Section 5.2

<u>US-APWR PLANT OVERVIEW</u>

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5.2 US-APWR PLANT OVERVIEW

5.2.1 Introduction

US-APWR (United States – Advanced Pressurized Water Reactor) is the designation for an evolutionary nuclear electric generating plant designed by Mitsubishi Heavy Industries (MHI), a Japanese industrial conglomerate. The US-APWR design is similar to that of a Japanese version (J-APWR), the first two units of which are scheduled to be constructed and operated as Tsuruga Units 3 and 4. The J-APWR design has been slightly modified for US applications to meet American utility requirements.

The Design Control Document for the US-APWR design was submitted to the USNRC for certification review in January of 2008. A combined operating license application was submitted in 2008 by Luminant Generation Company for two units at the Comanche Peak Nuclear Power Plant.

The US-APWR design is similar in many respects to that of currently operating large-capacity Westinghouse nuclear generating plants. Westinghouse Electric Company worked with MHI on many design aspects. The US-APWR design also incorporates instrumentation-and-control features and control room hardware similar to those already in use in Japanese plants.

Figure 5.2-1 shows a detailed cutaway view of the US-APWR. The main specifications of the plant are listed in Table 5.2-1.

5.2.2 Plant Design Overview

The US-APWR is a four-loop PWR plant with an electrical output rating of 1600 to 1700 MWe, depending on site conditions. The rated core thermal power level is 4451 MWt. The plant generating capacity is large relative to that of the typical nuclear generating plant currently in operation.

The most important aspect of the US-APWR design philosophy is the protection of the public and workers by the installation of effective barriers against radioactive materials and other hazards. Main design concepts of the US-APWR include the utilization of proven technology and a well-balanced safety design. Significant experience in the design, fabrication, installation, construction, and operation of PWRs in Japan has resulted in proven technologies being developed by MHI. These technologies have been incorporated into the design of the US-APWR. The US-APWR features highly reliable prevention functions, well-established mitigation systems with active and passive safety functions, and measures that protect against beyond-design-basis accidents. These three functions are integrated into the balanced US-APWR design, which has been developed using a deterministic design approach as well as through the application of risk-management technology and probabilistic risk assessment. Furthermore, the reliability of the physical barriers and the protection level are enhanced by the concept of defense in depth, which is applied from normal operation to beyond-design-basis accidents. The design of the

US-APWR based on the above principles is in accordance with US regulatory requirements.
Some of the high-level design characteristics of the US-AP1000 include:

- Many safety systems are comprised of four 50%-capacity trains. Safety systems are thus capable of performing their designed safety functions even with the failure of one train upon demand and with the unavailability of a second train due to maintenance.

- The Class 1E power system has four independent divisions, each of which includes an onsite emergency power source. Each division powers a separate train of safety equipment.

- Two alternate AC power sources are available to mitigate station blackouts.

- The plant is designed to withstand the effects of earthquakes, tornadoes, hurricanes, missiles, fires, and pipe ruptures.

- The target core damage frequency is less than 10^{-5}/reactor-year for internal and external events. The target large release frequency is less than 10^{-6}/reactor-year.

- The core is designed for a two-year fuel cycle.

- The overall availability goal is 95%.

- The full-power average linear heat rate is 4.6 kW/ft.

- The plant is designed to accept a load rejection of 100% from full power to house loads (with continued stable operation of house loads), without reactor trip or operation of the pressurizer or steam generator (SG) safety valves.

- Within a load range of 15% to 100% power, the plant is designed to accept ramp load changes of 5%/minute and step changes of 10% without reactor trip or steam dump actuation.

- The design life of the plant is 60 years without the planned replacement of the reactor vessel.

- The designs of major components required for power generation (steam generators, turbine-generator, reactor coolant pumps, nuclear fuel, and reactor internals) are based on evolutions of proven designs. The components upon which the US-APWR designs are based have operated with excellent reliability and availability in existing nuclear power plants, and modifications have been made to these designs to further improve their reliability and availability.

- An advanced control room with integrated digital technology and redundant architecture reduces the operator load and increases the reliability of instrumentation and controls.

5.2.3 Site Layout

The main US-APWR power block is comprised of the following buildings and structures:

- The reactor building (R/B), including the prestressed, post-tensioned concrete containment vessel (PCCV),
- The power source buildings (PS/Bs),
- The power source fuel storage vaults (PSFSVs),
- The essential service water pipe tunnel (ESWPT),
- The auxiliary building (A/B),
- The access building (AC/B), and
- The turbine building (T/B).

The outline and the arrangement of those buildings and structures are shown in Figures 5.2-2 and 5.2-3 (some details do not appear in the figures).

The containment facility, which houses the reactor coolant system, is comprised of the containment vessel and the annulus enclosing the containment penetration area. It provides an efficient leak-tight barrier and environmental radiation protection under all postulated conditions, including a loss-of-coolant accident. The containment vessel is a prestressed concrete structure designed to endure the peak pressure under loss-of-coolant-accident (LOCA) conditions. The refueling water storage pit (RWSP) is located in the lowest part of containment. It provides a continuous suction source for both safety injection pumps and containment spray pumps, thereby eliminating the switch-over of the suction source from the injection phase to the recirculation phase of accident recovery.

In addition to the containment vessel, the R/B also houses a safety-system pump and heat exchanger area, a fuel storage and handling area, a main steam and feedwater piping area, and a safety-related electrical area. The main steam and feedwater piping room, located on the top floor of the building, contains the piping where it passes between the containment and the T/B.

The two PS/Bs are adjacent to the R/B on separate reinforced concrete basemats. Each houses two emergency gas turbine generators (GTGs) and an alternate AC GTG. The PSFSVs are underground concrete structures which contain the fuel oil supplies for the GTGs.

The A/B contains waste disposal systems and the nonsafety-related electrical area. The AC/B houses the access control area and the chemical sampling and laboratory area. The T/B houses the nonsafety-related steam and power conversion equipment.

The R/B, PS/Bs, PSFSVs, and ESWPT are designed and constructed as safety-related structures, to the requirements of Seismic Category I, as defined in RG 1.29. These structures are designed to withstand the effects of all applicable loads and their combinations, including those associated with seismic events, hurricanes, floods, tornadoes, tsunamis, and earthquakes, without the loss of capability to perform their safety functions. They are also designed to withstand the effects of

postulated internal events, such as fires and floods, without the loss of capability to perform their safety functions.

