead legs" and low points in piping runs to avoid accumulation of radioactive crud and fluids in the line. Drains and flushing provisions are employed whenever feasible to reduce the impact of required "dead legs" and low points. Systems containing radioactive fluids are welded to the most practical extent to reduce leakage through flanged or screwed connections. For highly radioactive systems, butt welds are employed to minimize crud traps. Provisions are also made in radioactive systems for flushing with condensate or chemically cleaning the piping to reduce crud buildup.

(5) Equipment Layout

Equipment layout is designed to reduce the exposure of personnel required to inspect or maintain equipment. "Clean" pieces of equipment are located separately from those

which are sources of radiation whenever possible. For systems that have components that are major sources of radiation, piping and pumps are located in separate cubicles to reduce exposure from these components during maintenance. These major radiation sources are also separately shielded from each other.

(6) Contamination Control

Contaminated piping systems are welded to the most practical extent to minimize leaks through screwed or flanged fittings. For systems containing highly radioactive fluids, drains are hard piped directly to equipment drain sumps, rather than to allow contaminated fluid to flow across the floor to a floor drain. Certain valves in the main steam line are also provided with leakage drains piped to equipment drain sumps to reduce contamination of the steam tunnel. Pump casing drains are employed on radioactive systems whenever possible to remove fluids from the pump prior to disassembly. In addition, provisions for flushing with condensate, and in especially contaminated systems, for chemically cleaning the equipment prior to maintenance, are provided.

The HVAC system is designed to limit the extent of airborne contamination by providing air flow patterns from areas of low contamination to more contaminated areas. Penetrations through outer walls of the building containing radiation sources are sealed to prevent miscellaneous leaks into the environment. The equipment drain sump vents are fitted with charcoal canisters or piped directly to the radwaste HVAC system to remove airborne contaminants evolved from discharges to the sump. Wet transfer of both the steam dryer and separator also reduces the likelihood of contaminants on this equipment being released into the plant atmosphere. In areas where the reduction of airborne contaminants cannot be eliminated efficiently by HVAC systems, breathing air provisions are provided, for example, for CRD removal under the reactor pressure vessel and in the CRD maintenance room.

Appropriately sloped floor drains are provided in shielded cubicles and other areas where the potential for a spill exists to limit the extent of contamination. Curbs are also provided to limit contamination and simplify washdown operations. A cask decontamination vault is located in the reactor building where the spent fuel cask and other equipment may be cleaned. The CRD maintenance room is used for disassembling control rod drives to reduce the contamination potential.

Consideration is given in the design of the plant for reducing the effort required for decontamination. Epoxy-type wall and floor coverings have been selected which provide smooth surfaces to ease decontamination surfaces. Expanded metal-type floor gratings are minimized in favor of smooth surfaces in areas where radioactive spills could occur. Equipment and floor drain sumps are stainless steel lined to reduce crud buildup and to provide surfaces easily decontaminated.

12.3.1.3 Radiation Zoning

Radiation zones are established in all areas of the plant as a function of both the access requirements of that area and the radiation sources in that area. Operating activities, inspection requirements of equipment, maintenance activities, and abnormal operating conditions are considered in determining the appropriate zoning for a given area. The relationship between radiation zone designations and accessibility requirements is presented in the following tabulation:

Zone Designation	Dose Rate (mRem/hr)	Access Description
A	≤ 0.6	Uncontrolled, unlimited access
B	< 1	Controlled, unlimited access

Zone Designation	Dose Rate (mRem/hr)	Description
C	< 5	Controlled, limited access, 20 hr/wk
D	< 25	Controlled, limited acc..., 4 hr/wk
E	< 100	Controlled, limited access, 1 hr/wk
F	> 100	Controlled access. Authorization re...ired.

The dose rate applicable for a particular zone is based on operating experience and represents design dose rates in a particular zone, and should not be interpreted as the expected dose rates which would apply in all portions of that zone, or for all types of work within that zone, or at all periods of entry into the zone. Large BWR plants have been in operation for two decades, and operating experience with similar design basis numbers shows that only a small fraction of the 10CFR20 maximum permissible dose is received in such zones from radiation sources controlled by equipment layout or the structural shielding provided. Therefore, on a practical basis, a radiation zoning approach as described above accomplishes the as low as reasonably achievable objectives for doses as required by 10 CFR 20.1(c). The radiation zone maps for this plant with zone designations as described in the preceding tabulations are contained in Figures 12.3-1 through 12.3-22 and 12.3-37 through 12.3-55.

Access to areas in the plant is controlled and regulated by the zoning of a given area. Areas with dose rates such that an individual would receive a dose in excess of 100 mRem in a period of one hour are locked and posted with "High Radiation Area" signs. Entry to these areas is on a controlled basis. Areas in which an individual would receive a dose in excess of 5 mRem up to 100 mRem within a period of one hour are posted with signs indicating that this is a radiation area and include, in certain cases, barriers such as ropes or doors.

12.3.1.4 Implementation of ALARA

In this subsection, the implementation of design considerations to radioactive systems for maintaining personnel radiation exposures as low as reasonably achievable is described for the following five systems:

(1) Reactor water cleanup system;

(2) Residual heat removal system (shutdown cooling mode);

(3) Fuel pool cooling and cleanup system;

(4) Main steam; and

(5) Standby gas treatment system

12.3.1.4.1 Reactor Water Cleanup System

This system is designed to operate continuously to reduce reactor water radioactive contamination. Components for this system are located outside the containment and include filter demineralizers, a backwash receiving tank, regenerative and nonregenerative heat exchangers, pumps, and associated valves.

The highest radiation level components include the filter demineralizers, heat exchangers, and backwash receiving tank. The filter demineralizers are located in separate concrete-shielded cubicles which are accessible through shielded hatches. Valves and piping within the cubicles are reduced to the extent that entry into the cubicles is not required during any operational phase. Most of the valves and piping are located in a shielded valve gallery adjacent to the filter demineralizer cubicles. The valves are remotely operable to the greatest practical extent to minimize entry requirements into this area. The RWCS heat exchangers are also located in a shielded cubicle with valves operated remotely by use of extension valve stems, or from instrument panels located outside the cubicle. The backwash tank is shielded separately from the resin transfer pump, permitting maintenance of the pump without being exposed to the spent

resins contained in the backwash tank. The pump valves are operated remotely from outside the cubicle.

The RWCS system is provided with chemical cleaning connections which can utilize the condensate system to flush piping and equipment prior to maintenance. The RWCS filter demineralizer can be remotely back-flushed to remove spent resins and filter aid material. If additional decontamination is required, chemical addition connections are provided in the piping to clean piping as well as equipment prior to maintenance. The backwash tank employs an arrangement to agitate resins prior to discharge. The tank vent is fitted with a charcoal filter canister to reduce emission of radioiodines into the plant atmosphere. The HVAC system is designed to limit the spread of contaminants from these shielded cubicles by maintaining a negative pressure within the cubicles relative to the surrounding areas.

Personnel access to the cubicles for maintenance of these components is on a controlled basis whereby specific restrictions and controls are implemented to minimize personnel exposure.

12.3.1.4.2 Residual Heat Removal System (Shutdown Cooling Mode)

In the shutdown cooling mode, the system is placed in operation to recirculate reactor coolant to remove reactor decay heat following the period of approximately 2 to 4 hours after shutdown. During power operation, the system is not in use except for flow testing to and from the suppression pool. Therefore, there is no reactor coolant flow through the system and only traces of residual radioactive contamination may exist from prior operation.

System components are located in the reactor building and include three RHR pumps and three heat exchangers, which are actively used in the shutdown cooling mode. The heat exchangers and associated pumps work independently of the other pump and heat exchangers and are located in separate concrete-shielded cubicles. The cubicles are accessible through labyrinths which reduce radiation levels outside the cubicle to acceptable levels. A knockout wall constructed of vertically and horizontally lapped concrete blocks is provided for pump removal. A concrete hatch is provided through the roof of the cubicle for heat exchanger removal. Highest radiation levels occur at the heat exchangers during the cooldown period (1/2 to 4 hours after shutdown). During all other operation and plant shutdown periods, the radiation level near these components is considerably decreased.

Access to the RHR pumps and heat exchangers for any inspection or maintenance is permitted on a controlled basis. System maintenance is performed during periods of system shutdown when no reactor coolant is being circulated through the system. Specific restrictions and controls for personnel entry into the shielded cubicles are implemented to minimize personnel exposures. Inspection of the equipment in these cubicles can be conducted from platforming about the heat exchangers to simplify inspection of this equipment and consequently reduce the exposure during inspection.

The reactor building is not used exclusively for radioactive equipment or systems. However, all components of the system, as described, are contained within shielded cubicles. This shielding is sufficient to reduce the radiation level during the shutdown mode of operation to less than 5 mR/hr in adjacent areas where clean components, materials, or equipment are located.

System control panels and instrumentation are located in the main control room. This precludes exposure to the control operator during operation of the system for plant cooldown.

12.3.1.4.3 Fuel Pool Cooling and Cleanup System

This system is designed to operate continuously to handle the spent fuel cooling load and to reduce pool water radioactive contamination.

The system components are located in the reactor building. Included are two filter demineralizer units which serve to remove radioactive contamination from the fuel pool and suppression water. These units are the highest radiation level components in the system. Each unit is located in a concrete-shielded cubicle which is accessible through a shielded hatch. Provisions are made for remotely backflushing the units when filter and resin material are spent. This removal of radioactively contaminated material reduces the component radiation level considerably and serves to minimize exposures during maintenance. All valves (inlet, outlet, recycle, vent, and drain) to the filter demineralizer units are located outside the shielded cubicles in a separate shielded cubicle together with associated piping, headers, and instrumentation. The radiation level in this cubicle is sufficiently low to permit required maintenance to be performed. Piping potentially containing resin is continuously sloped downward to the backwash tank.

The backwash tank is shared with the RWCS (see Section 12.3.1.4.1). The system also includes two low radiation level heat exchangers and two circulation pumps. The heat exchangers' design radiation levels are low enough to locate them in an open alcove area. The pumps are located in a low radiation area adjacent to the shielded backwash tank. System piping is routed so as not to compromise zoning requirements as established in the radiation zone maps.

All of the aforementioned shielded system components are consolidated in the same section of the reactor building. Personnel access to shielded system components is controlled to minimize personnel exposure. Shielding for the components is designed to reduce the radiation level to less than 1 mR/hr in adjacent areas where normal access is permitted. Controlled areas where the new resin tank, filter aid tank, and pumps are located, are shielded to less than 5 mR/hr.

Operation of the system is accomplished from the MRC and local control panels located where designed radiation levels are less than 1 mR/hr and normal personnel access is permitted.

12.3.1.4.4 Main Steam System

All radioactive materials in the main steam system, located in the main steam-feedwater pipe tunnel of the reactor buildings, result from radioactive sources carried over from the reactor during plant operation, including high energy short-lived Nitrogen-16. During plant shutdown, residual radioactivity from prior plant operation is the radiation source.

Access to the main steam pipe tunnel in the reactor building is controlled. Entry into the reactor building steam tunnel is through a controlled personnel access door shielded by a concrete labyrinth to attenuate radiation streaming from the steam lines to adjoining areas. During reactor operation, the steam tunnel is not accessible except in the hot standby conditions under regulated access.

Leakage from selected valves on to surrounding areas is minimized by providing valve drains piped to equipment drain sumps. Floor drains are provided to minimize the spread of contamination should a leakage occur.

Penetrations through the steam tunnel walls are minimized to reduce the streaming paths made available by these penetrations. The blowout panels for the steam tunnel are located in the relatively inaccessible upper section of the RHR heat exchanger shielded cubicles which are controlled access areas. Penetrations through the steam tunnel walls, when they are required, are located so as to exit in controlled access areas or in areas that are not aligned with the steam lines. A lead-loaded silicone foam is employed whenever possible for these penetrations to reduce the available streaming area presented.

12.3.1.4.5 Standby Gas Treatment System

The standby gas treatment system treats the reactor building ventilation air in the event of the release of radioactivity to this building. The system contains radioactivity only in the event of an emergency of abnormal condition. However, it is a potential source of concentrated radioactivity following such an occurrence.

The system starts automatically on a high building ventilation radiation or LOCA signal and can also be manually started from the main control room. Operation of the system does not require entering the shielded filter cubicle.

The system consists of two parallel treatment trains, each train being located in its own shielded room. In addition, the fans for each train are shielded from the filter, which is the dominant source of radiation for the system. Each train includes high efficiency particulate filters and charcoal filters for removal of radioactivity prior to exhausting air to the outside environment.

All components are located in the reactor building, and personnel access to the shielded rooms for inspection or maintenance is on a controlled basis. A remote charcoal filter removal capability is provided to minimize exposures, which requires entry into the filter area only during the initial connection of the unit to the charcoal removal system. Sufficient space is provided around the filter unit to allow easy removal and bagging of the high efficiency filters.

The SGTS filter shielding is adequate to reduce the radiation level in fuel areas of the reactor building to less than 1 mR/hr following an isolation scram event with containment purge.

12.3.2 Shielding

12.3.2.1 Design Objectives

The primary objective of the radiation shielding is to protect operating personnel and the general public from radiation emanating from the reactor, the power conversion systems, the radwaste process systems, and the auxiliary systems, while maintaining appropriate access for operation and maintenance. The radiation shielding is also designed to keep radiation doses to equipment below levels at which disabling radiation damage occurs. Specifically, the shielding requirements in the plant are designed to perform the following functions:

(1) limit the exposure of the general public, plant personnel, contractors, and visitors to levels that are ALARA and within 10CFR20 requirements;

(2) limit the radiation exposure of personnel, in the unlikely event of an accident, to levels that are ALARA and which conform to the limits specified in 10CFR50, Appendix A, Criterion 19 to ensure that the plant is maintained in a safe condition during an accident; and

(3) limit the radiation exposure of critical components within specified radiation tolerances, to assure that component performance and design life are not impaired.

12.3.2.2 Design Description

12.3.2.2.1 General Design Guides

In order to meet the design objectives, the following design guides are used in the shielding design of the ABWR:

(1) All systems containing radioactivity are identified and shielded based on access and exposure level requirements of surrounding areas. The radiation zone maps described in Subsection 12.3.1.3 indicate design radiation levels for which shielding for equipment contributing to the dose rate in the area is designed.

(2) The source terms used in the shielding calculations are analyzed with a conservative approach. Transient conditions as well as shut down and normal operating conditions are considered to ensure that a conservative source is used in the analysis.

Shielding design is based on fission product quantities in the coolant corresponding to the design basis off-gas release, in addition to activation products. This is considered an anticipated operational occurrence, and hence represents conservatism in design. For components where N-16 is the major radiation source, a concentration based upon operating plant data is used.

(3) Effort is made to locate processing equipment in a manner which minimizes the shielding requirements. Shielded labyrinths are used to eliminate radiation streaming through access ways from sources located in cubicles.

(4) Penetrations through shield walls are located so as to minimize the impact on surrounding areas due to radiation streaming through the penetrations. The approaches used to locate and shield penetrations, when required, are discussed in Subsection 12.3.1.2 (1).

(5) Wherever possible, radioactive piping is run in a manner which will minimize radiation exposure to plant personnel. This involves:

(a) minimizing radioactive pipe routing in corridors;

(b) avoiding the routing of high-activity pipes through low-radiation zones;

(c) use of shielded pipe trenches and pipe chases, where routing of high-activity pipes in low-level areas cannot be avoided, or if these are not available and the pipe routing permits, embedding the pipes in concrete walls and floor; and

(d) separating radioactive and nonradioactive pipes for maintenance purposes.

(6) To maintain acceptable levels at the valve stations, motor-operated or diaphragm valves are used where practical. For valve maintenance, provision is made for draining and flushing associated equipment so that radiation exposure is minimized. If manual valves are used, provision is made for shielding the operator from the valve by use of shield walls and valve stem extensions, where practicable.

(7) Shielding is provided to permit access and occupancy of the control room to ensure that plant personnel exposure following an accident does not exceed the guideline values set forth in 10CFR50, Appendix A, Criterion 19. The analyses of the doses to Control Room personnel for the design basis accidents are included in Chapter 15.

(8) The dose at the site boundary as a result of direct and scattered radiation from the turbine and associated equipment is considered.

(9) In selected situations, provisions are made for shielding major radiation sources during inservice inspection to reduce exposure to inspection personnel. For example, steel platforms are provided for ISI of the RPV nozzle welds and associated piping.

(10) The primary material used for shielding is concrete at a density of 2.3 gr/cm^3. Concrete used for shielding purposes is designed in accordance with Regulatory Guide 1.69. Where special circumstances dictate, steel, lead, water, lead-loaded silicone foam, or a boron-laced refractory material is used.

(11) There is no field-routed piping in the ABWR design. Large and small piping, as well as instrument tubing, are routed by designers as indicated in the preceding paragraph (5).

12.3.2.2.2 Method of Shielding Design

The radiation shield wall thicknesses are determined using basic shielding data and proven shielding codes. A list of the computer programs used is contained in Table 12.3-1. The shielding design methods used also rely on basic radiation transport equations contained in Reference 1. The sources for basic shielding

data, such as cross sections, buildup factors, and radioisotope decay information, are listed in References 2 through 10.

The shielding design is based on the plant operating at maximum design power with the release of fission products resulting in a source of 100,000 mCi/sec of noble gas after a 30 minute decay period, and the corresponding activation and corrosion product concentrations in the reactor water listed in Section 11.1. Radiation sources in various pieces of plant equipment are cited in Section 12.2. Shutdown conditions, such as fuel transfer operation, as well as accident conditions, such as a LOCA or an FHA, have also been considered in designing shielding for the plant.

The mathematical models used to represent a radiation source and associate equipment and shielding are established to ensure conservative calculational results. Depending on the versatility of the applicable computer program, various degrees of complexity of the actual physical situation are incorporated. In general, cylindrically shaped equipment such as tanks, heat exchangers, and demineralizers are mathematically modelled as truncated cylinders. Equipment internals are sectionally homogenized to incorporate density variations where applicable. For example, the tube bundle section of a heat exchanger exhibits a higher density than the tube bundle clearance circle, due to the tube density, and this variation is accounted for in the model. Complex piping runs are conservatively modelled as a series of point sources spaced along the piping run. Equipment containing sources in a parallelpiped configuration, such as fuel assemblies, fuel racks, and the SGTS charcoal filters, are modelled as parallelpiped with a suitable homogenization of materials contained in the equipment. The shielding for these sources is also modelled on a conservative basis, with discontinuities in the shielding, such as penetrations, doors, and partial walls accounted for. The dimension of the floor decking is not considered in the shielding calculation as it is part of the effective shield thickness provided by the floor slab.

Pure gamma dose rate calculations, both scattered and direct, are conducted using point kernel codes (QADF/GGG). The source terms are divided into groups as a function of photon energy, and each group is treated independently of the others. Credit is taken for attenuation through all phases of material, and buildup is accounted for using a third-order polynomial buildup factor equation. The more conservative material buildup coefficients are selected for laminated shield configuration to ensure conservative results.

For combined gamma and neutron shielding situations, discrete ordinates (ANISN) techniques are applied.

The shielding thicknesses are selected to reduce the aggregate dose rate from significant radiation sources in surrounding areas to values below the upper limit of the radiation zone specified in the zone maps in Subsection 12.3.1.3. By maintaining dose rates in these areas at less than the upper limit values specified in the zone maps, sufficient access to the plant areas is allowed for maintenance and operational requirements.

Where shielded entries to high-radiation areas such as labyrinths are required, a gamma ray scattering code (GGG) is used to confirm the adequacy of the labyrinth design. The labyrinths are designed to reduce the scattered as well as the direct contribution to the aggregate dose rate outside the entry, such that the radiation zone designated for the area is not violated.

12.3.2.3 Plant Shielding Description

Figures 12.3-1 through 12.3-11 show the layout of equipment containing radioactive process materials. The general description of the shielding is described below;

(1) Drywell

The major shielding structures located in the drywell area consist of the reactor shield wall and the drywell wall. The reactor shield wall in general consists of 0.6m of concrete sandwiched between two 3.7 cm thick steel plates. The primary function served by the reactor shield wall is the reduction of radiation levels in the drywell due to the reactor, to valves that do not unduly limit the service life of the equipment located in the drywell. In addition, the reactor shield wall reduces gamma heating effects on the drywell wall, as well as providing for low radiation levels in the drywell during reactor shutdown. Penetrations through the reactor shield wall are shielded to the extent that radiation streaming through the penetrations does not exceed the total neutron and gamma dose rates at the core midplane just outside the reactor shield wall. The drywell is an F radiation zone during full power reactor operation and is not accessible during this period.

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The drywell wall is a 2m thick reinforced concrete cylinder, which is topped by a 2.4m thick reinforced concrete cap. The drywell wall attenuates radiation from the reactor and other radiation sources in the drywell, such as the recirculation system and main steam piping, to allow occupancy of the reactor building during full power reactor operation.

(2) Reactor Building

In general, the shielding for the reactor building is designed to maintain open areas at dose rates less than 0.6 mR/hr.

Penetrations of the drywell wall are shielded to reduce radiation streaming through the penetrations. Localized dose rates outside these penetrations are limited to less than 5 mR/hr. The penetrations through interior shield walls of the reactor building are shielded using a lead-loaded silicone sleeve to reduce the radiation streaming are made available by the penetrations. Penetrations are also located so as to minimize the impact of radiation streaming into surrounding areas.

The components of the reactor water cleanup (RWC) system are located in the reactor building. Both the RWC regenerative and nonregenerative heat exchangers are located in shielded cubicles separated from the other components of the system. Neither cubicle needs to be entered for system operation.

Process piping between the heat exchangers and the filter demineralizers is routed through shielded areas or embedded in concrete to reduce the dose rate in surrounding areas. The two RWC system filter demineralizers are located in separate shielded cubicles, which allows maintenance of one unit while operating the other. The dose rate in the adjoining filter demineralizer cubicle from the operating unit is less than 6 mR/hr. Entry into the filter demineralizer cubicle, which is infrequently required, is via a stepped shield plug at the top of the cubicle. The bulk of the piping and valves for the filter demineralizers is located in an adjacent shielded valve gallery. Backflushing and resin application of the filter demineralizers are controlled from an area where dose rates are less than 1 mR/hr. The RWC system backwash receiving tank is also separately shielded from the other components of the RWC system, including the tank discharge pump, which allows maintenance of the pump without direct exposure to the spent resins contained in the backwash tank. The backwash tank cubicle is shielded to reduce the dose rate outside the entry to less than 1 mR/hr.

Shielding of the Transverse Incore Probe (TIP) is provided by locating the higher radiation components in a separate shielded room with labyrinth entry way. The TIP itself during maintenance is withdrawn into a lead shielded cask for entry into the room. The TIP location is maintained by a position sensor on the instrument which is

alarmed to the control room. The TIP entry location into the room from the drywell is via the suppression pool instrumentation tunnel and then upward into the room. Area radiation monitors in both TIP room and spooler room maintain a secondary surveillance of both rooms being alarmed to both the control rooms and locally in the TIP facility. An inadvertent withdrawal of the TIP will result in alarming both the position sensor and area radiation monitors resulting in local alarms to egress the area.

(3) ECCS Components

The ECCS systems are located in separately shielded cubicles. Shield labyrinths are provided to gain entry into the cubicles, and equipment removal doors are shielded with removable horizontally and vertically lapped concrete block. Piping to and from the ECCS system is routed through shielded pipe chases. Access into the cubicles is not required to operate the systems. In general, the radiation levels in the open corridors of the reactor building are less than 1 mR/hr, except during RHR shutdown cooling mode operation, when radiation levels may temporarily range between 1 and 5 mR/hr in areas near the RHR cubicles.

The RWC system pumps are located in a shielded cubicle designed to reduce the radiation levels in the adjoining open corridor to less than 1 mR/hr. The pumps are separated by shield walls to allow operation of one of the pumps while performing maintenance on the other. Dose rates at this pump due to the operating pump and piping are less than 5 mR/hr. A shielded valve gallery is employed to permit manual operation of the valves associated with the RWC system pumps without entering the pump area. Piping for the pumps is directly routed from the steam tunnel to the RWC system pump area.

The CRD maintenance room walls are designed to reduce dose rates in the adjoining corridor to less than 1 mR/hr during all CRD maintenance operations except CRD transfer, when dose rates in the corridor temporarily range between 1 and 5 mR/hr.

The main steam lines are located in the shielded steam tunnel. The steam tunnel reduces the dose rates from the steam lines to less than 1 mR/hr in all adjoining areas except the roof of the steam tunnel, which is less that 5 mR/hr.

(4) Fuel Components

The fuel storage pool is designed to insure that the dose rate in adjoining areas is less than 1 mR/hr. During normal operation, dose rates in the pump area are less than 1 mR/hr. During an isolation transient, however, dose rates in the area temporarily increase to 700 mR/hr. Due to the nature of the event, egress from the area can be accomplished well before dose rates reach this level. Access to equipment in this area is not required during this occurrence. An individual in this area will know that the dose rate is increasing since a local-mounted area radiation monitoring sensor, converter, indicating auxiliary unit, and audio alarm are provided.

(5) Control Room

The dose rate in the control room is much less than 0.6 mR/hr during normal reactor operating conditions. The outer walls of the control building are designed to attenuate radiation from radioactive materials contained within the reactor building and from possible airborne radiation surrounding the control building following a LOCA. The walls provide sufficient shielding to limit the direct-shine exposure of control room personnel following a LOCA to a fraction of the 5 Rem limit as is required by 10CFR50, Appendix A, Criterion 19. Shielding for the outdoor air cleanup filters is also provided to allow temporary access to the mechanical equipment area of the control building following a LOCA, should it be required.

(6) The main steam tunnel extends from the primary containment boundary in the reactor building through the control building up to the turbine stop valves. The primary purpose of the steam tunnel is to shield the plant complex from N-16 gamma shine in the main steam lines. A minimum of 1.6 meters

of concrete or its equivalent (other material or distance) is required on any ray pathway from the main steam lines to any point which may be inhabited during normal operations. The design of the steam tunnel is shown on Figures 1.2-14, 1.2-15, 1.2-20, 1.2-21, and 1.2-28. The tunnel is classified as Seismic Category I in the reactor building and in the control building and is designed to UBC Seismic Standards in the turbine building. The interface between the buildings provides for bayonet connection to permit differential building motion during seismic events and shielding in the areas between buildings. The exact details on the bayonet design are not shown on the referenced arrangement drawings but requires complete shielding in the building interface area. The tunnel also serves a secondary purpose as a relief and release pathway for high energy events in the reactor building. Any high energy event (line break) in the reactor building will, through a series of blow out panels, vent into the steam tunnel and from the steam tunnel through the tunnel vent shaft to the turbine building (see Figure 1.2-28) for processing to the plant stack. See Subsection 6.2.3.3.1 for more complete description of this function.

12.3.3 Ventilation

The HVAC systems for the various buildings in the plant are discussed in Section 9.4, including the design bases, system descriptions, and evaluations with regard to the heating, cooling, and ventilating capabilities of the systems. This section discusses the radiation control aspects of the HVAC systems.

12.3.3.1 Design Objectives

The following design objectives apply to all building ventilation systems:

(1) The systems shall be designed to make airborne radiation exposures to plant personnel and releases to the environment ALARA. To achieve this objective, the guidance provided in Regulatory Guide 8.8 shall be followed.

(2) The concentration of radionuclides in the air in areas accessible to personnel for normal plant surveillance and maintenance shall be kept below the limits of 10CFR20 during normal power operation. This is accomplished by establishing in each area a reasonable comprimise between specifications on potential airborne leakages in the area and HVAC flow through the area. Appendix 12A to this chapter outlines the methodology by which such calculations are made.

The applicable guidance provided in Regulatory Guide 1.52 has been implemented for the ESF filter systems for the control building outdoor air cleanup system and the standby gas treatment system (STGS) as described in Subsections 6.5.1 and 9.4.1.

12.3.3.2 Design Description

In the following sections, the design features of the various ventilation systems that achieve the radiation control design objectives are discussed. For all areas potentially having airborne radioactivity, the ventilation systems are designed such that during normal and maintenance operations, airflow between areas is always from an area of low potential contamination to an area of higher potential contamination.

12.3.3.2.1 Control Room Ventilation

The control building atmosphere is maintained at a slightly positive pressure (up to 0.5 in. wg) at all times, except if exhausting or isolation are required, in order to prevent infiltration of contaminants. Fresh air is taken in via a dual inlet system, which has both intake structures on the roof of the building. The inlets are arranged with respect to the SGTS exhaust stack such that at least one of the intakes is free of contamination after a LOCA. Both inlets, however, can be submerged in contaminated air from a LOCA, but the calculated dose in the control room from such an eventuality is still below the limit of Criterion 19 of 10CFR50, Appendix A.

Outside air coming into the intakes is normally filtered by a particulate filter. If a high radiation level in the air is detected by the airborne radiation monitoring system, flow is automatically diverted to another filter train (an outdoor air cleanup unit) that has:

(1) a particular filter;

(2) a HEPA filter;

(3) a charcoal filter; and

(4) another HEPA filter.

Two redundant, divisionally separated radiation monitors and filter trains are provided. (See Subsection 9.4.1 for detailed description of the design.) Conservative calculations show that the filters keep the dose in the control room from a LOCA below the limits of Criterion 19 of 10CFR50, Appendix A.

The outdoor cleanup units are located in individual, closed rooms that help prevent the spread of any radiation during maintenance. Adequate space is provided for maintenance activities. The particulate and HEPA filters can be bagged when being removed from the unit. Before removing the charcoal, any radioactivity is allowed to decay to minimal levels, and is then removed through a connection in the bottom of the filter by a pneumatic transfer system. Air used in the transfer system goes through a HEPA filter before being exhausted. Face masks can worn during maintenance activities, if desired.

12.3.3.2.2 Drywell

Access into the drywell is not permitted during normal operation. The ventilation system inside merely circulates, without filtering, the air. The only airflow out of the drywell into accessible areas is minor leakage through the wall.

During maintenance, the drywell air is purged before access is allowed.

12.3.3.2.3 Reactor Building

The reactor building HVAC system is divided into three zones, which are separated by leaktight, physical barriers. The zones include:

(1) secondary containment (this area contains equipment that is a potential source of radioactivity and if a leak occurs, the other accessible areas of the building are not contaminated);

(2) electrical equipment area, cable tunnels, cable spreading rooms, remote control panel area, diesel generator rooms, reactor internal pump panel rooms, and the heating and ventilating equipment roo ; and

(3) steam tunnel (this room also contains a potential source of radioactive material leakage).

Air pressure in the rooms in Zone 1 is maintained slightly below outside atmospheric pressure by a fresh air supply and exhaust system. The supply air is filtered by a particulate filter. The exhaust stream is monitored for radioactivity, and if a high activity level is detected, the exhaust stream is diverted to the SGTS.

Normally, exhaust air is drawn from the corridor and various rooms. The exhaust duct has two isolation valves in series and a radiation monitor. The valves isolate the system if high airborne radioactivity is detected by the radiation monitor.

Zone 2 of the reactor building is maintained at a positive pressure during normal operation.

For a description of the reactor building HVAC system, see Subsection 9.4.5.

12.3.3.2.4 Radwaste Building

The radwaste building is divided into two zones for ventilation purposes. The control room is one zone, and the remainder of the building is the other zone. The air pressure in the first zone is maintained slightly above atmospheric, while the air pressure in the second zone is maintained slightly below atmospheric. Air in the second zone is drawn from outside the building and distributed to various work areas within the building. Air flows from the work areas and is then discharged via the reactor building stack. An alarm sounds in the control room if the exhaust fan fails. The exhaust flow is monitored for radioactivity, and if a high activity level is detected, the potentially radioactive cells are automatically isolated, but airflow through the work areas continues.

If the exhaust flow high-radiation alarm continues to annunciate after the tank and pump

rooms are isolated, the work area branch exhaust ducts are selectively manually isolated to locate the involved building area. Should this technique fail, because the airborne radiation has spread throughout the building, the control room air conditioning continues, but the air conditioning for the balance of the building is shut down.

The work area's exhaust air is drawn through a filter unit consisting of a particulate filter, a HEPA filter, a charcoal filter, and then another HEPA filter, before being discharged to the reactor building stack. The air is monitored for radioactivity, and if a high level is detected, supply and exhaust is terminated, and the SGTS is started.

Maintenance provisions for the filters are similar to those for the control building HVAC system.

See Subsection 9.4.6 for a detailed discussion of the radwaste building HVAC system.

12.3.4 Area Radiation and Airborne Radioactivity Monitors

This section defines and describes the area radiation system that monitors the gamma radiation levels throughout the plant except within the containment. The gamma radiation levels within the containment (drywell and suppression chamber) are monitored continuously by the containment atmospheric monitoring system (CAMS) as described in Subsection 7.6.2. Four gamma sensitive ion chambers (two per divisions 1 & 2) are provided by CAMS to monitor for airborne radioactivity up to 10^7 rads per/hr. Those four sensors are located at the penetrations listed in Table 6.2-8. The area radiation monitoring system is classified as non-safety.

12.3.4.1 System Objectives

The purpose of the area radiation monitoring system is to warn plant personnel of excessive gamma ray levels in service areas including the areas where nuclear fuel is stored or handled, to record and indicate the monitored gamma radiation levels in the control room at selected locations within the various plant buildings, and to provide audible local alarms at key locations where abnormal radiation levels could endanger plant personnel.

12.3.4.2 System Description

The area radiation monitoring system consists of gamma sensitive detectors, associated digital radiation monitors, auxiliary units, local audible warning devices and multipoint recorders. The detector signals are digitized and optically multiplexed for transmission to the radiation monitors. Each monitor has two adjustable trip circuits for alarm initiation, one high radiation level trip and one downscale trip. The downscale trip circuit operates on loss of power or when gross equipment failure occurs. Auxiliary units are provided in local areas for radiation indication and for initiating the sonic alarms on abnormal levels. The electronics are powered from the non-1E vital 120 Vac source while the recorders are powered from the 120 Vac instrument bus.

12.3.4.3 System Design

The area radiation monitoring detectors provided in each plant building are listed in Tables 12.3-3 through 12.3-7 along with area location maps shown in Figures 12.3-56 through 12.3-73. Also, these tables specify the sensitivity range of each channel as designated below along with requirements for local area alarms.

The channel sensitivity covers the following ranges:

a) Range 10^{-2} to 10^2 mR/hr - H (High Sensitivity)

b) Range 10^{-1} to 10^3 mR/hr - M (Medium Sensitivity)

c) Range 1 to 10^4 mR/hr - L (Low Sensitivity)

d) Range 10^2 to 10^6 mR/hr - LL (Low Low Sensitivity)

e) Range 10^{-1} to 10^4 mR/hr - VL (Very Low Sensitivity)

There are two radiation detectors that are located in the fuel storage and handling area, one is positioned to monitor the radiation near the fuel pool and the other is placed in the fuel handling area to monitor the radiation that may result from accidental fuel handling. Criticality detection monitors for this area are not needed to satisfy the criticality accident requirements of 10CFR70.24, because the ABWR design utilizes specialized high density fuel storage racks that preclude the possibility of criticality accident under normal and abnormal conditions. The new fuel bundles are stored in racks that are placed at the bottom of the fuel storage pool. A full array of loaded fuel storage racks are designed to be subcritical by at least 5% delta k. Refer to Sections 9.1 and 9.2 for details.

The detectors and radiation monitors are responsive to gamma radiation over an energy range of 80 keV 7 MeV. The energy dependence

will not exceed 20% of point from 100eV to 3 MeV. The overall system design accuracy is within 9.5% of equivalent linear full scale recorder output for any decade.

The trip alarm setpoints will be established in the field following equipment installation at the site. The exact settings will be based on sensor location, back ground radiation levels, expected radiation levels, and low occupational radiation exposures.

Each channel is calibrated based on a pseudo input signal to confirm accurate monitor response. The detectors are calibrated using standardized traceable radioactive source in order to establish the linearity and sensitivity of the channel for subsequent calibration. The area radiation monitoring system is designed to accommodate periodic surveillance testing.

The area radiation monitoring instrumentation is designed and properly located to provide early detection and warning for personnel protection to insure that occupational radiation exposures will be as low as is reasonably achieved (ALARA) in accordance with guidelines stipulated in Reg Guide 8.2 and 8.8.

The area radiation monitoring system includes instrumentation provided to assess the radiation conditions in crucial areas in the reactor building (the RHR equipment areas) where access may be required to service the safety related equipment during post LOCA per Reg Guide 1.97.

12.3.5 Post-Accident Access Requirements

The locations requiring access to mitigate the consequences of an accident during the 100-day post-accident period are the control room, the technical support center, the remote shutdown panel, the primary containment sample station (post accident sample system), the health physics facility (counting room), and the nitrogen gas supply bottles. Each area has low post LOCA radiation levels. The dose evaluations in Subsection 15.6.5 are within regulatory guidelines.

Access to vital areas through out the reactor building/control building/turbine building complex is controlled via the service building. Entrance to the service building and access to the other areas are controlled via double locked secured entry ways. Access to the reactor building is via two specific routes, one for clean access and the second for controlled access. During a event such as a design basis accident, the service building/control building are maintained under filtered HVAC at a positive pressure with respect to the environment. Air infiltration is minimized by positive flow via double entry ways. Therefore, radiation exposure is limited to gamma shine from the reactor building, turbine building, main steam line access corridor, and skyline. This shine is minimized by locating highly populated areas below ground.

During a design basis accident event, access to remote shutdown panel, nitrogen bottles, and the PASS and monitor systems is controlled from the service building via the controlled access way. These corridors are not maintained under filtered positive pressure so that personal protection equipment (radiation protection suits, breathing gear, etc.) will be required in the access corridor. Primary contamination would occur from leakage through the PASS system and air infiltration from the environment. Both pathways are considered minimal and minor contamination under even the most adverse conditions is expected.

