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ASEA BROWN BOVERI

March 23, 1993
LD-93-053

Docket No. 52-002

Attn: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Subject: System 80+™ Nuclear Island Structures
Design Description and ITAAC Submittal

Dear Sirs:

Enclosed is the Design Description (DD) and ITAAC for the System 80+ Nuclear Island Structure. Per our agreement with Mr. William Russell, this document is submitted with the intention that it be incorporated in the review of the prototype System 80+ DD and ITAAC which will occur March 29 - April 1, 1993.

If you have any questions regarding this submittal, please contact me or Mr. John Rec at 203-285-2861.

Very truly yours,

COMBUSTION ENGINEERING, INC.

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Acting Director
Nuclear Systems Licensing

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T. Boyce (NRC)
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1.3.3 NUCLEAR ISLAND STRUCTURES

Design Description

The Nuclear Island (NI) Structures house, protect, and support plant equipment. The NI Structures provide

personnel and equipment access,
support for operating loads,
radiation shielding,
structural components to withstand loads due to design basis external and internal events,
physical separation between Divisions of safety-related equipment, and
barriers to minimize or prevent the release of radioactive materials.

The NI Structures consist of the Reactor Building (RB) and the Nuclear Annex (NA). The RB and NA are further sub-divided into structures, buildings and areas. The RB and NA are structurally integrated on a common basemat.

The RB is a reinforced concrete and structural steel structure, which consists of the Shield Building (SB), the RB Subsphere, the Containment, and the Containment Internal Structures. The SB is composed of a reinforced concrete right cylinder with a hemispherical dome, which encloses the Containment, and is structurally connected to the NA. The area between the SB and the Containment is the RB Annulus. The RB Subsphere is located below the RB Annulus area and the Containment and is divided by a Divisional wall. Within the RB Subsphere, each Division is further divided, such that the RB Subsphere is separated into quadrants. The structural components of the RB Subsphere are structurally connected with the SB and support the Containment and Containment Internal Structures.

The Containment is a spherical, free-standing, welded steel structure. Access to the Containment is provided through personnel air locks and an equipment hatch. Penetrations are also provided for electrical and mechanical components and for the transport of nuclear fuel.

The Containment Internal Structures are reinforced concrete and structural steel structures that support the reactor vessel and reactor coolant system. The primary shield wall supports and laterally surrounds the reactor vessel. The secondary shield wall laterally surrounds the primary shield wall and is structurally connected to the primary shield wall by reinforced concrete slabs and walls. The secondary shield wall also provides support for the polar crane.

The Nuclear Annex consists of the Control Complex, the Diesel Generator Areas, the Fuel Handling Area, the Spent Fuel Storage Area, the Chemical and Volume Control System and Maintenance Area, and the Main Steam Valve Houses. The NA is a

reinforced concrete and structural steel structure which is structurally connected to the SB. The NA laterally surrounds the RB and is divided by a Divisional wall.

The NI Structures provide the features which accommodate the static and dynamic loads and load combinations which define the structural design basis. The design basis loads are those loads associated with:

Normal plant operation - dead loads, live loads, and equipment loads, including the effects of temperature and equipment vibration;

External events - rain, snow, wind, flood, tornado, and earthquake;

Internal events - flood, pipe rupture, equipment failure, and fire.

The Basic Configuration of the NI Structures is as shown in Figures. 1.3.3-1 through 1.3.3-11.

The ASME Code Section III Containment Components, including penetrations, shown on Figures 1.3.3-1 through 1.3.3-11, retain their pressure boundary integrity associated with the design basis pressure.

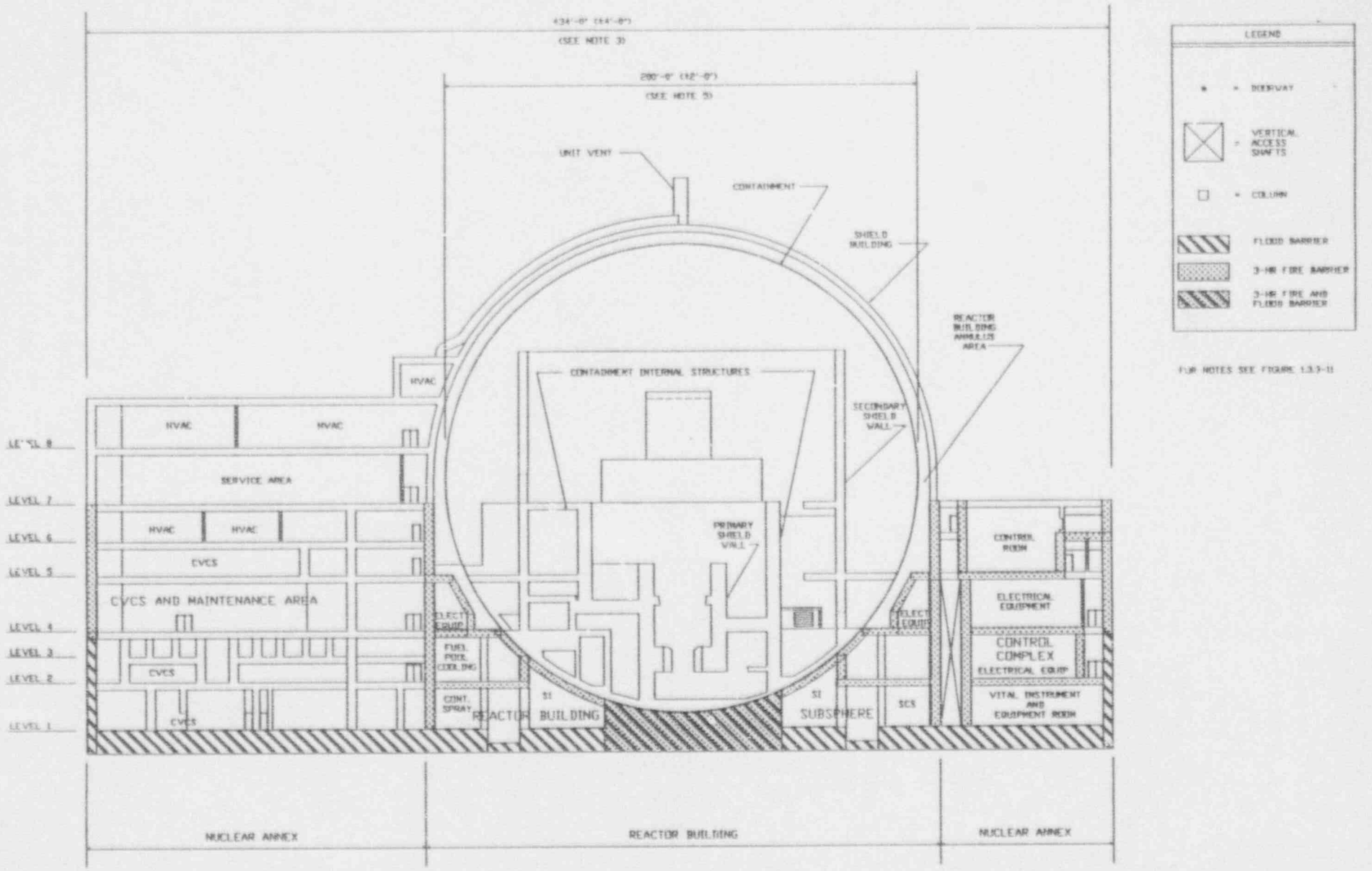
The Containment, including penetrations, shown on Figures 1.3.3-1 through 1.3.3-11 maintain the Containment leakage rate less than the maximum allowable leakage rate associated with the design basis pressure.