The remaining power-block buildings are designed as nonsafety-related structures, and are free standing on separate concrete basemats. The A/B and T/B are designed to meet Seismic Category II requirements, as defined in RG 1.206.

5.2.4 Basic System and Component Descriptions

The following sections provide high level discussions of major plant systems and components.

5.2.4.1 Reactor Core

The US-APWR core contains 257 fuel assemblies. Each fuel assembly consists of 264 fuel rods arranged in a square 17x17 array, together with 24 control rod guide thimbles, an in-core instrumentation guide tube, 11 grid spacers, and top and bottom nozzles. Each fuel rod consists of ZIRLO cladding tubes loaded with sintered uranium dioxide pellets, slightly enriched up to 5 wt%, and/or gadolinia-uranium dioxide pellets, blended with a maximum of 10 wt% of Gd_2O_3, a coil spring at the upper plenum, a lower plenum spacer, and end plugs welded at the top and bottom ends to seal pressurized helium gas within the rod.

The skeleton structure of the assembly consists of top and bottom nozzles, grid spacers, 24 symmetrically arrayed control rod guide thimbles, and one central in-core instrumentation guide tube. The fuel rods are positioned by 11 grid spacers. The grid spacers are mechanically fixed to the 24 control rod guide thimbles.

The design of the US-APWR fuel is similar to that of the J-APWR and the current Mitsubishi 17x17 fuel system. The Mitsubishi 17x17 fuel system has demonstrated high reliability, sustaining negligible fuel rod failure rates, as evidenced through significant experience in Japan. For the US-APWR fuel, as compared to the current Mitsubishi fuel, the active fuel length has been changed from 12 ft to approximately 14 ft, and the number of grid spacers has been changed from 9 to 11.

5.2.4.2 Reactor Coolant System

The reactor coolant system (RCS) provides reactor cooling and energy transport functions. The RCS consists of the reactor vessel, four steam generators, four reactor coolant pumps, the pressurizer, and reactor coolant piping and valves. The RCS arrangement is the standard four-loop configuration currently in use in operating Westinghouse plants, with one reactor coolant pump and one steam generator in each loop. The reactor coolant system, including connections to related auxiliary systems, constitutes the reactor coolant pressure boundary.

Reactor Vessel

The reactor vessel contains the fuel assemblies and the vessel internals designed to support the core and to direct reactor coolant flow. It is similar to the reactor vessels of currently operating PWRs; it includes a main cylindrical shell with an integral

hemispherical bottom head, and a removable hemispherical closure head which is bolted to the shell. The shell contains inlet and outlet nozzles for each coolant loop and four direct vessel injection nozzles for safety injection addition. All other vessel penetrations are made through the closure head.

One of the major vessel internals, and a significant departure from existing reactor plant design, is the solid-block neutron reflector (NR). The NR provides structural simplification and reliability and improves neutron economy. The NR consists of stacked stainless-steel ring blocks that surround the core; it replaces the baffle plates, former plates, and neutron pads of current PWR vessel internals. The NR has only about 50 parts, including bolts and nuts, while the baffle former structure of a current PWR has more than 2000 bolts. This improved design not only increases the reliability of the structure but also reduces the inspection requirements for bolts located in the high neutron fluence region. The NR also contributes to the reduction of neutron fluence to the reactor vessel by 60% relative to the fluence experienced by a conventional four-loop PWR's reactor vessel.

Reactor Coolant Pumps

The four reactor coolant pumps (RCPs) are vertical-shaft, single-stage, mixed-flow pumps with diffusers. Each RCP assures a reactor coolant flow rate sufficient to maintain a departure from nucleate boiling ratio greater than that specified in the safety analysis. In the event of a loss of offsite power, each RCP provides an adequate flow rate during coastdown conditions because of the pump flywheel's rotational inertia.

Leakage along the RCP shaft is normally controlled by three shaft seals arranged in series, so that any reactor coolant leakage to the containment is essentially zero.

Steam Generators

The SGs are vertical-shell, U-tube evaporators with integral moisture separating equipment. Reactor coolant enters the channel head via the coolant inlet nozzle, flows through the inverted U-tubes, transferring heat from the primary side to the secondary side, and leaves from the channel head via the coolant outlet nozzle. The channel head is divided into a hot leg side and a cold leg side by a vertical divider plate that is welded to the channel head and the tubesheet. The tube material is thermally treated Alloy 690. The material of the tubesheet and the channel head is low alloy steel. The cladding on the primary side of the tubesheet is Ni-Cr-Fe alloy, and the cladding on the channel head is stainless steel.

The US-APWR SG is designed to have 30% more heat transfer area than that of the J-APWR SG, for higher efficiency, with the adoption of smaller-diameter tubes and a tight triangular lattice.

Pressurizer

The pressurizer provides the point in the RCS where liquid and vapor are maintained in equilibrium under saturated conditions for pressure control. The pressurizer is a vertical, cylindrical vessel with hemispherical top and bottom heads. It is constructed of low alloy steel with austenitic stainless steel cladding on all surfaces

exposed to the reactor coolant. Electrical immersion heaters are installed vertically through the bottom head of the vessel, while the spray nozzle, safety depressurization valve (SDV), and safety relief valve (SRV) connections are made to the top head of the vessel.

The four spring-loaded SRVs are positioned in separate relief lines from the pressurizer. Another relief line incorporates the motor-operated SDVs and motor-operated severe-accident depressurization valves (DVs) arranged in parallel (three relief paths total). All relief lines run to spargers in the pressurizer relief tank inside the containment, except for the severe-accident DV line, which discharges to the containment. The SRVs provide the ultimate overpressure protection for the RCS. The spray valves limit RCS pressure rises following less-severe transients to prevent the undesirable opening of the pressurizer SRVs. Additionally, the pressurizer's large size (2900 ft^3) helps to accommodate pressure increases without challenges to the SRVs.

5.2.4.3 Steam and Power Conversion System

The steam and power conversion system consists of the turbine-generator (TG), main steam supply system (MSS), condensate and feedwater system (CFS), emergency feedwater system (EFWS), turbine bypass system (TBS), steam generator blowdown system (SGBDS), and other systems.