The reactor building vital areas are all located off one of of the two primary access ways except the nitrogen bottle areas which are located on the refueling floor and are accessible from the clean access corridor at the 4800 level (B1F) and up three floors to the 23500 level (3F). There are two access corri- dors, clean and dirty, with contamination in those areas limited to air inflitration from the environment and penetration leakage from the PASS system. In addition, the lines penetrating the PASS room are doubly valved permitting line isolation in the event of any potential rupture. Sources of radiation therefore are limited to minor leakage and gamma shine including the stack monitor room which contains only instrumentation and associated penetrations for monitoring stack effluent.

12.3.6 Post-Accident Radiation Zone Maps

The post-accident radiation zone maps for the areas in the reactor building are presented in Figures 12.3-12 through 12.3-22. The zone maps represent the maximum gamma dose rates that exist in these areas during the post-accident, period. These dose rates do not include the airborne contribution in the reactor building.

Post-accident zone maps of the control building and turbine building are presented in Figures 12.3-54 and 55 respectively. The zone maps are designed to reflect the criteria established in Subsection 3.1.2.2.10.

12.3.7 Deleted

12.3.8 References

1. N. M. Schaeffer, *Reactor Shielding for Nuclear Engineers*, TID-25951, U.S. Atomic Energy Commission (1973).

2. J. H. Hubbell, *Photon Cross Sections, Attenuation Coefficients, and Energy Absorption Coefficients from 10 KeV to 100 GeV*, NSRDS-NBS20, U.S. Department of Commerce, August 1969.

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4. *Reactor Handbook*, Volume III, Part B, E.P. Blizzard, U.S. Atomic Energy Commission (1962).

5. Lederer, Hollander, and Perlman, *Table of Isotopes*, Sixth Edition, (1968).

6. M.A. Capo, *Polynomial Approximation of Gamma Ray Buildup Factors for a Point Isotropic Source*, APEX-510, November 1958.

7. *Reactor Physics Constants*, Second Edition, ANL-5800, U.S. Atomic Energy Commission, July 1963.

8. ENDF/B-III and ENDF/B-IV Cross Section Libraries, Brookhaven National Laboratory.

9. PDS-31 Cross Section Library, Oak Ridge National Laboratory.

10. DLC-7, ENDF/B Photo[illegible]raction Library.

Table 12.3-1

COMPUTER CODES USED IN SHIELDING DESIGN CALCULATIONS

Computer Code	Description
QADF	A multigroup, multiregion, point kernal, gamma ray code for calculating the flux and dose rate at discrete locations within a complex source-geometry configuration.
GGG	A multigroup, multiregion, point kernal code for calculating the contribution due to gamma ray scattering in a hetrogeneous three-dimensional space
DOT.4	A discrete ordinates, two-dimensional transport code. Multigroup, multiregion neutron or gamma transport

Table 12.3-2

TYPICAL NICKEL AND COLBALT CONTENT OF MATERIALS

Material	Nickel (%)	Colbalt (%)
Carbon Steel	0.25	1% of Ni
Stainless Steel	10	1% of Ni
Ni-Cr-Fe (Inconel 600, Inconel X750)	70	1% of Ni
Stellite 6	3	58

Table 12.3-3

AREA RADIATION MONITORS
REACTOR BUILDING

No.	Location & Description	Figure #	Sensitivity Range	Local Alarms
1	Reactor area (A)-4F	12.3-62	H	X
2	Reactor area (B)-4F	12.3-62	LL	
3	Fuel storage pool area (A)-4F	12.3-62	LL	X
4	Fuel storage pool area (B)-4F	12.3-62	LL	
5	R/B 4F south area	12.3-62	H	
6	R/B 4F SE area	12.3-62	H	X
7	R/B 3F NW area	12.3-60	H	
8	R/B 3F SE area	12.3-60	H	X
9	CUW control panel area-B3F	12.3-56	H	
10	R/B equipment hatch-B2F	12.3-57	H	X
11	HCU area (A)-B3F	12.3-56	M	X
12	HCU area (B)-B3F	12.3-56	M	X
13	SRV/MSIV valve maintenance room-3F	12.3-63	M	X
14	R/B 1F SE hatch area	12.3-49	H	X
15	RPV instrument rack room (A)-B1F	12.3-58	H	X
16	RPV instrument rack room (B)-B1F	12.3-58	H	X
17	R/B B1F SE hatch area	12.3-58	H	
18	TIP drive machine room-El 1500	12.3-57	M	X
19	TIP machine equipment room-El 1500	12.3-57	L	X
20	Core cooling water sampling room-M4F	12.3-61	M	X
21	CRD maintenance room-B2F	12.3-57	M	X
22	R/B B2F SE hatch area	12.3-57	H	X
23	R/B B2F NW hatch area	12.3-57	H	X
24	R/B B3F NW area-RHR "A" equip area	12.3-56	VL	X
25	R/B B3F SE area-RHR "B" equip area	12.3-56	VL	X

Table 12.3-4

AREA RADIATION MONITORS CONTROL BUILDING

No.	Location & Description	Figure #	Sensitivity Range
1	Main Control Room	12.3-64	H
2	Passage Way Underneath Steam Tunnel	12.3-64	H
3	RBCW "A" Area-El -1315	12.3-64	H
4	RBCW "B" Area-El -1315	12.3-64	H
5	RBCW "C" Area-El -1315	12.3-64	H

Table 12.3-5

AREA RADIATION MONITORS SERVICE BUILDING

No.	Location & Description	Figure #	Sensitivity Range
1	Service Building Tech. Support Center	12.3-64	H

Table 12.3-6

AREA RADIATION MONITORS
RADWASTE BUILDING

No.	Location & Description	Figure #	Sensitivity Range	Local Alarms
1	R/W Building Control Room-El 16000	12.3-68	H	
2	Maintenance area #1-El 16000	12.3-68	H	X
3	Maintenance Area #2-El 16000	12.3-68	H	X
4	R/W Building HVAC Exhaust El 1600	12.3-68	H	
5	R/W Building Truck Area-El 7300	12.3-67	H	
6	MSW Compactor Area-El 7300	12.3-67	H	
7	Corridor to Aux. Building-El 7300	12.3-67	H	X
8	Equip Rack Area #1-El -0200	12.3-66	H	
9	Equip Rack Area #2-El -0200	12.3-66	H	
10	R/W Building MSW Control Room-El -0200	12.3-66	H	
11	Rad Waste Sampling Room-El -6500	12.3-65	H	
12	MSW Equipment Area-El -6500	12.3-65	H	X
13	R/W Equipment Rack Area #1-El -6500	12.3-65	H	
14	R/W Equipment Rack Area #2-El -6500	12.3-65	H	

Table 12.3-7

AREA RADIATION MONITORS
TURBINE BUILDING

No.	Location & Description	Figure No.	Sensitivity Range	Local Alarms
1.	Condensate Pump Maintenance Area	12.3-70	M	
2.	Condensate Sampling & Control Area	12.3-70	M	X
3.	Off-Gas Sample & Control Area	12.3-70	M	X
4.	RFP 1A, 1B & 1C Area	12.3-70	H	X
5.	Filter Maintenance Area	12.3-71	M	X
6.	Demineralizer Area	12.3-71	H	
7.	SJAE A & Recombiner Area	12.3-71	H	
8.	SJAE B & Recombiner Area	12.3-71	H	
9.	HP Heaters & Drain Tank Area 1	12.3-71	H	
10.	HP Heaters & Drain Tank Area 2	12.3-71	H	
11.	MSR 1A & 1C Area	12.3-72	H	
12.	MSR 1B & 1D Area	12.3-72	H	
13.	Turbine Building Operating Floor	12.2-73	H	X
14.	Equipment Main Access Area	12.3-73	H	X

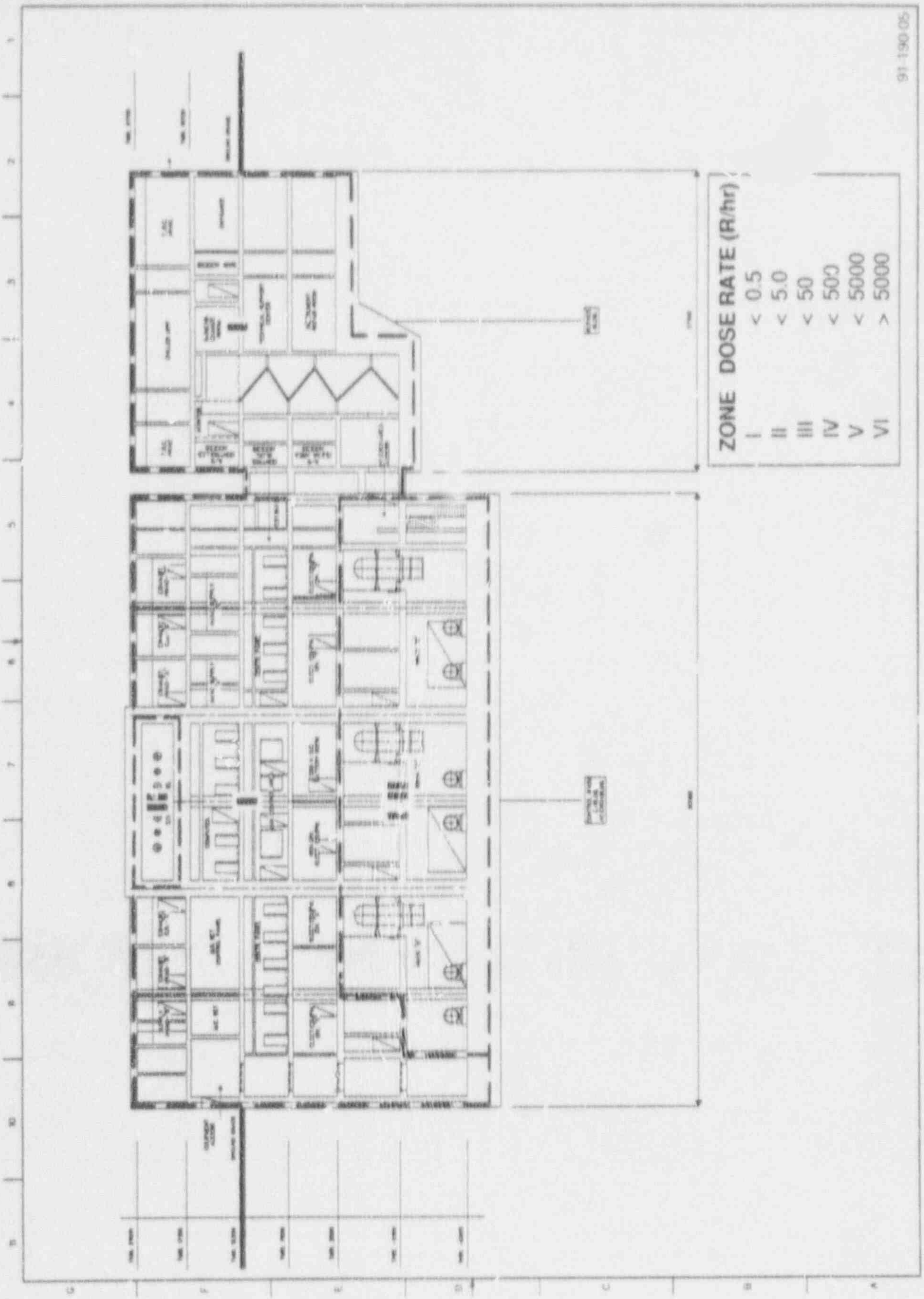


Figure 12.3-54 CONTROL BUILDING, RADIATION ZONE, POST-LOCA, SIDE VIEW

Figure 12.3–54 CONTROL BUILDING, AREA RADIATION MONITORS

GE PROPRIETARY INFORMATION - provided under seperate cover

(Figures 12.3-65 through 12.3-68, pages 12.3-79 through 12.3-82)

Page	Amendment
12.3-79	10
12.3-80	10
12.3-81	10
12.3-82	10

APPENDIX 12A

CALCULATION OF AIRBORNE RADIONUCLIDES

12A.1 CALCULATION OF AIRBORNE RADIONUCLIDES

This appendix presents a simplified methodology to calculate the airborne concentrations of radionuclides in a compartment. This methodology is conservative in nature and assumes that diffusion and mixing in a compartment is basically instantaneous with respect to those mitigating mechanisms such as radioactive decay and other removal mechanisms. The following calculations need to be performed on an isotope by isotope basis to verify airborne concentrations are within the limits of 10CFR20.

(1) For the compartment, all sources of airborne radionuclides need to be identified such as:

(a) Flow of contaminated air from other areas

(b) Gaseous releases from equipment in the compartment

(c) Evolution of airborne sources from sumps or water leaking from equipment

(2) Second, the primary sinks of airborne radionuclides need to be identified. This will primarily be outflow from the compartment but may also take the form of condensation onto room coolers.

(3) Given the above information the following equation will calculate a conservative concentration.

$$C_i = \frac{1}{V} \sum_j \frac{S_{ij}}{(\lambda_i + \sum_k R_{ijk})}$$

Where:

C_i = Concentration of the ith radionuclides in the room

V = Volume of room

S_{ij} = The jth source (rate) of the ith radionuclide to the room. These sources are discussed below.

R_{ijk} = the kth removal constant for the jth source and the ith radionuclide as discussed below.

λ_i = radionuclide decay constant

Evaluation Parameters

The following parameters require evaluation on a case by case basis dictated by the physical parameters and processes germaine to the modeling process.

(1) S_{ij} - is defined as the source rate for radionuclide i into the compartment. Typically these sources take the form of:

(a) Inflow of contaminated air from an upstream compartment. Given the concentration of radionuclide i, c_i, in this air and a flow rate of "r", the source rate then becomes $S_{ij} = rc_i$.

(b) Production of airborne radionuclides from equipment. This typically takes two forms, gaseous leakage, and liquid leakage.

(i) For gaseous leakage sources, the source rate is equal to the concentration of radionuclide i, c_i, and the leakage rate, "r", or $S_{ij} = rc_i$.

(ii) For liquid sources, the source rate is similar but more complex. Given a liquid concentration c_i and a leakage rate, "r", the total release from the leak is rc_i. The fraction of this release which then becomes airborne is typically evaluated by a partition factor, P_f which may be conservatively estimated from:

Noble Gases $P_f = 1$

All others $P_f = \dfrac{h_t - h_f}{h_s - h_f}$

where: h_t = saturated liquid enthalpy

h_f = saturated liquid enthalpy at one atmosphere = 100.10 Kcal/Kg

h_s = saturated vapor enthalpy at one atmosphere = 639.18 Kcal/Kg

Therefore the liquid release rate becomes, $rc_i P_f$.

(2) R_{ijk} is defined as the removal rate constant and typically consists of:

(a) Exhaust rate from the compartment. This term considers not only the exhaust of any initially contaminated air but also any clean air which may be used to dilute the compartment air.

(b) Compartment filter systems are treated by the equation:

$R_{ijk} = (1-F_i) * r_i$

where r_i = filter system flow rate

F_i = filter efficiency for radionuclide i

(c) Other removal factors on a case by case basis which may be deemed reasonable and conservative.

Example Calculation

(Values used below are examples only and should not be used in any actual evaluation.)

This example will look at I-131 in a compartment 6.1x6.1x7.6 = 282.80 m^3 = V

First all primary source of radionuclides needs to be identified and categorized.

(1) Flow into the compartment equals 424.8m^3 per hour with the input I-131 concen- tration equal to 2 x 10^{-10} μCi/ml (from upstream compartments) or 2.4 x 10^{-11} Ci/sec. No other sources of air either contaminated or clean air are assumed.

(2) The compartment contains a pump carrying reactor coolant with a maximum specified leakage rate of 0.000034 m^3 per hour at 273.6^{O}C.

(a) Conservatively it can be estimated based upon properties from steam tables (see note 1) that under these conditions 44% of the liquid will flash to steam and become airborne. Along with the flashing liquid it is assumed that a proportional amount of I-131 will become airborne therefore F_f = 0.44.

(b) Using the design basis iodine concentrations for reactor water from Table 11.1-2 of 0.016 μCi/gm of I-131, it is calculated that the pump is providing a source of I-131 of 5.0 x 10^{-11} Ci/sec to the air. (see Note 2)

Second, the sinks for airborne material need to be identified. This example include only exhaust which is categorized as flow out of the compartment at 150% per hour or 4.2 x 10^{-4} per second.

Therefore, for an equilibrium situation, the I-131 airborne concentration from this liquid source would be calculated from the following equation.

$A = S_1/(\lambda + R_1) + S_2/(\lambda + R_2)$, where

S_1 = source rate in Curies per second = 5.0 x 10^{-11} Ci/sec from liquid

S_2 = source rate from inflow = 2.4 x 10^{-11} Ci/sec

λ = isotope decay constant in units of per second = 9.977 x 10^{-7}/sec

R_1 = R_2 = removal rate constant per second (exfiltration) = 4.2 x 10^{-4} per second

A = 6.2 x 10^{-10} μCi/ml of I-131.

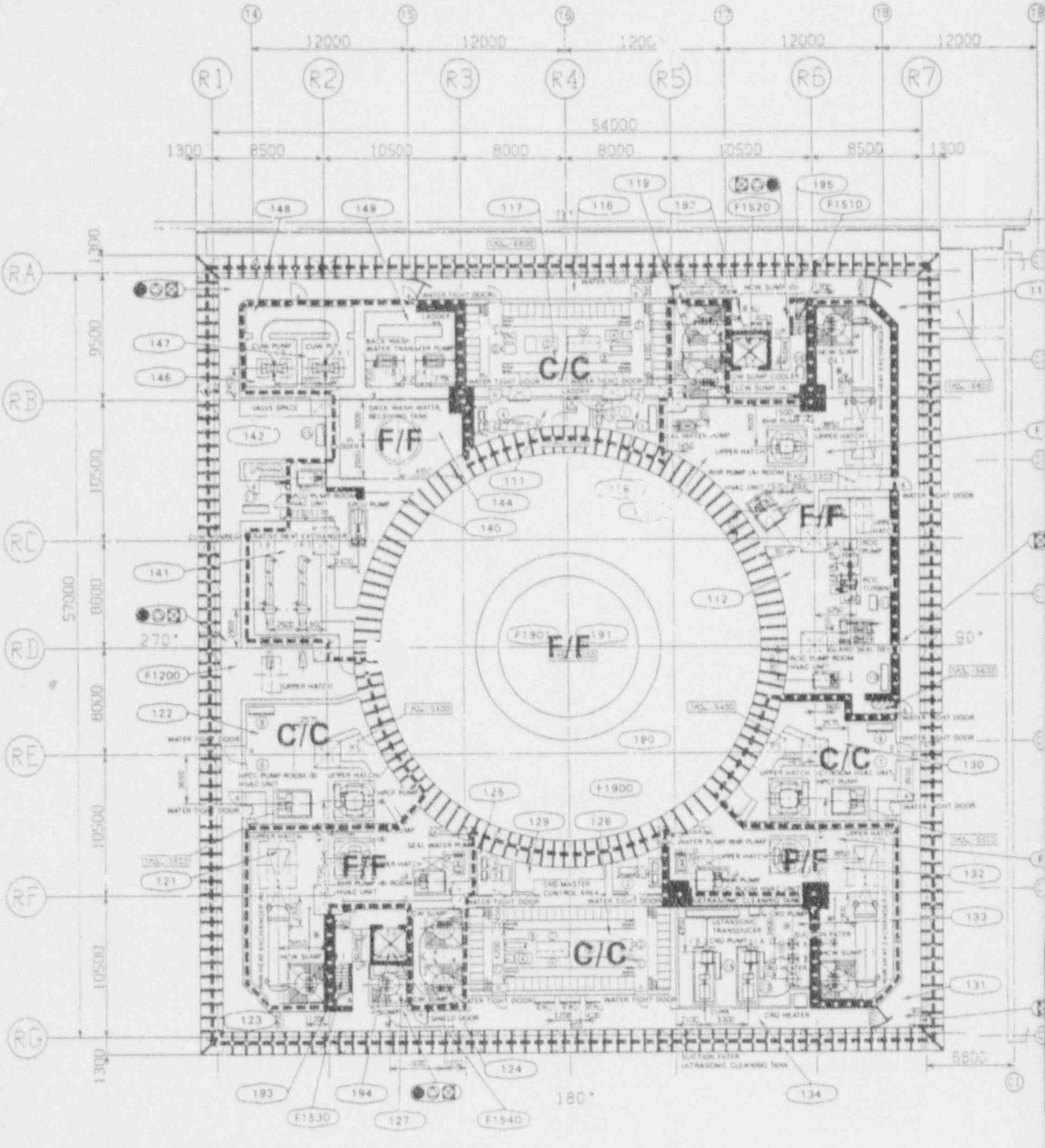
Notes:

1. The assumption of 44% flashing at 273.6^{O}C is extremely conservative, see Reference 1 for a discussion of fission product transport.

2. Water density assumed at 0.743 gm/cm^3 based upon standard tables for water at 273.6^{O}C.

12A.2 References

1. Paquette, et al, *Volatility of Fission Products During Reactor Accidents*, Journal of Nuclear Materials, Vol 130 Pg 129-138, 1985.



FULL POWER/SHUTDOWN
RADIATION LEVELS IN
MREM/HOUR
A ≤ 0.8
B < 1
C < 5
D < 25
E < 100
F ≥ 100

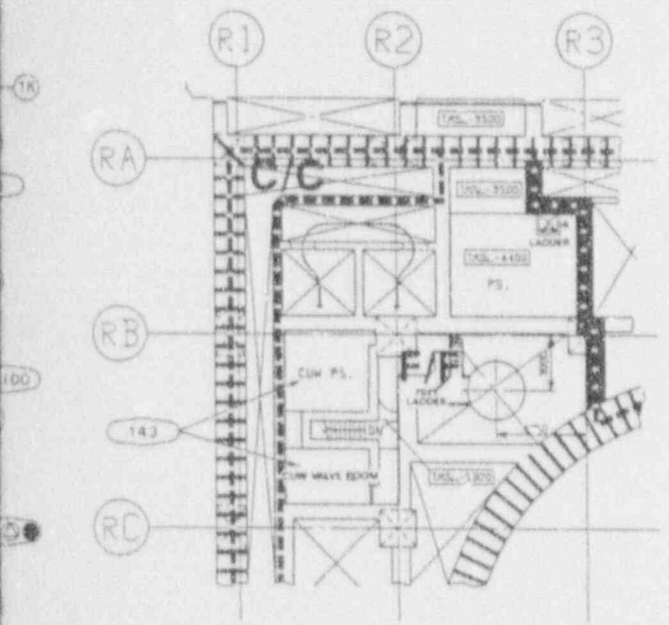
TASL-B200 (B3F)

SI
APERTURE
CARD

Also Available On
Aperture Card

(REMARKS)
EQUIPMENT

RHR PUMP (A)
RHR PUMP (B)
RHR PUMP (C)
RHR HX (A)
RHR HX (B)
RHR HX (C)
HPCF PUMP (B)
HPCF PUMP (C)
CUW NON-RE HX
CUW PUMP
CUW BACK WASH TRANSFER PUMP
CUW BACK WASH TANK
CRD PUMP
SUCTION FILTER
RCIC PUMP
RCIC TURBINE



FIRE PROTECTION SYMBOLS

(F1901) FIRE AREA NUMBER
a. LEFT HAND DIGIT IS BOTTOM FLOOR NUMBER STARTING WITH 1 = ELEVATION (-) 8200
b. SECOND DIGIT FROM LEFT IS THE ELECTRICAL DIVISION NUMBER

(135) ROOM NUMBER
HOSE RACK
PORTABLE EXTINGUISHER
STANDPIPE
3 HOUR RATED FIRE BARRIER (WALL)
RATED FIRE BARRIER (FLOOR)
3 HOUR FIRE RATED DOOR
SECONDARY CONTAINMENT BOUNDARIES (3 HOUR RATED FIRE BARRIER)
SPRINKLER SYSTEM

NO. RACK LIST RACK NAME

1. CORE FLOW (IA) INSTRUMENT RACK
2. CORE FLOW (IB) INSTRUMENT RACK
3. CORE FLOW (IIA) INSTRUMENT RACK
4. CORE FLOW (IIB) INSTRUMENT RACK
5. RHR SYSTEM (A) INSTRUMENT RACK
6. RHR SYSTEM (B) INSTRUMENT RACK
7. RHR SYSTEM (C) INSTRUMENT RACK
8. HIGH PRESSURE CORE SPRAY SYSTEM (B) INSTRUMENT RACK
9. HIGH PRESSURE CORE SPRAY SYSTEM (C) INSTRUMENT RACK
10. REACTOR CORE ISOLATION COOLING SYSTEM INSTRUMENT RACK
11. REACTOR CORE ISOLATION COOLING SYSTEM TURBINE INSTRUMENT RACK
12. CONTROL ROD DRIVE HYDRAULIC SYSTEM INSTRUMENT RACK
13. CRD PUMP (A) INSTRUMENT RACK
14. CRD PUMP (B) INSTRUMENT RACK
15. REACTOR COOLANT CLEAN-UP SYSTEM INSTRUMENT RACK
16. SCRAM SEISMIC SENSOR, FOUR EACH
17. SUPPRESSION POOL DISCHARGE SYSTEM SAMPLING RACK
18. RHR HEAT EXCHANGER EXIT SAMPLING RACK

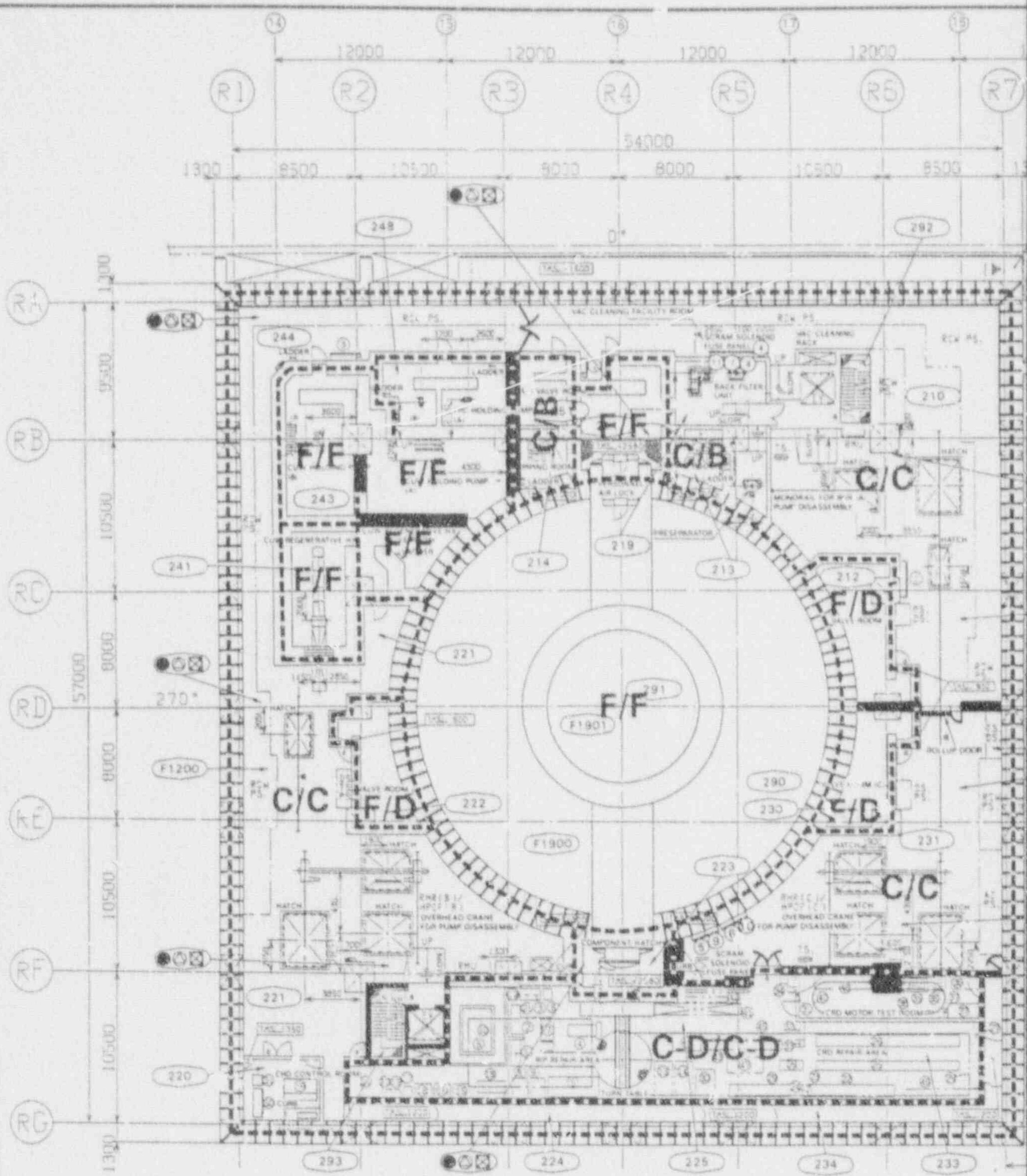
A. ACCUMULATOR INSTALLATION-REMOVAL TRANSPORTATION DOLLY
B. ACCUMULATOR DISASSEMBLY-ASSEMBLY DOLLY
C. ACCUMULATOR WORKING BENCH
D. SCRAM VALVE-SCRAM PILOT VALVE WORKING BENCH
E. SCRAM PILOT VALVE TEST FACILITY
F. PUMP UNIT
G. GENERAL PURPOSE WORKING BENCH
H. TOOL BOX

REMARK (COMMON)

1. CURB HEIGHT IS 200 mm IN CASE OF NONE REMARK
2. EACH SYMBOL MARKS MEAN AS FOLLOWS.
   (a) GRATING
   (b) CHECKER PLATE
   (c) CONCRETE BLOCK
   (d) FIREPLUG
   (e) FRONT OF PANEL AND RACK (FRONT)
   (f) PULL SPACE FOR MAINTENANCE
   (g) HANDRAIL
   (h) MONORAIL
   (i) EV ELEVATOR
   (j) PS PIPE SPACE
   (k) DS HVAC DUCT SPACE
   (l) TS CABLE TRAY SPACE
   (m) NL NORMAL LOCK DOOR
   (n) STEEL SHIELDING DOOR
   (o) CURB

9205200194-01

Figure 12 3-1 REACTOR BUILDING RADIATION ZONE MAP FOR FULL POWER AND SHUTDOWN OPERATIONS AT ELEVATION -8200mm (B3F)



TMSL-1700 (B2F)

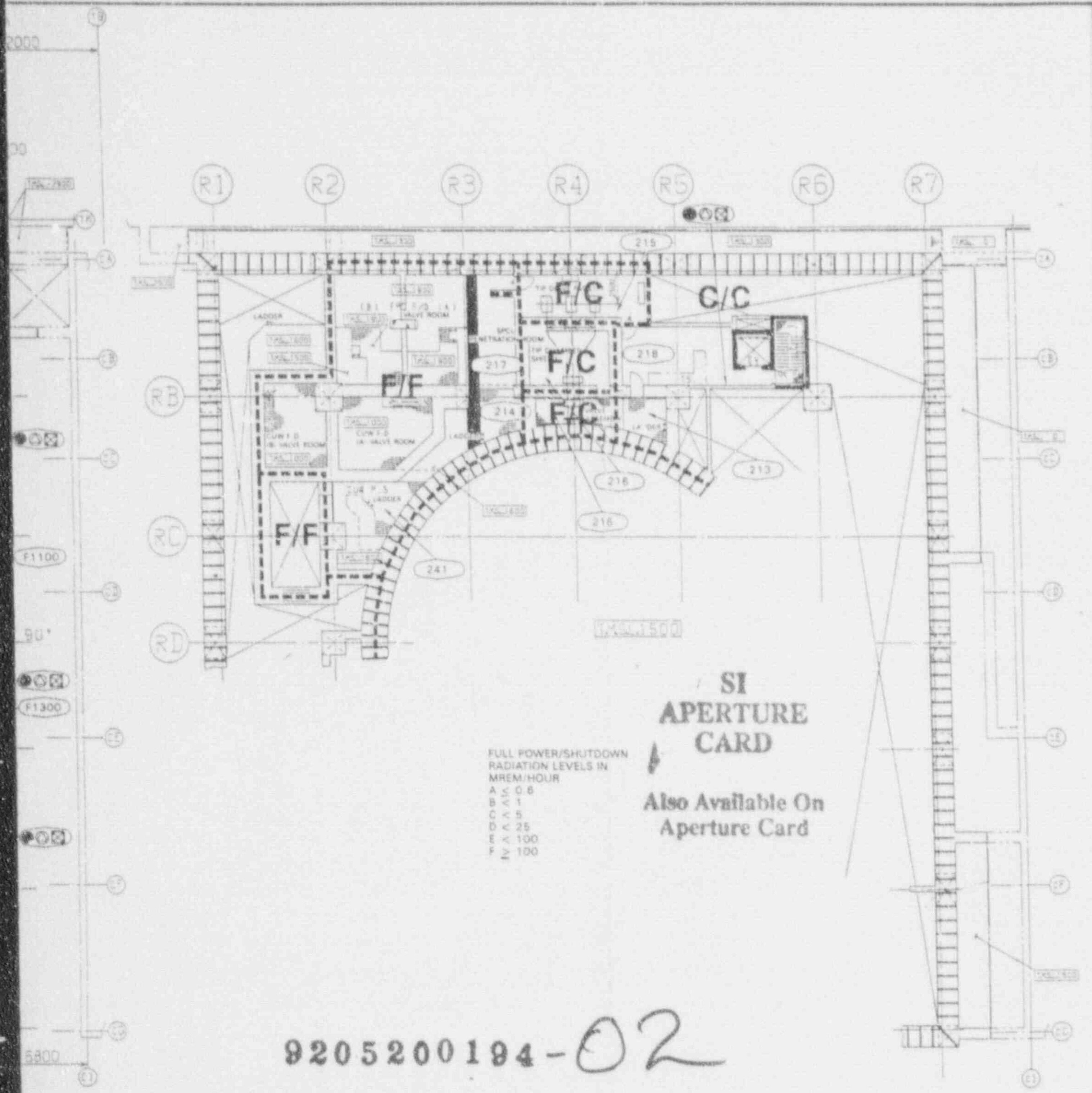
(REMARKS)

EQUIPMENT

CUW RE HX
CUW F/D VALVE ROOM
RIP MAINTENANCE AREA
FMCRD MAINTENANCE AREA
CRD CONTROL ROOM

RACK LIST

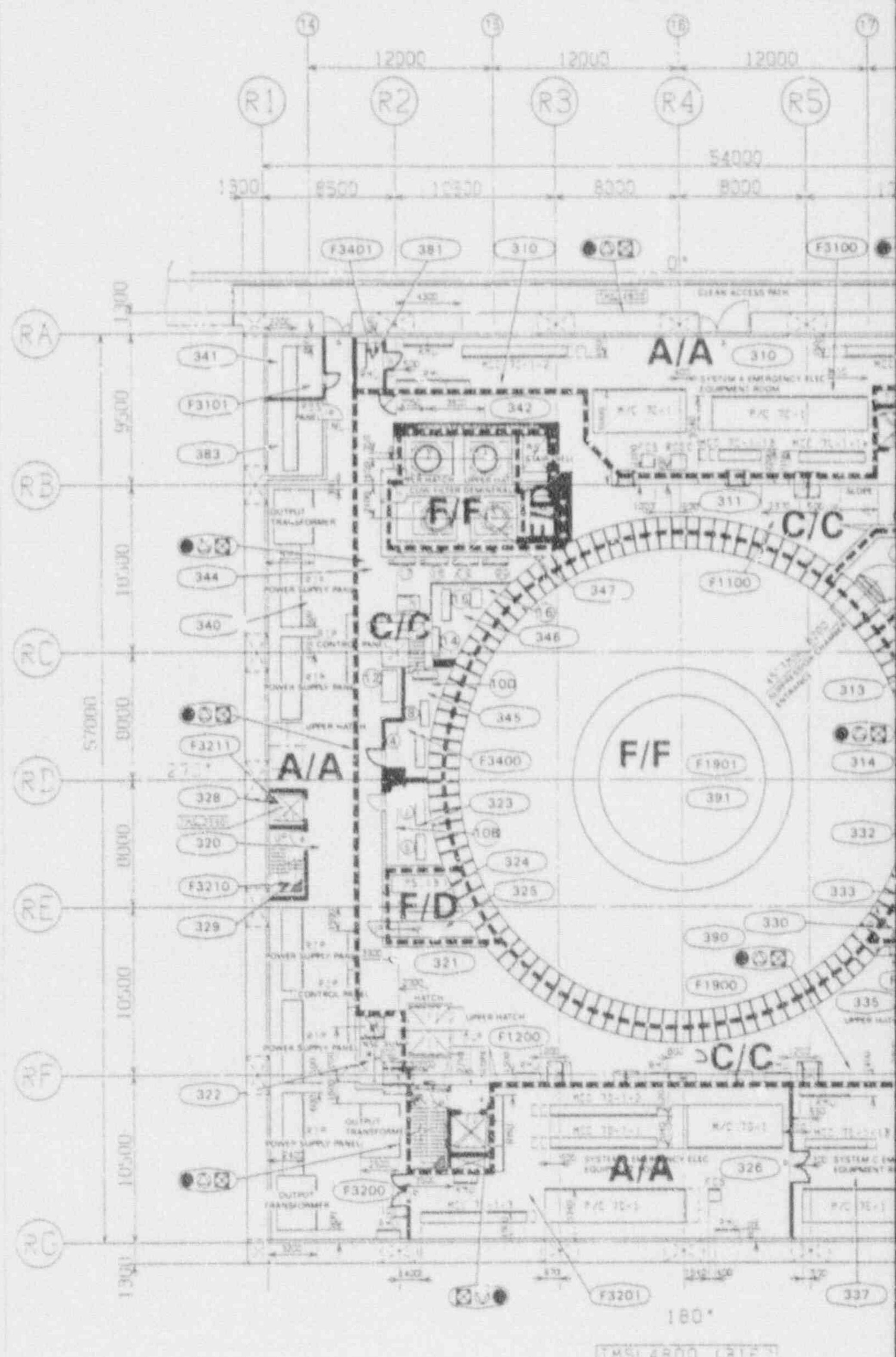
NO.	RACK NAME
1.	REACTOR CORE ISOLATION COOLING SYSTEM (STEAM SYSTEM) INSTRUMENT RACK
2.	FPC F/D SOLENOID OPERATED VALVE RACK
3.	CUW F/D SOLENOID OPERATED VALVE RACK A
3.	CUW F/D SOLENOID OPERATED VALVE RACK B
4.	SCRAM SOLENOID FUSE PANEL
5.	SCRAM SOLENOID FUSE PANEL
6.	SCRAM SOLENOID FUSE PANEL
7.	SCRAM SOLENOID FUSE PANEL
8.	SCRAM SOLENOID FUSE PANEL
9.	SCRAM SOLENOID FUSE PANEL
10.	SCRAM SOLENOID FUSE PANEL
11.	SCRAM SOLENOID FUSE PANEL