The NI Structures are Seismic Category I.

Flood doors shown on Figures 1.3.3-1 through 1.3.3-11 have sensors with open and close status indication provided at a monitored location.

Inspections, Tests, Analyses, and Acceptance Criteria

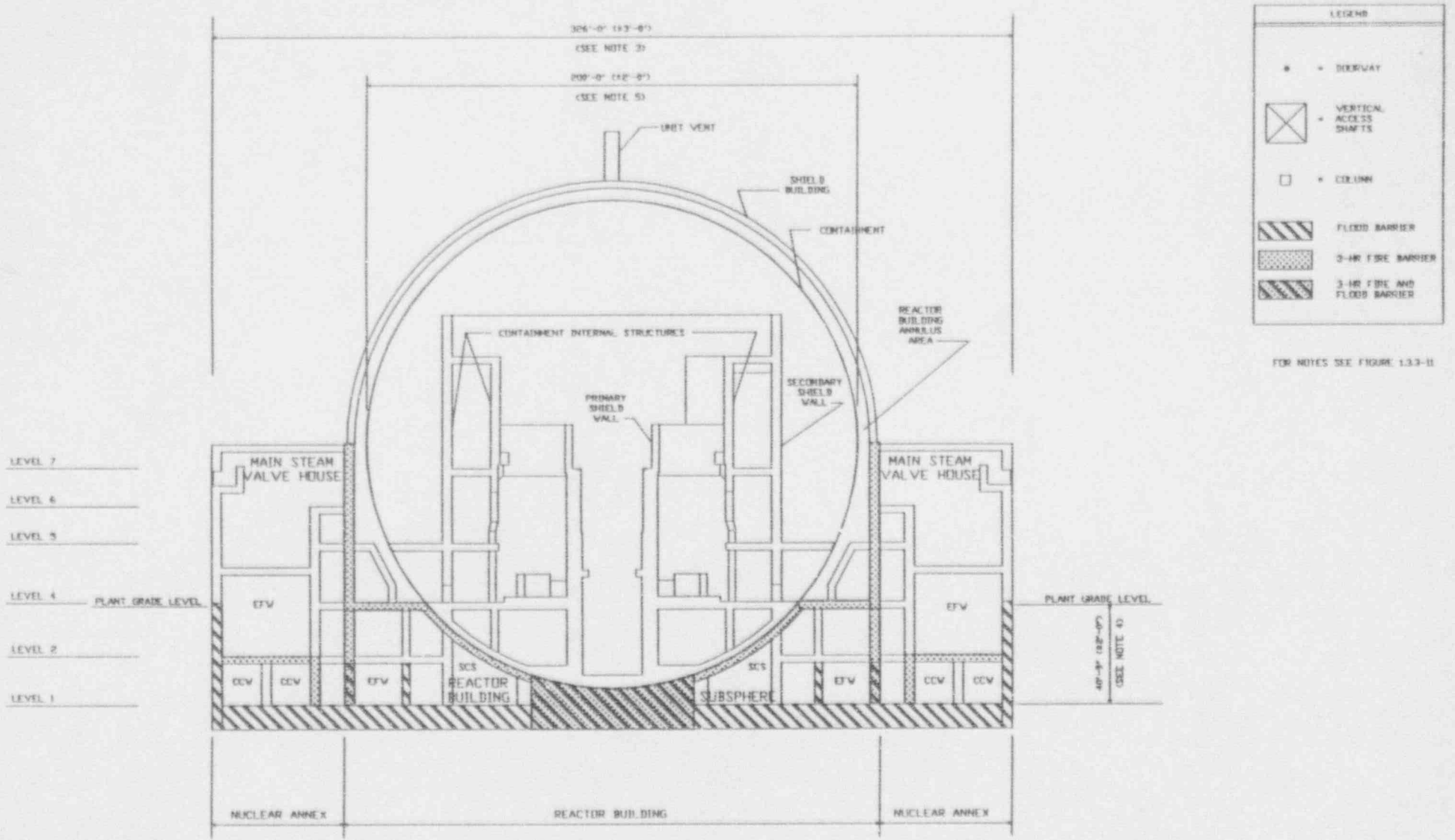
Table 1.3.3-1 specifies the inspections, tests, analyses, and associated acceptance criteria for the Nuclear Island Structures.