The steam and power conversion system is designed to remove heat energy from the reactor coolant system via the four steam generators and to convert it to electrical power in the turbine generator. The main condenser removes air and other noncondensible gases from the condensate and transfers heat to the circulating water system (CWS). The deaerator additionally deaerates the condensate and supplies deaerated water to the feedwater pumps. Extraction steam from the turbine heats the feedwater, and the main feedwater system returns it to the steam generators.

The steam generated in the four steam generators is supplied to the high pressure turbine by the MSS. After expansion through the high pressure turbine, the steam passes through the two moisture separator reheaters (MSRs), and is then admitted to the three low pressure turbines. A portion of the steam is extracted from the high and low pressure turbines for seven stages of feedwater heating.

Exhaust steam from the low-pressure turbines is condensed and deaerated in the main condenser. The heat exhausted in the main condenser is removed by the CWS. The condensate pumps take suction from the condenser hotwell and deliver the condensate through four stages of low pressure closed feedwater heaters to the fifth-stage, open deaerating heater. Condensate then flows to the suction of the steam generator feedwater booster pumps and is discharged to the suctions of the main feedwater pumps. The steam generator feedwater pumps discharge the feedwater through two stages of high pressure feedwater heaters to the four steam generators.

The turbine-generator has an output ranging from 1600 MWe to 1700 MWe, depending on plant conditions. The nuclear steam supply system (NSSS) has a thermal output of 4466 MWt.

5.2.4.4 Engineered Safety Feature Systems

The US-APWR design employs advanced technologies and sufficient safety-system redundancy and reliability to achieve a significant reduction in core damage frequency.

Many safety systems are comprised of four 50%-capacity trains, so that safety functions are still performed even if one train fails and a second train is unavailable due to maintenance. The four-train design applies to the safety injection system, the containment spray system, and the emergency feedwater system, as well as to safety-related support systems (component cooling water and essential service water) and to Class 1E electrical power.

The US-APWR safety injection system includes four high-head trains which directly inject to the reactor vessel. This configuration increases redundancy and independence and enhances safety and reliability. Interconnecting piping between the trains is eliminated. The SI pump trains are automatically initiated and supply borated water from the RWSP.

The four-train containment spray system (CSS) also takes suction from the RWSP. The CSS pumps and heat exchangers double as residual heat removal system components during normal shutdown and refueling activities.

The US-APWR design eliminates the switch-over of emergency water sources following a LOCA by having the RWSP inside containment as shown in Figure 5.2-4. This feature significantly contributes to lowering the core damage frequency.

The advanced accumulators of the US-APWR design enhance both safety and economics by their injection-flow characteristics and by eliminating the low-head injection system. The vortexing flow damper mechanism of the advanced accumulator enables the accumulator to discharge at a high rate during the early stages of a LOCA and at a lower rate during the later stages. The accumulator discharge thus occurs over an extended period. The combined performance of the accumulator system and high-head safety injection system eliminates the need for a low-head injection system. The advanced accumulator also allows relaxing the startup time requirement for emergency power sources to 100 seconds; the US-APWR design thus employs gas turbine generators as emergency AC power supplies.

5.2.4.5 Instrumentation and Control

The US-APWR instrumentation and control systems almost exclusively employ digital controllers for plant control and protection. An exception is the analog diverse actuation system, which provides certain protection functions through conventional equipment that is totally independent of the digital platform of the protection and safety monitoring system and the plant control and monitoring system. Control room operators monitor the plant status on large-screen displays and take manual actions at computer work stations.

5.2.4.6 Electrical Power

The Class 1E onsite power system has four independent divisions. Each division, in addition to its connection to offsite power sources from the grid, has a separate and independent onsite emergency power source, which is a gas turbine generator (GTG). The plant also has two non-Class 1E GTGs as alternate AC power sources. Figure 5.2-5 is a simplified diagram of the AC bus arrangement and power sources.

5.2.5 Plant Comparisons

The major US-APWR design parameters and their values are shown in Tables 5.2-2 through 5.2-7. These values are shown in comparison with those of the J-APWR design and of a currently operating US four-loop plant. The four-loop US plant parameters are representative of the Standardized Nuclear Unit Power Plant System.

As mentioned above, the US-APWR is similar in many respects to currently operating Westinghouse PWRs. In addition to the larger electrical output of the plant, and the larger numbers and capacities of systems and components which support it, the following summarizes the major differences between the US-APWR design and currently operating plants:

- **Neutron Reflector:** The US-APWR vessel internals design employs a solid-block neutron reflector which surrounds the core, whereas the vessel internals of a typical currently operating PWR include a bolted baffle and former assembly.

- **RCS Relief Valves:** For overpressure protection and depressurization capability, the US-APWR has four pressurizer safety relief valves and three additional relief paths with manually operated depressurization valves. Currently operating plants have three safety relief valves and two automatic/manual power-operated relief valves.

- **Safety Systems:** Many US-APWR safety systems are comprised of four 50%-capacity trains. The safety systems of currently operating plants typically have two 100%-capacity trains.

- **Emergency Core Cooling Systems (ECCSs):** The US-APWR design includes high-head safety injection pumps and advanced passive accumulators which are designed to discharge for extended periods. These accumulators eliminate the need for low-head safety injection pumps. Currently operating plants have both high- and low-head safety injection pumps and accumulators. In addition, the US-APWR water source for emergency core cooling is the in-containment refueling water storage pit. Currently operating plants have an externally located refueling water storage tank. The RWSP's location eliminates the need for switching the ECCS pump suctions to a containment source. Figure 5.2-6 illustrates the comparison between the US-APWR design and existing plants.

- **Instrumentation and Control:** The US-APWR design incorporates digital controllers for plant control and protection, whereas the instrumentation and

control systems for currently operating plants are mainly analog. In addition, the US-APWR control room includes operator work stations and large-screen displays, in contrast to the panels of switches, pushbuttons, and status boards of existing plants.

- **Electrical Power:** The US-APWR Class 1E power system has four independent divisions, each of which includes an onsite emergency gas turbine generator. The US-APWR design also has two alternate AC gas turbine generators. Currently operating plants typically have two independent electrical divisions backed by emergency diesel generators, and a variety of provisions for alternate AC power sources.