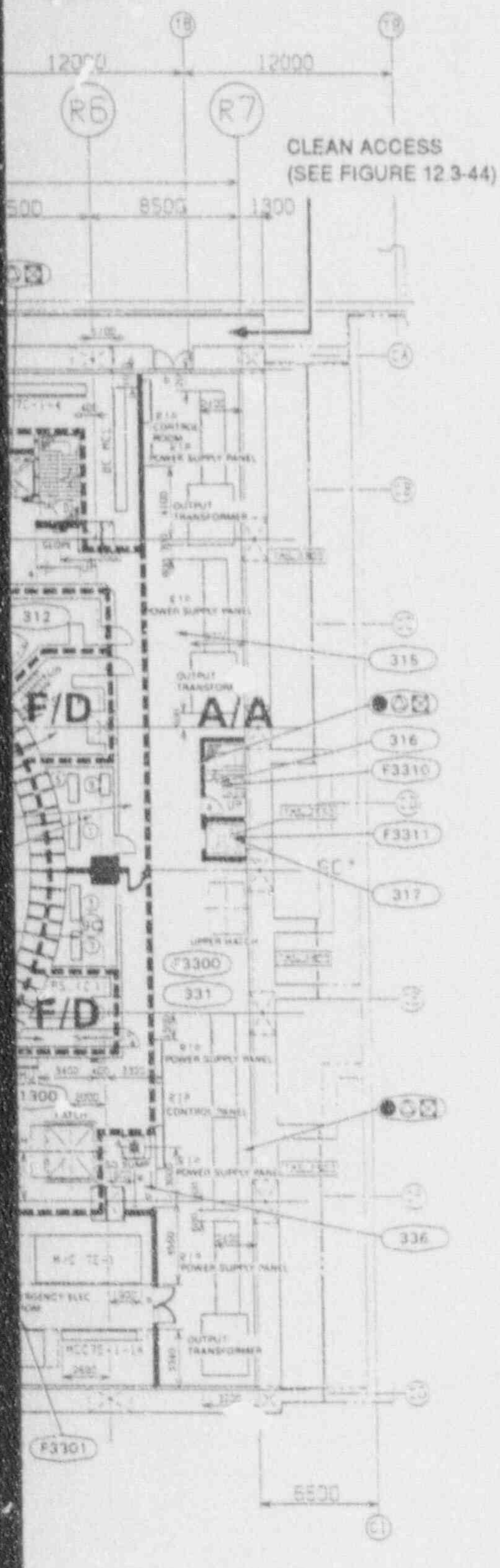
9205200194-02

1. MOTOR ASSEMBLY/ DISASSEMBLY AREA
2. MOTOR DISASSEMBLY PARTS AREA
3. SPARE PARTS TOOL STORAGE RACK
4. MOTOR TEMPORARY PLACE
5. MOTOR CARRYING DOLLY AREA
6. DECONTAMINATION ELECTRICAL TEST TANK
7. WORK BENCH
8. MOVABLE TOOL TABLE
9. SPARE MOTOR STORAGE AREA
10. OVERHEAD CRANE HOOK REACH
11. CHANGING SPACE
12. PUMP TANK FOR WASHING
13. STRETCH TUBE NUT HANDLING TOOL STORAGE AREA
14. SECOND SEAL HANDLING TOOL STORAGE AREA
15. BOTTOM CLOSE FLANGE STORAGE AREA
16. MAIN FLANGE STAND TOOL STORAGE AREA
17. AUX COVER HANDLING TOOL STORAGE AREA
18. MOTOR CONTAINER TEMPORARY PLACE
19. HANDLING TOOL CONTROL BOX STORAGE AREA
20. HANDLING TOOL HYDRAULIC UNIT STORAGE AREA
21. COUPLING STAND HANDLING TOOL STORAGE AREA
22. CRD STORAGE TANK
23. ULTRASONIC CLEANING TANK
24. ULTRASONIC TRANSDUCER
25. CRD DISASSEMBLY CLEANING TANK
26. CRD WORK TABLE
27. BALL-NUT DECENT TEST TABLE
28. SPOOL PIECE WORK TABLE
29. SPOOL PIECE STORAGE TANK
30. SEAL HOUSING TEST FACILITY
31. PARTS TEMPORARY PLACE
32. TOOL RACK
33. STORAGE RACK
34. MOVABLE PARTS TABLE
35. MOTOR UNIT WORK TABLE
36. MOTOR TEST FACILITY
37. BRAKE-SYNCHRO TEST FACILITY
38. MOTOR STORAGE RACK
39. OVERHEAD CRANE RECH LIMIT
40. MONORAIL
41. RIP TEMPORARY PLACE
42. MOTOR BRACKET TEMPORARY PLACE
43. CRD CART STORAGE AREA
44. MOTOR UNIT SPOOL PIECE DOLLY STORAGE AREA
45. ATTACHMENT STORAGE AREA
46. CRD STORAGE AREA
47. SPOOL PIECE STORAGE AREA
48. MOTOR SPARE PARTS AREA
49. CRD REPLACEMENT FACILITY CONTROL PANEL
50. CRD REPLACEMENT FACILITY DRIVE PANEL
51. CRD REPLACEMENT FACILITY PRINTER

Figure 12.3-2 REACTOR BUILDING RADIATION ZONE MAP FOR FULL POWER AND SHUTDOWN OPERATIONS AT ELEVATION -1700mm (B2F)



12000
12000
12000
54000
R1
R2
R3
R4
R5
RA
RB
RC
RD
RE
RF
RG
A/A
F/F
C/C
F/D
F3401
381
310
F3100
341
F3101
383
342
311
344
340
347
F1100
346
313
345
F3400
F1901
391
314
F3211
328
320
323
332
F3210
324
325
333
329
330
390
321
F1900
335
F1200
322
326
F3200
F3201
337
0°
180°
270°
57000
CLEAN ACCESS PATH
OUTPUT TRANSFORMER
POWER SUPPLY PANEL
CONTROL PANEL
UPPER HATCH
TMSL4800 (B1F)



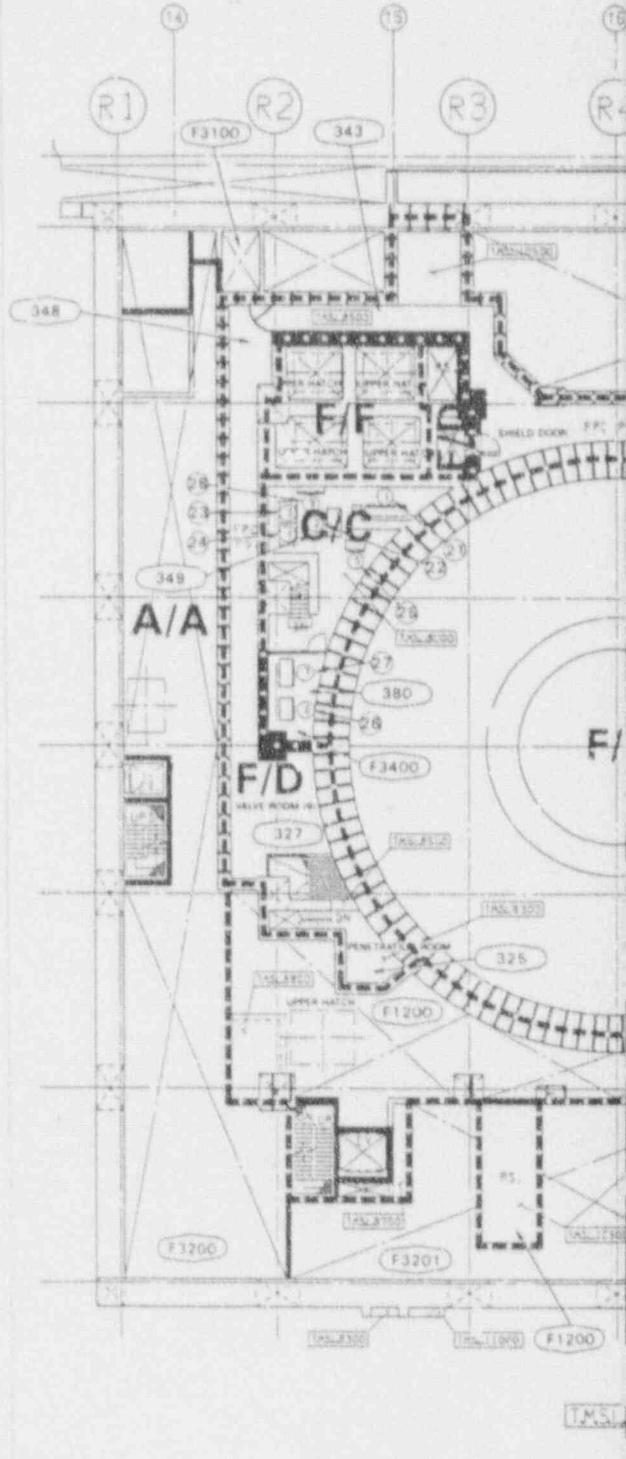
NO. RACK LIST

1. REACTOR SYSTEM (I) INSTRUMENT RACK
2. REACTOR SYSTEM (II) INSTRUMENT RACK
3. REACTOR SYSTEM (III) INSTRUMENT RACK
4. REACTOR SYSTEM (IV) INSTRUMENT RACK
5. MAIN STEAM FLOW (I) INSTRUMENT RACK
6. MAIN STEAM FLOW (II) INSTRUMENT RACK
7. MAIN STEAM FLOW (III) INSTRUMENT RACK
8. MAIN STEAM FLOW (IV) INSTRUMENT RACK
9A. LEAK DETECTION SYSTEM (A) INSTRUMENT RACK
9C. LEAK DETECTION SYSTEM (C) INSTRUMENT RACK
10B. LEAK DETECTION SYSTEM (B) INSTRUMENT RACK
10D. LEAK DETECTION SYSTEM (D) INSTRUMENT RACK
12. REACTOR WATER SAMPLING TRANSMITTER PANEL
13. FPC FD SAMPLING TRANSMITTER
14. FPC FD MAIN VALVE RACK
15. FPC FD CONDUCTIVITY METER RACK
16. FPC FD SAMPLING HOOD
17. FPC F/D INSTRUMENT RACK (B)
18. FPC F/D INSTRUMENT RACK (A)
19. CUW F/D INSTRUMENT RACK (B)
20. CUW F/D INSTRUMENT RACK (A)
21. REACTOR WATER SAMPLING COOLER RACK
22. REACTOR WATER SAMPLE DEPRESSURIZATION RACK
23. REACTOR WATER pH METER RACK
24. REACTOR WATER DISSOLVED OXYGEN METER
25. REACTOR WATER CONDUCTIVITY METER RACK
26. REACTOR WATER SAMPLING HOOD
27. REACTOR WATER GRAB SAMPLING RACK
28. PAS RELATED AO VALVE RACK

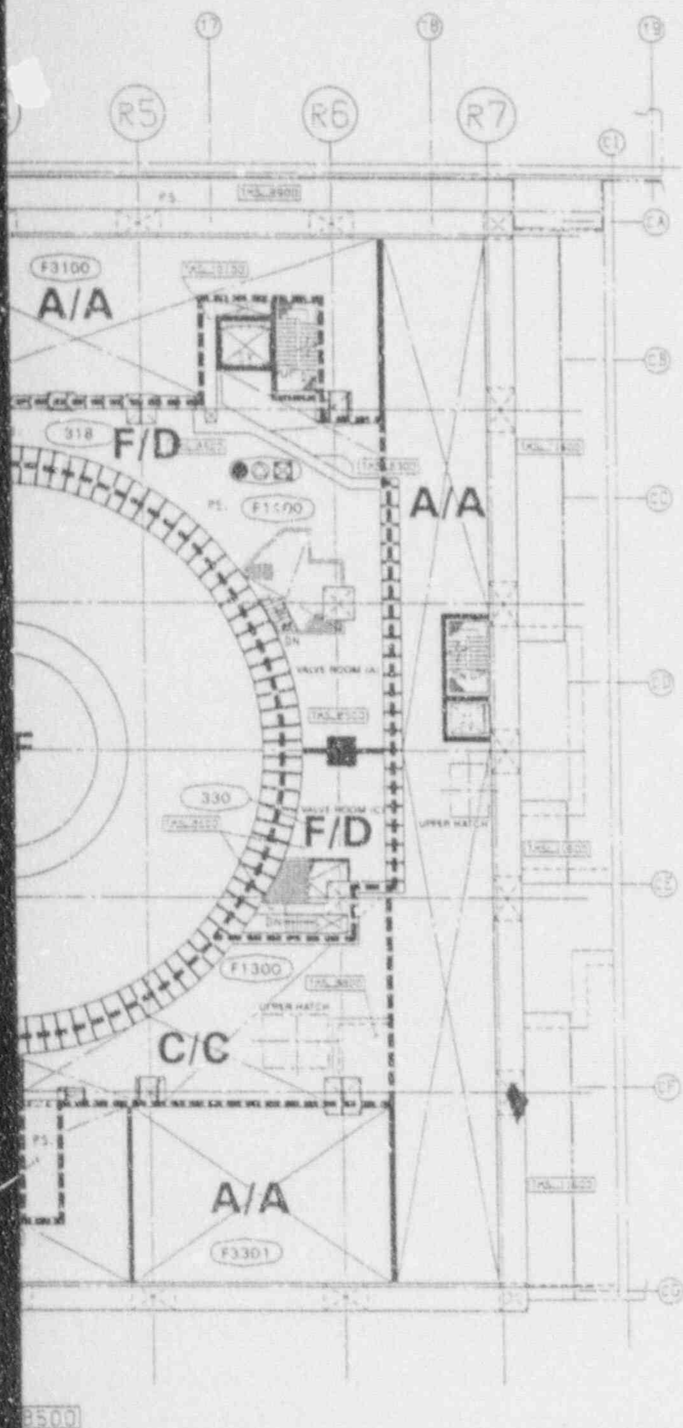
FULL POWER/SHUTDOWN
RADIATION LEVELS IN
MREM/HOUR
A ≤ 0.6
B ≤ 1
C < 5
D < 25
E < 100
F ≥ 100

(REMARKS)
EQUIPMENT
EMERGENCY ELECTRIC ROOM (A)
EMERGENCY ELECTRIC ROOM (B)
EMERGENCY ELECTRIC ROOM (C)
RSS PANEL
RIP PANEL

Figure 12.3-3 REACTOR BUILDING RADIATION ZONE MAP FOR FULL POWER AND SHUTDOWN OPERATIONS AT ELEVATION 4800mm (B1F)



FULL POWER/SHUTDOWN
RADIATION LEVELS IN
MREM/HOUR
A ≤ 0.6
B ≤ 1
C < 5
D < 25
E < 100
F ≥ 100



NO. RACK LIST

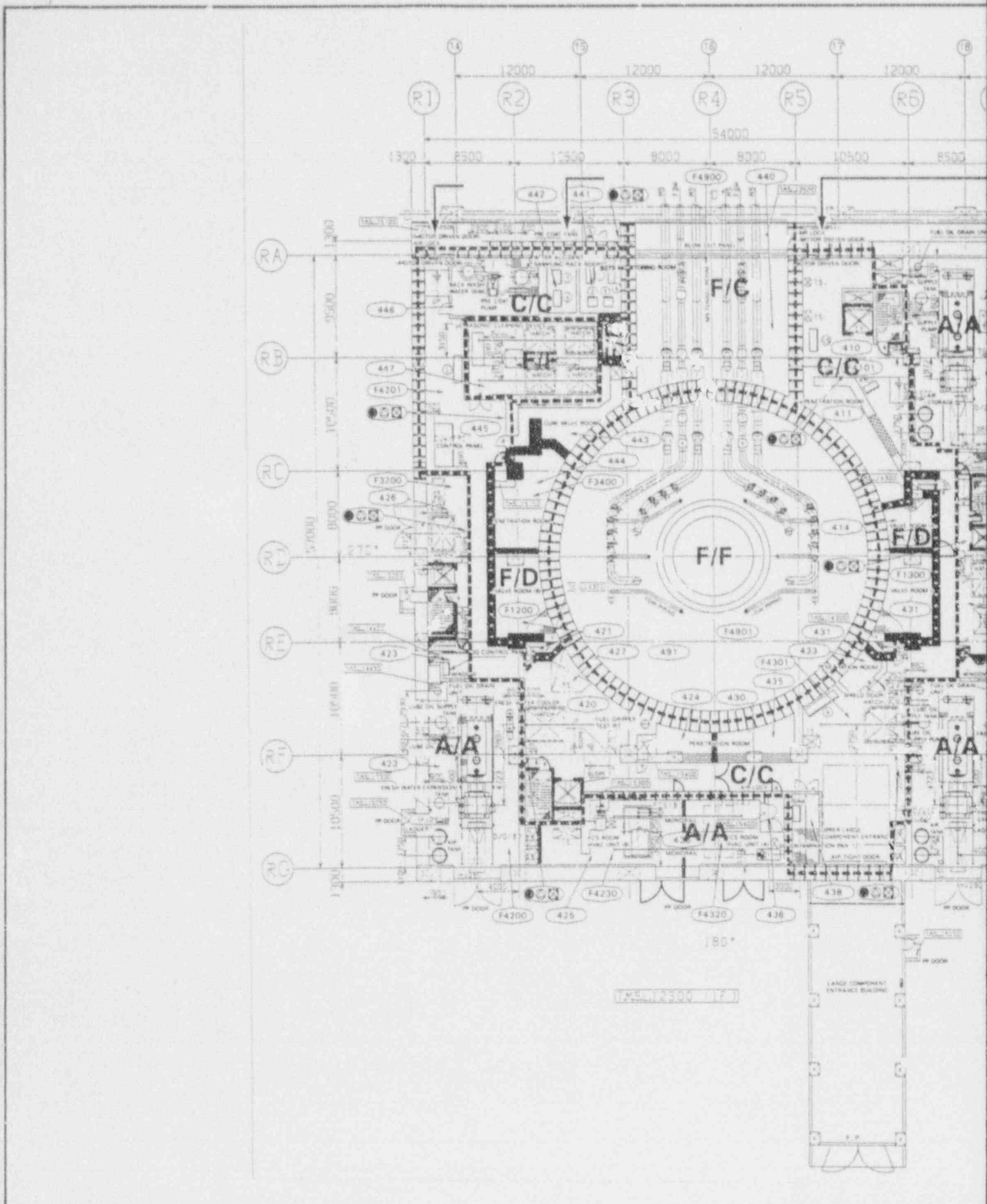
1. REAC. SYSTEM (I) INSTRUMENT RACK
2. REACTOR SYSTEM (II) INSTRUMENT RACK
3. REACTOR SYSTEM (III) INSTRUMENT RACK
4. REACTOR SYSTEM (IV) INSTRUMENT RACK
5. MAIN STEAM FLOW (I) INSTRUMENT RACK
6. MAIN STEAM FLOW (II) INSTRUMENT RACK
7. MAIN STEAM FLOW (III) INSTRUMENT RACK
8. MAIN STEAM FLOW (IV) INSTRUMENT RACK
9A. LEAK DETECTION SYSTEM (A) INSTRUMENT RACK
9C. LEAK DETECTION SYSTEM (C) INSTRUMENT RACK
10B. LEAK DETECTION SYSTEM (B) INSTRUMENT RACK
10D. LEAK DETECTION SYSTEM (D) INSTRUMENT RACK
12. REACTOR WATER SAMPLING TRANSMITTER PANEL
13. FPC FD SAMPLING TRANSMITTER

NO. RACK LIST

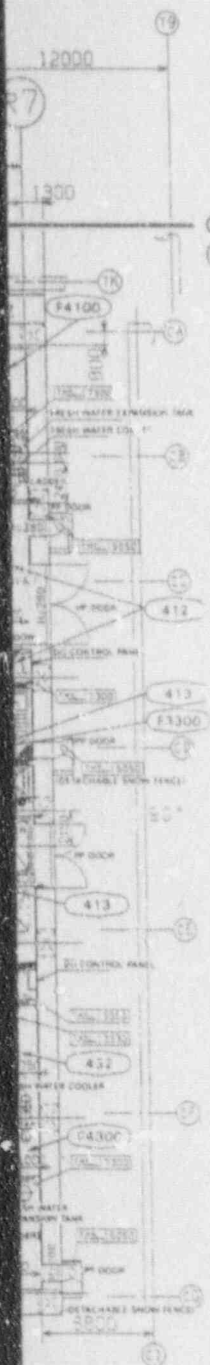
14. FPC FD MAIN VALVE RACK
15. FPC FD CONDUCTIVITY METER RACK
16. FPC FD SAMPLING HOOD
17. FPC F/D INSTRUMENT RACK (B)
18. FPC F/D INSTRUMENT RACK (A)
19. CUW F/D INSTRUMENT RACK (B)
20. CUW F/D INSTRUMENT RACK (A)
21. REACTOR WATER SAMPLING COOLER RACK
22. REACTOR WATER SAMPLE DEPRESSURIZATION RACK
23. REACTOR WATER pH METER RACK
24. REACTOR WATER DISSOLVED OXYGEN METER
25. REACTOR WATER CONDUCTIVITY METER RACK
26. REACTOR WATER SAMPLING HOOD
27. REACTOR WATER GRAB SAMPLING RACK
28. PAS RELATED AO VALVE RACK

(REMARKS)
EQUIPMENT
EMERGENCY ELECTRIC ROOM (A)
EMERGENCY ELECTRIC ROOM (B)
EMERGENCY ELECTRIC ROOM (C)
RSS PANEL
RIP PANEL

Figure 12.3-4 REACTOR BUILDING RADIATION ZONE MAP FOR FULL POWER AND SHUTDOWN OPERATIONS AT ELEVATION 8500mm (B1F)



14
15
16
17
18
12000
12000
12000
12000
R1
R2
R3
R4
R5
R6
54000
1300
8500
10500
8000
8000
10500
8500
RA
RB
RC
RD
RE
RF
RG
57000
270°
180°
F/C
C/C
F/F
A/A
F/D
F/F
F/D
A/A
C/C
A/A
A/A
C/C
F4900
440
442
441
446
447
F4201
445
443
444
F3200
426
F3400
410
411
414
F1300
431
F1200
421
427
491
F4801
431
433
F4301
435
423
420
424
430
423
438
F4200
425
F4230
F4320
436



CONTROLLED ACCESS
(SEE FIGURE 12.3-46)

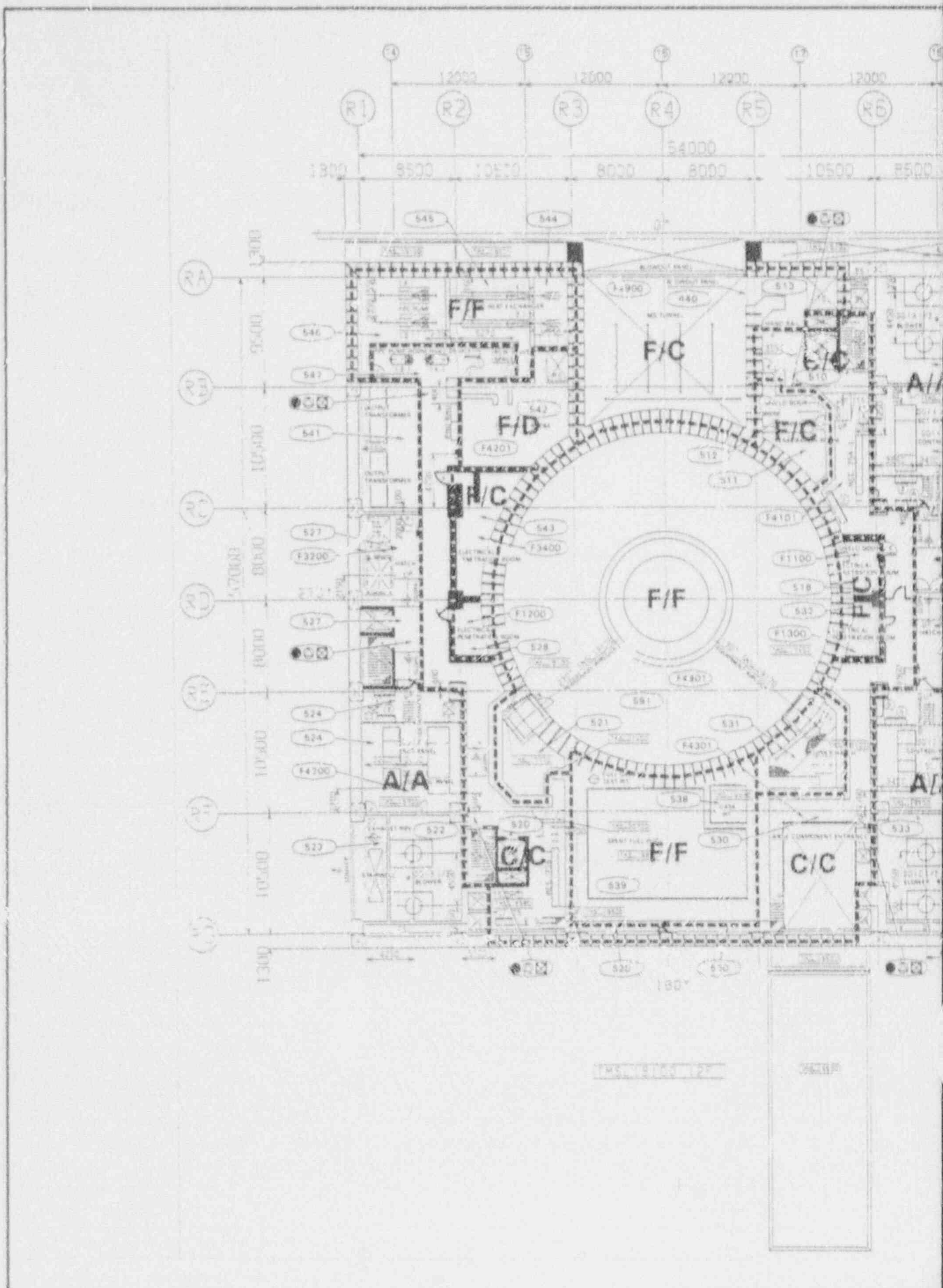
(REMARKS)
EQUIPMENT
PRE COAT PUMP
FUEL HANDLING MACHINE TEST PIT

INSTRUMENT RACK LIST

NO.	NAME
1	POST ACCIDENT SAMPLE TRANSFER RACK
2	POST ACCIDENT SAMPLE RECOVERY RACK
3	POST ACCIDENT SAMPLING LOCAL OPERATING PANEL
4	STANDBY GAS TREATMENT SYSTEM OFF GAS RADIATION MONITOR SAMPLE RACK
5	STANDBY GAS TREATMENT SYSTEM OFF GAS RADIATION MONITOR GAS SAMPLER RACK (A)
6	STANDBY GAS TREATMENT SYSTEM OFF GAS RADIATION MONITOR GAS SAMPLER RACK (B)
7	STANDBY GAS TREATMENT SYSTEM OFF GAS RADIATION MONITOR PARTICULATE IODINE SAMPLE RACK
8	STANDBY GAS TREATMENT SYSTEM OFF GAS RADIATION MONITOR PARTICULATE IODINE SAMPLE RACK OPERATING PANEL
9	CONTAINMENT VESSEL PRESSURE LEAK TEST RACK
10	REACTOR CONTAINMENT VESSEL DEW POINT RECORDER RACK

FULL POWER/SHUTDOWN
RADIATION LEVELS IN
MREM/HOUR
A ≤ 0.6
B ≤ 1
C < 5
D < 25
E < 100
F ≥ 100

Figure 12.3-5 REACTOR BUILDING RADIATION ZONE MAP FOR FULL POWER AND SHUTDOWN OPERATIONS AT ELEVATION 12300mm (1F)



12000
12000
12200
12000
R1
R2
R3
R4
R5
R6
54000
1300
8500
10500
8000
8000
10500
8500
RA
RB
RC
RD
F/F
F/C
C/C
A/A
F/D
R/C
F/C
F/F
A/A
C/C
F/F
C/C
F4201
F3200
F3400
F1200
F4101
F1100
F1300
F4301
F4200
F4801
545
544
546
547
541
542
527
543
512
511
513
510
518
528
524
521
531
591
538
520
522
530
533
539
180°

SI
APERTURE
CARD

Also Available On
Aperture Card

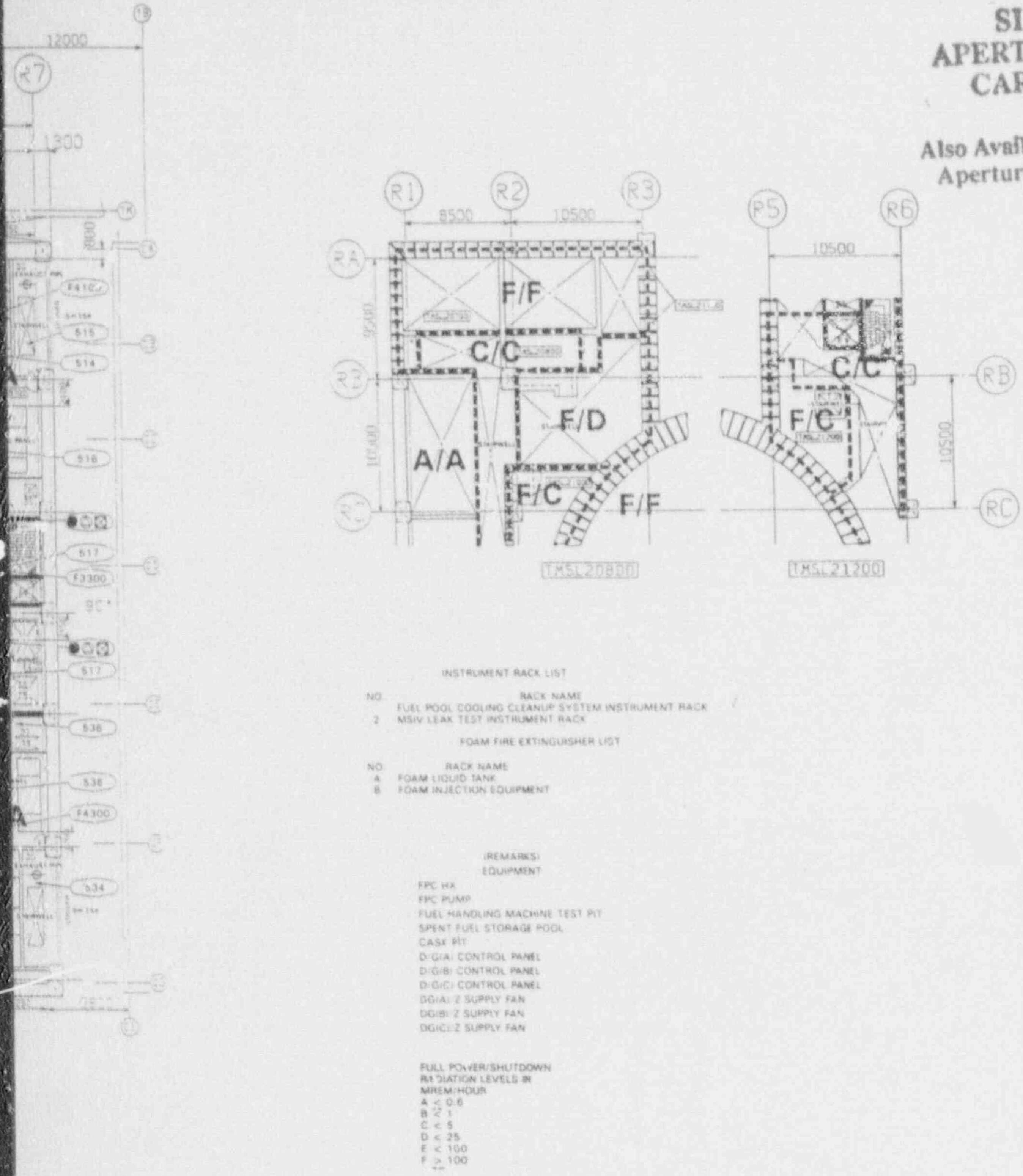


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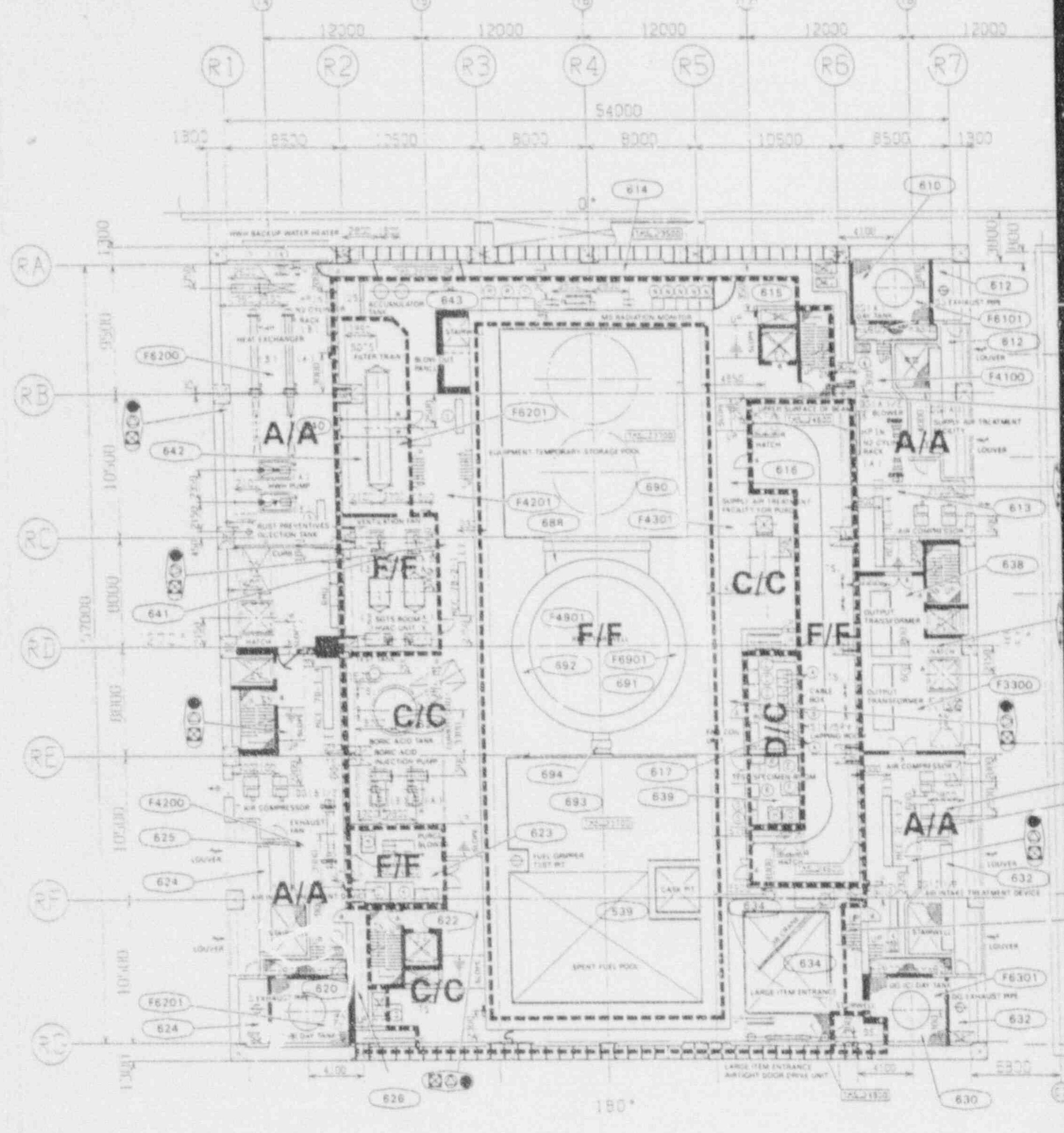
Figure 12.3-6 REACTOR BUILDING RADIATION ZONE MAP FOR FULL POWER AND SHUTDOWN OPERATIONS AT ELEVATION 18100mm (2F)



T.M.S.L. 23500 (3F)

INSTRUMENT RACK

NO.	RACK NAME
1.	STANDBY GAS TREATMENT SYSTEM INSTRUMENT RACK
2.	CONTAINMENT VESSEL ATMOSPHERE MONITOR CALIBRATION GAS CYLINDER RACK A
3.	CONTAINMENT VESSEL ATMOSPHERE MONITOR CALIBRATION GAS CYLINDER RACK B
4.	SCRAM SEISMIC SENSOR