FOR NOTES SEE FIGURE 1.3.3-11

NUCLEAR ISLAND
SECTION A-A

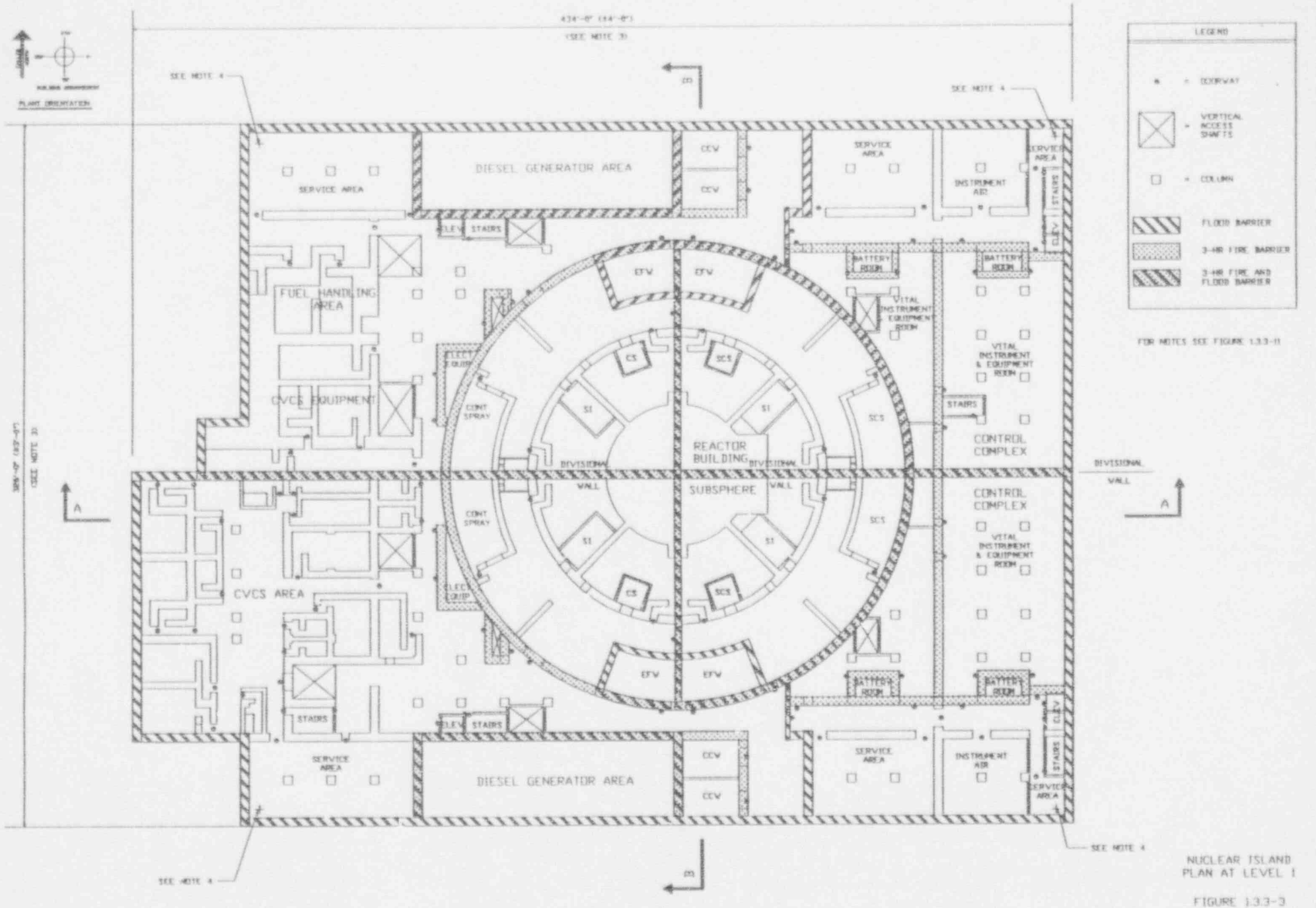
FIGURE 1.3.3-1



FOR NOTES SEE FIGURE 1.3.3-11

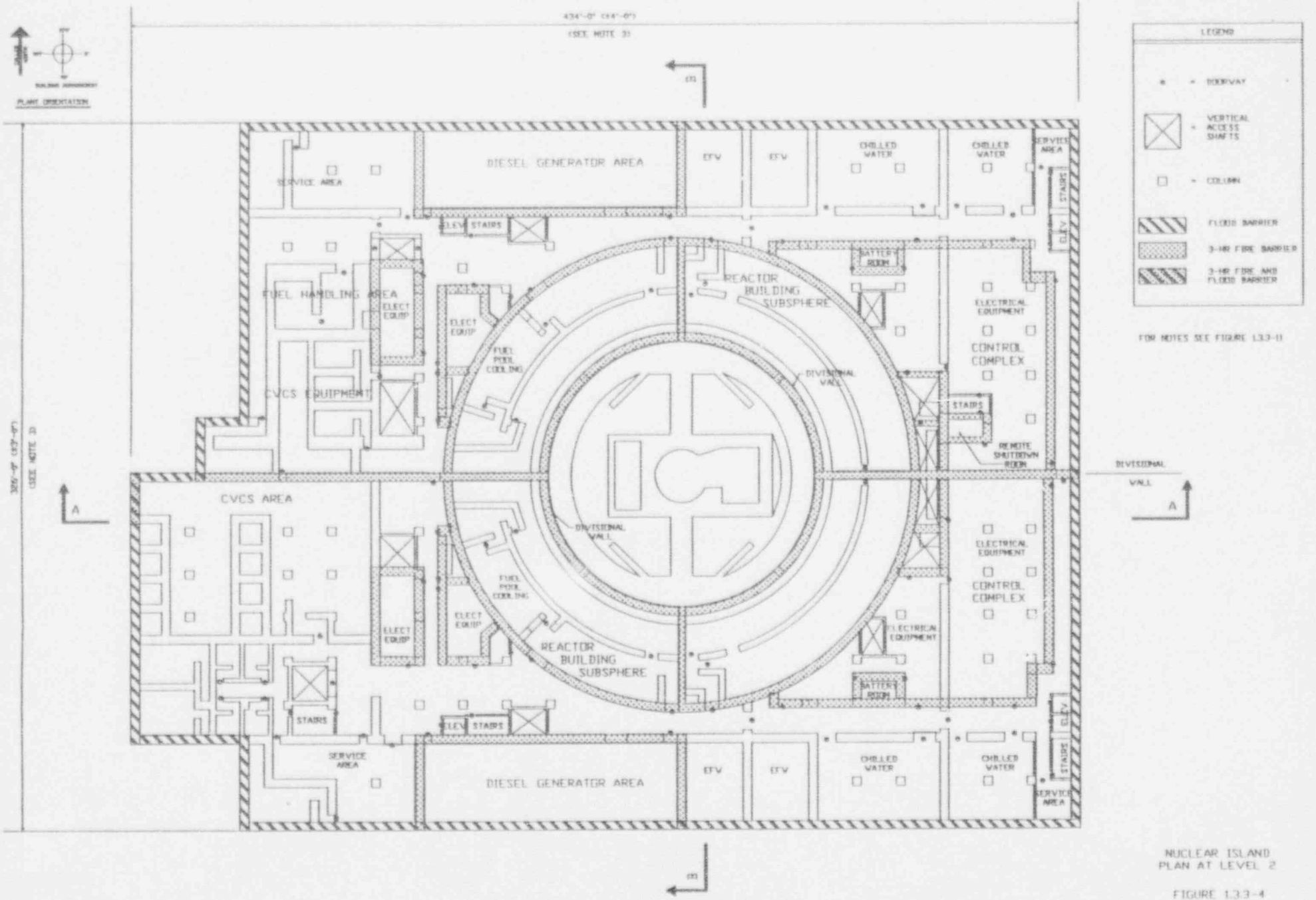
NUCLEAR ISLAND
SECTION B-B

FIGURE 1.3.3-2



NUCLEAR ISLAND
PLAN AT LEVEL 1

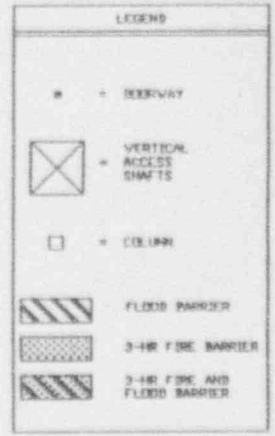
FIGURE 1.3.3-3



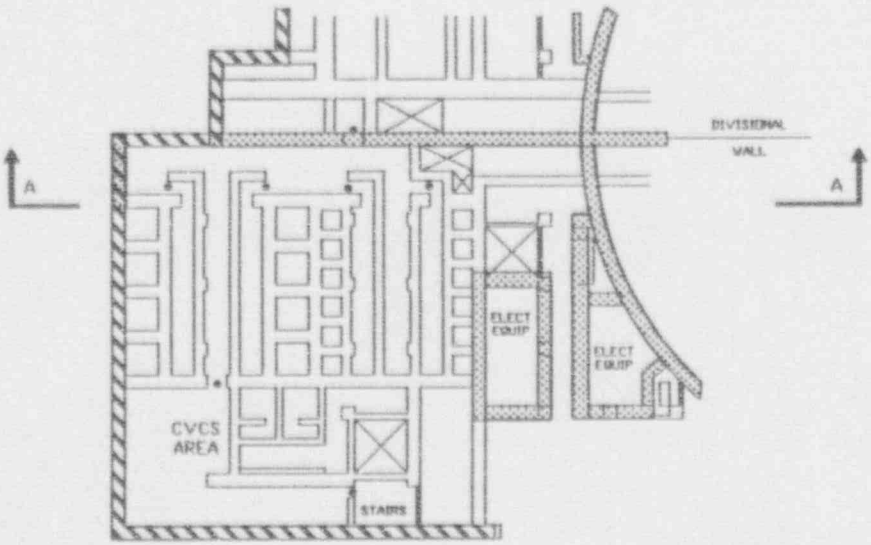