Table 5.2-1 Main Specifications of the US-APWR

Core Thermal Output (MWt) Electric Power (MWe)		4451 1700 class
Number of Loops		4
Coolant Pressure (psia) Coolant Temperature (hot leg) (°F)		2250 617
Reactor	Number of Fuel Assemblies Fuel Rod Lattice Active Core Length (ft) Vessel Height x Diameter (in.)	257 17 x 17 14 535 x 203
Steam Generator	Heat Transfer Area (ft^2 / SG)	91,500
Reactor Coolant Pump	Thermal Design Flow (gpm/loop)	112,000
Turbine	LP Last-stage Rotating Blades (in.)	70 class

Table 5.2-2 Comparison of General Information and Reactor Core Characteristics

Parameter	US-APWR	J-APWR	US Current four-loop
Gross electrical output (MWe)	1,700 class	1,538	1,186
Core thermal output (MWt)	4,451	4,451	3,411
Operation pressure (psia)	2,250	2,250	2,250
Hot leg temperature (°F)	617	617	618
Number of fuel assemblies	257	257	193
Fuel assembly lattice	17x17	17x17	17x17
Effective fuel length (ft.)	14	12	12
Number of fuel rods per fuel assembly	264	264	264
Average linear heat rate (kW/ft.)	4.6	5.3	5.4
Number of Rod Cluster Control Assemblies (RCCA)	69	69	53
Design life (years)	60	60	40

Table 5.2-3 Comparison of Reactor Coolant and Connecting Systems (1)

Parameter	US-APWR	J-APWR	US Current four-loop
Reactor Coolant System			
Number of heat transfer loops	4	4	4
Operation pressure (psia)	2,250	2,250	2,250
Hot leg temperature (°F)	617	617	618
Reactor Vessel			
Vessel inner diameter(in)	203	203	173
Thermal shield/ reflector design	Neutron Reflector	Neutron Reflector	Neutron Pad Design
In-core instrumentation	Top mounted	Bottom mounted	Bottom mounted
Steam Generator			
Number	4	4	4
Type	Vertical U-tube heat exchanger	Vertical U-tube heat exchanger	Vertical U-tube heat exchanger
Heat transfer area (ft2)	91,500	70,000	55,000
Number of U-tube	6,747	5,830	5,626
Reactor Coolant Pump			
Number	4	4	4
Type	Vertical shaft, single-stage centrifugal	Vertical shaft, single-stage centrifugal	Vertical shaft, single-stage centrifugal

Table 5.2-3 Comparison of Reactor Coolant and Connecting Systems (2)

Parameter	US-APWR	J-APWR	US Current four-loop
Thermal design flow (gpm/loop)	112,000	113,600	95,700
Motor output(hp/unit)	8,200	8,200	7,000
Pressurizer			
Internal volume (ft3)	2,900	2,300	1,800
Surge nozzle nominal diameter (in)	16	16	14
Reactor Coolant Pipes			
Pipe inner diameter(in)	31	31	Reactor inlet 27-1/2 Reactor outlet 29 RCP suction 31
Residual heat removal system			
Residual heat removal pump			
Number	4	4	2
Type	Horizontal, centrifugal	Horizontal, centrifugal	Vertical centrifugal
Flow rate(gpm)	3,000	3,000	3,800
SI use	no	no	yes
Containment Spray use	yes	yes	no
Residual heat exchanger			
Number	4	4	2
Type	Shell and U-tube type	Shell and U-tube type	Shell and U-tube type

Table 5.2-4 Comparison of Engineered Safety Features (1)

Parameter	US-APWR	J-APWR	US Current four-loop
Containment			
Type	PCCV	PCCV	PCCV
Inner Diameter(ft-in)	149-2	149-2	140
Inner Height(ft-in)	226-5	226-5	205
Containment Heat Removal System			
Containment Spray Pump			
Number	4	4	2
Type	Horizontal, centrifugal type	Horizontal, centrifugal type	Vertical, centrifugal type
Design flow rate(gpm)	3,000	3,000	Injection 3,165 Recirculation 3,750
RHR use	yes	yes	no
Residual heat exchanger			
Number	4	4	- (containment air fan cooler)
Type	Horizontal, U-tube type	Horizontal, U-tube type	-
Containment Spray Nozzles			
Number	348	344	197/header
Type	Hollow cone	Hollow cone	Hollow cone

Table 5.2-4 Comparison of Engineered Safety Features (2)

Parameter	US-APWR	J-APWR	US Current four-loop
Containment Air Fan Cooler (Safety)			
Number	-	-	4
Emergency Core Cooling Systems **High Pressure Safety Injection Pump**			
Number	4	4	2
Type	Multi-stage centrifugal pump with Inducer	Multi-stage centrifugal pump with Inducer	Multi-stage centrifugal
Flow rate(gpm)	1,540	1,540	440
Charging / Safety Injection Pump			
Number	-	-	2
Type	-	-	Centrifugal
Flow rate(gpm)	-	-	150
Low Pressure Safety Injection Pump			
Number	-	-	2
Type	-	-	Vertical centrifugal
Flow rate(gpm)	-	-	3,800
RHR use	-	-	yes
Accumulator			
Number	4	4	4
Type	Dual flow rate	Dual flow rate	Single flow rate

Table 5.2-4 Comparison of Engineered Safety Features (3)

Parameter	US-APWR	J-APWR	US Current four-loop
Water volume(gallon)	15,850	15,850	6,358
Emergency Water Storage Pit			
Number	1	1	1
Type	Pit inside containment	Pit inside containment	Tank outside containment
Capacity(gallon)	607,640	607,640	394,000

Table 5.2-5 Comparison of Instrument & Control and Electrical Systems

Parameter	US-APWR	J-APWR	US Current four-loop
Type of I&C system	Fully digital with exception of the analog Diverse Actuation System (DAS)	Fully digital with exception of the analog Diverse Actuation System (DAS)	analog
Electric Power System			
Safety Power System			
Number of Power Generator	4	2	2
Type	Gas Turbine Generator	Diesel Generator	Diesel Generator

Table 5.2-6 Comparison of Turbines

Parameter	US-APWR	J-APWR	US Current four-loop
Turbine			
Type	Tandem Compound Six Flow	Tandem Compound Six Flow	Tandem Compound Six Flow
Number of elements	Four (one HPT and three LPTs)	Four (one HPT and three LPTs)	Four (one HPT and three LPTs)