ISI ROOM AND AUXILIARY FACILITIES

NO.	FACILITY NAME	QTY
A	CONTROL DATA COLLECTION EQUIPMENT	8
B	STABILIZED POWER SUPPLY SYSTEM	1
C	DESK	3
D	STORAGE	2
E	CALIBRATION TEST PIECE FOR M/S NOZZLE CORNER	1
F	CALIBRATION TEST PIECE FOR NOZZLE CORNER	1
G	CALIBRATION TEST PIECE FOR NOZZLE CORNER	1
H	CALIBRATION TEST PIECE FOR NOZZLE CORNER	1
J	RPV SHELL ADJUST TEST FACILITY	1
K	RPV BOTTOM PLATE ADJUST TEST FACILITY	1
L	RPV NOZZLE ADJUST TEST FACILITY	1
M	PIPING ADJUST TEST FACILITY	1
N	ISI DEVICE STORAGE	5
P	ISI DEVICE STORAGE	3
Q	RPV CALIBRATION TEST PIECE STORAGE	1
R	RPV CONSUMABLE MATERIALS AND CALIBRATION TEST PIECE STORAGE	2
S	PIPING CALIBRATION TEST PIECE STORAGE	2

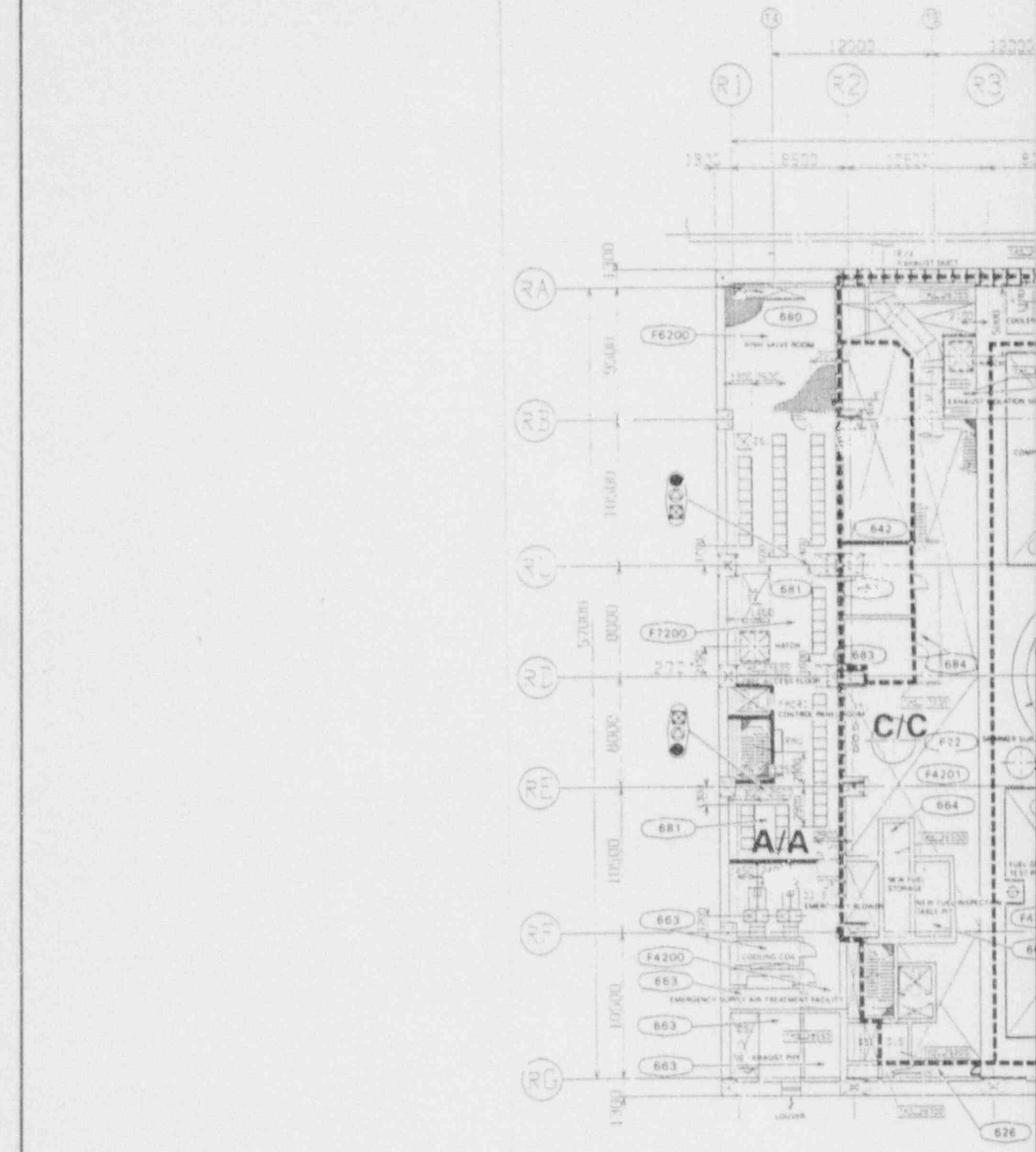
(REMARKS)
EQUIPMENT

D/S PIT
CASK PIT
SPENT FUEL STORAGE POOL
ISI INSPECTION ROOM
SGTS FILTER TRAIN
SGTS FAN
SLC PUMP
SLC TANK
SLC TEST TANK
DG (A) DAY TANK
DG (B) DAY TANK
DG (C) DAY TANK
HWH PUMP
HWH HX

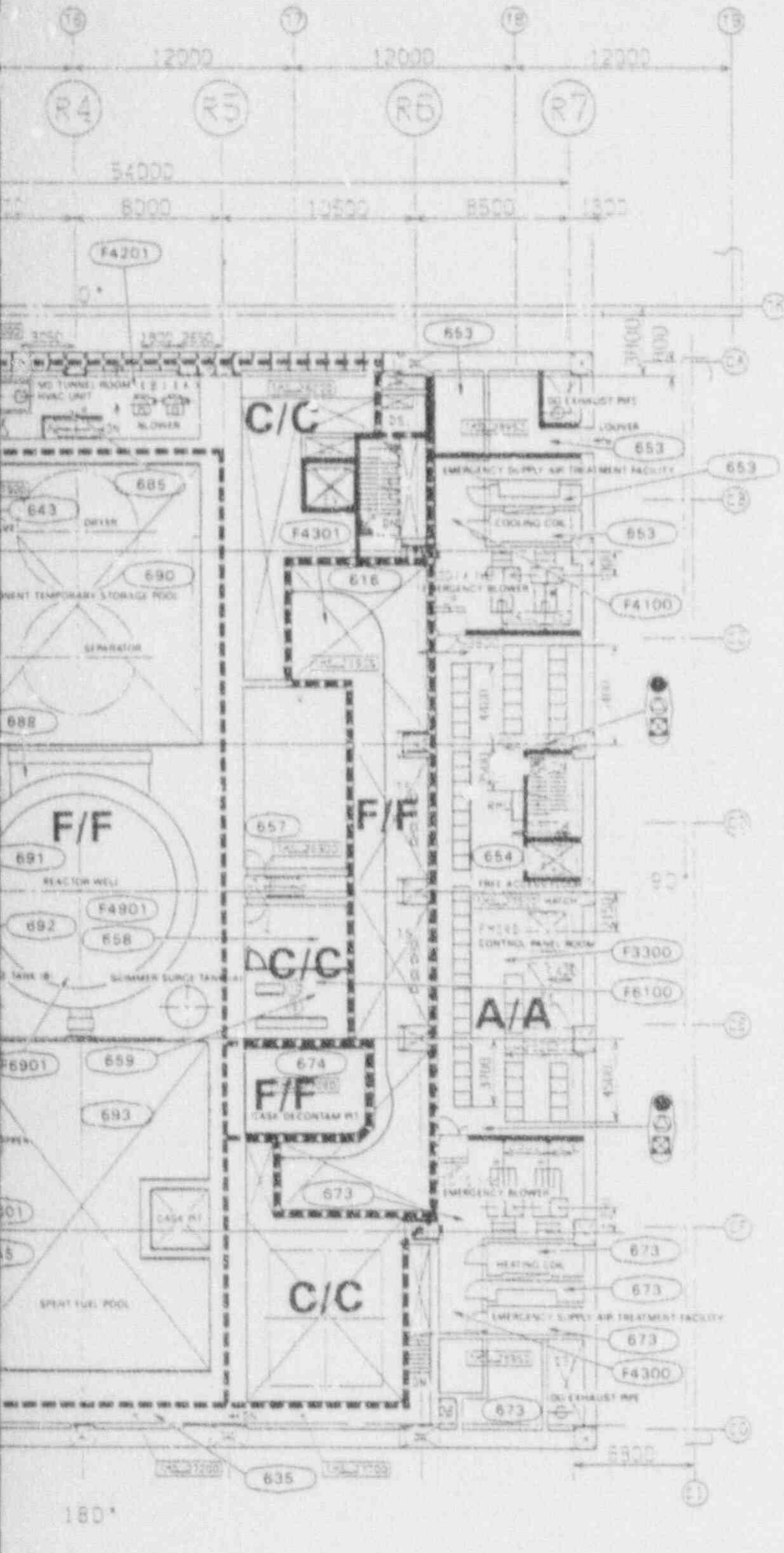
FULL POWER/SHUTDOWN
RADIATION LEVELS IN
MREM/HOUR

A $\leq$ 0.6
B $\leq$ 1
C < 5
D < 25
E < 100
F $\geq$ 100

Figure 12.3-7 REACTOR BUILDING RADIATION ZONE MAP FOR FULL POWER AND SHUTDOWN OPERATIONS AT ELEVATION 23500mm (3F)



R1
R2
R3
12000
12000
RA
RB
RC
RD
RE
RF
RG
57000
1300
9500
10500
8000
8000
10500
10500
1300
F6200
680
642
681
F7200
HATCH
683
684
C/C
F22
F4201
664
A/A
681
NEW FUEL STORAGE
663
F4200
COOLING COIL
663
EMERGENCY SUPPLY AIR TREATMENT FACILITY
663
663
LOUVER
626

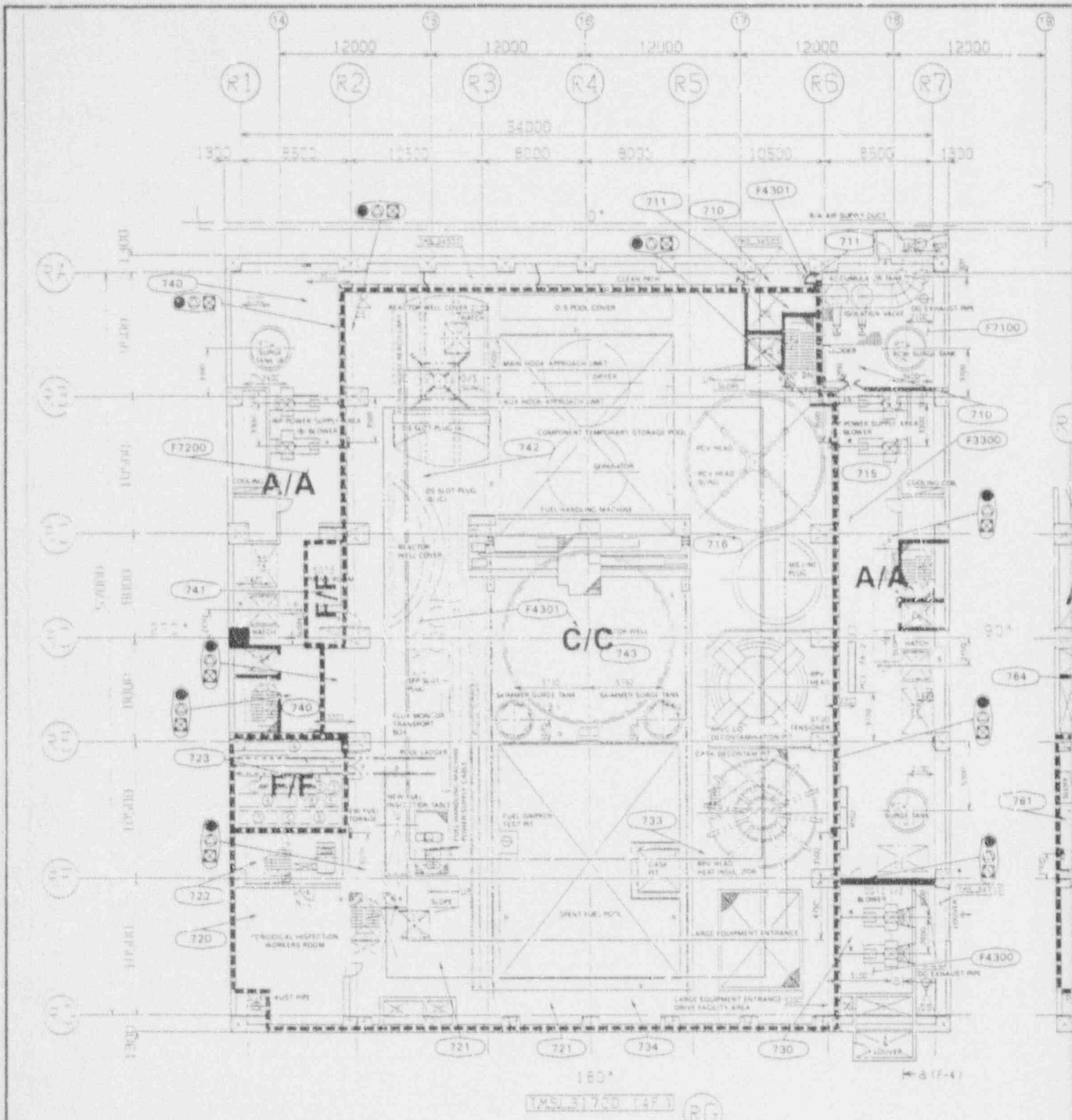


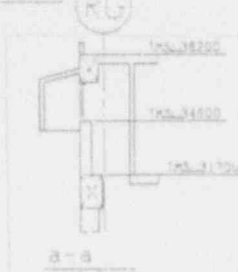
(REMARKS)
EQUIPMENT
D.S PIT
CASK PIT
SPENT FUEL STORAGE POOL
CASK WASHDOWN PIT
FMCRD PANEL ROOM
NEW FUEL STORAGE PIT
NEW FUEL INSPECTION PIT

FULL POWER/SHUTDOWN
RADIATION LEVELS IN
MREM/HOUR
A $\le$ 0.6
B $\le$ 1
C < 5
D < 25
E < 100
F $\geq$ 100

9205200194-08

Figure 12.3-8 REACTOR BUILDING RADIATION ZONE MAP FOR FULL POWER AND SHUTDOWN OPERATIONS AT ELEVATION 27200mm (4F)



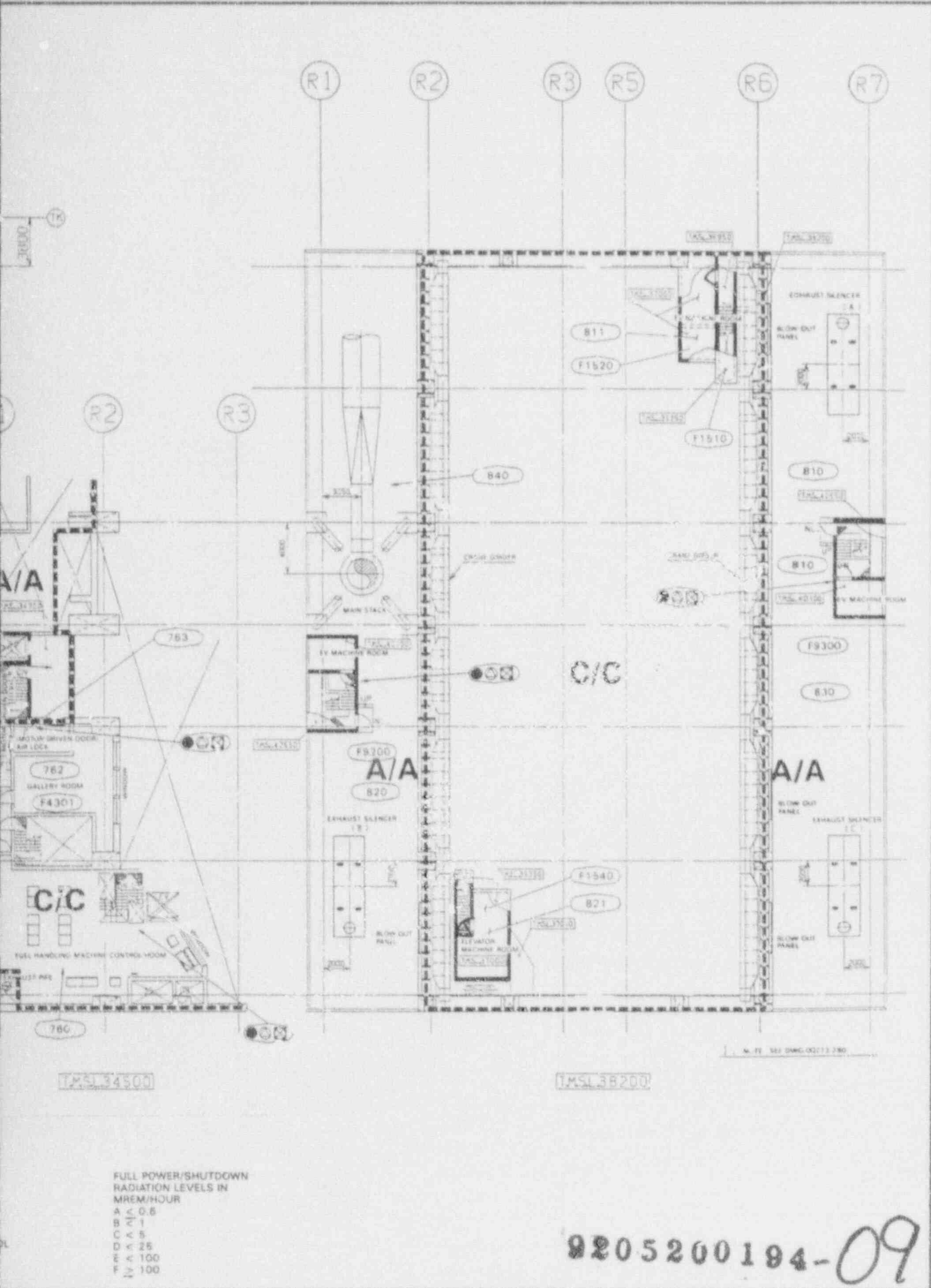


NO.	RACK NAME
1.	INSPECTION POOL
2.	TEMPORARY INSTALLED RAIL
3.	MONO RAIL
4.	TEMPORARY INST RAIL STORAGE AREA
5.	IMPELLER SHAFT GRIPPER STORAGE AREA
6.	DIFFUSER WEAR RING GRIPPER STORAGE AREA
7.	DIFFUSER STRETCH TUBE GRIPPER STORAGE AREA
8.	UPPER PLUG STORAGE AREA
9.	RIP UPPER PORTION HANDLING CONNECTOR ROD STORAGE AREA

(REMARKS)
EQUIPMENT
D/S PIT
SPENT FUEL STORAGE PO

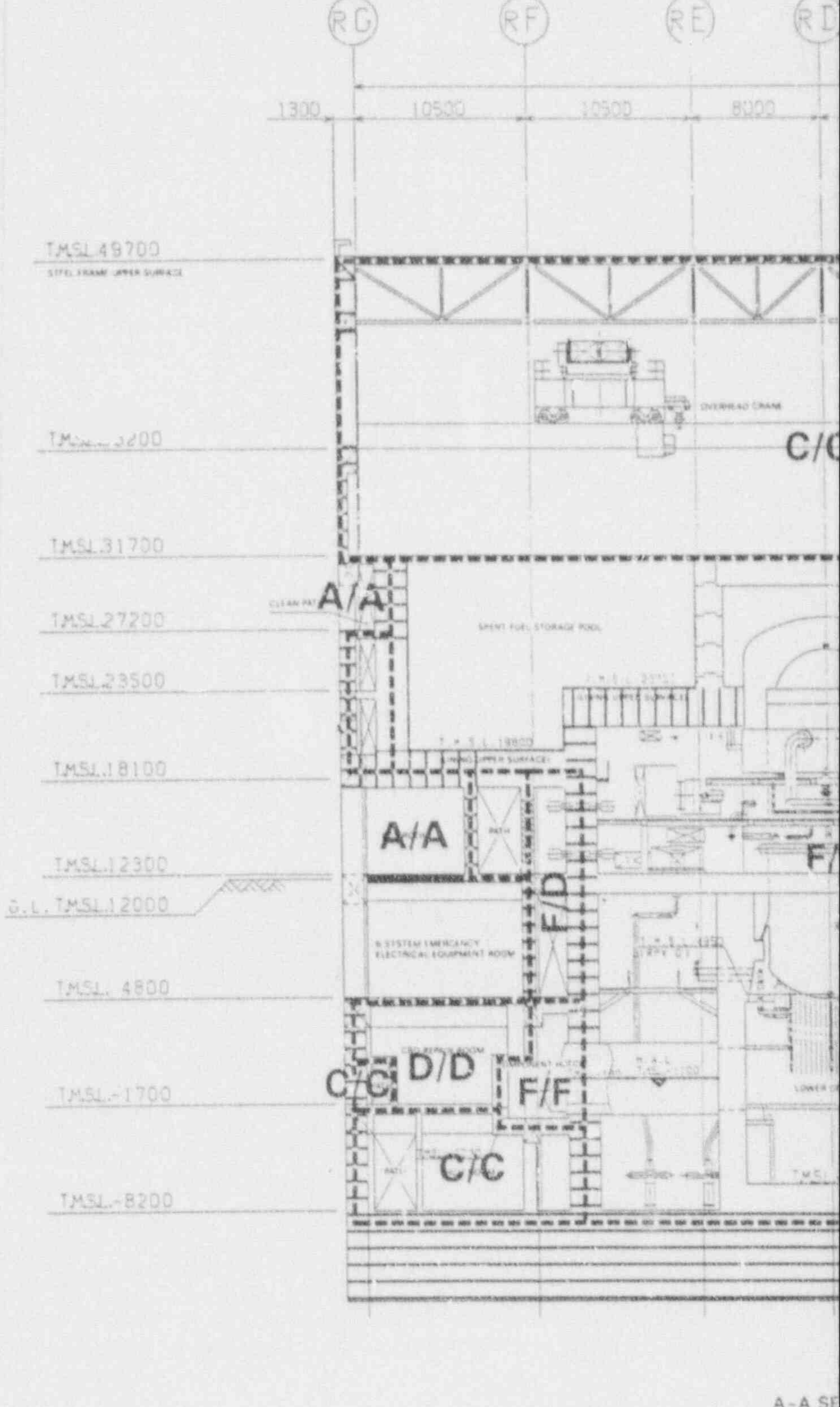
SI
APERTURE
CARD

Also Available On
Aperture Card

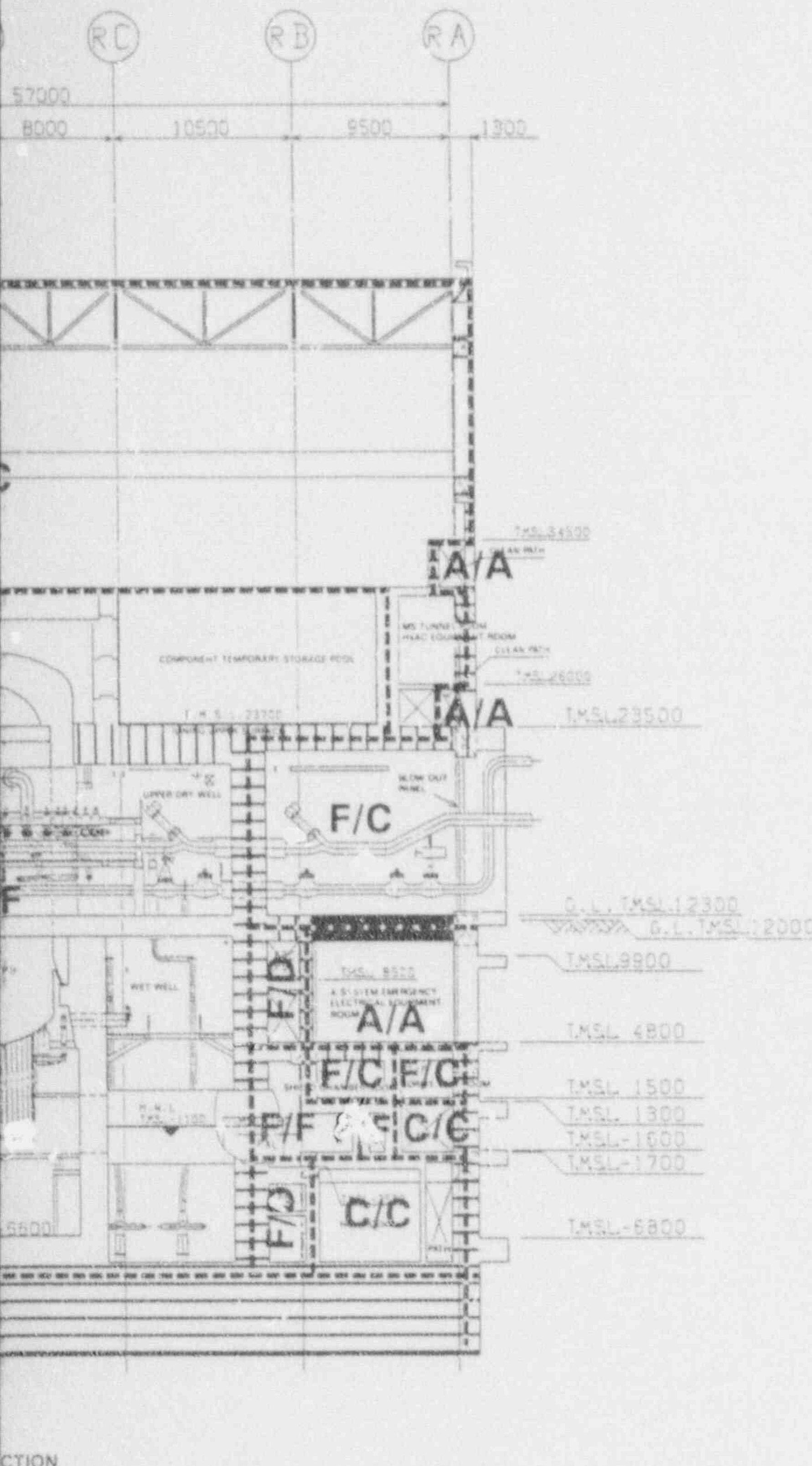


9205200194-09

Figure 12.3-9 REACTOR BUILDING RADIATION ZONE MAP FOR FULL POWER AND SHUTDOWN OPERATIONS AT ELEVATION 31700mm (4FM)

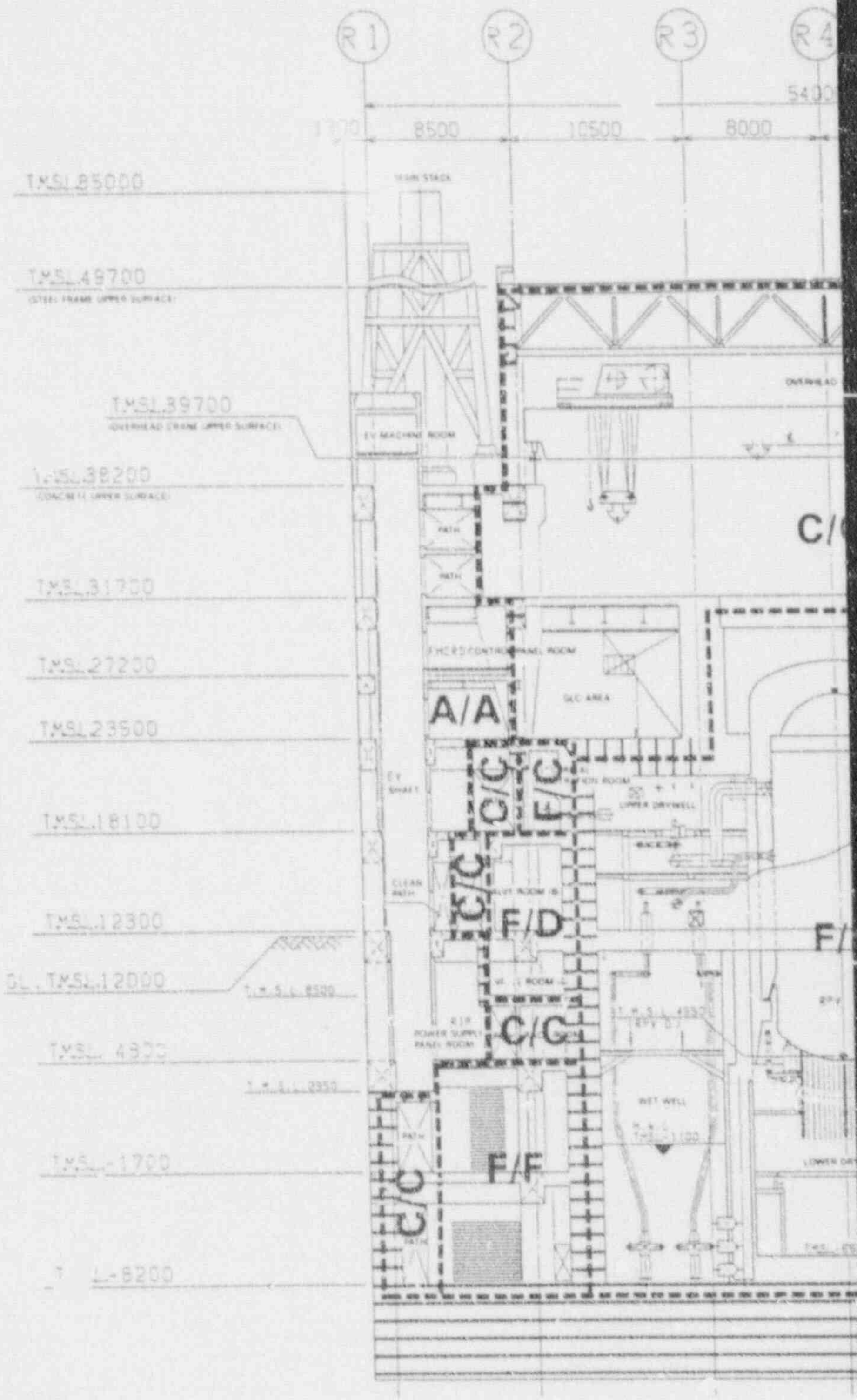


RG
RF
RE
RD
1300
10500
10500
8000
T.M.S.L.49700
STEEL FRAME UPPER SURFACE
OVERHEAD CRANE
C/C
T.M.S.L.31700
CLEAN PATH
A/A
T.M.S.L.27200
SPENT FUEL STORAGE POOL
T.M.S.L.23500
T.M.S.L.18100
A/A
PATH
T.M.S.L.12300
G.L. T.M.S.L.12000
F/D
T.M.S.L. 4800
C/C
D/D
F/F
T.M.S.L.-1700
C/C
T.M.S.L.-8200
A-A SE

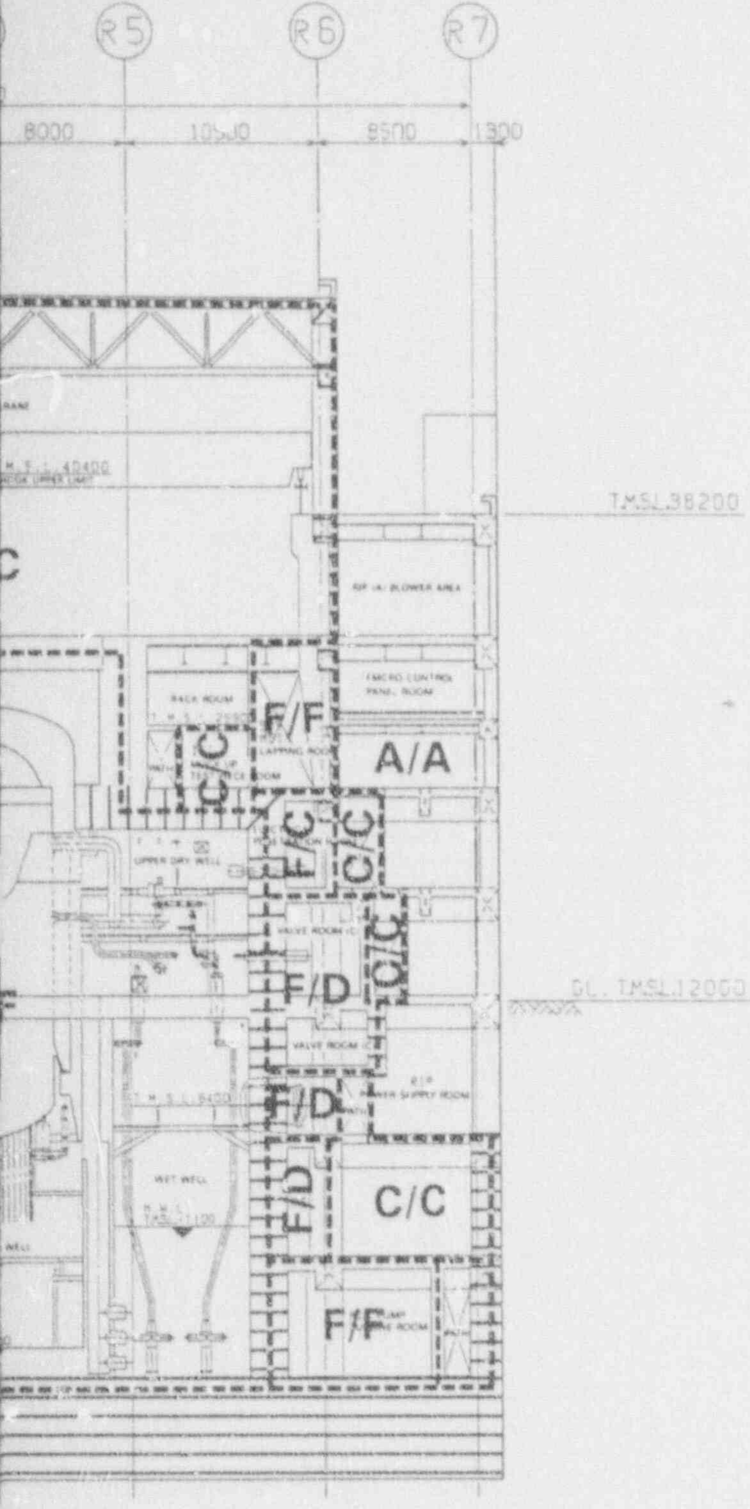


FULL POWER/SHUTDOWN
RADIATION LEVELS IN
MREM/HOUR
A ≤ 0.6
B ≤ 1
C ≤ 5
D ≤ 25
E ≤ 100
F ≥ 100

Figure 12.3-10 REACTOR BUILDING RADIATION ZONE MAP FOR FULL POWER AND SHUTDOWN OPERATIONS AT CROSS SECTION VIEW A-A

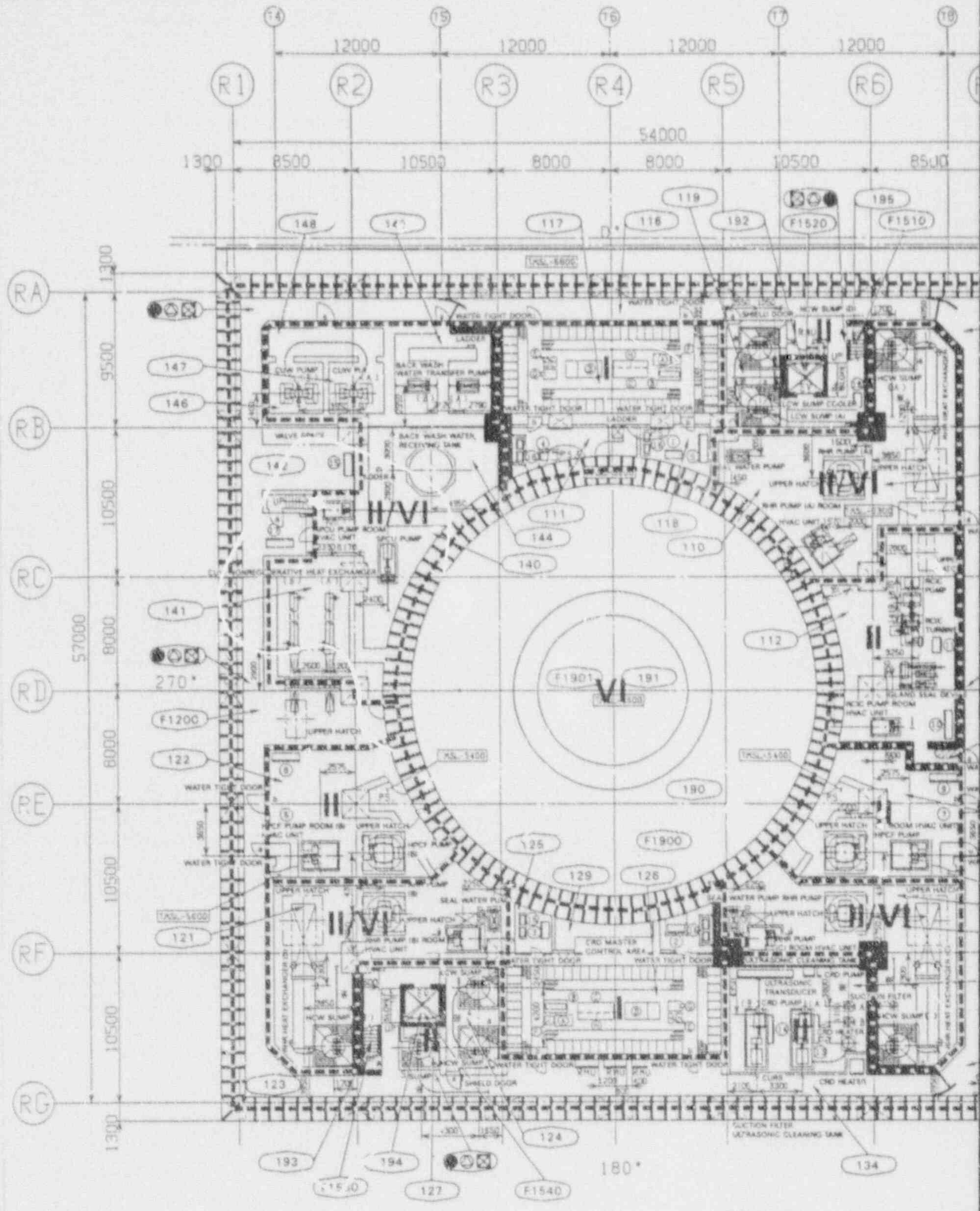

R1
R2
R3
R4
8500
10500
8000
TMSL 85000
TMSL 49700
TMSL 39700
TMSL 31700
TMSL 27200
TMSL 23500
TMSL 18100
TMSL 12300
GL TMSL 12000
TMSL -1700
A/A
C/C
F/C
C/C
F/D
C/C
F/F
C/C