NUCLEAR ISLAND
PLAN AT LEVEL 2

FIGURE 1.3.3-4

PLANT ORIENTATION

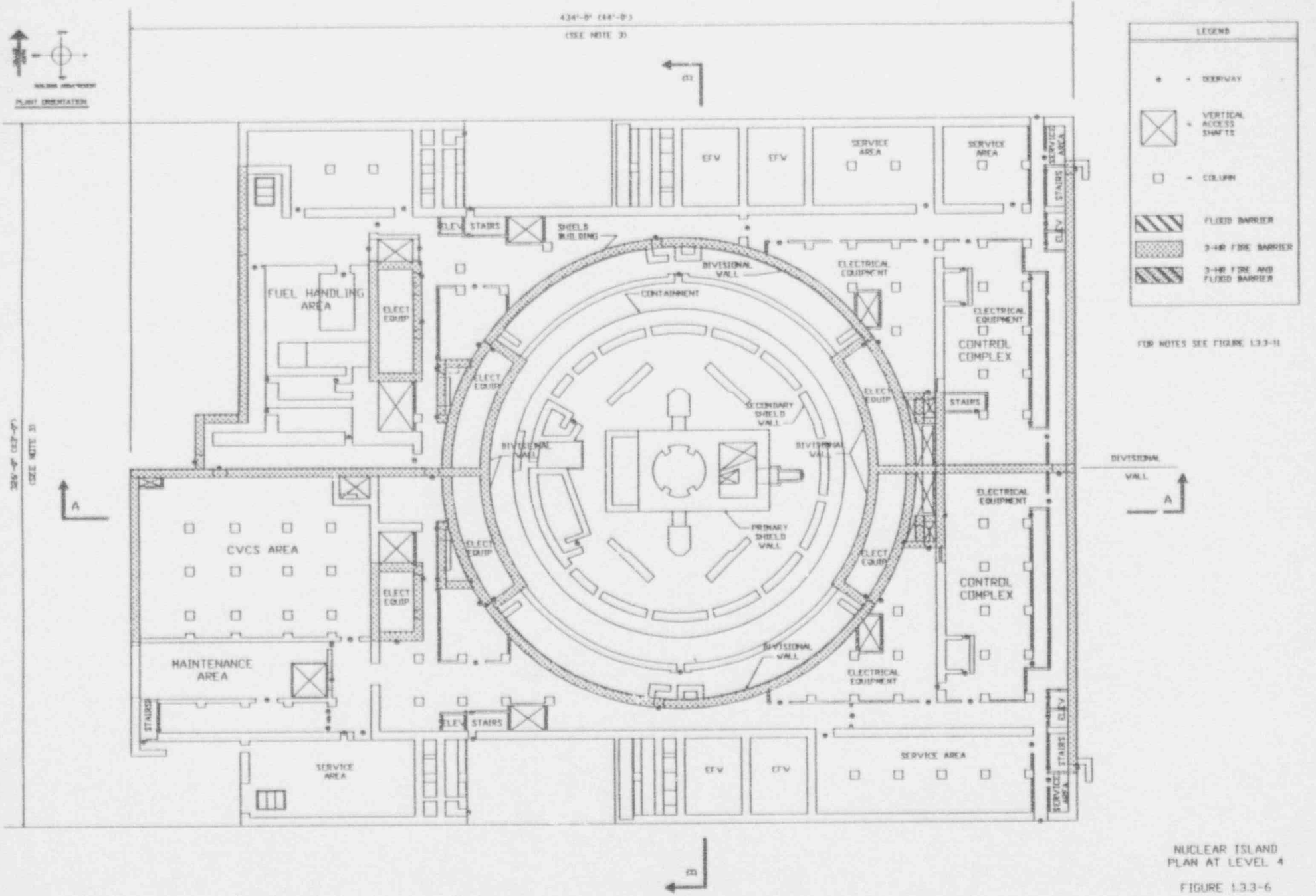


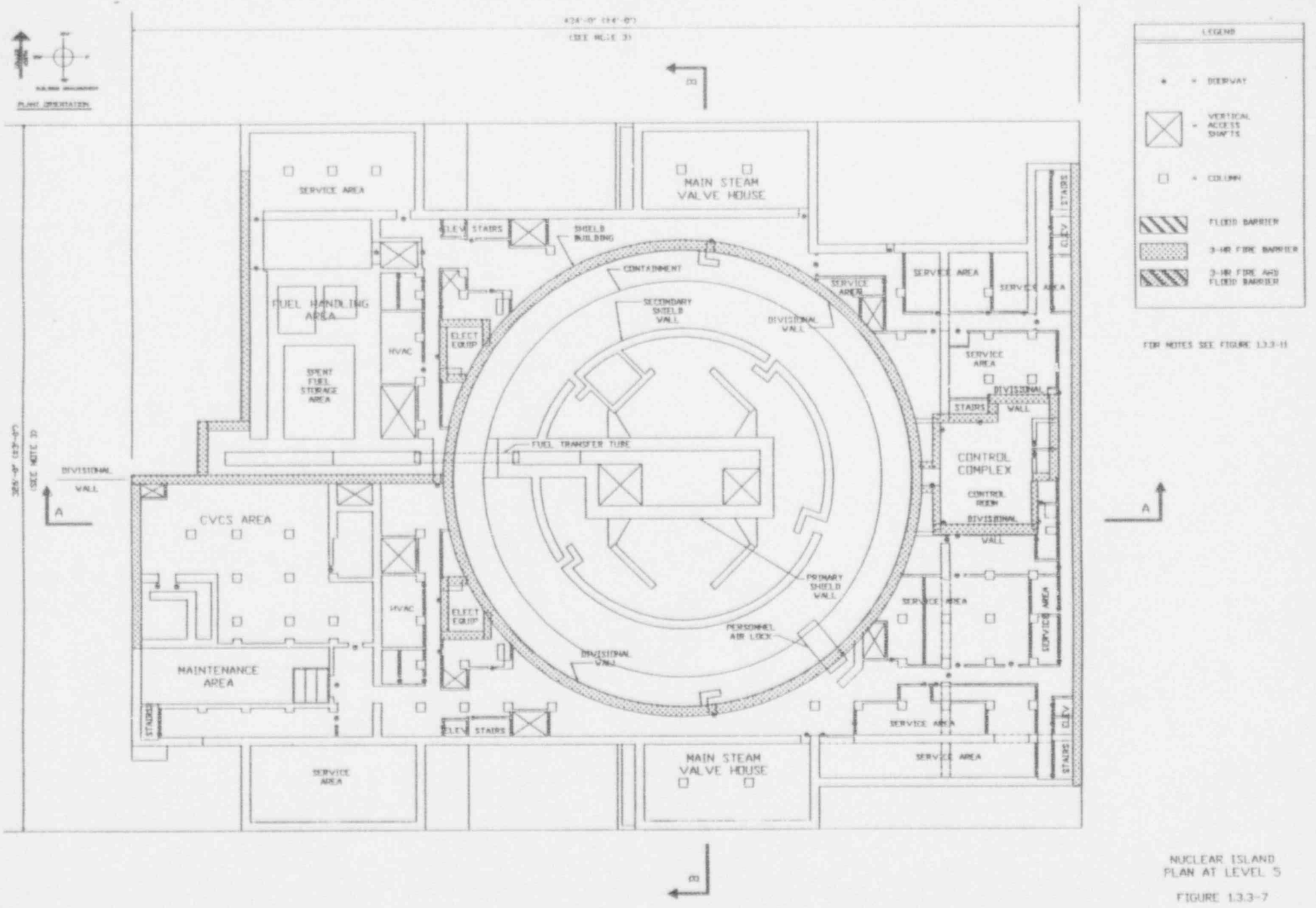
FOR NOTES SEE FIGURE 1.3.3-11



NUCLEAR ISLAND
PLAN AT LEVEL 3

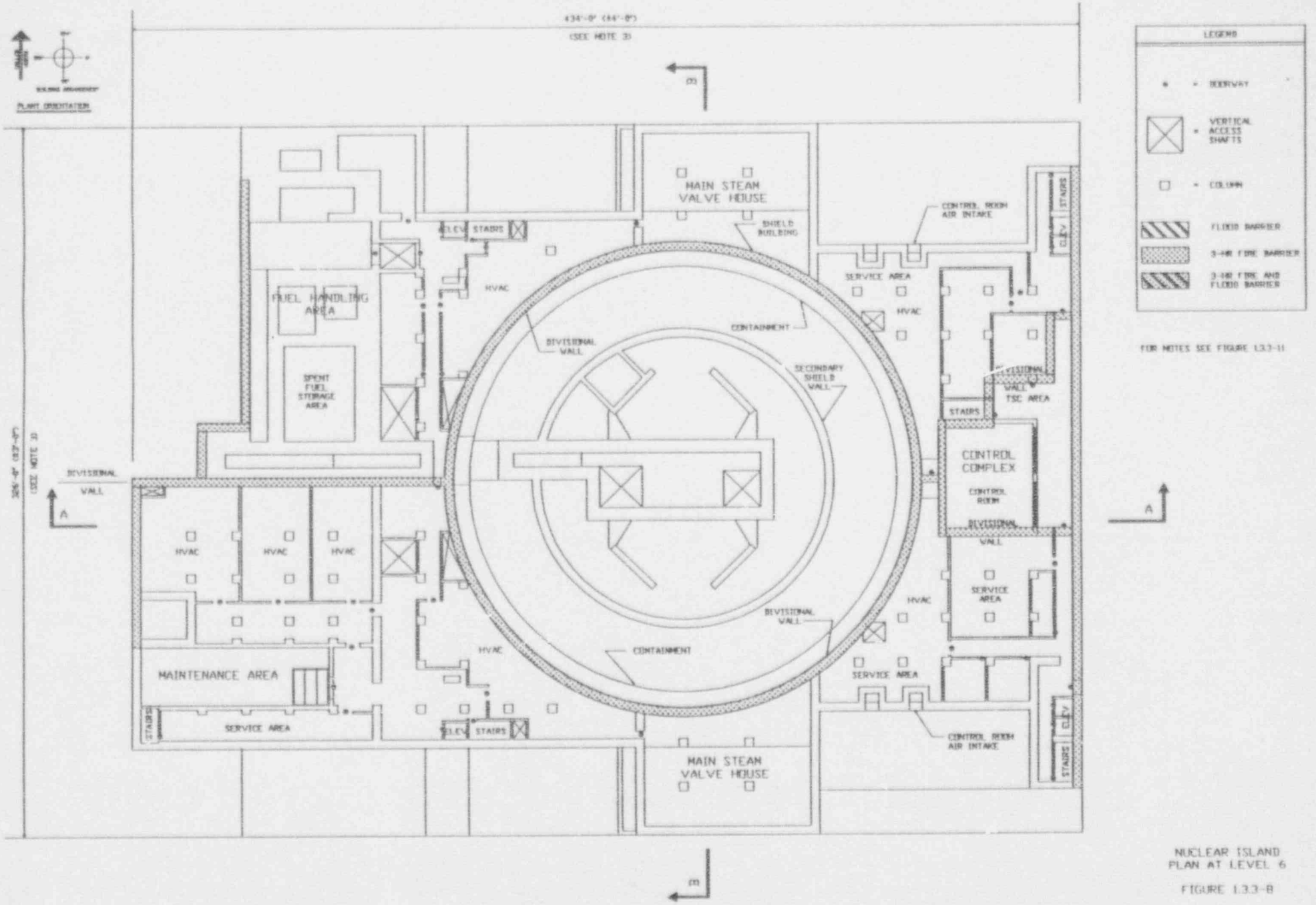
FIGURE 1.3.3-5


PLANT ORIENTATION
434'-0" (44'-0")
(SEE NOTE 3)
326'-4" (32'-4")
(SEE NOTE 3)
LEGEND
DOORWAY
VERTICAL ACCESS SHAFTS
COLUMN
FLUID BARRIER
3-HR FIRE BARRIER
3-HR FIRE AND FLUID BARRIER
FOR NOTES SEE FIGURE 1.3.3-11
FUEL HANDLING AREA
ELECT EQUIP
ELEC STAIRS
SHIELD BUILDING
DIVISIONAL WALL
CONTAINMENT
ELECTRICAL EQUIPMENT
CONTROL COMPLEX
SECONDARY SHIELD WALL
PRIMARY SHIELD WALL
STAIRS
ELEV
SERVICE AREA
CVCS AREA
MAINTENANCE AREA
A
NUCLEAR ISLAND
PLAN AT LEVEL 4
FIGURE 1.3.3-6



