THE DESIGN FEATURES OF THE ADVANCED POWER REACTOR 1400

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Received September 17, 2009

The Advanced Power Reactor 1400 (APR1400) is an evolutionary advanced light water reactor (ALWR) based on the Optimized Power Reactor 1000 (OPR1000), which is in operation in Korea. The APR1400 incorporates a variety of engineering improvements and operational experience to enhance safety, economics, and reliability. The advanced design features and improvements of the APR1400 design include a pilot operated safety relief valve (POSRV), a four-train safety injection system with direct vessel injection (DVI), a fluidic device (FD) in the safety injection tank, an in-containment refueling water storage tank (IRWST), an external reactor vessel cooling system, and an integrated head assembly (IHA). Development of the APR1400 started in 1992 and continued for ten years. The APR1400 design received design certification from the Korean nuclear regulatory body in May of 2002. Currently, two construction projects for the APR1400 are in progress in Korea.

KEYWORDS : APR1400, KURD, Advanced Design Features, MMIS

1. INTRODUCTION

The Advanced Power Reactor 1400 (APR1400) design is an evolutionary ALWR design and incorporates a variety of engineering improvements and operational experience to enhance safety, economics and reliability. Design features to address the NRC's Severe Accident and Safety Goal Policy Statements are also incorporated into the APR1400 design.

The APR1400 design is based on the actual experience from the OPR1000 design; thus, configuration of the reactor coolant system (RCS) of the APR1400 is identical to that of the OPR1000. A cutaway view of the APR1400 is shown in Fig. 1. Advanced design features and improvements have been incorporated: a pilot operated safety relief valve (POSRV), a four-train safety injection system with direct vessel injection (DVI), a fluidic device (FD) in the safety injection tank, IRWST, an external reactor vessel cooling system, and an integrated head assembly (IHA).

The evolutionary APR1400 design concept is based on Korean Utility Requirements Document (KURD) that was established by making reference to ALWR utility requirements documents developed by Electric Power Research Institute and organizations in other countries. The major design requirements for the APR1400 are summarized as follows;

- Capacity : 4000 MWth
- Plant design lifetime : 60 years
- Seismic design : SSE 0.3 g
- Safety requirements
  - · Core damage frequency : less than 10^{-5}/RY
  - · Containment failure frequency : less than 10^{-6}/RY
  - · Occupational radiation exposure : less than 1 man-Sv/RY
  - · Operator action time : Min. 30 minutes
  - · Station blackout coping time : Min. 8 hours
  - · Thermal margin : more than 10 %
  - · Hot leg temperature : 615 °F
  - · Emergency core cooling system : Four-train
    DVI
    IRWST
- Performance requirements
  - · Plant availability : 90 %
  - · Unplanned trip : less than 0.8/year

2. NUCLEAR STEAM SUPPLY SYSTEM

2.1 Reactor Coolant System

The APR1400 is a two-loop pressurized water reactor. Its nuclear steam supply system (NSSS) is designed to operate at a rated thermal output of 4000 MWth with a corresponding electrical output of 1455 MWe. It contains