B-B SECTION

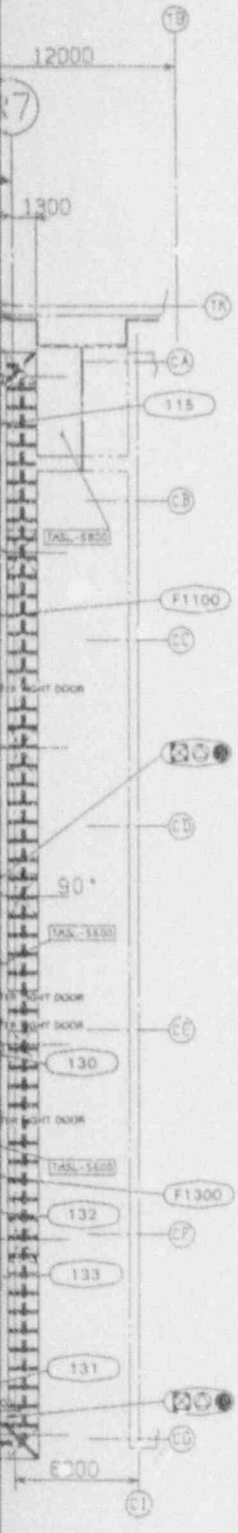


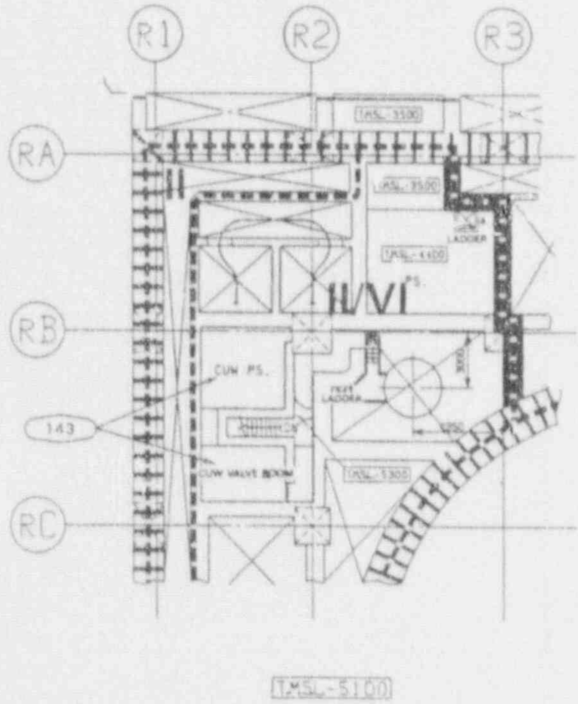
FULL POWER/SHUTDOWN
RADIATION LEVELS IN
MREM/HOUR
A ≤ 0.6
B ≤ 1
C < 5
D < 25
E < 100
F ≥ 100

Figure 12.3-11 REACTOR BUILDING RADIATION ZONE MAP FOR FULL POWER AND SHUTDOWN OPERATIONS AT CROSS SECTION VIEW B-B



TMSL-8200 (B3F)





(REMARKS)
EQUIPMENT
RHR PUMP (A)
RHR PUMP (B)
RHR PUMP (C)
RHR HX (A)
RHR HX (B)
RHR HX (C)
HPCF PUMP (B)
HPCF PUMP (C)
CUW NON-RE HX
CUW PUMP
CUW BACK WASH TRANSFER PUMP
CUW BACK WASH TANK
CRD PUMP
SUCTION FILTER
RCIC PUMP
RCIC TURBINE

FIRE PROTECTION SYMBOLS

- (F1901) FIRE AREA NUMBER
  - a. LEFT HAND DIGIT IS BOTTOM FLOOR NUMBER STARTING WITH 1 = ELEVATION (-) 8200
  - b. SECOND DIGIT FROM LEFT IS THE ELECTRICAL DIVISION NUMBER
- (135) ROOM NUMBER
- HOSE RACK
- PORTABLE EXTINGUISHER
- STANDPIPE
- 3-HOUR RATED FIRE BARRIER (WALL)
- RATED FIRE BARRIER (FLOOR)
- 3-HOUR FIRE RATED DOOR
- SECONDARY CONTAINMENT BOUNDARIES (3-HOUR RATED FIRE BARRIER)
- SPRINKLER SYSTEM

NO.	RACK LIST	RACK NAME
1.	CORE FLOW (IA) INSTRUMENT RACK	
2.	CORE FLOW (IB) INSTRUMENT RACK	
3.	CORE FLOW (IIA) INSTRUMENT RACK	
4.	CORE FLOW (IIB) INSTRUMENT RACK	
5.	RHR SYSTEM (A) INSTRUMENT RACK	
6.	RHR SYSTEM (B) INSTRUMENT RACK	
7.	RHR SYSTEM (C) INSTRUMENT RACK	
8.	HIGH PRESSURE CORE SPRAY SYSTEM (B) INSTRUMENT RACK	
9.	HIGH PRESSURE CORE SPRAY SYSTEM (C) INSTRUMENT RACK	
10.	REACTOR CORE ISOLATION COOLING SYSTEM INSTRUMENT RACK	
11.	REACTOR CORE ISOLATION COOLING SYSTEM TURBINE INSTRUMENT RACK	
12.	CONTROL ROD DRIVE HYDRAULIC SYSTEM INSTRUMENT RACK	
13.	CRD PUMP (A) INSTRUMENT RACK	
14.	CRD PUMP (B) INSTRUMENT RACK	
15.	REACTOR COOLANT CLEAN-UP SYSTEM INSTRUMENT RACK	
16.	SCRAM SEISMIC SENSOR, FOUR EACH	
17.	SUPPRESSION POOL DISCHARGE SYSTEM SAMPLING RACK	
18.	RHR HEAT EXCHANGER EXIT SAMPLING RACK	

A. ACCUMULATOR INSTALLATION-REMOVAL TRANSPORTATION DOLLY
B. ACCUMULATOR DISASSEMBLY-ASSEMBLY DOLLY
C. ACCUMULATOR WORKING BENCH
D. SCRAM VALVE-SCRAM PILOT VALVE WORKING BENCH
E. SCRAM PILOT VALVE TEST FACILITY
F. PUMP UNIT
G. GENERAL PURPOSE WORKING BENCH
H. TOOL BOX

REMARK (COMMON)

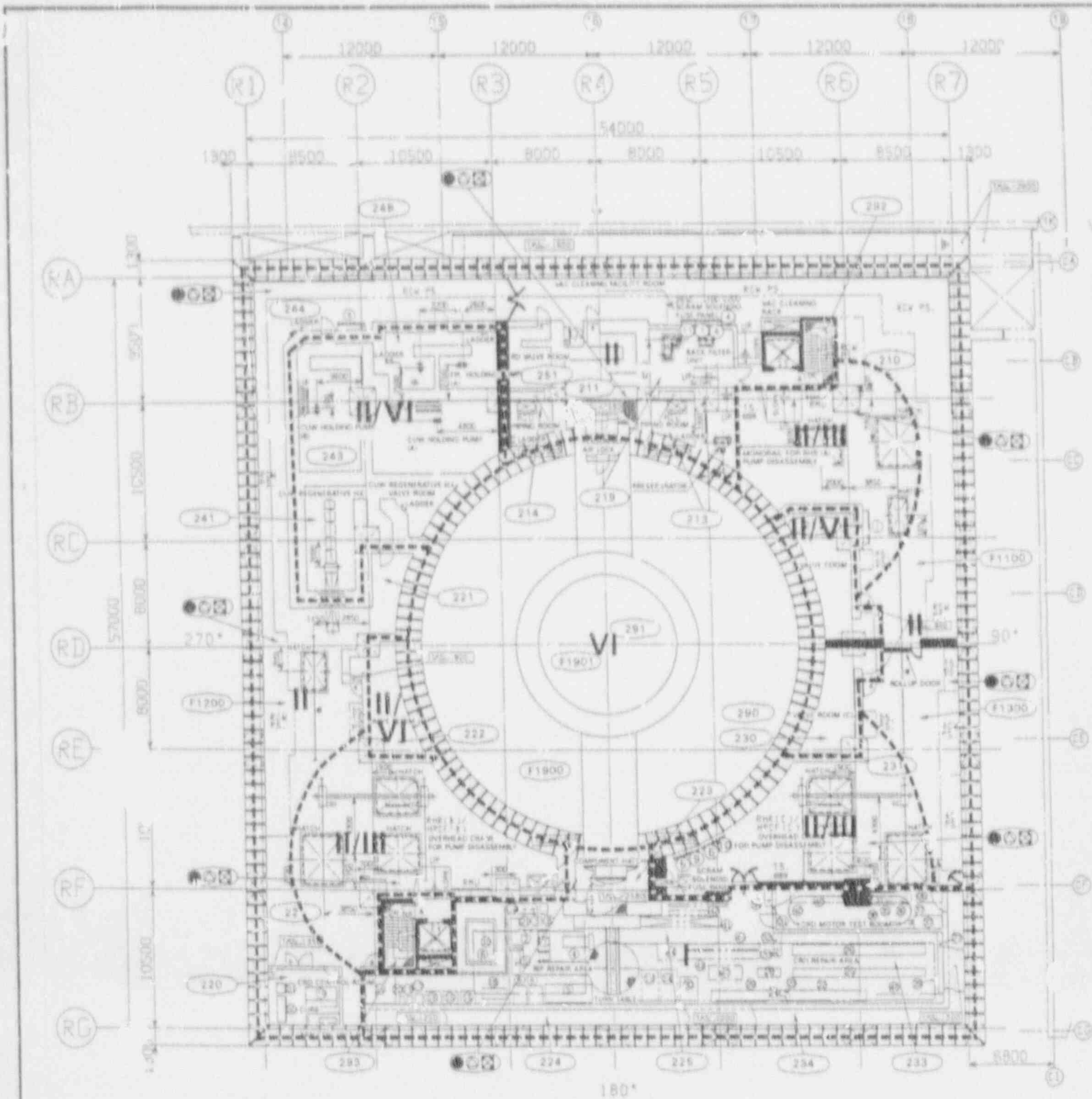
1. CURB HEIGHT IS 200 mm IN CASE OF NONE REMARK
2. EACH SYMBOL MARKS MEAN AS FOLLOWS:
   - (a) GRATING
   - (b) CHECKER PLATE
   - (c) CONCRETE BLOCK
   - (d) FIREPLUG
   - (e) FRONT OF PANEL AND RACK (FRONT)
   - (f) PULL SPACE FOR MAINTENANCE
   - (g) HANDRAIL
   - (h) MONORAIL
   - (i) EV ELEVATOR
   - (j) PS PIPE SPACE
   - (k) DS HVAC DUCT SPACE
   - (l) TS CABLE TRAY SPACE
   - (m) NL NORMAL LOCK DOOR
   - (n) STEEL SHIELDING DOOR
   - (o) CURB

ZONE	DOSE RATE (R/HR)
I	<0.5
II	<5.0
III	<50
IV	<500
V	<5000
VI	>5000

9205200194 -12

DOSE I/DOSE II
DOSE I – IF UNIT NOT USED DURING DEGRADED CORE ACCIDENT
DOSE II – IF USED WITH DEGRADED CORE ACCIDENT

Figure 12.3–12 REACTOR BUILDING RADIATION ZONE MAP POST LOCA AT ELEVATION (–)8200mm (B3F)



TMSL-1700 (32F)

(REMARKS)

EQUIPMENT

CUW RE HX
CUW F/D VALVE ROOM
RIP MAINTENANCE AREA
FMCRD MAINTENANCE AREA
CRD CONTROL ROOM

RACK LIST

NO.	RACK NAME
1.	REACTOR CO[illegible] ISOLATION COOLING SYSTEM (STEAM SYS[illegible]M) INSTRUMENT RACK
2.	FPC F/D SOLENOID OPERATED VALVE RACK
3.	CUW F/D SOLENOID OPERATED VALVE RACK A
3.	CUW F/D SOLENOID OPERATED VALVE RACK B
4.	SCRAM SOLENOID FUSE PANEL
5.	SCRAM SOLENOID FUSE PANEL
6.	SCRAM SOLENOID FUSE PANEL
7.	SCRAM SOLENOID FUSE PANEL
8.	SCRAM SOLENOID FUSE PANEL
9.	SCRAM SOLENOID FUSE PANEL
10.	SCRAM SOLENOID FUSE PANEL
11.	SCRAM SOLENOID FUSE PANEL

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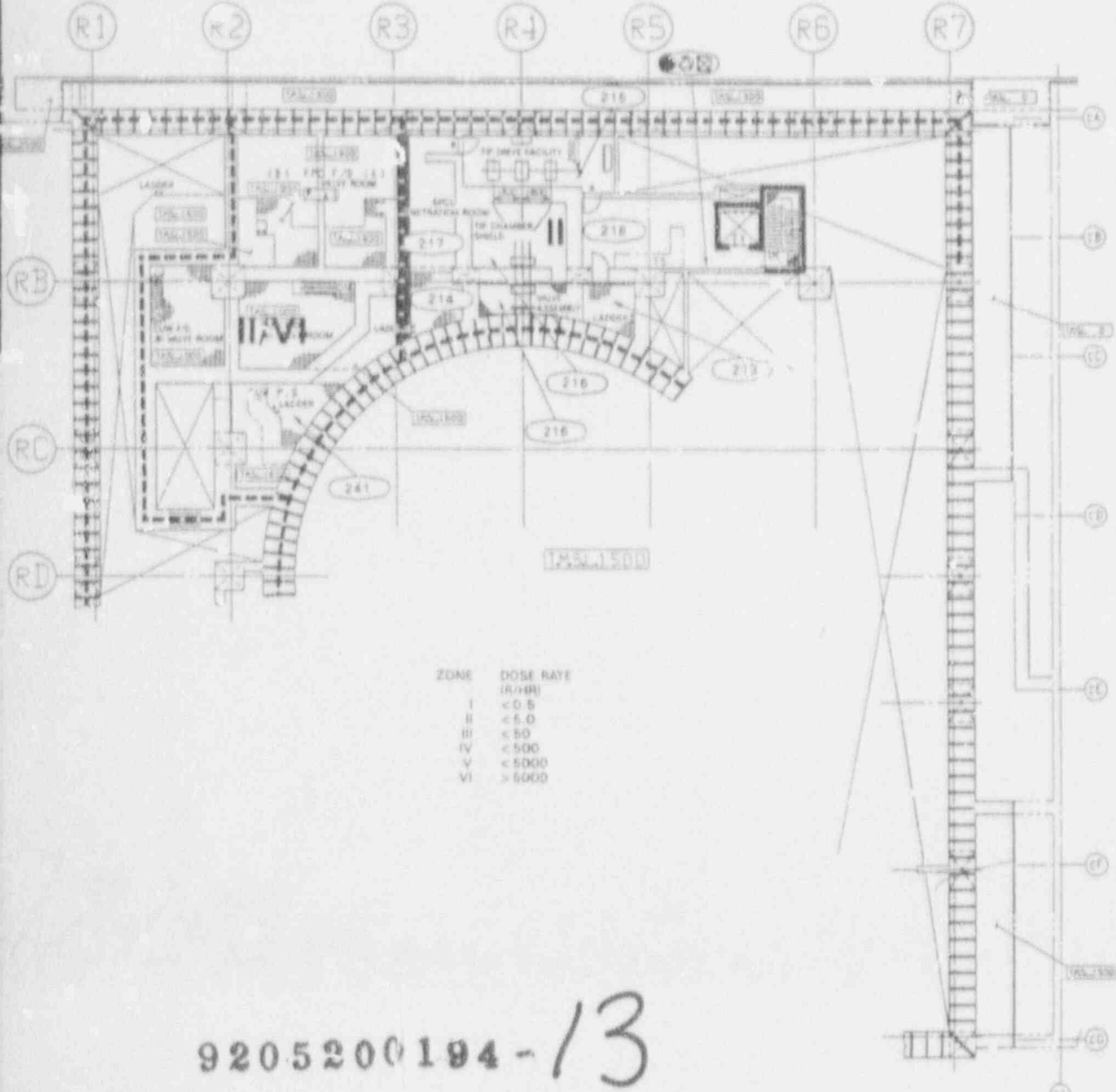
CARD

Also Available On
Aperture Card

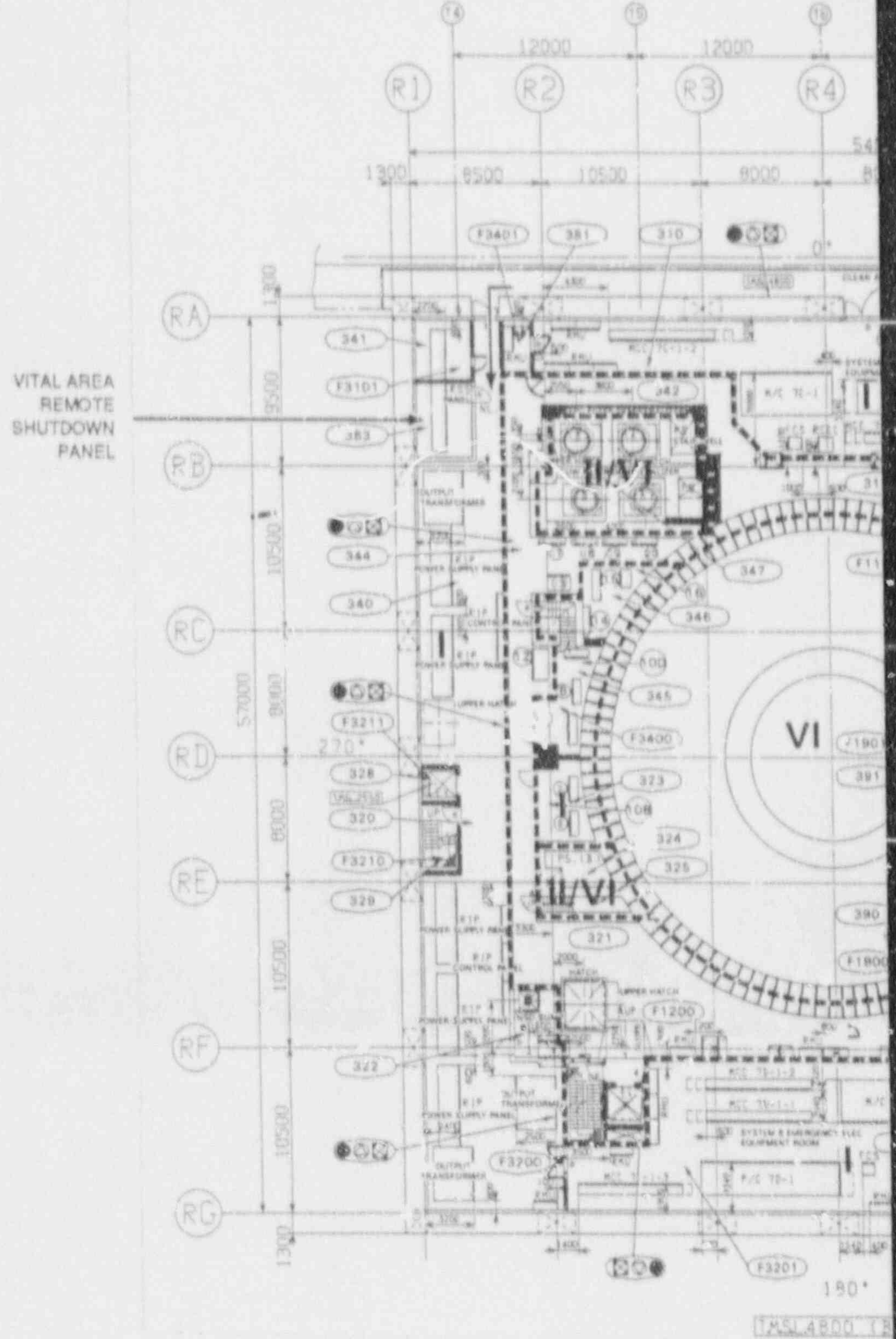


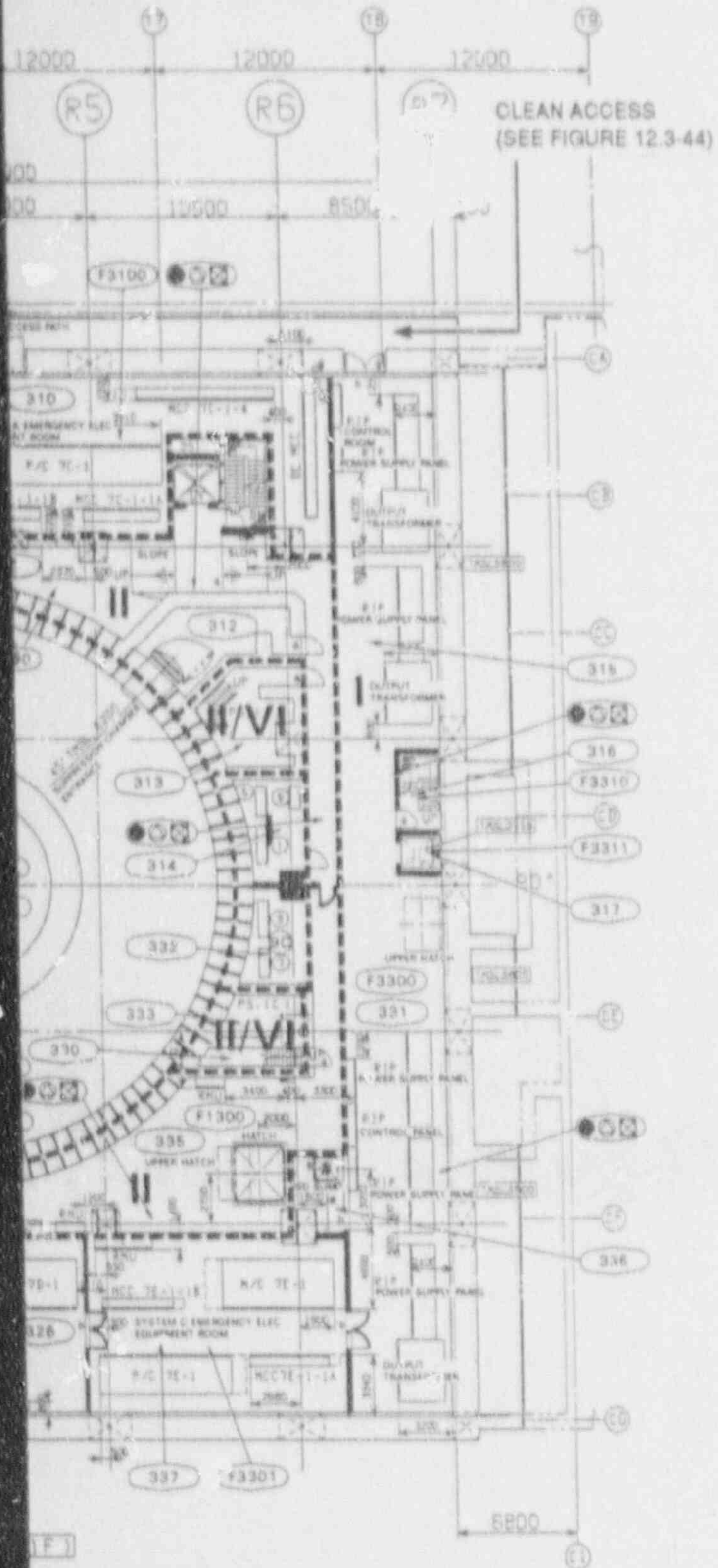
9205200194 -/13

MOTOR ASSEMBLY/ DISASSEMBLY AREA
MOTOR DISASSEMBLY PARTS AREA
SPARE PARTS TOOL STORAGE RACK
MOTOR TEMPORARY PLACE
MOTOR CARRYING DOLLY AREA
DECONTAMINATION
ELECTRICAL TEST TANK
WORK BENCH
MOVABLE TOOL TABLE
SPARE MOTOR STORAGE AREA
OVERHEAD CRANE HOOK REACH
CHANGING SPA'.E
PUMP TANK FOR WASHING

13. STRETCH TUBE NUT HANDLING TOOL STORAGE AREA
14. SECOND SEAL HANDLING TOOL STORAGE AREA
15. BOTTOM CLOSE FLANGE STORAGE AREA
16. MAIN FLANGE STAND TOOL STORAGE AREA
17. AUX COVER HANDLING TOOL STORAGE AREA
18. MOTOR CONTAINER TEMPORARY PLACE
19. HANDLING TOOL CONTROL BOX STORAGE AREA
20. HANDLIN.J TO.JL HYDRAULIC UNIT STOR^ L AREA
21. COUPLING ..AND HANDLING TOOL STORAGE AREA
22. CRD STORAGE TANK
23. ULTRASONIC CLEANING TANK
24. U' 'ASONIC TRANSDUCER
25. CRD DISASSEMBLY CLEANING TANK
26. CRD WORK TABLE
27. BALL-NUT DECENT TEST TABLE
28. SPOOL PIECE WORK TABLE
29. SPOOL PIECE STORAGE TANK
30. SEAL HOUSING TEST FACILITY
31. PARTS TEMPORARY PLACE
32. TOOL RACK
33. STORAGE RACK
34. MOVABLE PARTS TABLE
35. MOTOR UNIT WORK TABLE
36. MOTOR TEST FACILITY
37. BRAKE SYNCHRO TEST FACILITY
38. MOTOR STORAGE RACK
39. 'VERHEAD CRANE RECH LIMIT
40. :ONORAIL
41. RIP TEMPORARY PLACE
42. MOTOR BRACKET TEMPORARY PLACE
43. CRD CART STORAGE AREA
44. MOTOR UNIT SPOOL PIECE DOLLY STORAGE AREA
45. ATTACHMENT STORAGE AREA
46. CRD STORAGE AREA
47. SPOOL PIECE STORAGE AREA
48. MOTOR SPARE PARTS AREA
49. CRD REPLACEMENT FACILITY CONTROL PANEL
50. CRD REPLACEMENT FACILITY DRIVE PANEL
51. CRD REPLACEMENT FACILITY PRINTER

Figure 12.3–13 REACTOR BUILDING RADIATION ZONE MAP POST LOCA AT ELEVATION (–) 1700mm (B2F)


VITAL AREA
REMOTE
SHUTDOWN
PANEL
R1
R2
R3
R4
RA
RB
RC
RD
RE
RF
RG
12000
12000
1300
6500
10500
8000
9500
10500
8000
8000
10500
10500
57000
1300
0°
270°
180°
II/VI
II/VI
VI
341
F3101
383
344
340
F3211
328
320
F3210
329
322
F3401
381
310
342
347
346
345
F3400
323
324
325
321
F1200
F3200
F3201
390
F1900
391
OUTPUT TRANSFORMER
POWER SUPPLY PANEL
CONTROL PANEL
UPPER HATCH
MCC TC-1-2
M/C TC-1
P/C TE-1
SYSTEM B EMERGENCY ELEC EQUIPMENT ROOM
TMSL4800



SI
APERTURE
CARD

Also Available On
Aperture Card

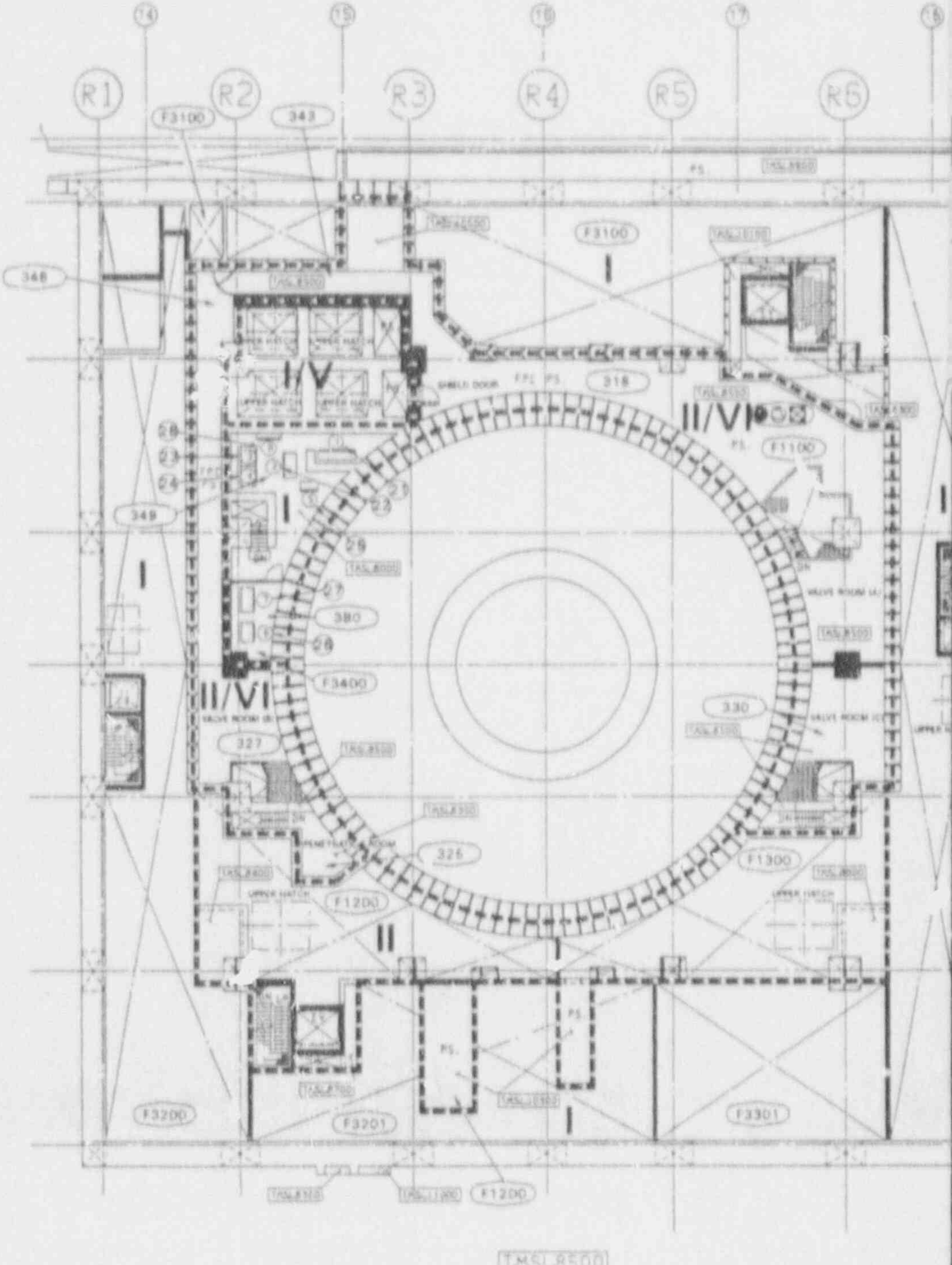
NO.	RACK LIST
1.	REACTOR SYSTEM (I) INSTRUMENT RACK
2.	REACTOR SYSTEM (II) INSTRUMENT RACK
3.	REACTOR SYSTEM (III) INSTRUMENT RACK
4.	REACTOR SYSTEM (IV) INSTRUMENT RACK
5.	MAIN STEAM FLOW (I) INSTRUMENT RACK
6.	MAIN STEAM FLOW (II) INSTRUMENT RACK
7.	MAIN STEAM FLOW (III) INSTRUMENT RACK
8.	MAIN STEAM FLOW (IV) INSTRUMENT RACK
9A.	LEAK DETECTION SYSTEM (A) INSTRUMENT RACK
9C.	LEAK DETECTION SYSTEM (C) INSTRUMENT RACK
10B.	LEAK DETECTION SYSTEM (B) INSTRUMENT RACK
10D.	LEAK DETECTION SYSTEM (D) INSTRUMENT RACK
12.	REACTOR WATER SAMPLING TRANSMITTER PANEL
13.	FPC FD SAMPLING TRANSMITTER
14.	FPC FD MAIN VALVE RACK
15.	FPC FD CONDUCTIVITY METER RACK
16.	FPC FD SAMPLING HOOD
17.	FPC F/D INSTRUMENT RACK (B)
18.	FPC F/D INSTRUMENT RACK (A)
19.	CUW F/D INSTRUMENT RACK (B)
20.	CUW F/D INSTRUMENT RACK (A)
21.	REACTOR WATER SAMPLING COOLER RACK
22.	REACTOR WATER SAMPLE DEPRESSURIZATION RACK
23.	REACTOR WATER pH METER RACK
24.	REACTOR WATER DISSOLVED OXYGEN METER
25.	REACTOR WATER CONDUCTIVITY METER RACK
26.	REACTOR WATER SAMPLING HOOD
27.	REACTOR WATER GRAB SAMPLING RACK
28.	PAS RELATED AO VALVE RACK

ZONE	DOSE RATE (R/HR)
I	< 0.5
II	< 5.0
III	< 50
IV	< 500
V	< 5000
VI	> 5000

(REMARKS)
EQUIPMENT
EMERGENCY ELECTRIC ROOM (A)
EMERGENCY ELECTRIC ROOM (B)
EMERGENCY ELECTRIC ROOM (C)
RSS PANEL
RIP PANEL

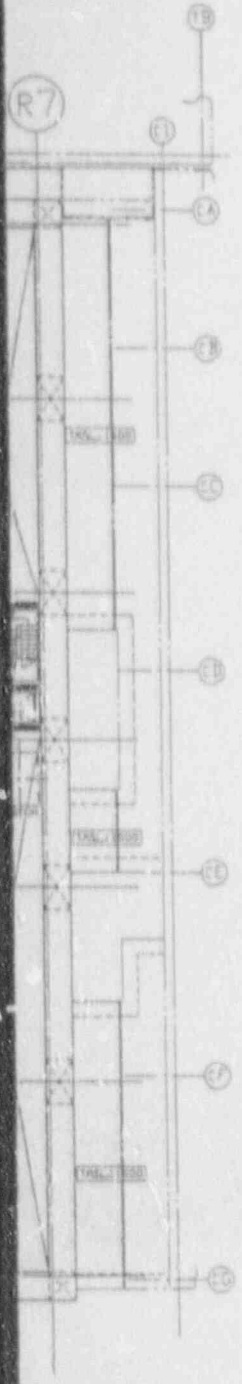
9205200194–14

Figure 12.3–14 REACTOR BUILDING RADIATION ZONE MAP POST LOCA AT ELEVATION 4800mm (B1F)



ZONE

I
II
III
IV
V
VI



SI
APERTURE
CARD

Also Available On
Aperture Card

NO.	RACK LIST
1.	REACTOR SYSTEM (I) INSTRUMENT RACK
2.	REACTOR SYSTEM (II) INSTRUMENT RACK
3.	REACTOR SYSTEM (III) INSTRUMENT RACK
4.	REACTOR SYSTEM (IV) INSTRUMENT RACK
5.	MAIN STEAM FLOW (I) INSTRUMENT RACK
6.	MAIN STEAM FLOW (II) INSTRUMENT RACK
7.	MAIN STEAM FLOW (III) INSTRUMENT RACK
8.	MAIN STEAM FLOW (IV) INSTRUMENT RACK
9A.	LEAK DETECTION SYSTEM (A) INSTRUMENT RACK
9C.	LEAK DETECTION SYSTEM (C) INSTRUMENT RACK
10B.	LEAK DETECTION SYSTEM (B) INSTRUMENT RACK
10D.	LEAK DETECTION SYSTEM (D) INSTRUMENT RACK
12.	REACTOR WATER SAMPLING TRANSMITTER PANEL
13.	FPC FD SAMPLING TRANSMITTER