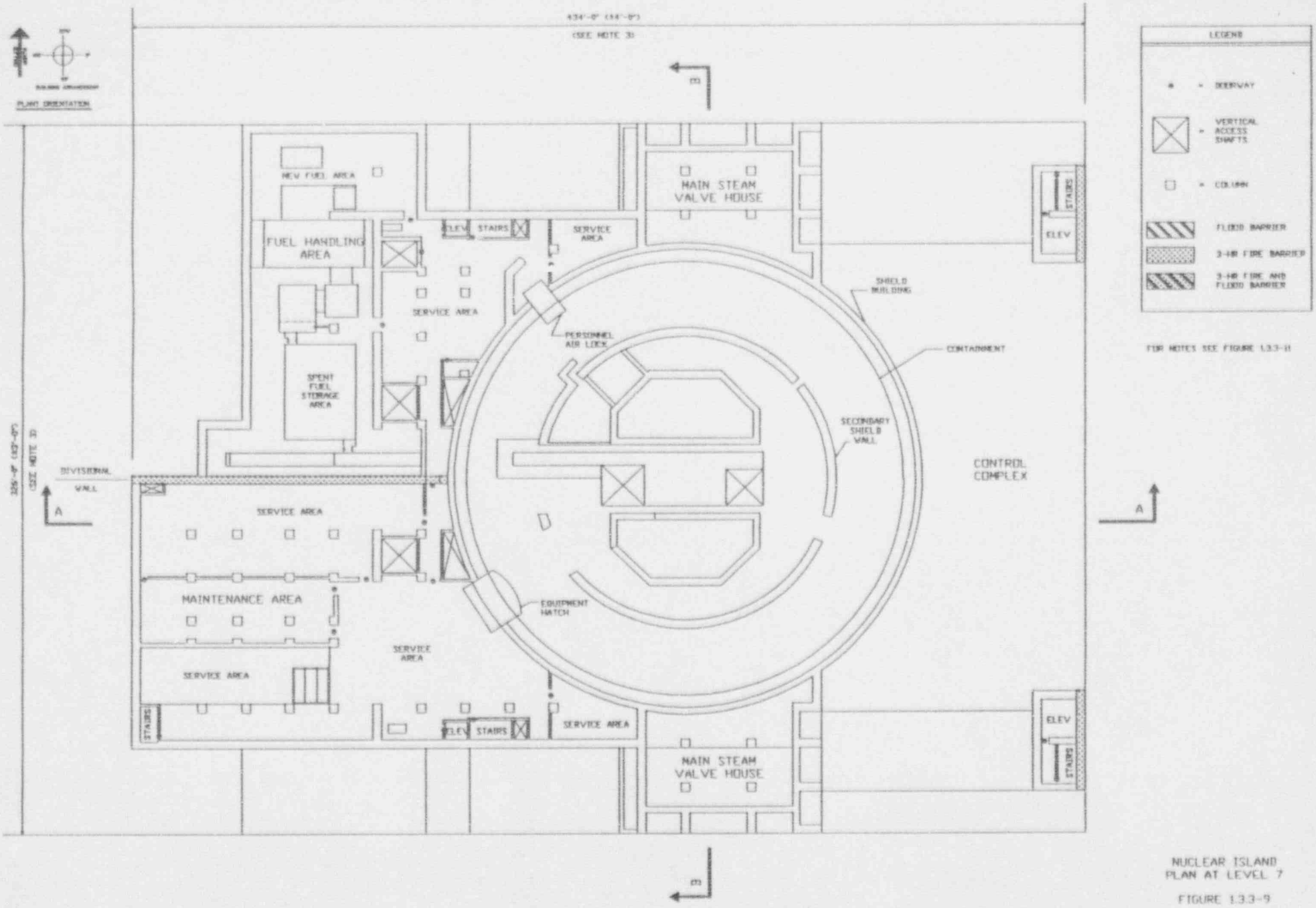
NUCLEAR ISLAND
PLAN AT LEVEL 5

FIGURE 1.3.3-7



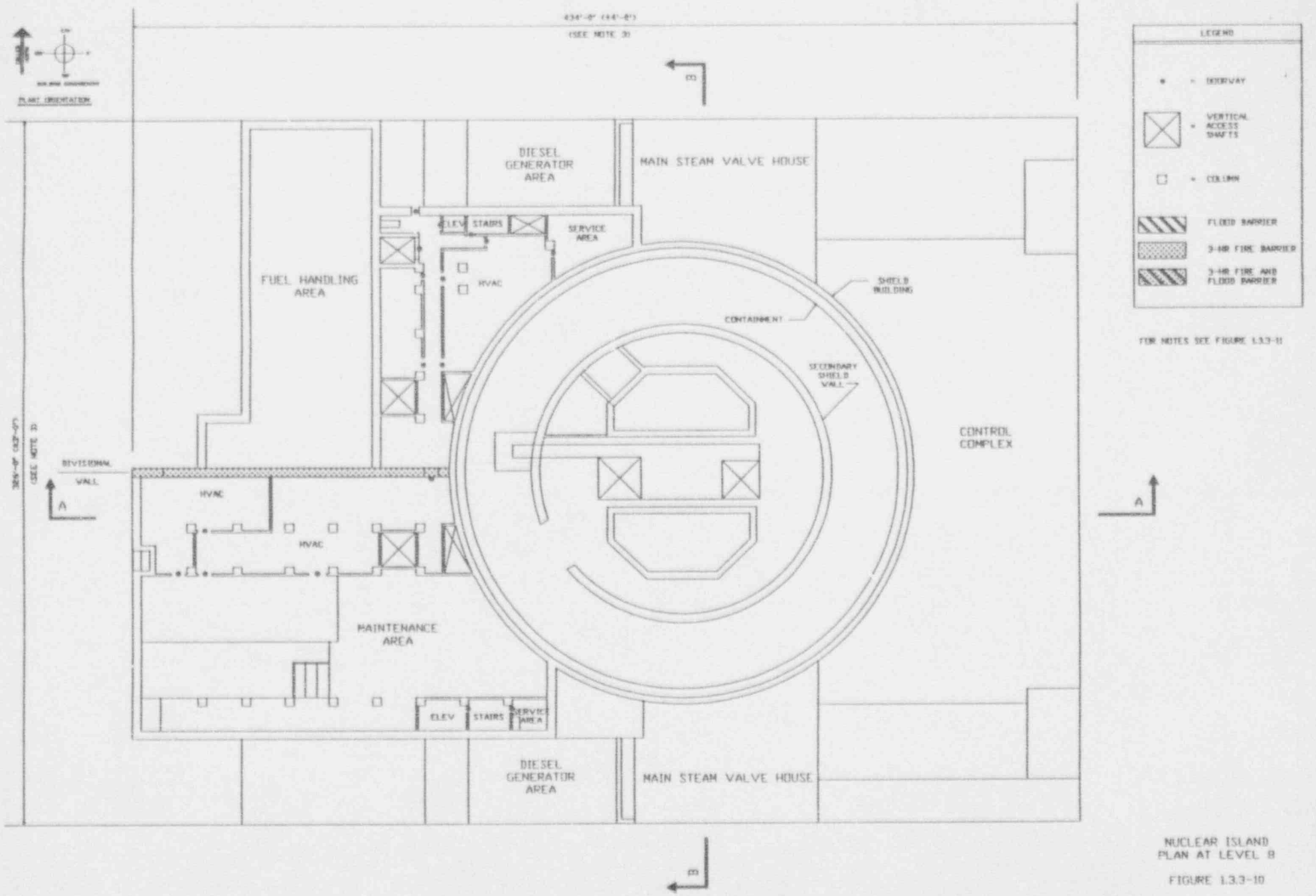
NUCLEAR ISLAND
PLAN AT LEVEL 6

FIGURE 1.3.3-8



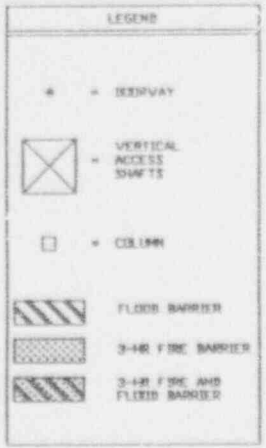
NUCLEAR ISLAND
PLAN AT LEVEL 7

FIGURE 1.3.3-9



NUCLEAR ISLAND
PLAN AT LEVEL 8

FIGURE 1.3.3-10



NOTES FOR FIGURES:

1. FLOOD DOORS ARE PROVIDED IN FLOOD BARRIERS, AND PENETRATIONS ARE SEALED UP TO THE FLOOD LEVEL. SENSORS ARE PROVIDED ON FLOOD DOORS WITH OPEN AND CLOSE STATUS INDICATIONS AT A MONITORED LOCATION.

2. 3-HOUR FIRE RATED DOORS AND ELECTRICAL AND MECHANICAL PENETRATION SEALS ARE PROVIDED FOR OPENINGS IN THE 3-HOUR FIRE RATED BARRIERS.

3. THIS DIMENSION IS MEASURED AT THE TOP ELEVATION OF THE LEVEL 4 REINFORCED CONCRETE FLOOR (±0'-6") IN A DIRECTION PARALLEL TO THE RESPECTIVE PLANT ORIENTATION AZIMUTH, 0° - 180° (±2°) OR 90° - 270° (±2°), BETWEEN THE EXTERIOR SURFACES OF THE REINFORCED CONCRETE AT THE CORNERS SHOWN.

4. THIS DIMENSION IS THE DIFFERENCE BETWEEN THE PLANT GRADE ELEVATION AND THE TOP ELEVATION OF THE LEVEL 1 REINFORCED CONCRETE FLOOR AT THE LOCATIONS INDICATED ON FIGURE 1.3.3-3. THE PLANT GRADE ELEVATION IS DETERMINED AT THE EXTERIOR CORNER OF THE REINFORCED CONCRETE WALL ADJACENT TO THE LOCATIONS INDICATED ON FIGURE 1.3.3-3.

5. 200'-0" (±2'-0") IS THE INSIDE DIAMETER OF THE STEEL CONTAINMENT SPHERE. THE INSIDE RADIUS OF THE SPHERE IS 100'-0" (±1'-0"). THE INSIDE RADIUS IS MEASURED AT THE ELEVATION OF THE CENTER OF THE SPHERE IN FOUR DIRECTIONS, PLANT AZIMUTHS 0° (±5°), 90° (±5°), 180° (±5°), 270° (±5°). ONE ADDITIONAL INSIDE RADIUS IS MEASURED FROM THE CENTER OF THE SPHERE, VERTICALLY (±5°), TO THE TOP OF THE CONTAINMENT.

ABBREVIATIONS:

BLDG	BUILDING
CONT	CONTAINMENT
ELECT	ELECTRICAL
ELEV	ELEVATOR
EQUIP	EQUIPMENT
HR	HOUR
MAINT	MAINTENANCE
SYS	SYSTEM

NUCLEAR ISLAND
NOTES, LEGEND,
AND ABBREVIATIONS

FIGURE 1.3.3-11

TABLE 1.3.3-1

NUCLEAR ISLAND STRUCTURES
Inspections, Tests, Analyses, and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The Basic Configuration of the Nuclear Island Structures is as shown in Figures 1.3.3-1 through 1.3.3-11.	1. Inspections of the configurations of Nuclear Island Structures will be conducted.	1. For the structures shown on Figures 1.3.3-1 through 1.3.3-11, the Nuclear Island Structures conform with the Basic Configuration.