Table 5.2-7 Comparison of Auxiliary Systems

Parameter	US-APWR	J-APWR	US Current four-loop
Emergency Feedwater System			
Motor Driven Emergency Feedwater Pump			
Number	2	2	2
Type	Horizontal, centrifugal	Horizontal, centrifugal	Horizontal, centrifugal
Turbine Driven Emergency Feedwater Pump			
Number	2	2	1
Type	Horizontal, centrifugal	Horizontal, centrifugal	Horizontal, centrifugal
Chemical and Volume Control System			
Charging Pump			
Number	2	3	2
Type	Horizontal centrifugal	Horizontal centrifugal	Horizontal centrifugal
SI use	no	no	yes
Volume Control Tank			
Number	1	1	1
CCW Pump			
Number	4	4	4
Type	Horizontal, centrifugal	Horizontal, centrifugal	Horizontal, centrifugal
CCW Heat Exchanger			
Number	4	4	4
Type	Plate type	Plate type	Shell and straight tube

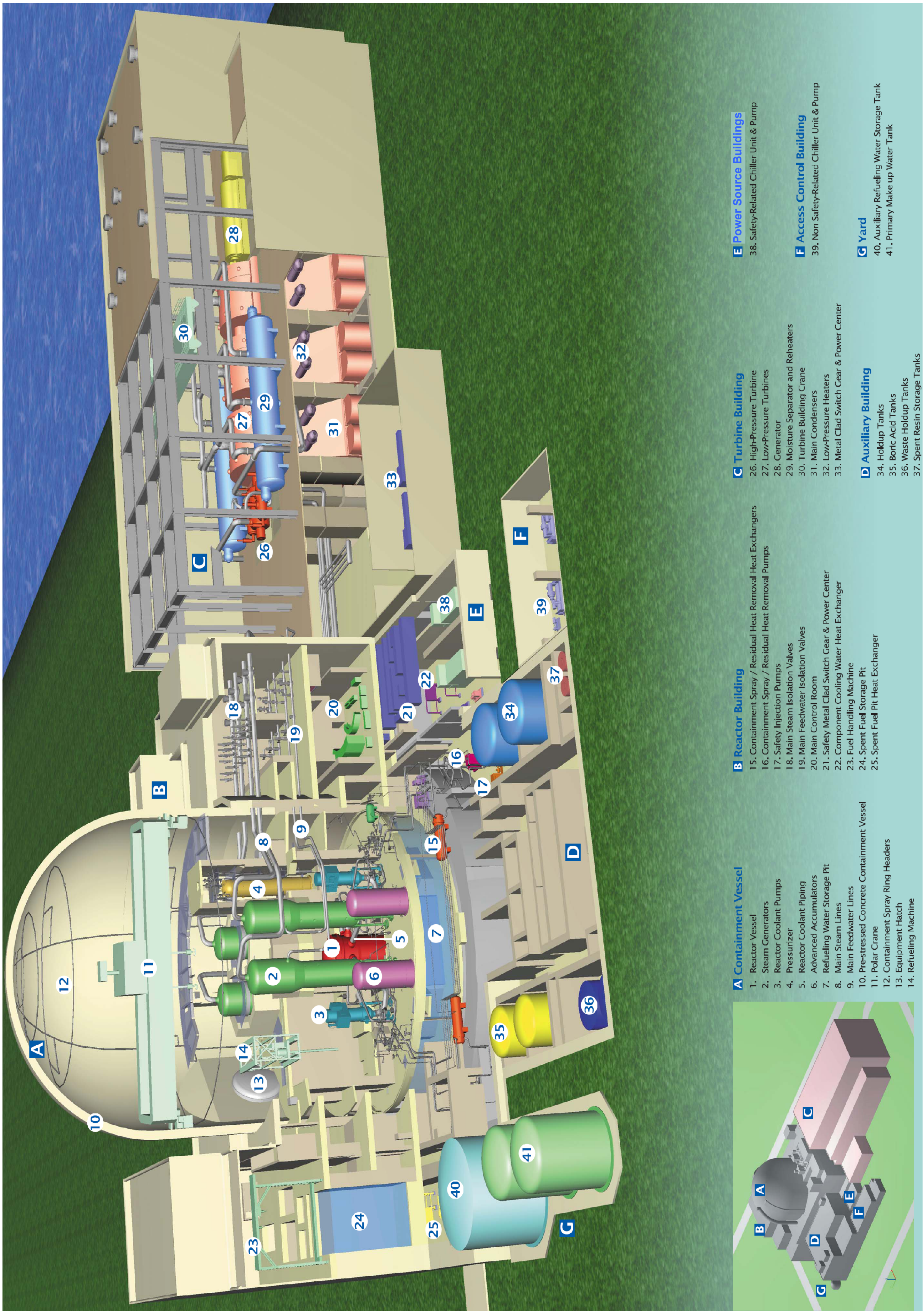

Figure 5.2-1 US-APWR Cutaway View

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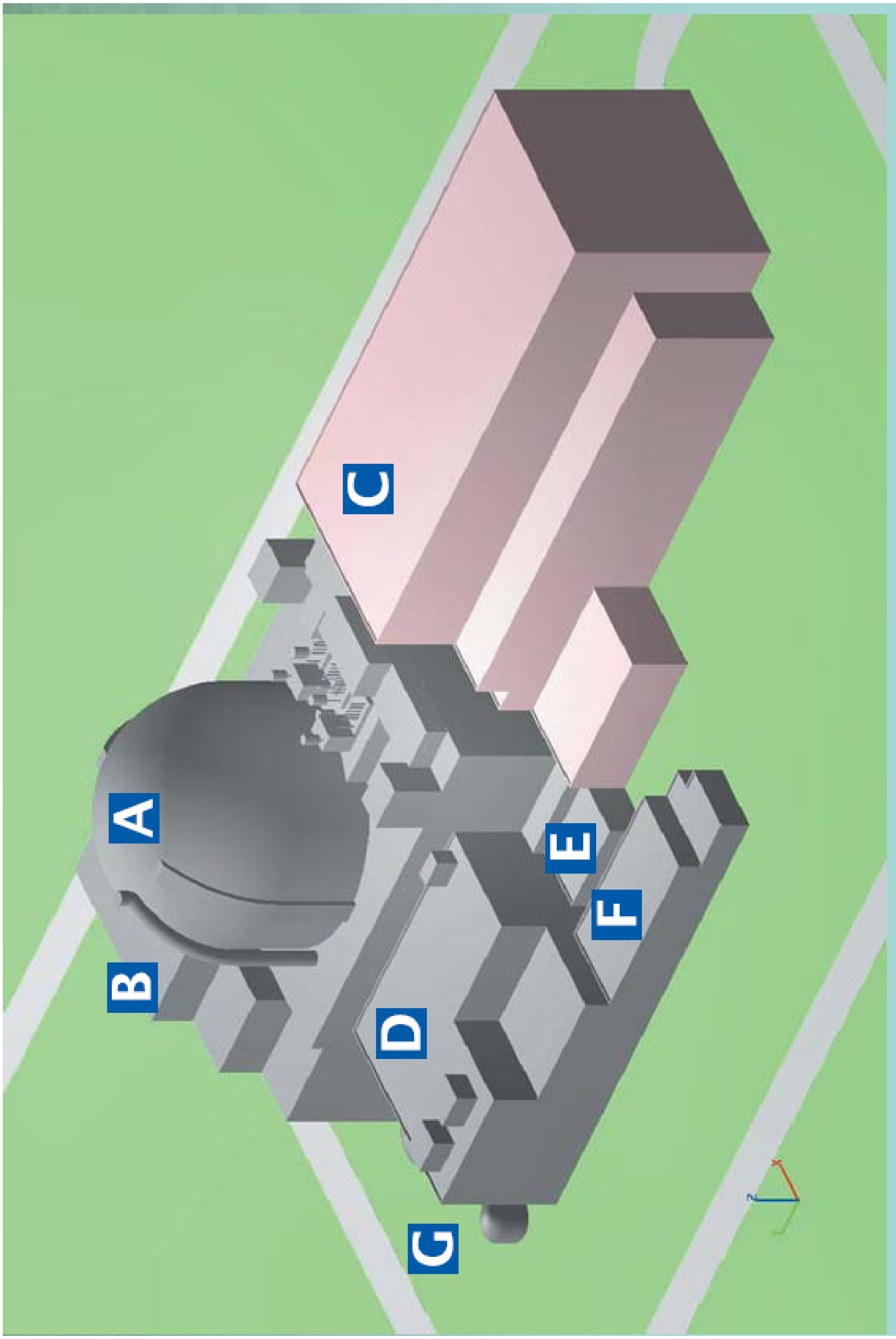

Figure 5.2-2 US-APWR Plant Building Layout

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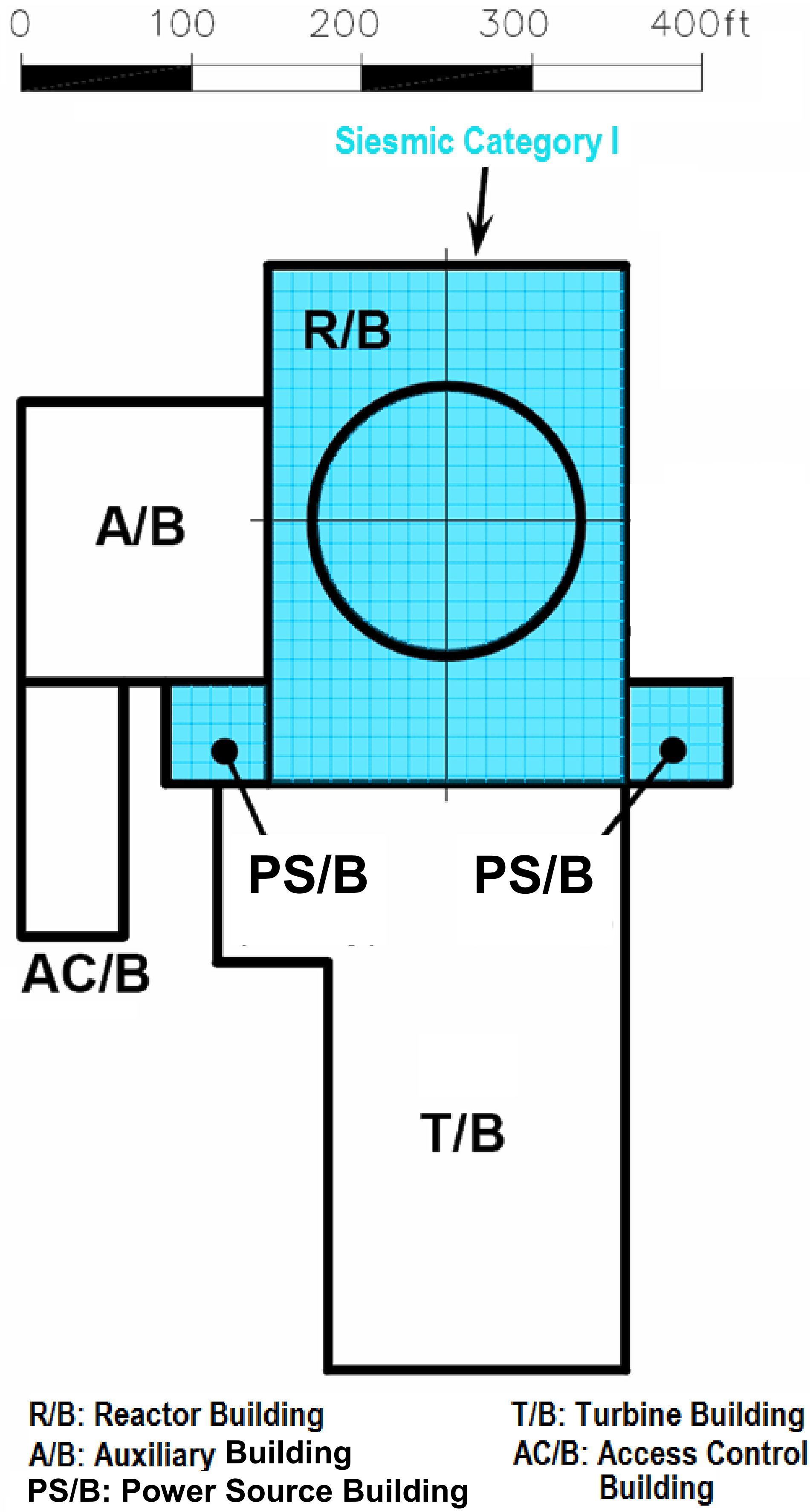