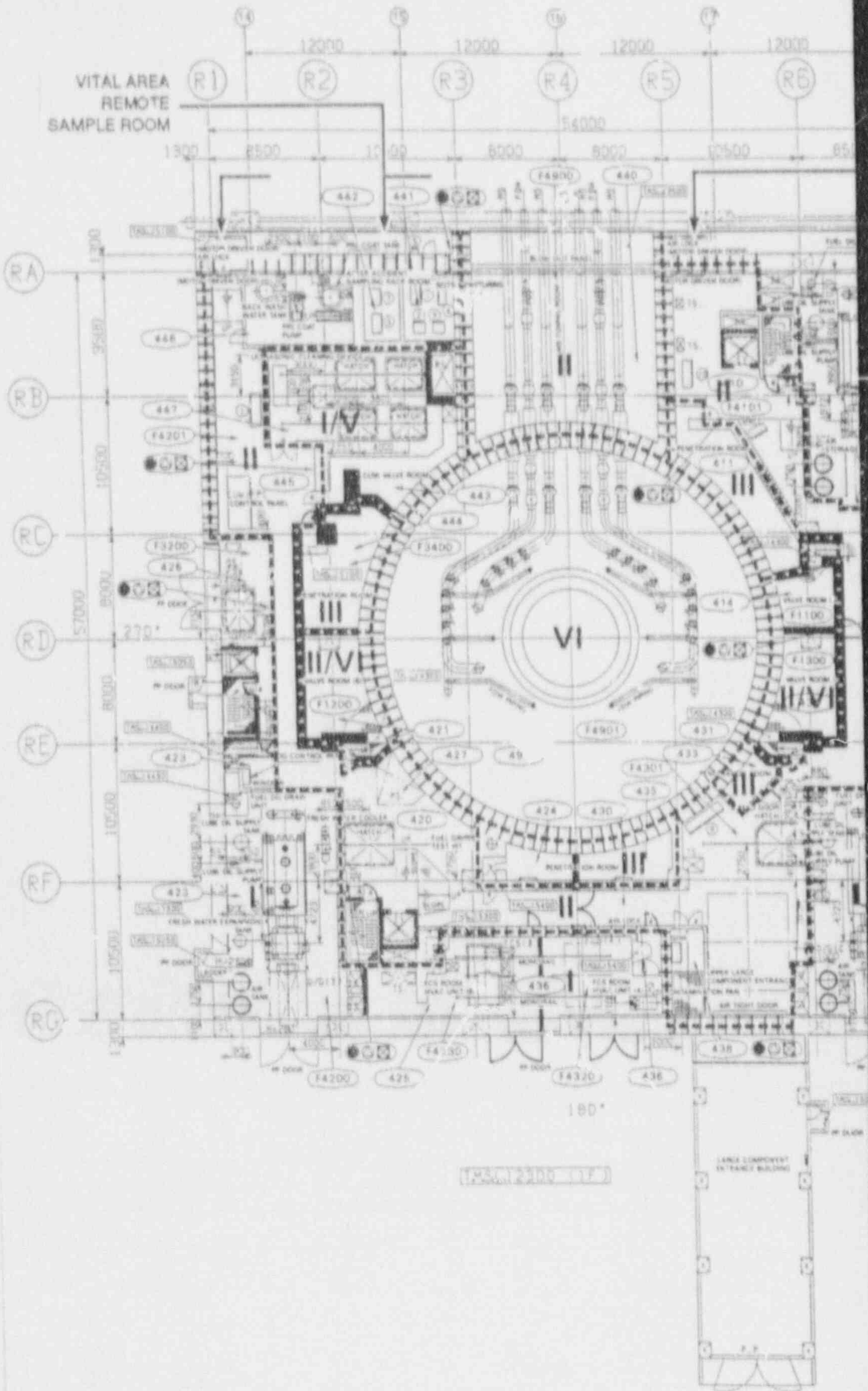
NO.	RACK LIST
14.	FPC FD MAIN VALVE RACK
15.	FPC FD CONDUCTIVITY METER RACK
16.	FPC FD SAMPLING HOOD
17.	FPC F/D INSTRUMENT RACK (B)
18.	FPC F/D INSTRUMENT RACK (A)
19.	CUW F/D INSTRUMENT RACK (B)
20.	CUW F/D INSTRUMENT RACK (A)
21.	REACTOR WATER SAMPLING COOLER RACK
22.	REACTOR WATER SAMPLE DEPRESSURIZATION RACK
23.	REACTOR WATER pH METER RACK
24.	REACTOR WATER DISSOLVED OXYGEN METER
25.	REACTOR WATER CONDUCTIVITY METER RACK
26.	REACTOR WATER SAMPLING HOOD
27.	REACTOR WATER GRAB SAMPLING RACK
28.	PAS RELATED AO VALVE RACK

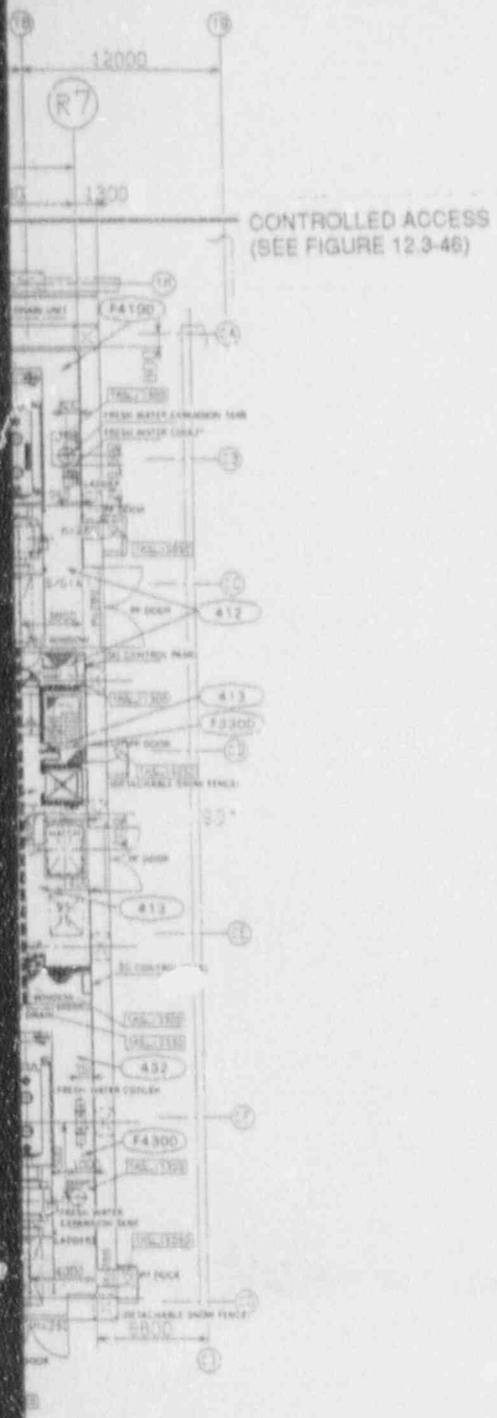
(REMARKS)
EQUIPMENT
EMERGENCY ELECTRIC ROOM (A)
EMERGENCY ELECTRIC ROOM (B)
EMERGENCY ELECTRIC ROOM (C)
RSS PANEL
RIP PANEL

...SE RATE
...HR)
...0.5
...5.0
...50
...500
...5000
...000

9205200194-15

Figure 12.3–15 REACTOR BUILDING RADIATION ZONE MAP POST LOCA AT ELEVATION 8500mm


VITAL AREA
REMOTE
SAMPLE ROOM
R1
R2
R3
R4
R5
R6
RA
RB
RC
RD
RE
RF
RG
12000
12000
12000
12000
54000
57000
270°
180°
VI
I/V
III
II/VI
II/VI
III



(REMARKS)
EQUIPMENT
PRE COAT PUMP
FUEL HANDLING MACHINE TEST PIT

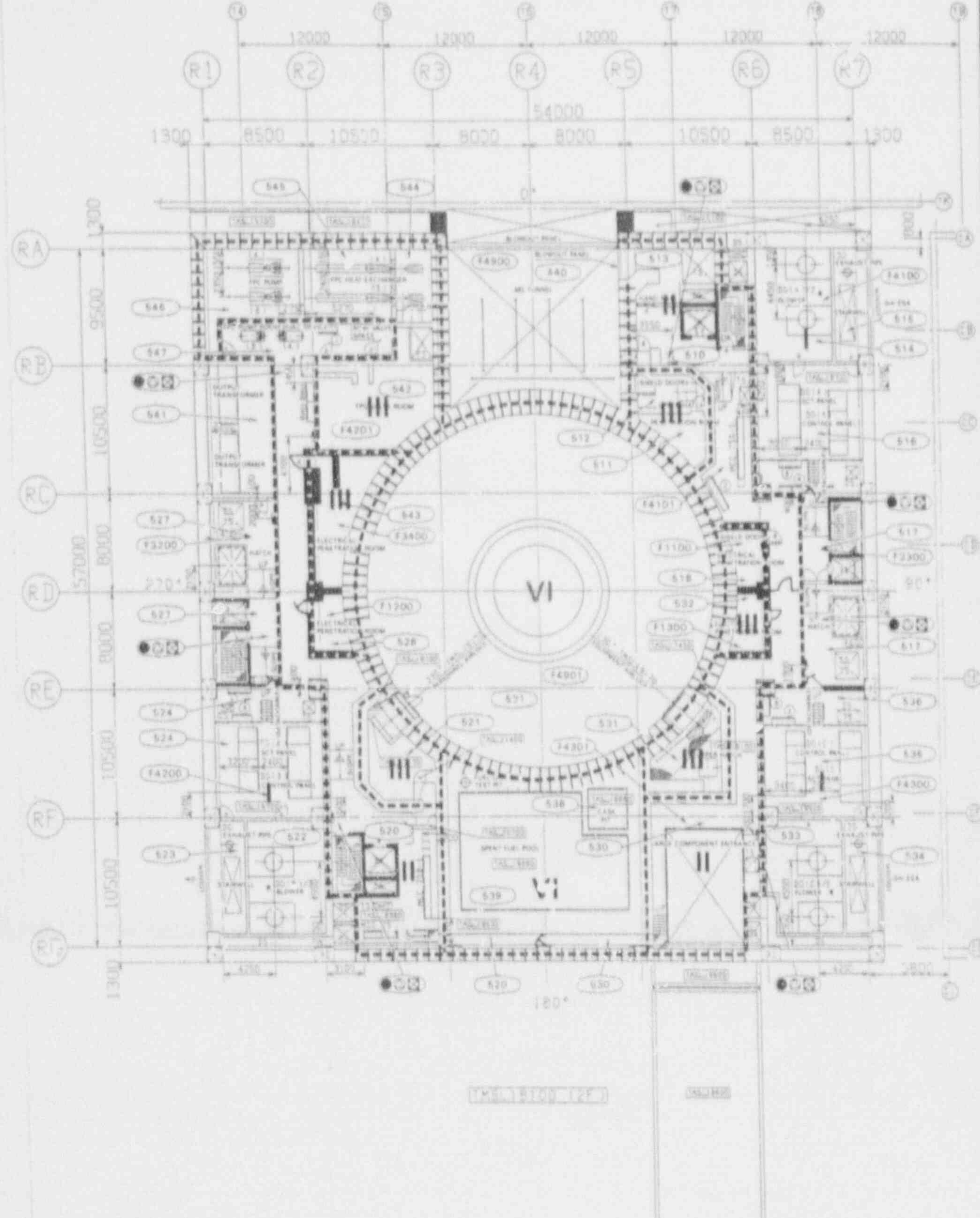
INSTRUMENT RACK LIST

NO.	NAME
1	POST ACCIDENT SAMPLE TRANSFER RACK
2	POST ACCIDENT SAMPLE RECOVERY RACK
3	POST ACCIDENT SAMPLING LOCAL OPERATING PANEL
4	STANDBY GAS TREATMENT SYSTEM OFF GAS RADIATION MONITOR SAMPLE RACK
5	STANDBY GAS TREATMENT SYSTEM OFF GAS RADIATION MONITOR GAS SAMPLER RACK (A)
6	STANDBY GAS TREATMENT SYSTEM OFF GAS RADIATION MONITOR GAS SAMPLER RACK (B)
7	STANDBY GAS TREATMENT SYSTEM OFF GAS RADIATION MONITOR PARTICULATE IODINE SAMPLE RACK
8	STANDBY GAS TREATMENT SYSTEM OFF GAS RADIATION MONITOR PARTICULATE IODINE SAMPLE RACK OPERATING PANEL
9	CONTAINMENT VESSEL PRESSURE LEAK TEST RACK
10	REACTOR CONTAINMENT VESSEL DEW POINT RECORDER RACK

ZONE	DOSE RATE (R/HR)
I	<0.5
II	<5.0
III	<50
IV	<500
V	<5000
VI	>5000

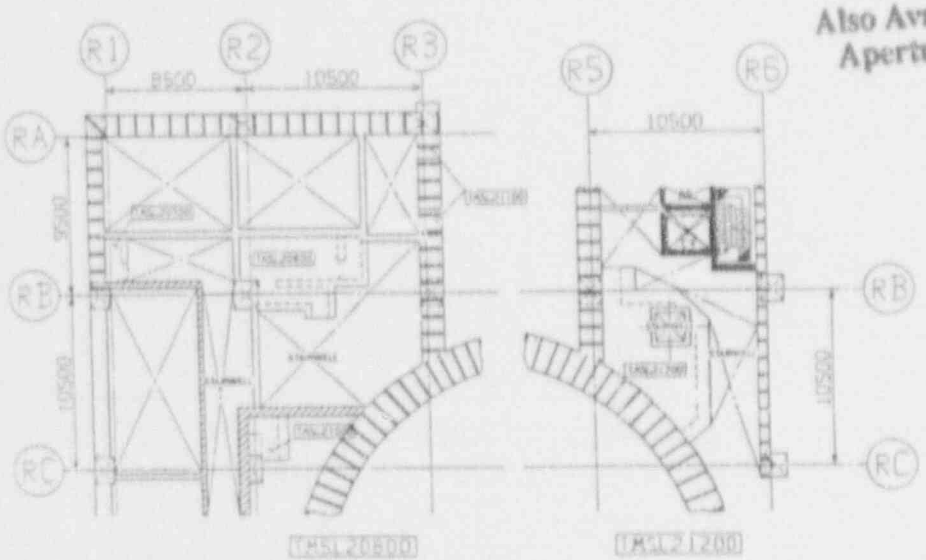
9205200194-16

Figure 12.3–16 REACTOR BUILDING RADIATION ZONE MAP POST LOCA AT ELEVATION 12300mm (1F)


12000
R1
R2
R3
R4
R5
R6
R7
54000
1300
8500
10500
8000
RA
RB
RC
RD
RE
RF
9500
57000
0°
90°
180°
270°
VI
II
545
544
546
547
541
542
543
F4201
F4900
540
513
510
512
511
F4101
F4100
515
514
516
517
F2300
F1100
518
532
F1300
617
527
F3200
F3400
F1200
528
F4901
521
531
F4301
524
F4200
536
535
F4300
522
520
538
530
533
534
523
539
SPENT FUEL POOL
LARGE COMPONENT ENTRANCE

SI
APERTURE
CARD

Also Available On
Aperture Card



INSTRUMENT RACK LIST

NO	RACK NAME
1	FUEL POOL COOLING CLEANUP SYSTEM INSTRUMENT RACK
2	MSIV LEAK TEST INSTRUMENT RACK

FOAM FIRE EXTINGUISHER LIST

NO	RACK NAME
A	FOAM LIQUID TANK
B	FOAM INJECTION EQUIPMENT

(REMARKS)

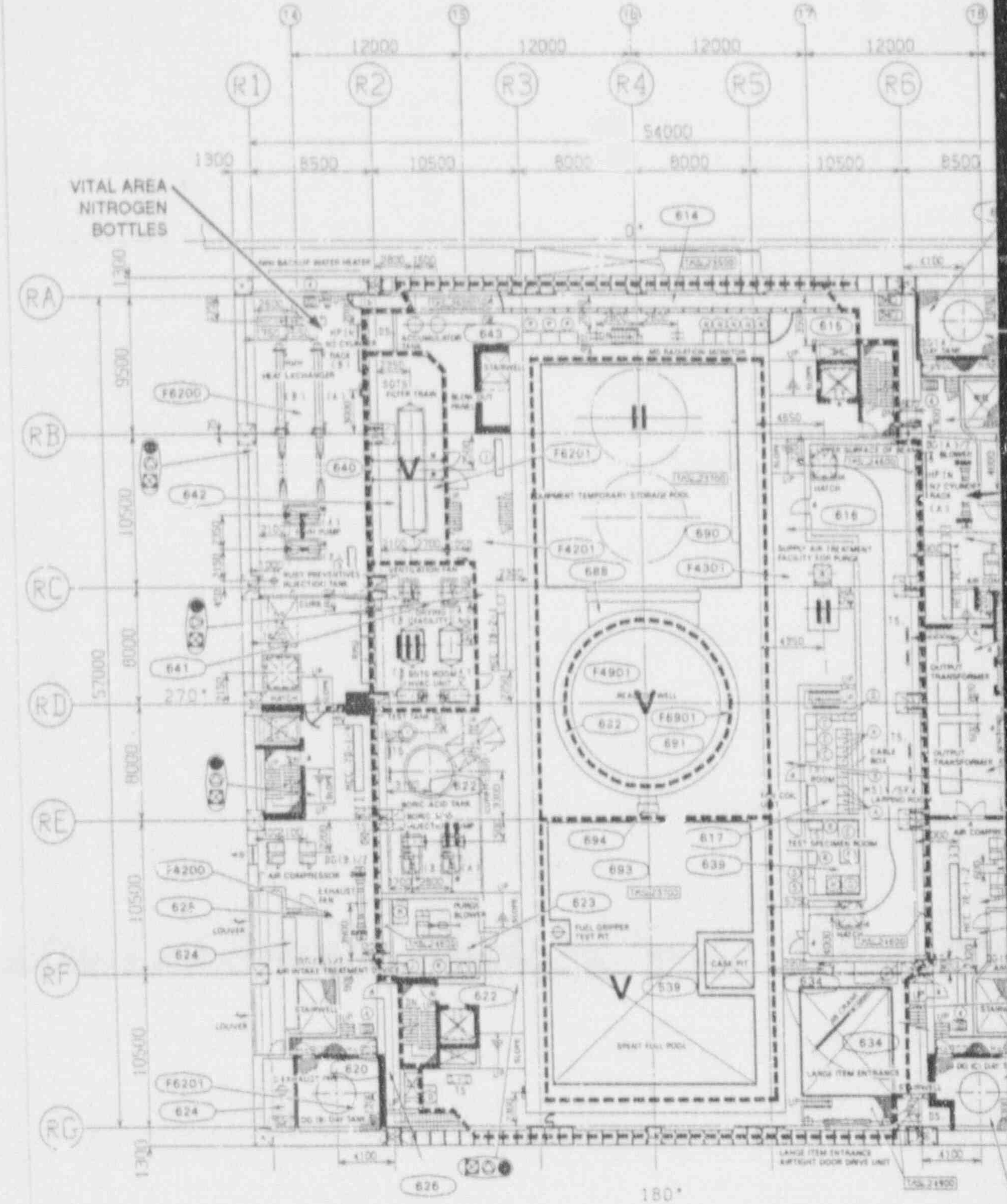
EQUIPMENT

FPC HX
FPC PUMP
FUEL HANDLING MACHINE TEST PIT
SPENT FUEL STORAGE POOL
CASK PIT
D/G(A) CONTROL PANEL
D/G(B) CONTROL PANEL
D/G(C) CONTROL PANEL
DG(A)/Z SUPPLY FAN
DG(B)/Z SUPPLY FAN
DG(C)/Z SUPPLY FAN

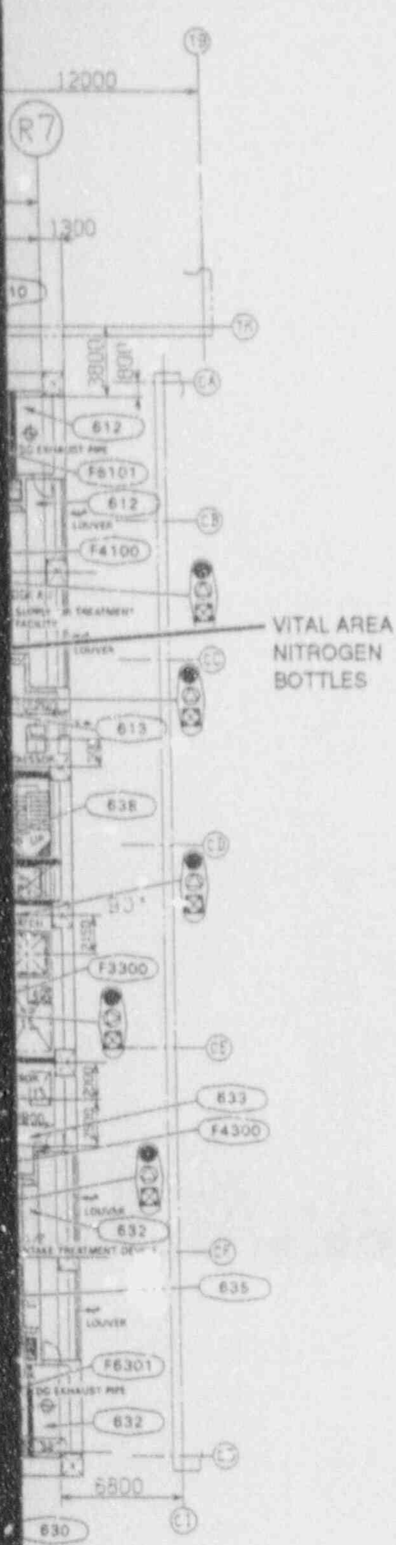
ZONE	DOSE RATE (R/HR)
I	< 0.5
II	< 5.0
III	< 50
IV	< 500
V	< 5000
VI	> 5000

9205200104-17

Figure 12.3–17 REACTOR BUILDING RADIATION ZONE MAP POST LOCA AT ELEVATION 18100mm (2F)



T.M.S.L. 23500 (3F)



INSTRUMENT RACK

		NO.	RACK NAME
C41	H22-P043	1.	STANDBY GAS TREATMENT SYDTEM INSTRUMENT RACK
D23	H22-P044A	2.	CONTAINMENT VESSEL ATMOSPHERE MONITOR CALIBRATION GAS CYLINDER RACK A
D23	H22-P044B	3.	CONTAINMENT VESSEL ATMOSPHERE MONITOR CALIBRATION GAS CYLINDER RACK B
		4	SCRAM SEISMIC SENSOR

ISI ROOM AND AUXILIARY FACILITIES

NO.	FACILITY NAME	QTY
A	CONTROL DATA COLLECTION EQUIPMENT	8
B	STABILIZED POWER SUPPLY SYSTEM	1
C	DESK	3
D	STORAGE	2
E	CALIBRATION TEST PIECE FOR M/S NOZZLE CORNER	1
F	CALIBRATION TEST PIECE FOR NOZZLE CORNER	1
G	CALIBRATION TEST PIECE FOR NOZZLE CORNER	1
H	CALIBRATION TEST PIECE FOR NOZZLE CORNER	1
J	RPV SHELL ADJUST TEST FACILITY	1
K	RPV BOTTOM PLATE ADJUST TEST FACILITY	1
L	RPV NOZZLE ADJUST TEST FACILITY	1
M	PIPING ADJUST TEST FACILITY	1
N	ISI DEVICE STORAGE	5
P	ISI DEVICE STORAGE	3
Q	RPV CALIBRATION TEST PIECE STORAGE	1
R	RPV CONSUMABLE MATERIALS AND CALIBRATION TEST PIECE STORAGE	2
S	PIPING CALIBRATION TEST PIECE STORAGE	2

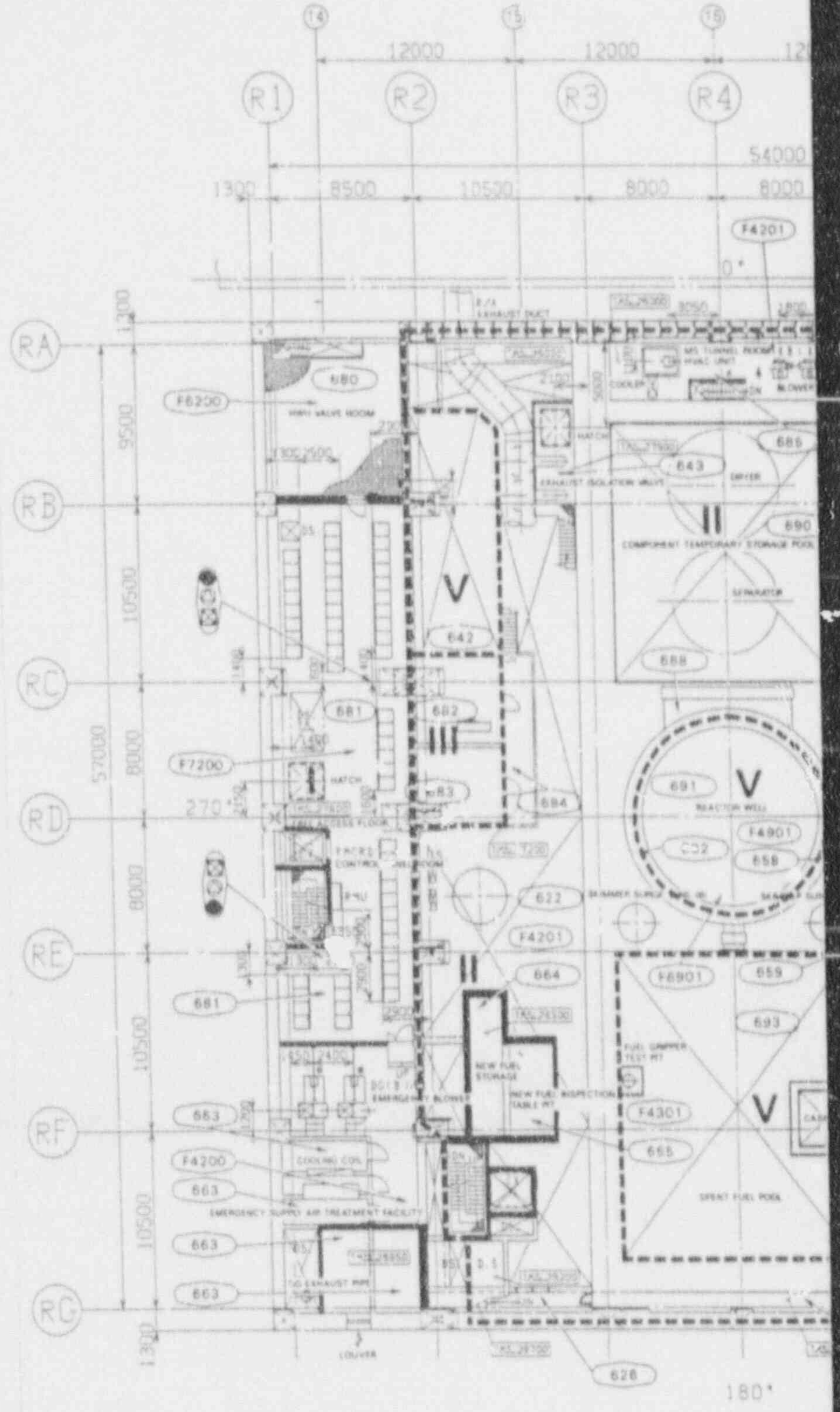
(REMARKS)
EQUIPMENT

- D/S PIT
- CASK PIT
- SPENT FUEL STORAGE POOL
- ISI INSPECTION ROOM
- SGTS FILTER TRAIN
- SGTS FAN
- SLC PUMP
- SLC TANK
- SLC TEST TANK
- DG (A) DAY TANK
- DG (B) DAY TANK
- DG (C) DAY TANK
- FWH PUMP
- HWH HX

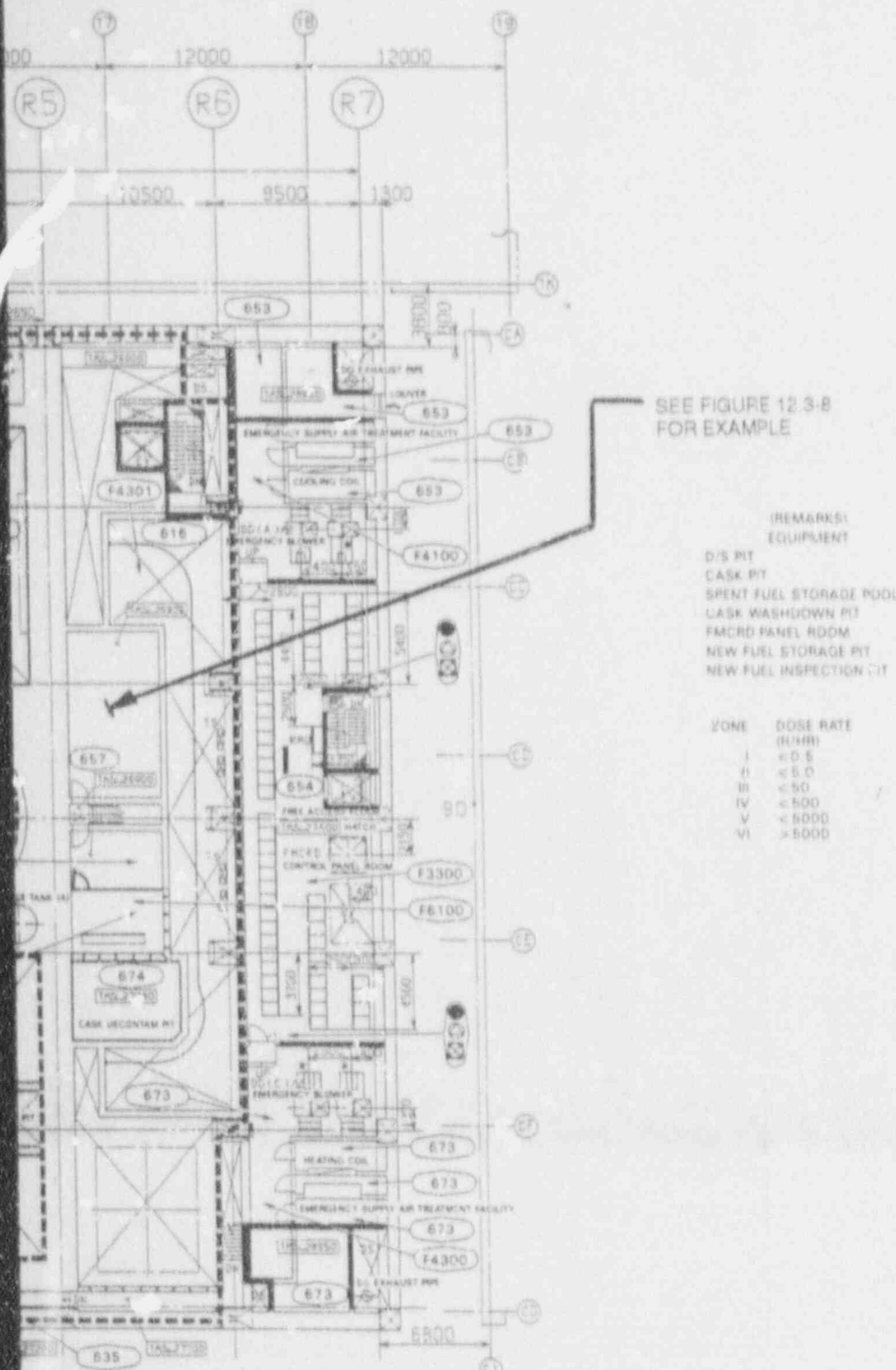
ZONE	DOSE RATE (R/HR)
I	< 0.5
II	< 5.0
III	< 50
IV	< 500
V	< 5000
VI	> 5000

9205200194-18

Figure 12.3-18 REACTOR BUILDING RADIATION ZONE MAP POST LOCA AT ELEVATION 23500mm (3F)

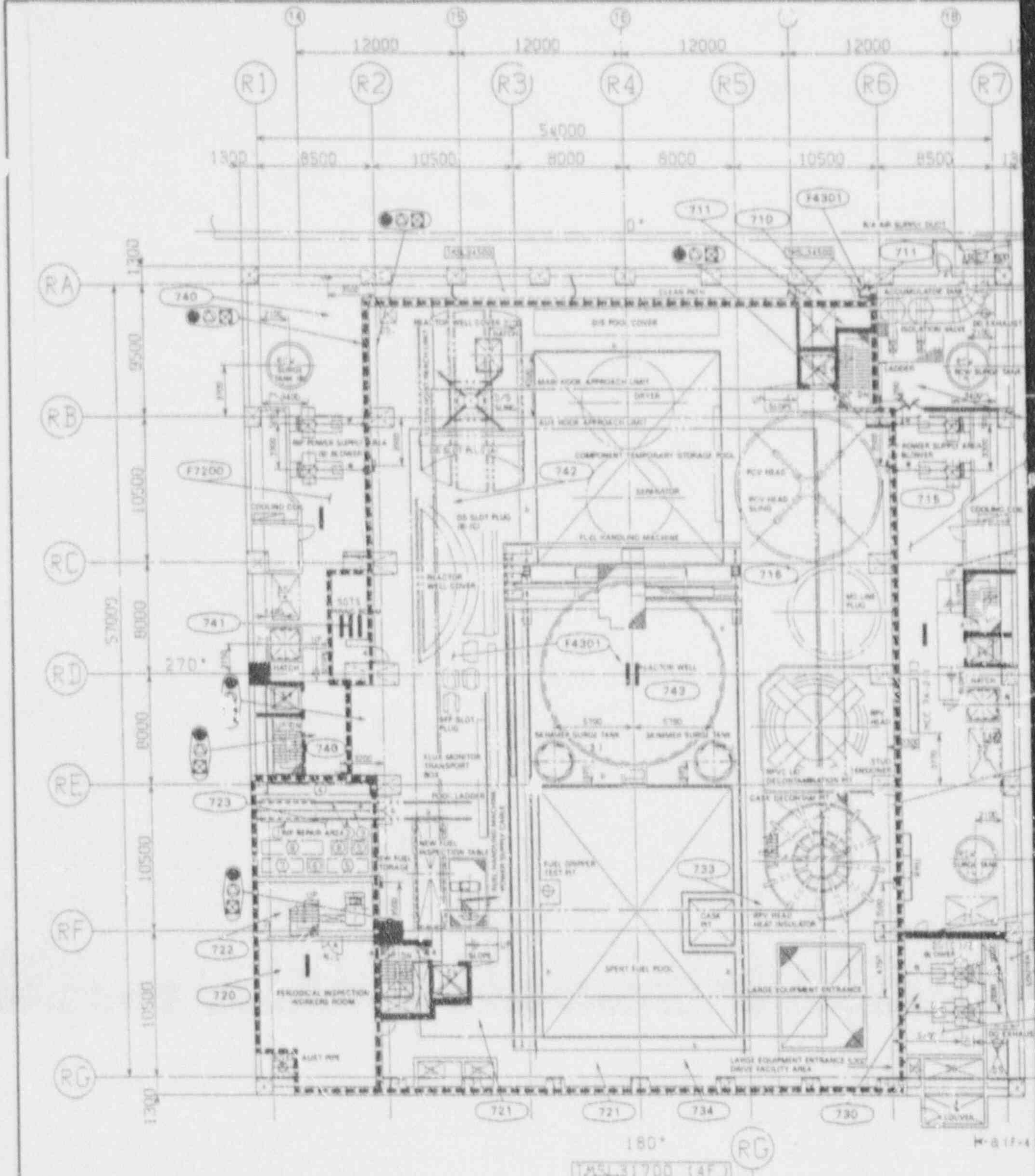


14
15
16
12000
12000
R1
R2
R3
R4
54000
1300
8500
10500
8000
8000
F4201
0°
RA
RB
RC
RD
RE
RF
RG
9500
10500
8000
8000
10500
10500
57000
1300
270°
180°
680
F6200
643
685
690
642
688
681
682
F7200
691
684
F4901
658
622
F4201
664
681
659
F6901
693
663
F4301
655
F4200
663
663
663
626
HATCH
REACTOR WELL
COMPONENT TEMPORARY STORAGE POOL
DRYER
SEPARATOR
NEW FUEL STORAGE
NEW FUEL INSPECTION TABLE PIT
EMERGENCY BLOWER
COOLING COIL
EMERGENCY SUPPLY AIR TREATMENT FACILITY
SPENT FUEL POOL
EXHAUST ISOLATION VALVE
LOUVER
FUEL GRIPPER TEST PIT



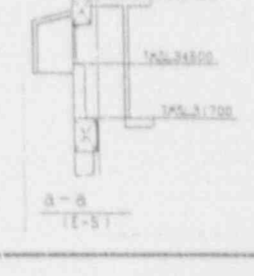
9205200194-19

Figure 12.3–19 REACTOR BUILDING RADIATION ZONE MAP POST LOCA AT ELEVATION 27200mm (4F)



NO. RACK NAME

1. INSPECTION POOL
2. TEMPORA INSTALLED RAIL
3. MONO-RAIL
4. TEMPORARY INST RAIL STORAGE AREA
5. IMPELLER SHAFT GRIPPER STORAGE AREA
6. DIFFUSER WEAR RING GRIPPER STORAGE AREA
7. DIFFUSER STRETCH TUBE GRIPPER STORAGE AREA
8. UPPER PLUG STORAGE AREA
9. RIP UPPER PORTION HANDLING CONNECTOR ROD STORAGE AREA



a-a
(E-5)