2. The Nuclear Island Structures will withstand the structural design basis loads specified in Section 1.3.3 of the Design Description.	2. A structural analysis will be performed which reconciles the as-built data with the structural design basis specified in Section 1.3.3 of the Design Description.	2. A structural analysis report exists which concludes that the as-built Nuclear Island Structures will withstand the design basis loads specified in Section 1.3.3 of the Design Description.
3.a) The ASME Code Section III Containment Components, including penetrations, shown on Figures 1.3.3-1 through 1.3.3-11, retain their pressure boundary integrity associated with the design basis pressure.	3.a) A pressure test will be conducted on those components of the Containment required to be pressure tested by ASME Code Section III.	3.a) The results of the pressure test of ASME Code Section III components of the Containment conform with the pressure testing criteria in ASME Code Section III.
b) The Containment, including penetrations shown on Figures. 1.3.3-1 through 1.3.3-11 maintain the Containment leakage rate less than the maximum allowable leakage rate associated with the design basis pressure.	b) An inspection and leak rate test will be conducted.	b) The results of the inspection and leak rate test conform with the inspection and leak rate criteria of 10CFR50, Appendix J.

TABLE 1.3.3-1 (Continued)

NUCLEAR ISLAND STRUCTURES
Inspections, Tests, Analyses, and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
4. Flood doors shown on Figure 1.3.3-1 through 1.3.3-11 have sensors with open and close status indication provided at a monitored location.	4. Inspection for existence of flood door sensors and open and close status indications will be performed.	4. The flood door sensors and open and close status indications shown on Figures 1.3.3-1 through 1.3.3-11 exist.

For reference purposes only. Not intended to comprise a part of either the Tier 1 or Tier 2 System 80+ submittal.

SUPPORTIVE INFORMATION FOR NUCLEAR ISLAND (NI) STRUCTURES (1.3.3)

1. Amplifying Information for NI Structures

   See CESSAR-DC Sections 3.3 through 3.8

2. CESSAR-DC Chapter 14 Tests Applicable to NI Structures

   See CESSAR-DC Section 14.2.12.1.130

REFERENCE INFORMATION FOR [illegible]AR ISLAND (NI) STRUCTURES
(1.3.5)

Relationship of NI Structures to the Safety Analysis

The Containment must withstand the pressure and temperatures of the DBA without exceeding the design leakage rate.

REFERENCE INFORMATION FOR NUCLEAR ISLAND (NI) STRUCTURES (1.3.3)

Relationship of PRA to NI Structures

Physical separation is provided between redundant divisions of safety-related equipment.