Figure 5.2-3 US-APWR Site Arrangement

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Legend

(blue line)	Emergency Core Cooling System
(green line)	Containment Spray System and Residual Heat Removal System
SIP	Safety Injection Pump
CS/RHRP	Containment Spray / Residual Heat Removal Pump
CS/RHRHx	Containment Spray / Residual Heat Removal Heat Exchanger
ACC	Accumulator
RWSP	Refueling Water Storage Pit
GT/G	Gas Turbine Generator
R/V	Reactor Vessel
RCP	Reactor Coolant Pump
S/G	Steam Generator
PRZ	Pressurizer
S	Safety Injection Signal
P	Containment Spray Signal

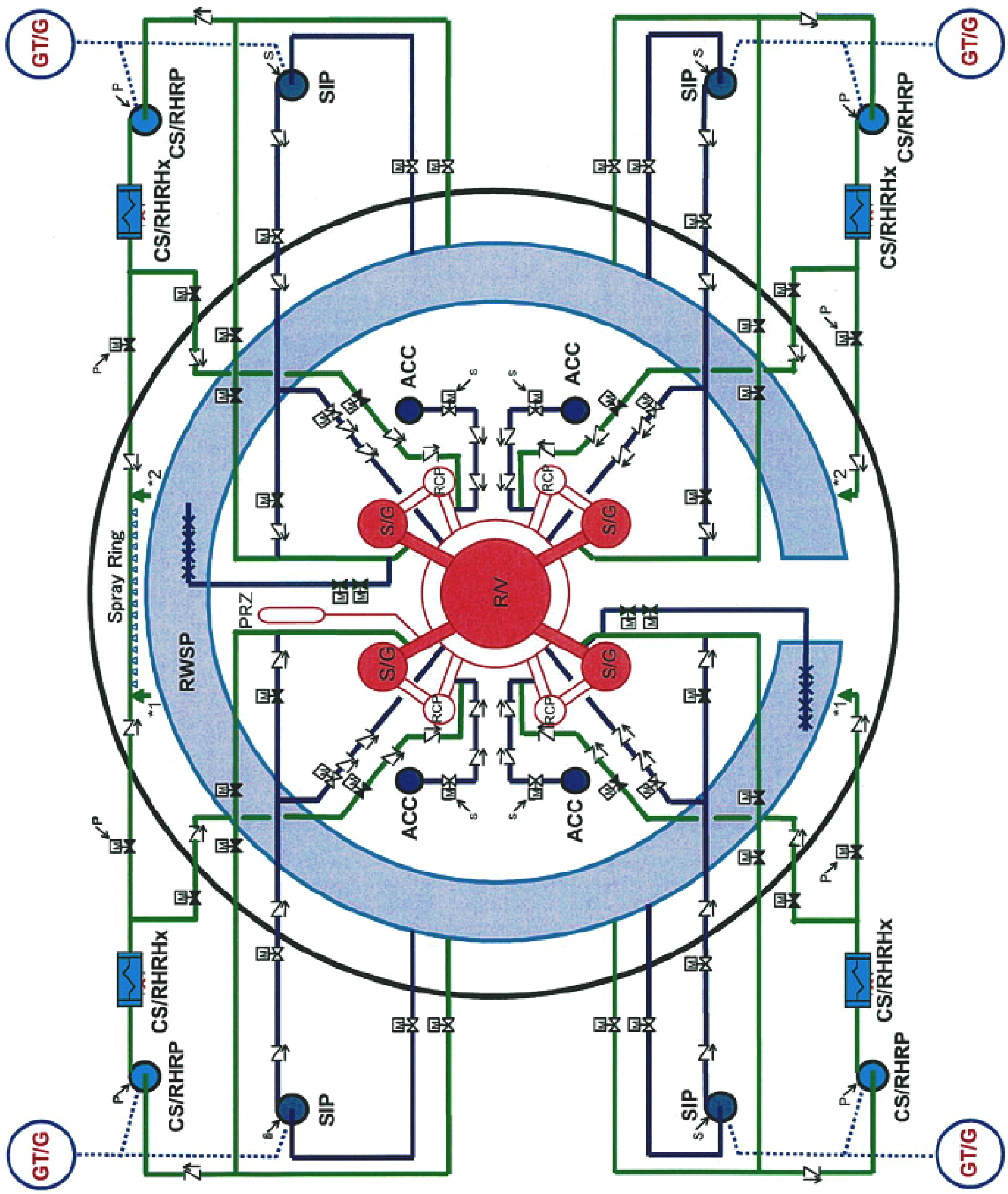

Figure 5.2-4 US-APWR Safety System Configuration

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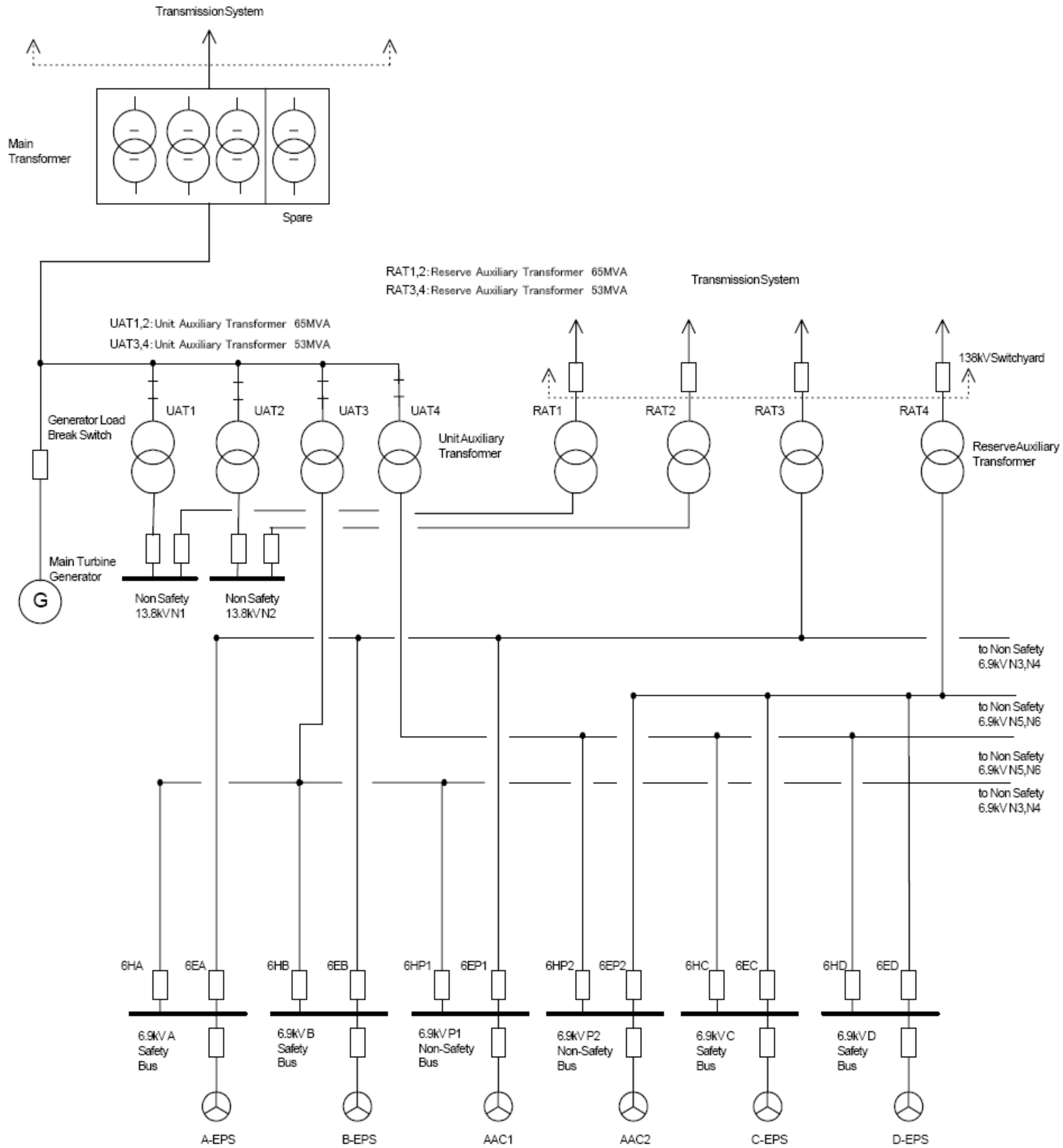

Figure 5.2-5 US-APWR AC Electrical Power

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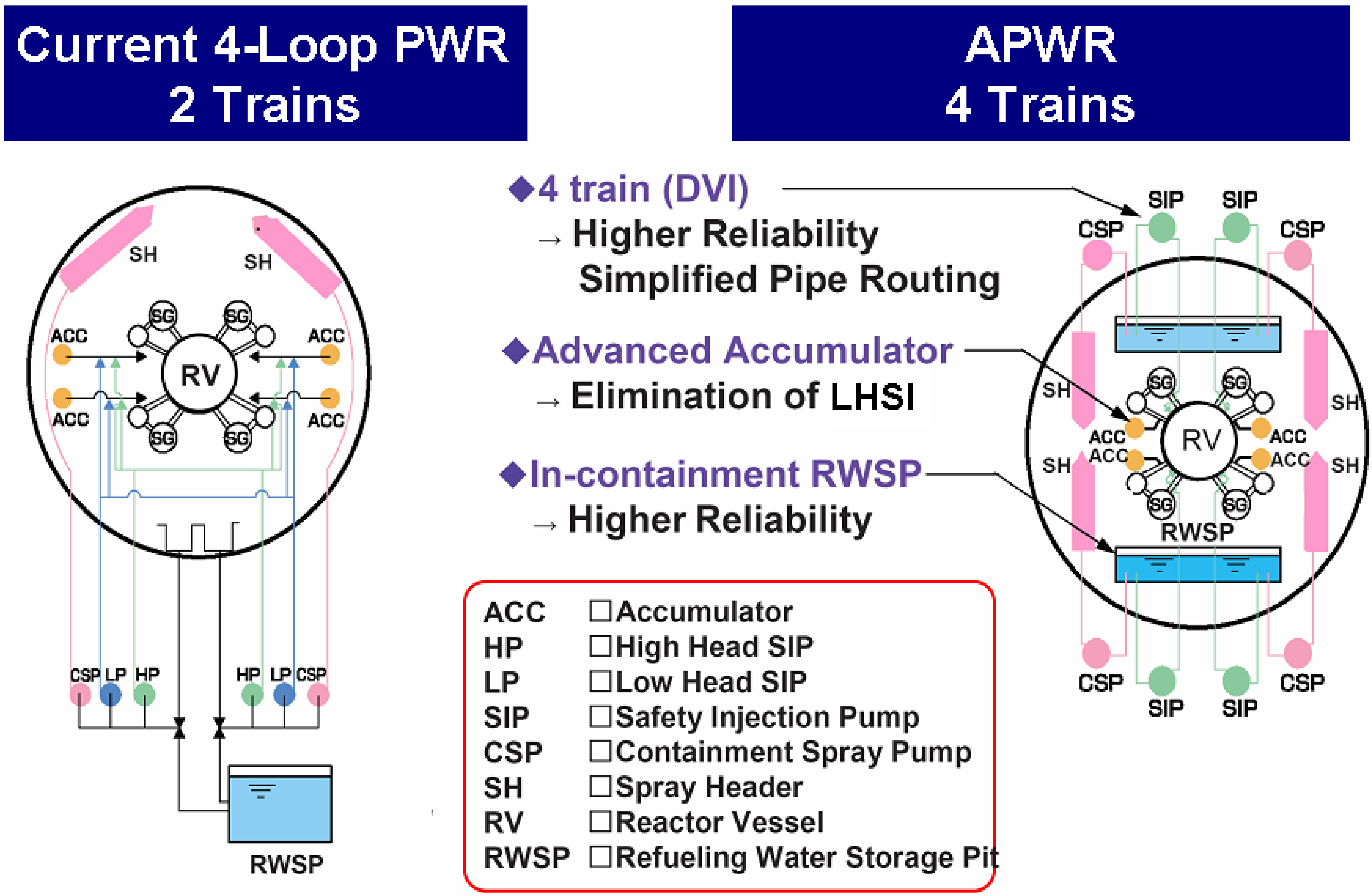

Figure 5.2-6 US-APWR vs. Current-Plant Safety Systems

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