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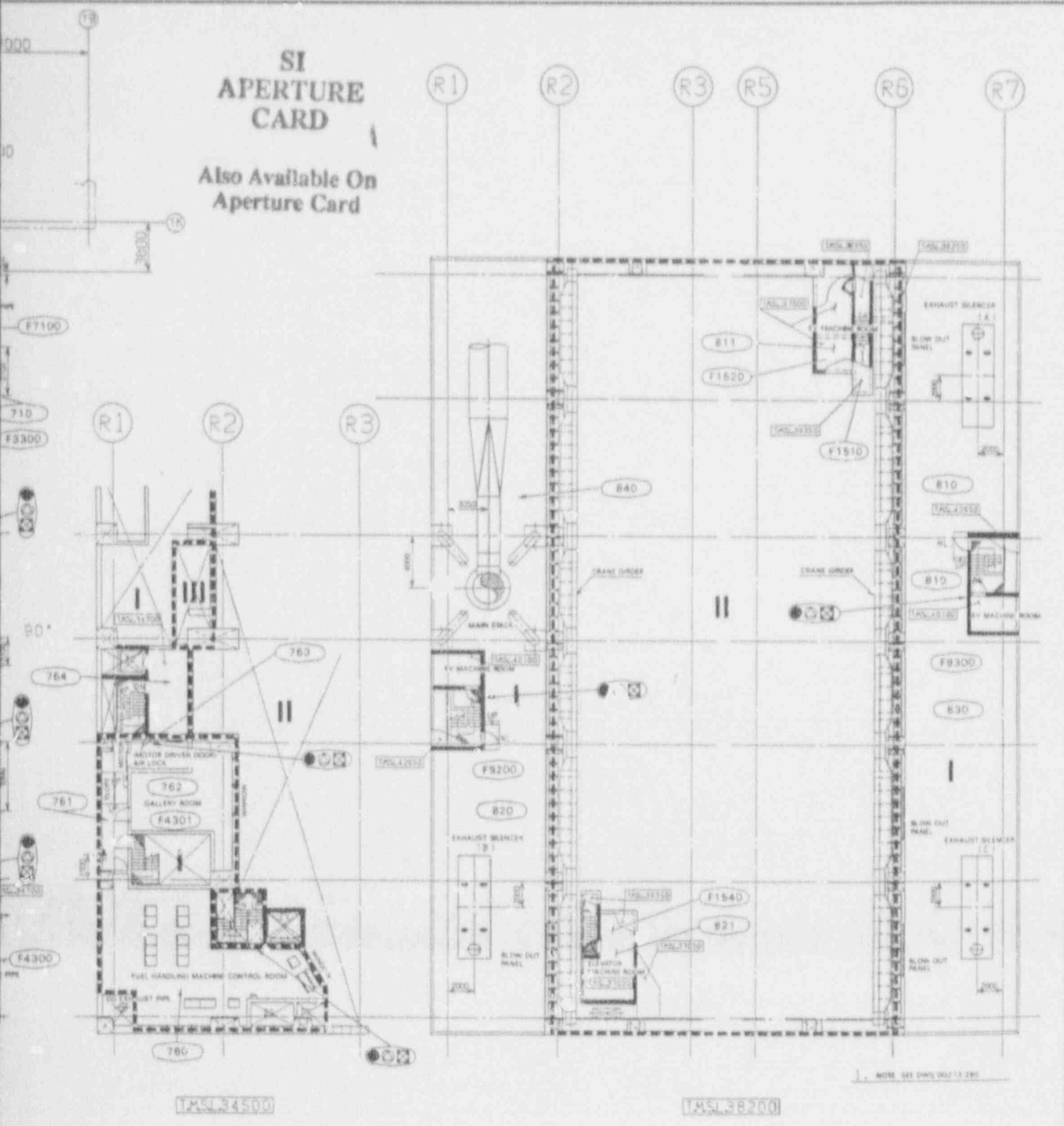
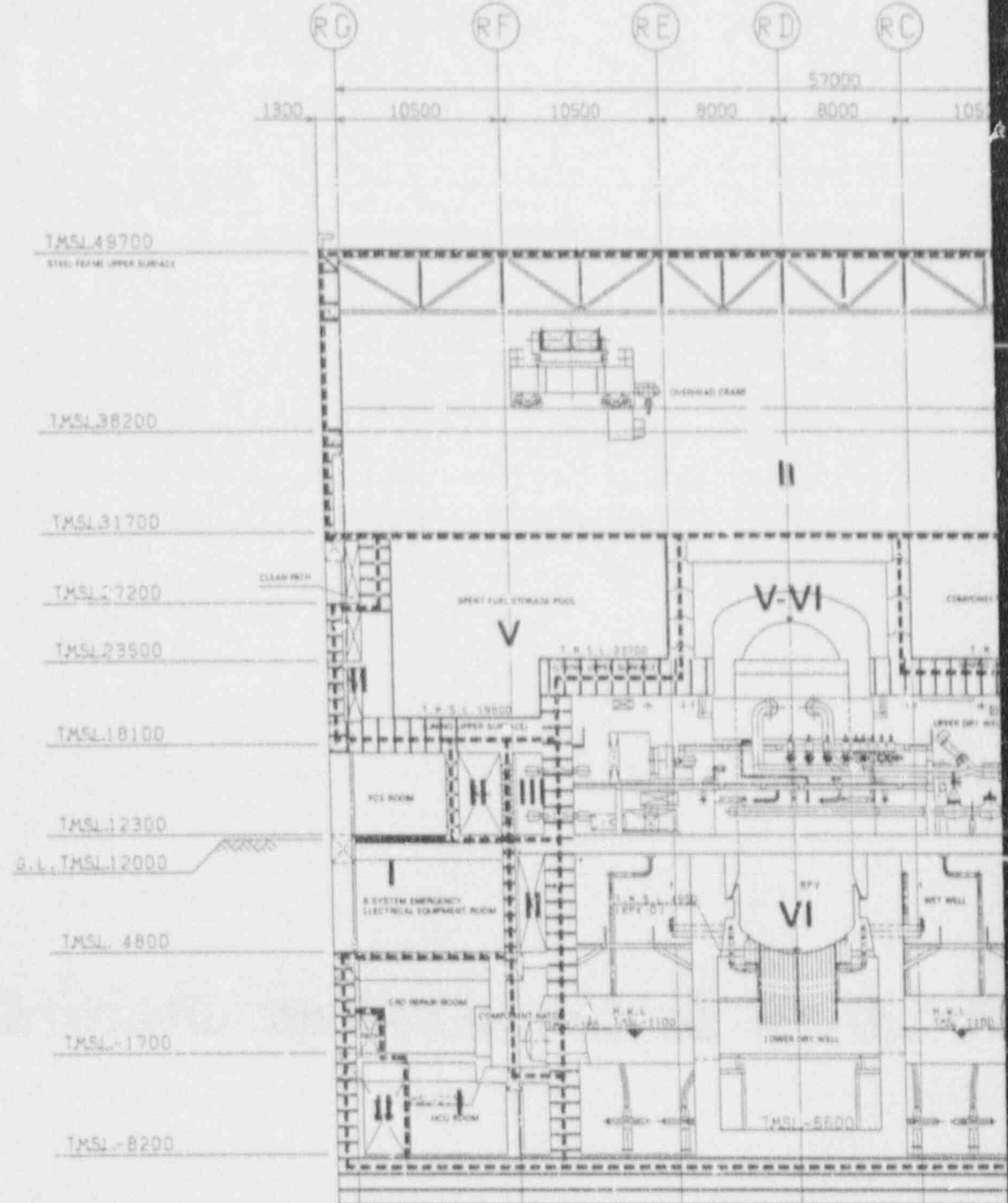


ZONE	DOSE RATE (R/HR)
I	< 0.5
II	< 5.0
III	< 50
IV	< 500
V	< 5000
VI	> 5000

(REMARKS)
EQUIPMENT
NT
T FUEL STORAGE POOL

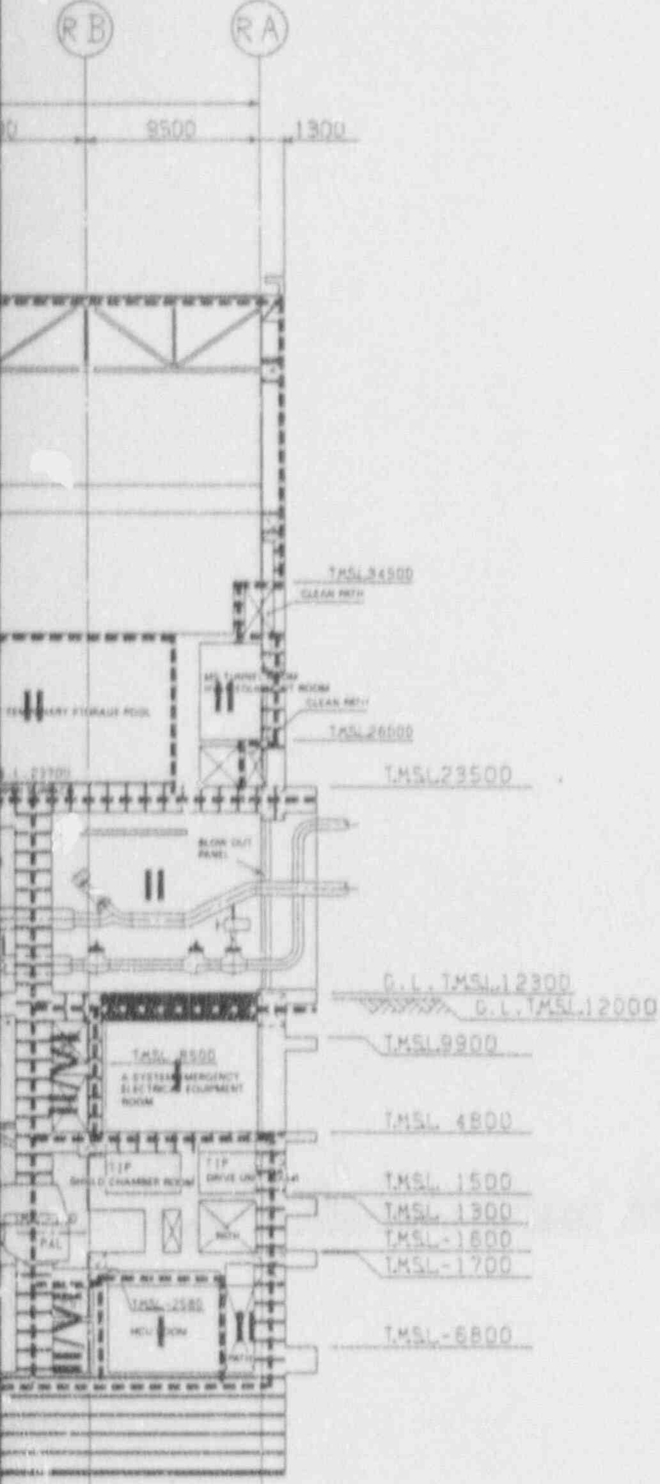
9205200194-20

Figure 12.3–20 REACTOR BUILDING RADIATION ZONE MAP POST LOCA AT ELEVATION 31700mm



RG
RF
RE
RD
RC
57000
1300
10500
10500
8000
8000
TMSL.49700
STEEL FRAME UPPER SURFACE
OVERHEAD CRANE
TMSL.38200
II
TMSL.31700
TMSL.27200
CLEAN PATH
SPENT FUEL STORAGE POOL
V
V-VI
TMSL.23500
TMSL.18100
FCS ROOM
TMSL.12300
G.L.TMSL.12000
I
B SYSTEM EMERGENCY ELECTRICAL EQUIPMENT ROOM
RPV
VI
WET WELL
TMSL. 4800
CRD REPAIR ROOM
LOWER DRY WELL
TMSL.-1700
HCU ROOM
TMSL.-6600
TMSL.-8200

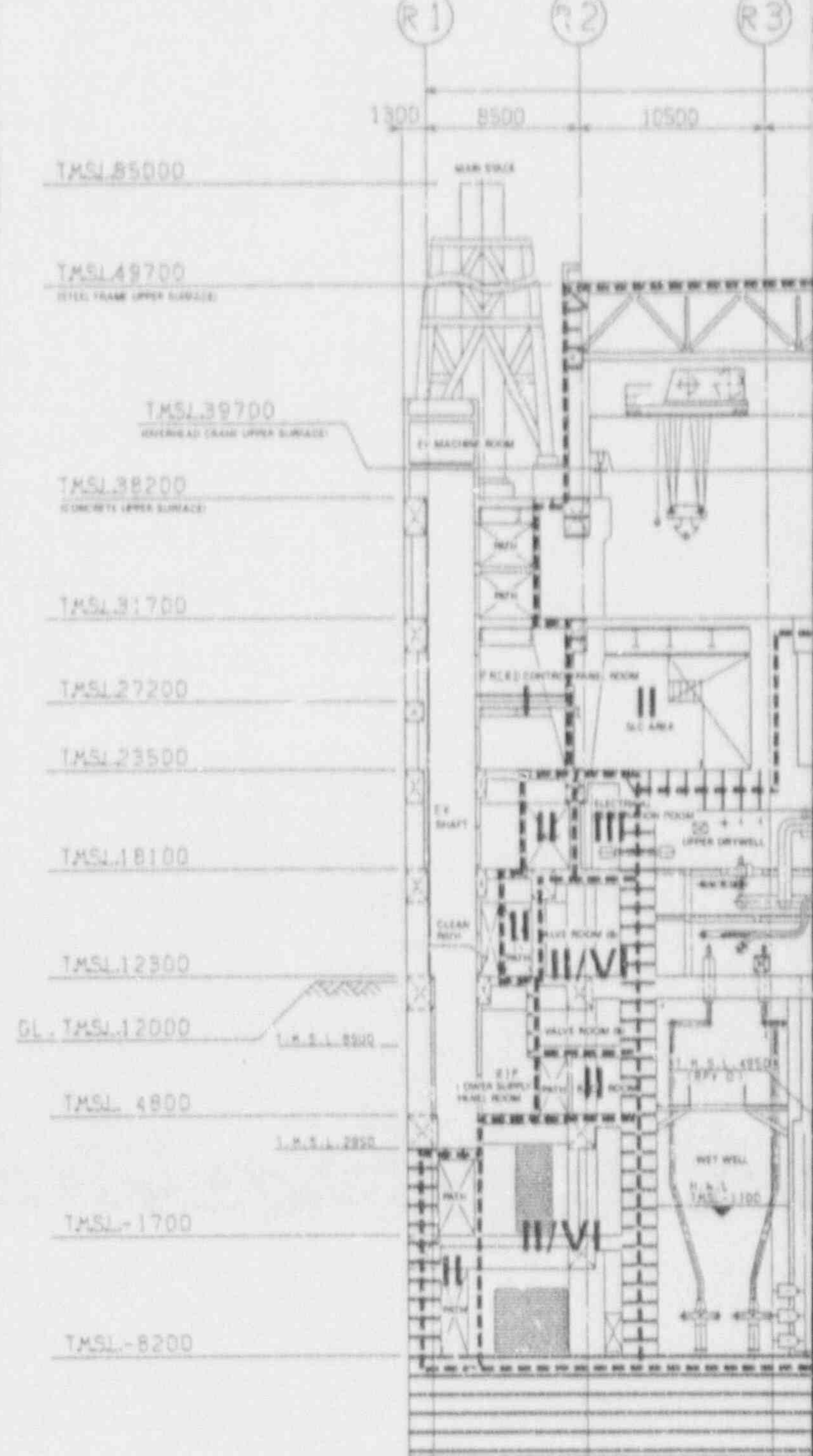
A-A SECTION

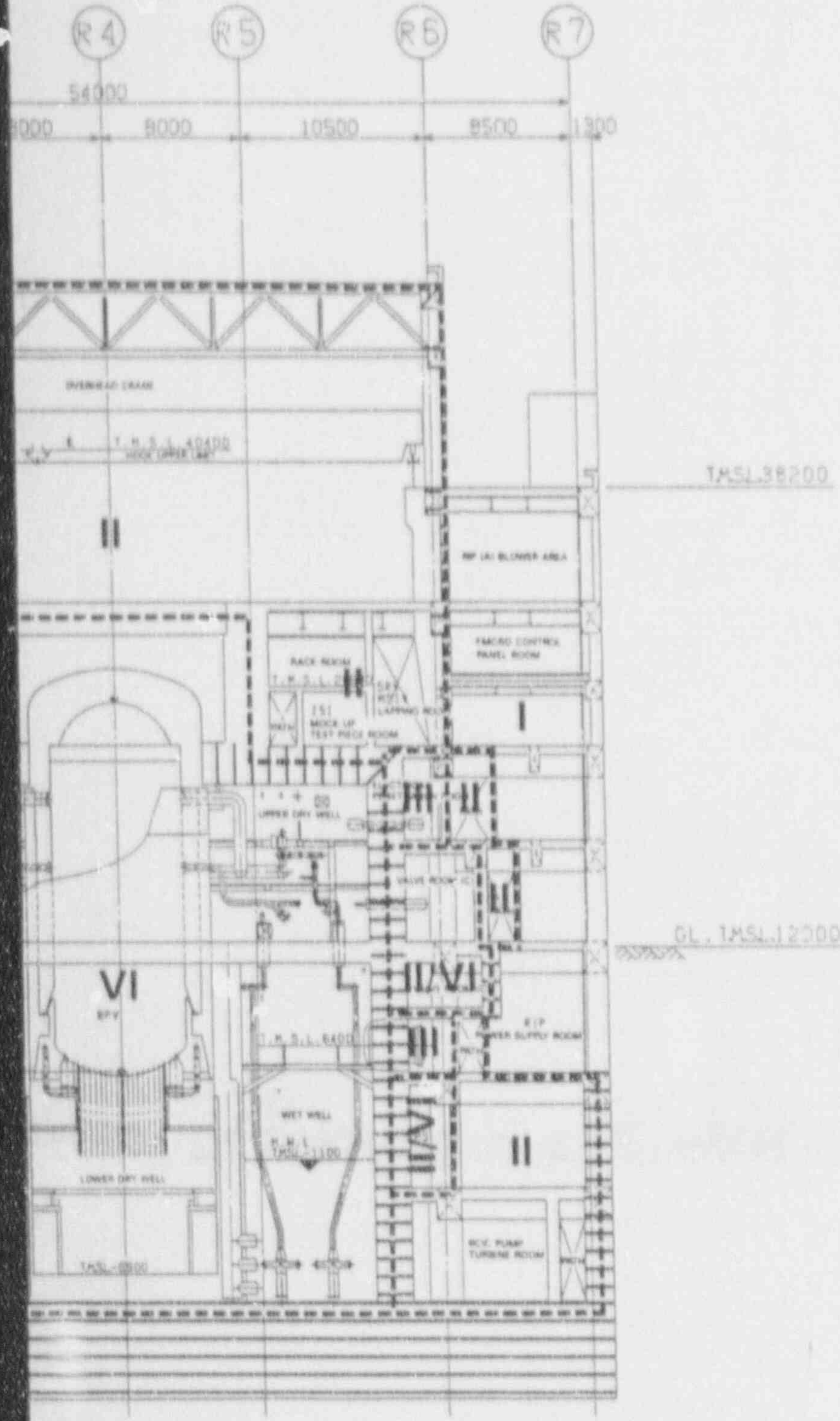


ZONE	DOSE RATE (R/HR)
I	< 0.5
II	< 5.0
III	< 50
IV	< 500
V	< 5000
VI	> 5000

9205200194-21

Figure 12.3-21 REACTOR BUILDING RADIATION ZONE MAP POST LOCA AT CROSS SECTION A-A


R1
R2
R3
1300
8500
10500
TMSL 85000
MAIN STACK
TMSL 49700
TMSL 39700
EV MACHINE ROOM
TMSL 38200
TMSL 31700
TMSL 27200
SLC AREA
TMSL 23500
UPPER DRYWELL
EV SHAFT
TMSL 18100
CLEAN PATH
II/VI
TMSL 12300
GL. TMSL 12000
TMSL 4800
WET WELL
TMSL -1700
II/VI
TMSL -8200



ZONE	DOSE RATE (R/HR)
I	< 0.5
II	< 5.0
III	< 50
IV	< 500
V	< 5000
VI	> 5000

B SECTION

Figure 12.3-22 REACTOR BUILDING RADIATION ZONE MAP POST LOCA AT CROSS SECTION B-B

1. RW/B LCW SAMP TANK
2. RW/B LCW SAMP PUMP
3. RW/B HCW SAMP TANK
4. RW/B HCW SAMP PUMP
5. RW/B HSD SAMP TANK
6. RW/B HSD SAMP PUMP

7. LCW COLLECTOR TANK
8. LCW SAMPLE TANK
9. LCW COLLECTOR PUMP
10. LCW SAMPLE PUMP
11. LCW DEMINERALIZER
12. LCW FILTER

13. HCW COLLECTOR TANK
14. HCW RESIN SUPPLY TANK-CHANGED TO HCW
15. HCW CAUSTIC TANK
16. HCW ACID TANK
17. HCW COLLECTOR PUMP
18. HCW CAUSTIC PUMP
19. HCW ACID PUMP
20. HCW DEMINERALIZER
21. HCW DISTILLATE TANK
22. HCW DISTILLATE PUMP
23. HCW CONCENTRATOR RECIRCULATION PUMP
24. HCW CONCENTRATOR
25. HCW CONCENTRATOR HEATER
26. HCW CONCENTRATOR CONDENSER

27. HSD SAMPLE TANK
28. HSD SAMPLE PUMP
29. HSD FILTER

30. CUW PHASE SEPARATOR
31. SPENT RESIN TANK
32. SLURRY AGITATION PUMP
33. SLURRY PUMP
34. DECANT PUMP

35. CONW LIQUID WAST TANK
36. CONW SEAL WATER TANK
37. CONW LIQUID WAST PUMP
38. CONW SEAL WATER PUMP

39. SOL WAST SUPPLY TANK
40. SOL POWDER HOPPER
41. SOL BINDER HOPPER
42. SOL BINDER MEASURING HOPPER
43. SOL SOLIDIFICATION AGENT SILO
44. SOL SOLIDIFICATION AGENT MEASURING HOPPER
45. SOL ADDITIVE WATER TANK
46. SOL MIXING TANK

Figure 12.3-36 RADWASTE BUILDING, EQUIPMENT LIST (SHEET 1 OF 2)

47. SOL CLEANING WATER TANK
48. SOL CLEANING WATER RECEIVER TANK
49. SOL WAST SUPPLY TANK RECIRCULATION PUMP
50. SOL WAST SUPPLY PUMP
51. SOL VENT BLOWER
52. SOL FILTER BLOWER
53. SOL CLEANING WATER RECEIVER PUMP
54. SOL DECANT PUMP
55. SOL DRYER
56. SOL MIST SEPARATOR
57. SOL CONDENSER
58. SOL PELLETIZER
59. SOL PELLET FILLING MACHINE
60. SOL PARTICLE FILTER
61. SOL HEPA FILTER
62. SOL DRUM CONVEYOR
63. SOL SHIELD DOOR
64. SOL PELLETIZER CONTROL UNIT
65. SOL CAPPING MACHINE
66. SOL AIR HEATER
67. SOL SOLIDIFICATION AGENT PARTICLE FILTER

68. MSW WAST OIL TANK
69. MSW WAST OIL RECEIVE PUMP
70. MSV WAST OIL FEED PUMP
71. MSW COMBUSTION AIR BLOWR
72. MSW OFF-GAS BLOWER
73. MSW AUXILIARY EXHAUST GAS BLOWER
74. MSW INCINERATOR
75. MSW PRIMARY CERAMIC FILTER
76. MSW SECONDARY CERAMIC FILTER
77. MSW DRY ACTIVE WAST SHOOTER
78. MSW AIR PRE-HEATER
79. MSW INCINERATOR GLOVE BOX
80. MSW CERAMIC FILTER GLOVE BOX
81. MSW ASH DISCHARGING CONVEYOR
82. MSW ASH DISCHARGING EQUIPMENT
83. MSW RELIEF GAS FILTER
84. MSW HEPA FILTER
85. MSW AIR MIXER
86. MSW CERAMIC FILTER BURNER
87. MSW WAST OIL BURNER
88. MSW INCINERATOR ASH DISCHARGING BOX
89. MSW CERAMIC FILTER BACKBLOW EQUIPMENT
90. MSW BOX PULLET STORAGE SYSTEM
91. MSW SUPER COMPACTOR
92. MSW COMPACTOR
93. TANK VENT FILTER
94. HVAC SUPPLY
95. HVAC EXHAUST

Figure 12.3-36 RADWASTE BUILDING, EQUIPMENT LIST (SHEET 2 of 2)

A ≤ 0.6 mrem/hr
B < 1.0 mrem/hr
C < 5.0 mrem/hr
D < 25 mrem/hr
E <100 mrem/hr
F ≥100 mrem/hr
Note: See Figure 12.3–36 for equipment list.