3.4 WATER LEVEL (FLOOD) DESIGN

All Seismic Category I structures, components and equipment are designed for applicable loadings caused by postulated floods. Section 2.4 of the site-specific SAR describes, in detail, the relationship of the site-specific flood levels to safety-related buildings and facilities. D

3.4.1 FLOOD ELEVATIONS

The elevation level for floods at the reactor site is determined in accordance with Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants," and ANSI/ANS 2.8-1992, "Determining Design Basis Flooding at Power Reactor Sites." The design basis level for the System 80+ Standard Design is 1 foot below plant finished yard grade. Flood level values in excess of this 1 foot level are site-specific and protection measures for that flood level are described in Section 2.4 of the site-specific SAR. K

3.4.2 PHENOMENA CONSIDERED IN DESIGN LOAD CALCULATION

All safety-related structures of the reactor building complex are designed to withstand the static and dynamic forces of the plant flood level. Other safety-related structures or systems essential for plant operation are designed for the site-related flood level as described in Section 2.4 of the site-specific SAR.

3.4.3 FLOOD FORCE APPLICATION

The design flood is used in determining the applicable water level for design of all Seismic Category I structures in accordance with the load combinations discussed in Section 3.8.4. The forces acting on those structures are determined on the basis of full external hydrostatic pressure corresponding to that flood level. All Seismic Category I structures will be in a stable condition due to both moment and uplift forces resulting from the proper load combinations, including design basis flood levels. D

3.4.4 FLOOD PROTECTION

3.4.4.1 Flood Protection Measures for Seismic Category I Structures

The flood protection measures for Seismic Category I structures, systems and components are designed in accordance with Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants." ~~The following structures and systems in the reactor complex area are designed for flood level protection:~~

~~Nuclear Island~~
~~- Reactor Building~~
~~- Nuclear Annex (including)~~
~~- Diesel Generator Building~~
~~- Control Building~~
~~- Main Steam Valve~~

~~House and EFW Enclosures and Fuel Pool Building~~

DELETE K

These safety-related structures are designed to ~~maintain a dry environment during all~~ protect safety-related equipment from floods by incorporating the following safeguards into their construction:

A. No exterior access openings will be lower than 1 foot above plant grade elevation.

B. The finished yard grade adjacent to the safety-related structures will be maintained at least 1 foot below the ground floor elevation. D

C. Waterstops are used in all horizontal and vertical construction joints in all exterior walls up to flood level elevation.

D. Water seals are provided for all penetrations in exterior walls up to flood level elevation.

E. Waterproofing of walls subject to flooding is provided. I

For other safety related structures where flood protection measures are required (e.g. pumping systems, stoplogs, watertight doors, dikes, retaining walls and drainage systems) the design of means for providing such protection will be described in Section 2.4 of the site-specific SAR. D

INSERT 1

~~Redundant equipment is separated and compartmentalized so that a single flooding event does not affect redundant safety systems. Equipment such as the auxiliary shutdown panels are elevated off the floor so that flooding events will not affect these important pieces of equipment.~~ I

K

3.4.5 ANALYTICAL AND TEST PROCEDURES

A description of the methods and test procedures by which static and dynamic effects of the design basis flood conditions or design basis groundwater conditions are applied is detailed in Section 2.4 of the site-specific SAR. D

INSERT 1

Flood protection in the System 80+™ design minimizes possible flood sources. Service Water is located outside the Nuclear Annex to eliminate unlimited sources of water. Component Cooling Water and Emergency Feedwater are fully separated by division, thus eliminating the possibility of a single flood source within these systems impacting both divisions.

Lengths of high energy and moderate energy piping have been minimized by equipment location. Equipment is located in quadrants around the spherical containment to minimize the lengths of piping runs. The RB Subsphere provides further close proximity of equipment to reduce piping runs from containment.

Protection from external flooding is provided by elevated building entrances. Secondary flooding sources located in the Turbine Building are confined to that building. Entrances to the Nuclear Annex from the Turbine Building are elevated above plant grade to prevent flood propagation.

Flood barriers have been integrated into the design to provide further flood protection while minimizing the impact on maintenance accessibility. The primary means of flood control in the Nuclear Annex and RB Subsphere is provided by the divisional wall which serves as a barrier between redundant trains of safe shutdown systems and components. Each half of the Subsphere is further divided such that it is divided into quadrants to separate redundant safe shutdown components to the extent practical. Flood barriers provide separation between the quadrants, while maintaining equipment removal capability. Emergency Feedwater pumps are located in separate compartments within the quadrants with each compartment protected by flood barriers.

Penetrations are sealed and no doors are provided up to EL.70+0 in the divisional wall that separates the Nuclear Annex and the Reactor Building Subsphere. Where flood doors are provided, open and close sensors are also provided with status indication. Flood barriers also provide separation between electrical equipment and fluid mechanical systems at the lowest elevation within the Nuclear Annex. At higher elevations, safety-related electrical components are elevated above the floor so that flooding events will not affect components. Additional barriers (e.g., curbs, sealed penetrations) are provided or safety-related electrical componenets elevated, as necessary to mitigate the effects of postulated pipe rupture addressed in Section 3.6.

Flood protection is also integrated into the floor drainage systems. The floor drainage systems are separated by division and Safety Class 3 valves to prevent backflow of water to areas containing safety related equipment. Each subsphere quadrant contains its own separate Safety Class 3 sump pump and associated instrumentation, which is powered from the diesel generators in the event of loss of offsite power.

The Nuclear Annex has its own divisionally separated floor drainage system, with no common drain lines between divisions. Floors are gently sloped to allow good drainage to the divisional sumps.

Flood protection is incorporated into the component cooling water heat exchanger building. This structure is divisionally separated by a wall such that a flood in one division can not flood the other division.

The Diesel Generator Building floor drain sump pumps and associated instrumentation are ANSI/ANS Safety Class 3 to prevent flooding of the diesel generators. These pumps are also powered from the diesel generator in the event of loss of offsite power.

Add the following to Sec. 3.8.4.5:

A structural analysis report/s will be prepared for Seismic Category I structures. This report/s will document that design changes and identified construction deviations which could potentially affect the structural capability of the structure have been incorporated into the structural analysis.

The following records will be reviewed, as applicable:

1) Construction records stating material properties for concrete, reinforcing steel, and structural steel

2) As-built structure dimensions and arrangements

3) Design documents for the structure

Deviations from the design are acceptable provided the following acceptance criteria are met:

1) An evaluation is performed (depending on the extent of the deviations, the evaluation may range from the documenting of an engineering judgement to performance of a revised analysis and design) and

2) The structural design meets the requirements specified in Section 3.8 and

3) The seismic responses of the as-built structure are bounded by the design basis floor response spectra and the forces and moments within the structure do not exceed the design basis forces and moments by more than 10 percent.

The structural analysis report will summarize the results of the reviews, evaluations, and corrective actions, as applicable, and conclude that the as-built structure is in accordance with the design.