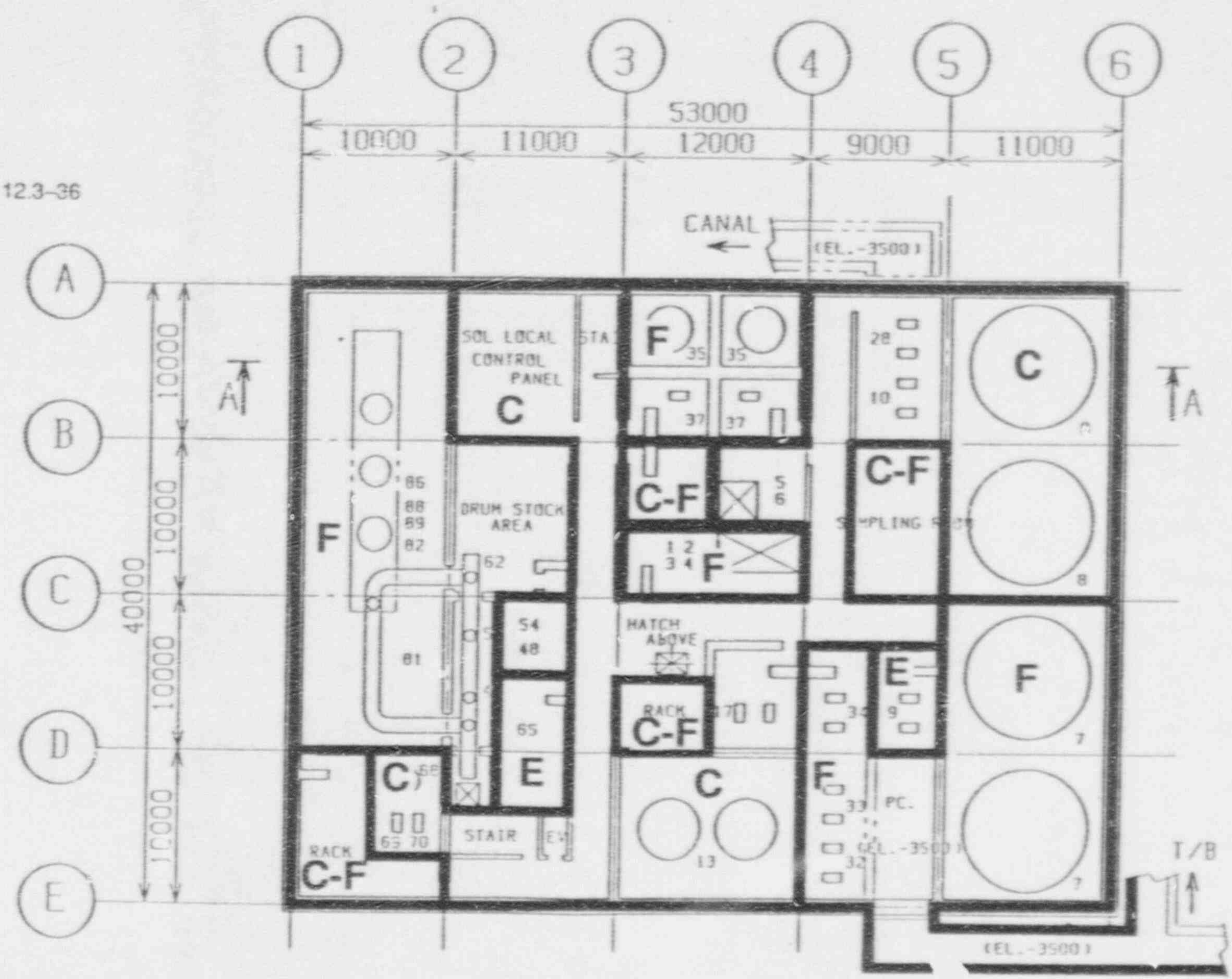


Figure 12.3–37 RADWASTE BUILDING, RADIATION ZONE MAP, NORMAL OPERATION AT ELEVATION (–) 6500mm

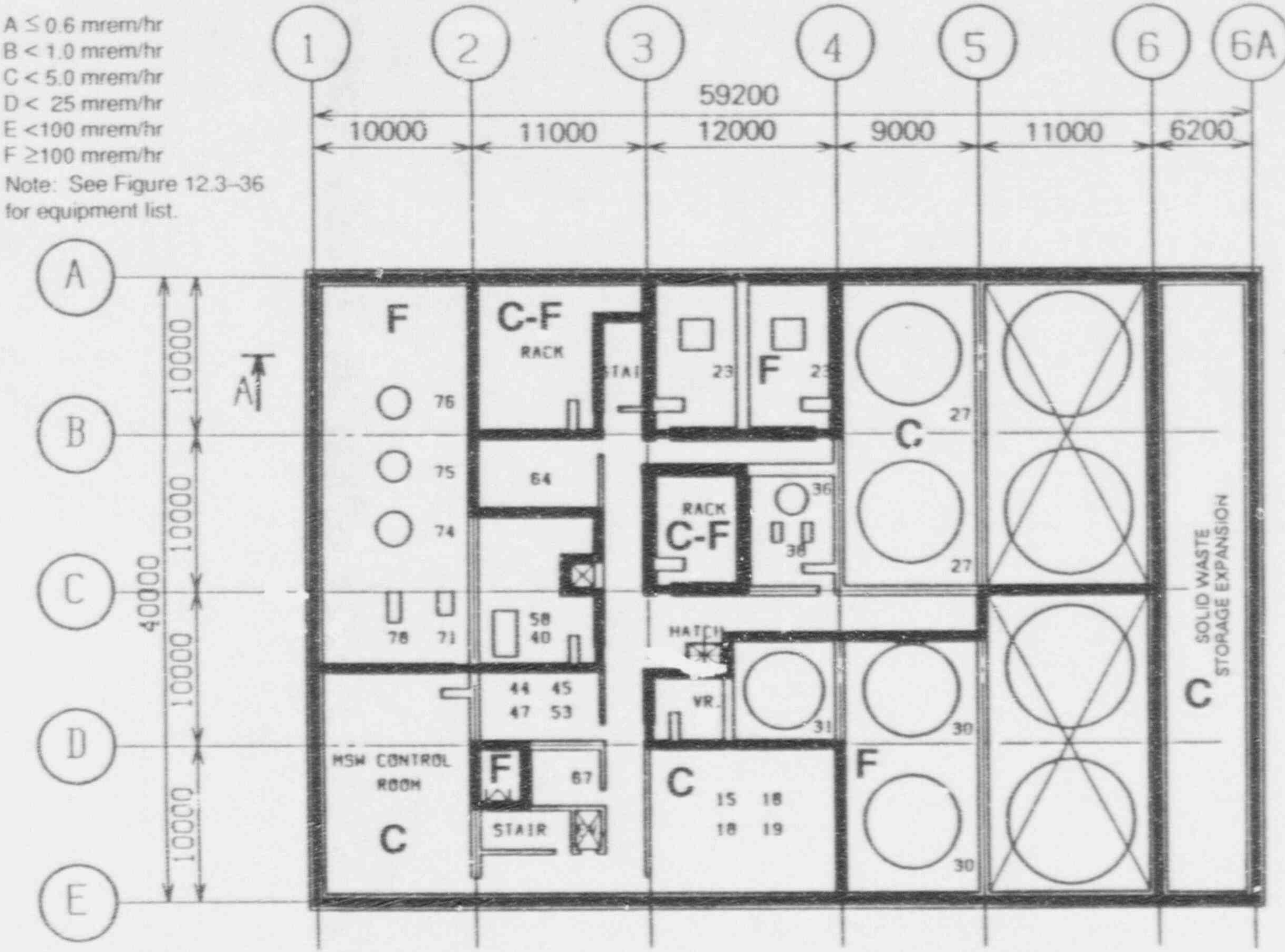


Figure 12.3–38 RADWASTE BUILDING, RADIATION ZONE MAP, NORMAL OPERATION AT ELEVATION (–) 200mm

General Electric Company
PROPRIETARY INFORMATION
Class III

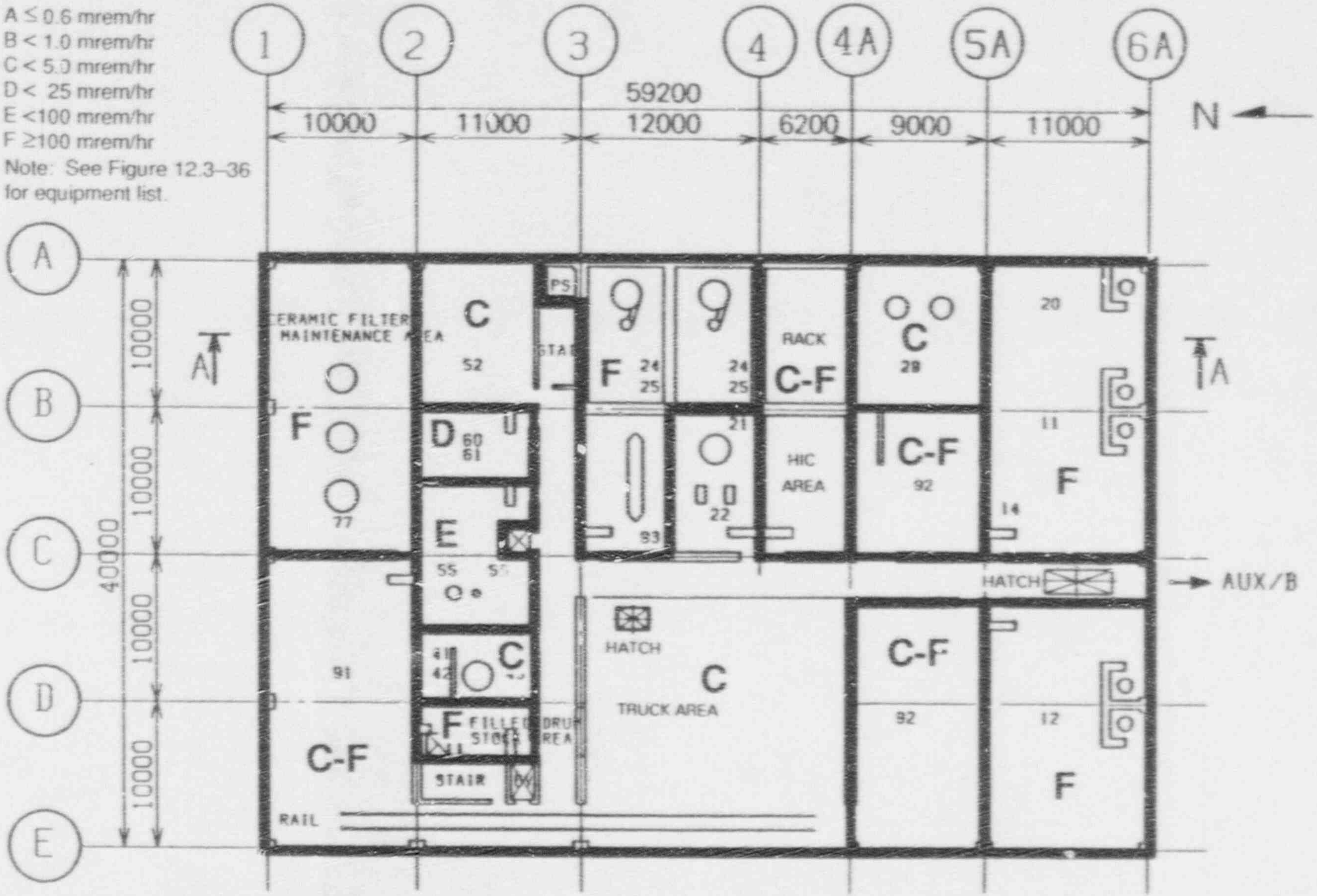


Figure 12.3–39 RADWASTE BUILDING, RADIATION ZONE MAP, NORMAL OPERATION AT ELEVATION 7300mm

General Electric Company
PROPRIETARY INFORMATION
Class III

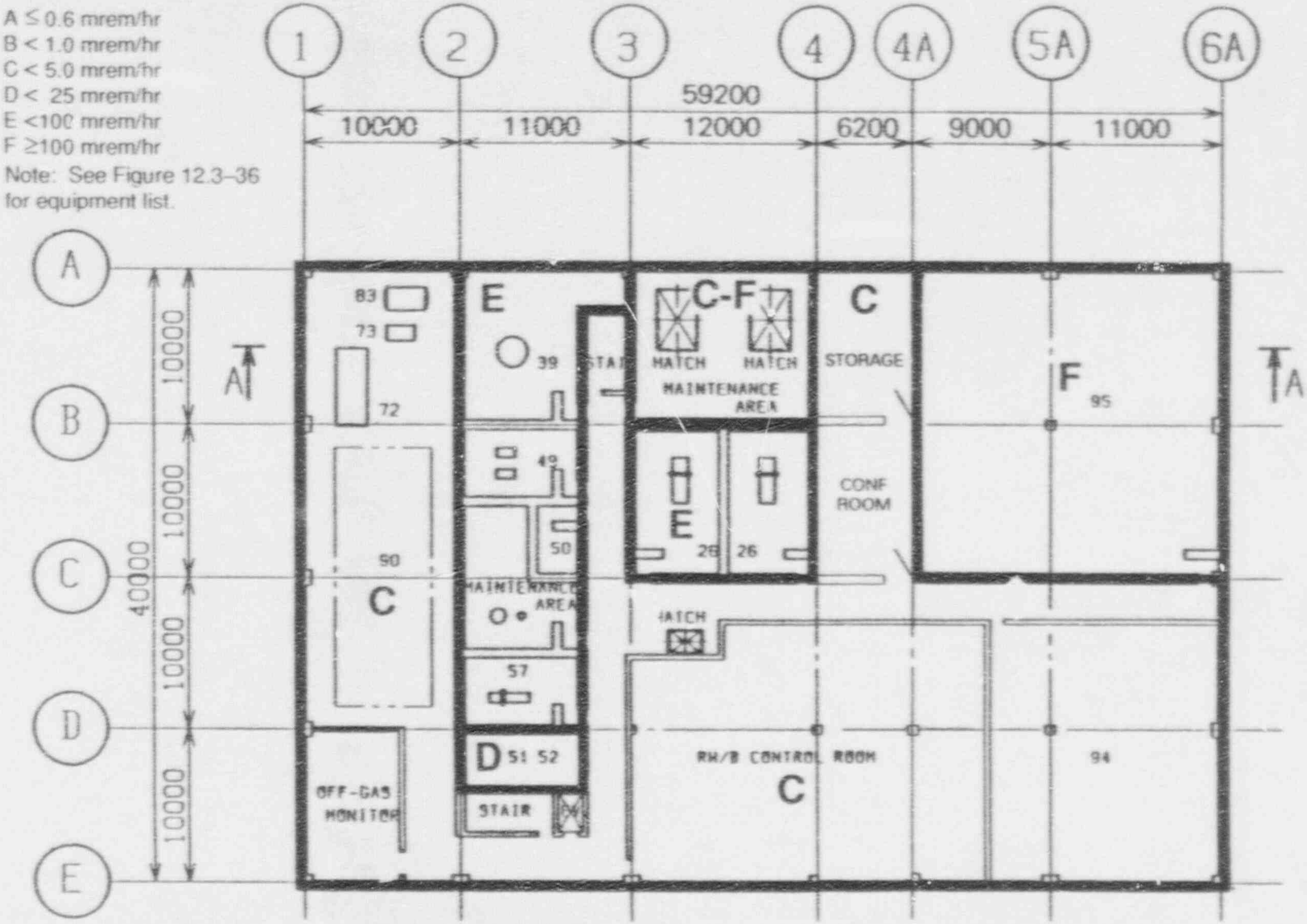


Figure 12.3–40 RADWASTE BUILDING, RADIATION ZONE MAP, NORMAL OPERATION AT ELEVATION 16000mm

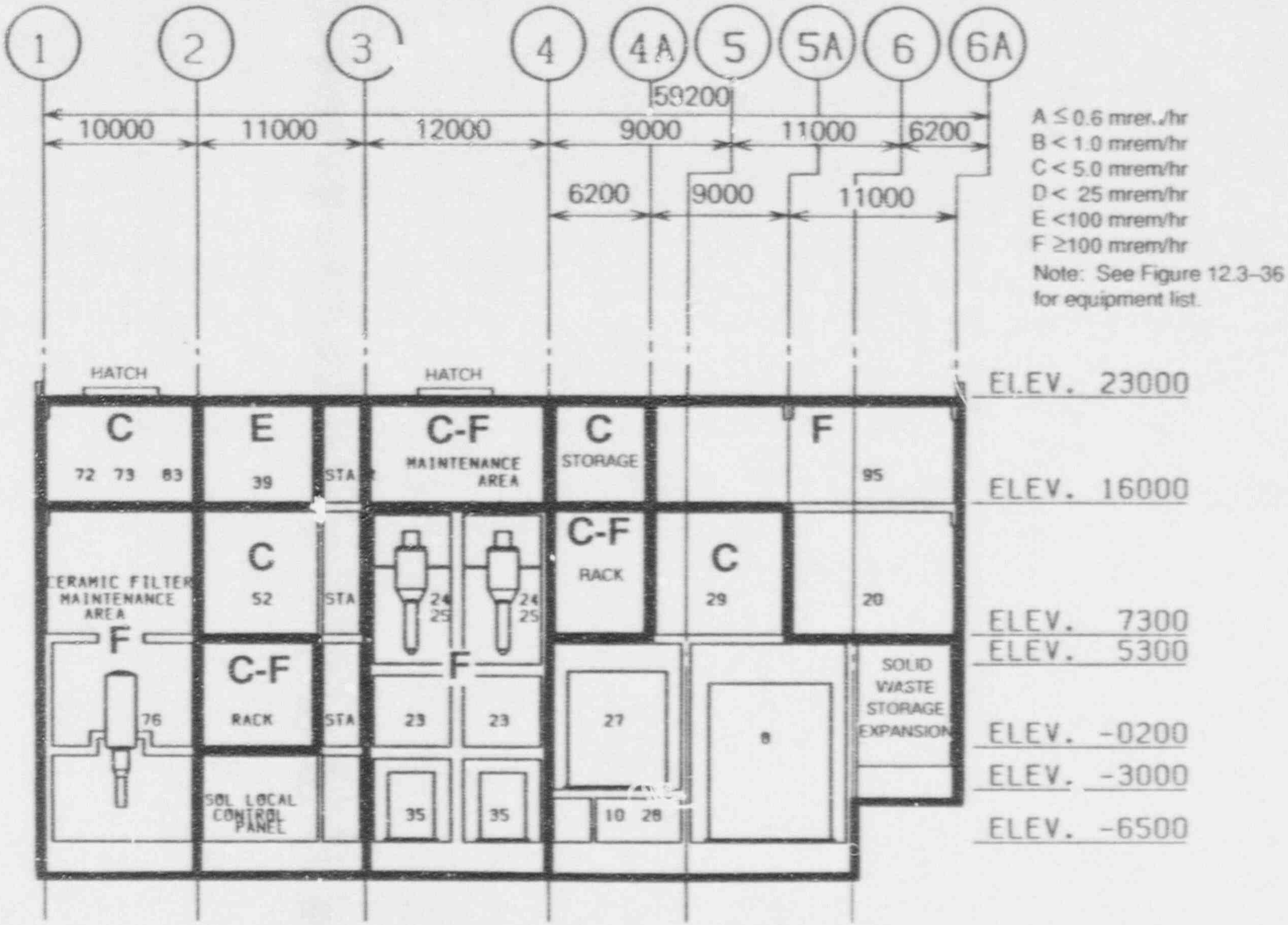
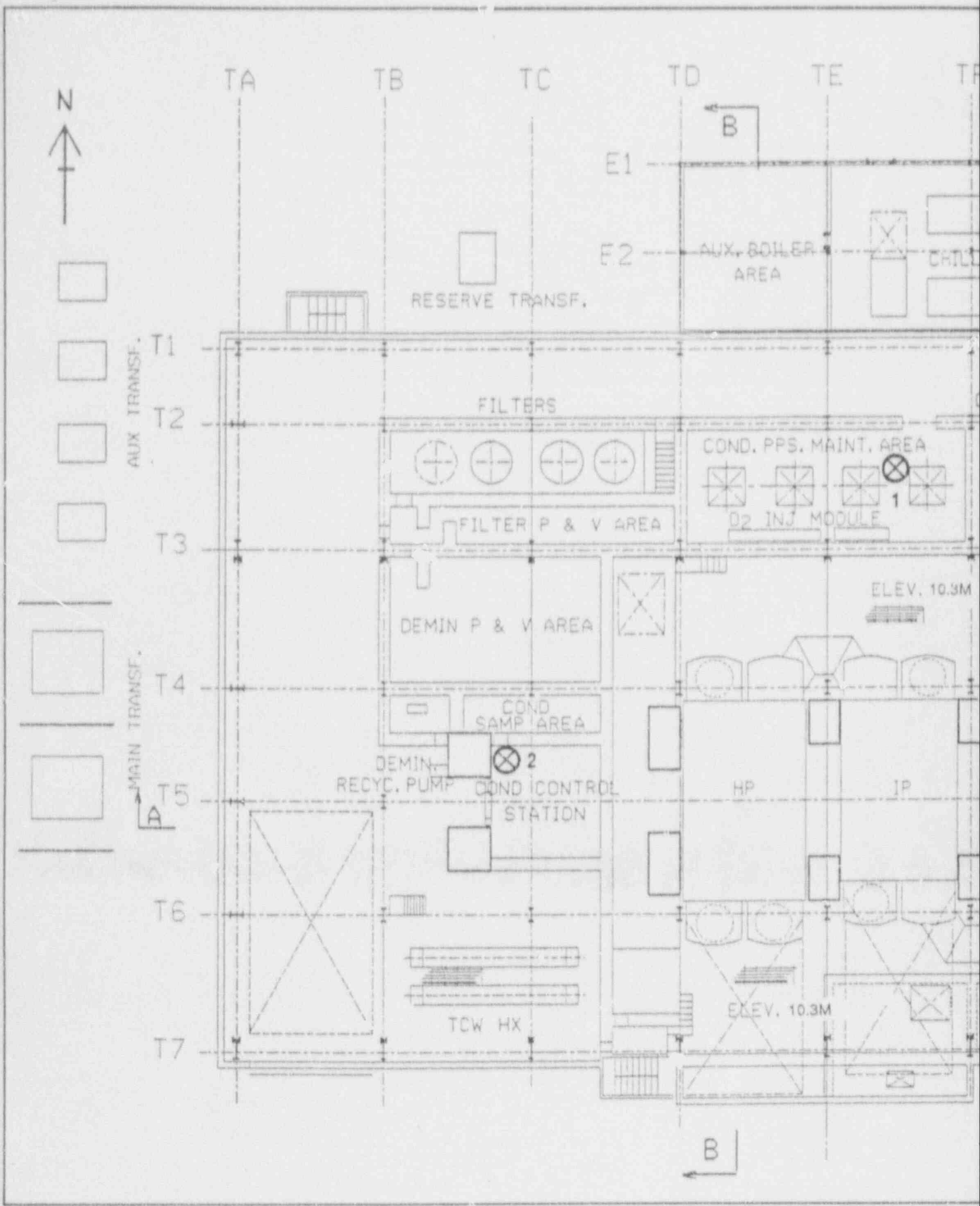


Figure 12.3–41 RADWASTE BUILDING, RADIATION ZONE MAP, NORMAL OPERATION AT CROSS SECTION A–A



N
TA
TB
TC
TD
TE
B
E1
E2
AUX. BOILER AREA
RESERVE TRANSF.
AUX TRANSF.
T1
T2
FILTERS
COND. PPS. MAINT. AREA
1
O2 INJ MODULE
FILTER P & V AREA
T3
ELEV. 10.3M
DEMIN P & V AREA
MAIN TRANSF.
T4
COND SAMP AREA
DEMIN. RECYC. PUMP
2
COND CONTROL STATION
A
T5
HP
IP
T6
TCW HX
ELEV. 10.3M
T7
B

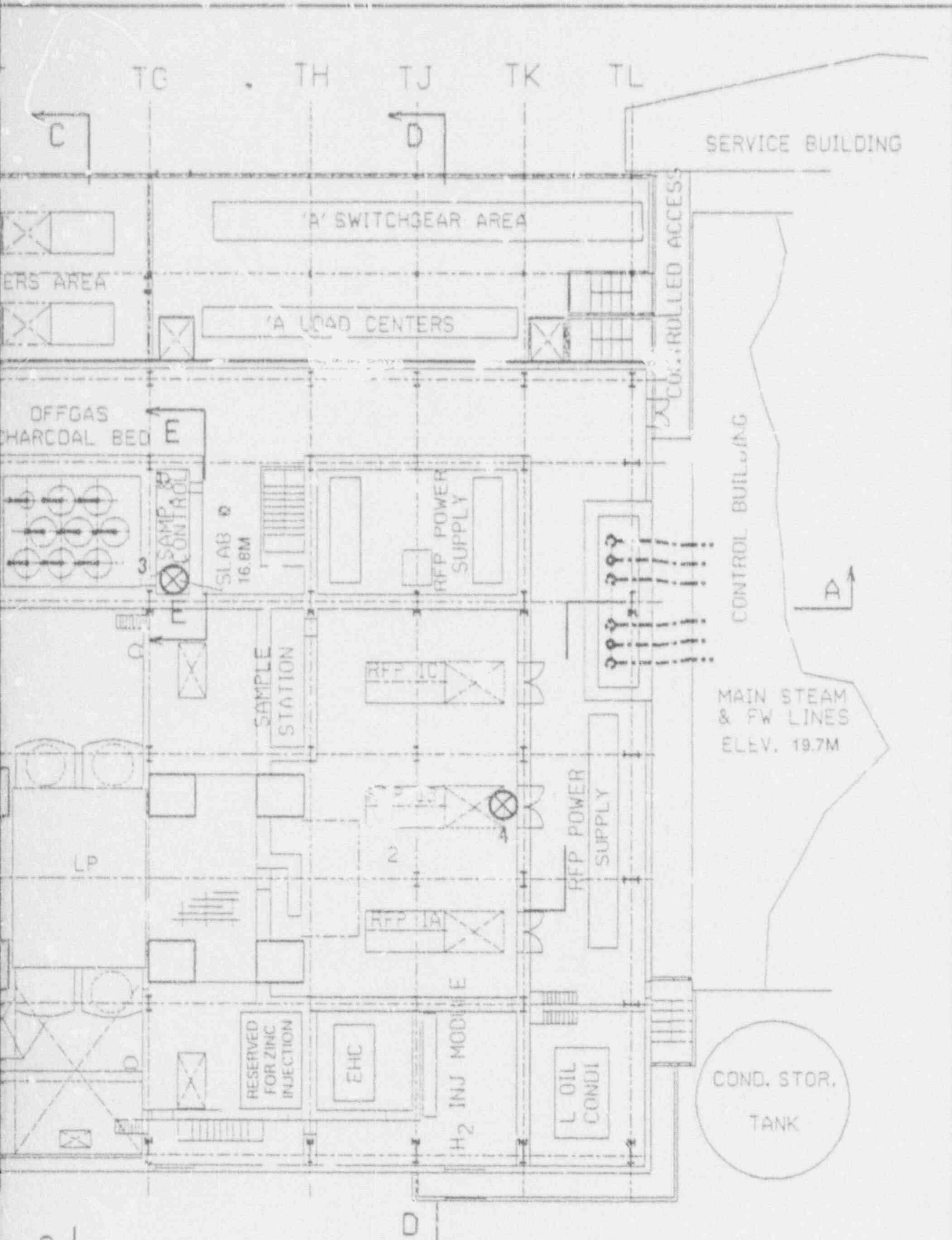


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Figure 12.3-70 TURBINE BUILDING, GRADE LEVEL 2, AREA RADIATION MONITOR, ELEVATION 12.3M

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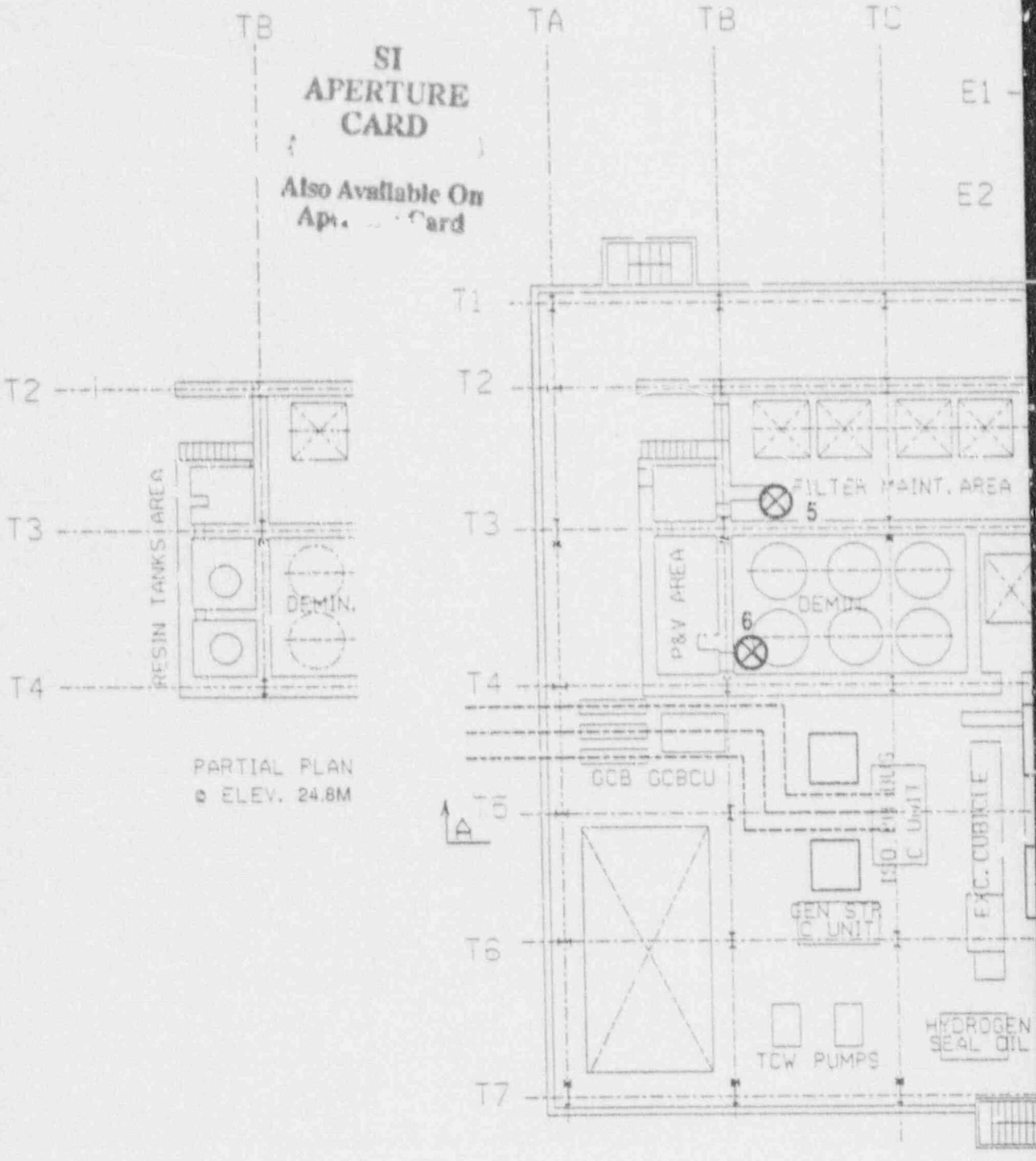


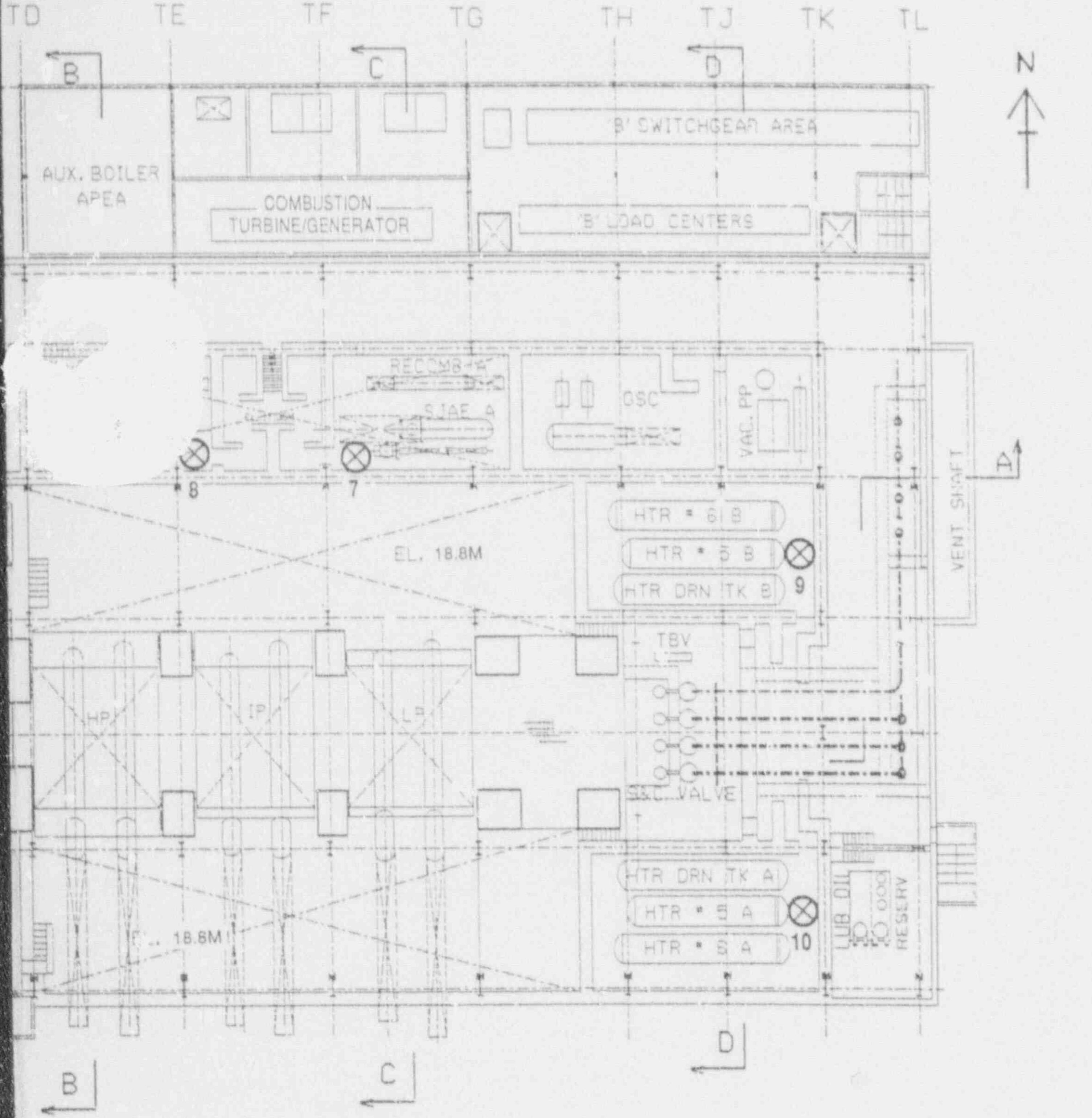
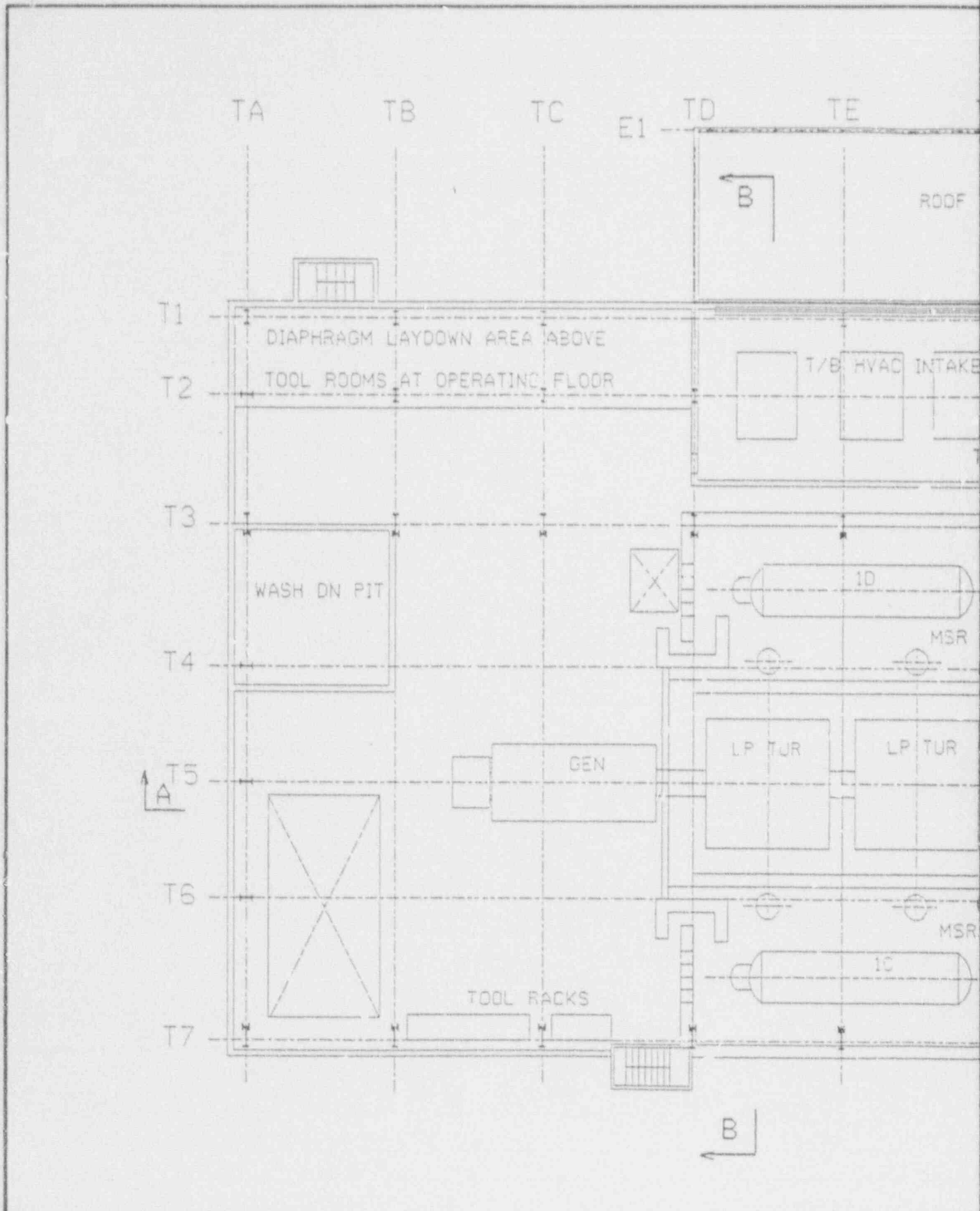
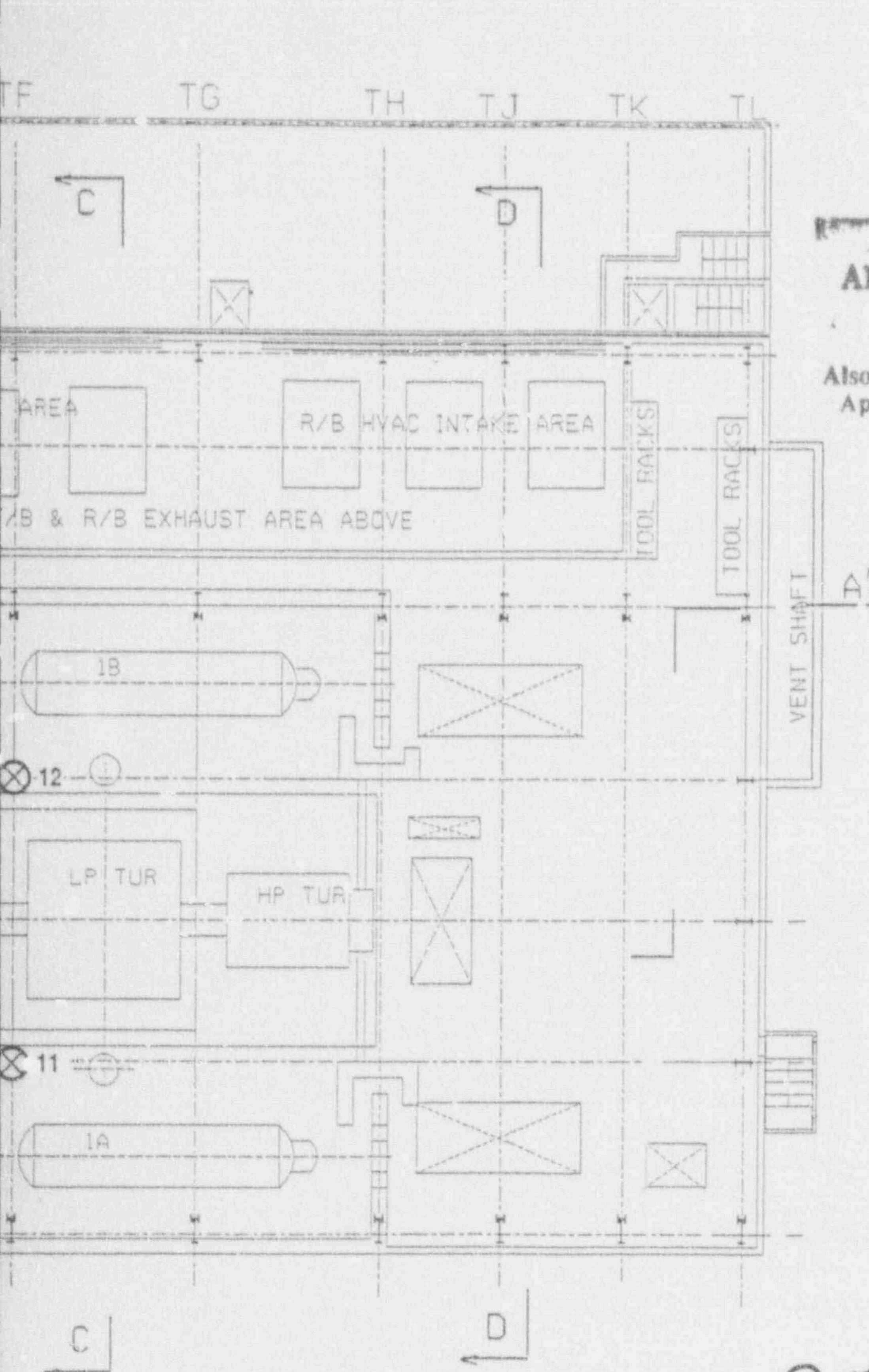


Figure 12.3-71 TURBINE BUILDING, LEVEL 3, AREA RADIATION MONITOR, ELEVATION 20.3M



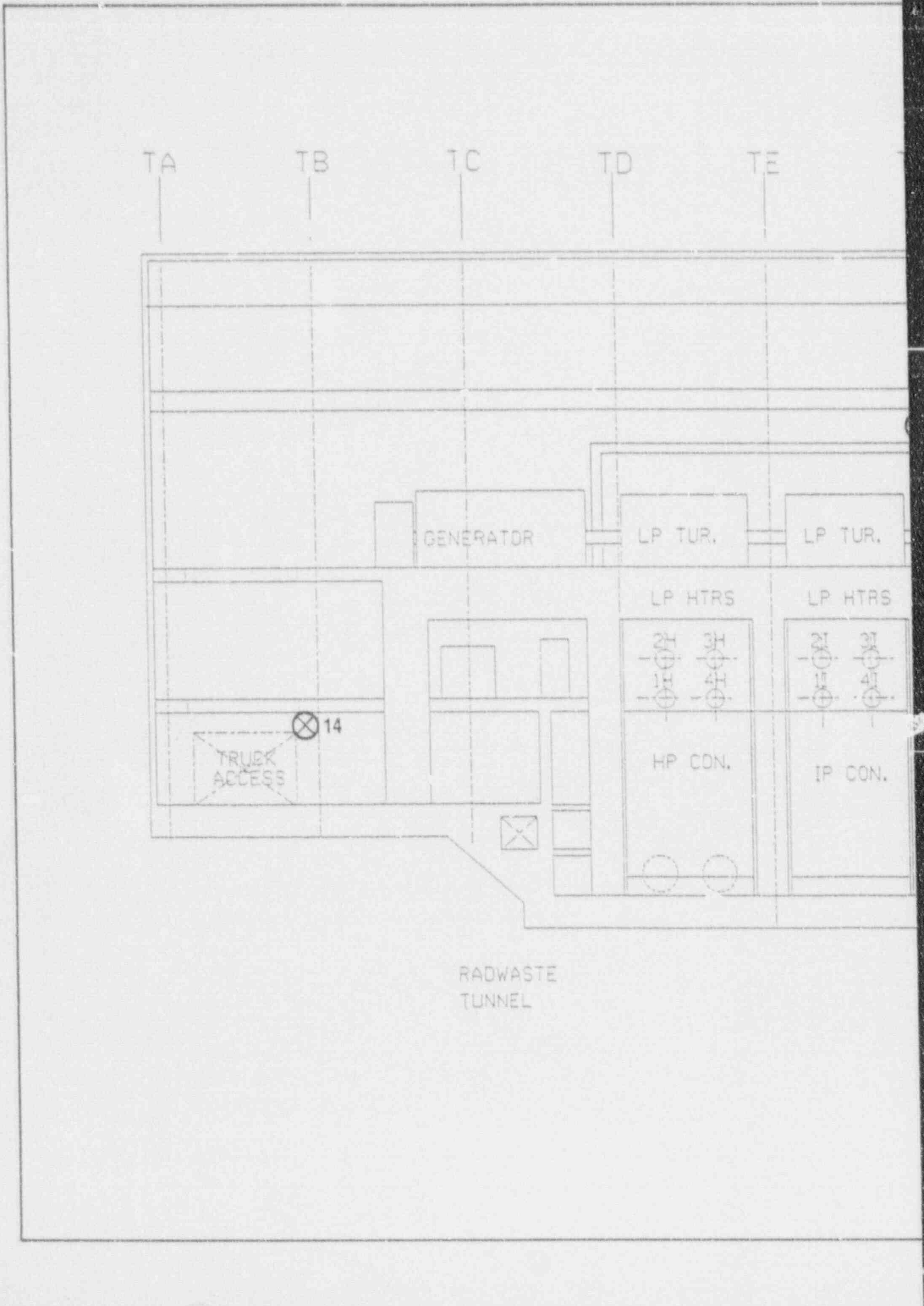
TA
TB
TC
TD
TE
E1
B
ROOF
T1
DIAPHRAGM LAYDOWN AREA ABOVE
T2
TOOL ROOMS AT OPERATING FLOOR
T/B HVAC INTAKE
T3
WASH DN PIT
1D
MSR
T4
GEN
LP TUR
LP TUR
T5
A
T6
MSR
1C
TOOL RACKS
T7
B



9205200194-25

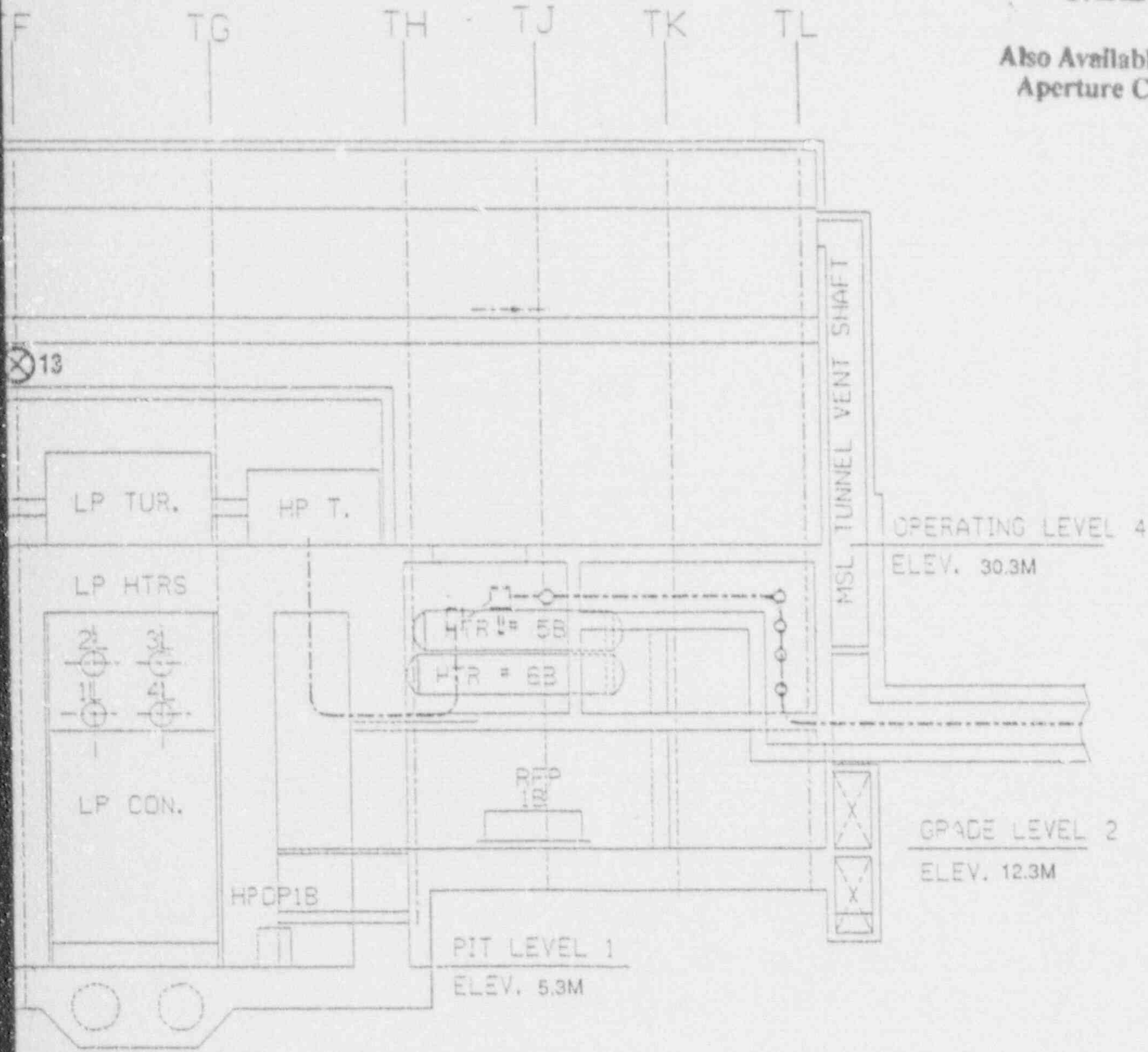
91-268-03

Figure 12.3-72 TURBINE BUILDING, LEVEL 4, AREA RADIATION MONITOR, ELEVATION 30.3M


TA
TB
TC
TD
TE
GENERATOR
LP TUR.
LP TUR.
LP HTRS
LP HTRS
2H
3H
1H
4H
2I
3I
1I
4I
14
TRUCK ACCESS
HP CON.
IP CON.
RADWASTE TUNNEL

SI
APERTURE
CARD

Also Available On
Aperture Card



9205200194-26

Figure 12.3-73 TURBINE BUILDING, AREA RADIATION MONITOR, LONGITUDINAL SECTION A-A