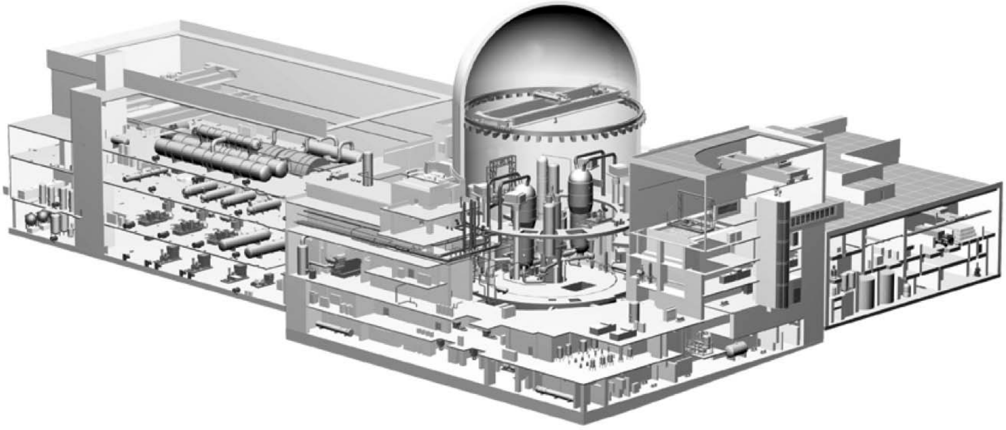

Fig. 1. APR1400 Cutaway

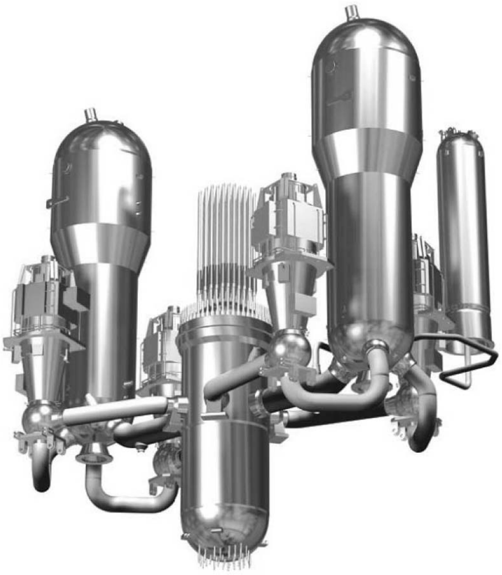

Fig. 2. The APR1400 RCS Arrangement

Table 1. Major Design Parameters of the RCS

Parameters	Design Value
NSSS Power (MWth)	4000
Electrical Power, guaranteed (MWe)	1455
Design Life Time (Years)	60
Seismic Design Basis (g)	0.3 (SSE)
Reactor Inlet Temperature (ºF)	555
Reactor Outlet Temperature (ºF)	615
Design/Operating Pressure (psia)	2500/2250
Design Temperature (ºF)	650

two primary coolant loops, each of which consists of one 42-inch ID hot leg, two 30-inch ID cold legs, one SG, and two RCPs. One PZR with heaters is connected to a hot leg of the RCS. The APR1400 RCS arrangement is shown in Fig. 2.

The hot leg temperature of the APR1400 decreases to 615 ºF from 621 ºF (OPR1000) to increase the operating margin. This contributes to a decrease in the number of unplanned reactor trips during normal operation and to the enhancement of the operation flexibility. Moreover, the decrease in the hot leg temperature relieves the degradation of the SG tube due to stress corrosion by adopting an advanced tube material, Inconel 690, which is known to be more resistant to stress corrosion cracking than Inconel 600, which has been used in conventional plants.

The PZR of the APR1400 is designed to be larger than that of the OPR1000 in order to accommodate Condition III transients without a reactor trip. The pilot operated safety relief valves (POSRVs), which replace the conventional spring loaded safety valves, are used to perform the functions of PZR safety valves and safety depressurization valves simultaneously. This change leads to reliable valve operation without chattering and leakage and to remote manual operation of the valves under post-accident conditions.

The SG has several advanced design features including its use of high performance moisture separators and steam dryers, an increased heat transfer area, an integral feedwater economizer, and an increased tube-plugging margin. In addition, it has a larger secondary feedwater inventory, which extends the dry out time and operator response time.

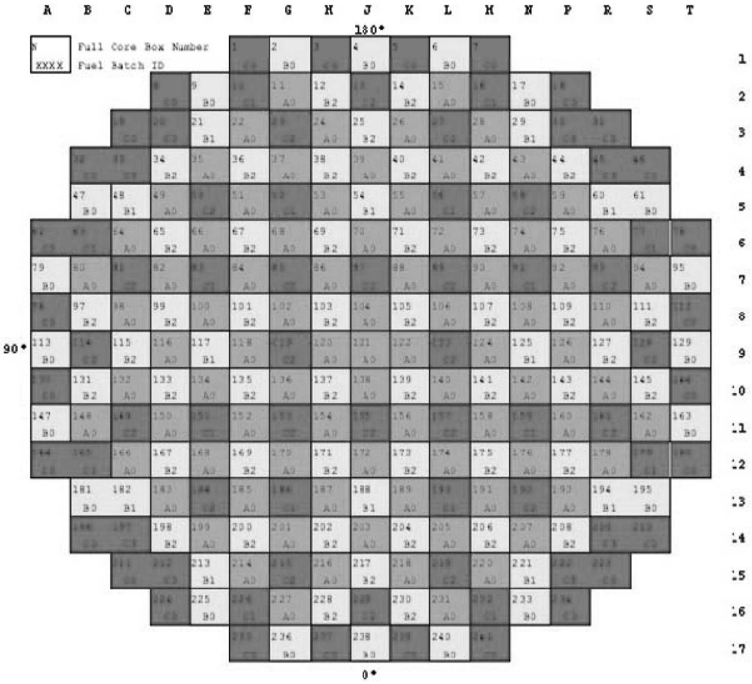

Fig. 3. Core Loading Pattern of APR1400

Major design parameters of the RCS are summarized in Table. 1.

2.2 Reactor Core and Fuel

The reactor core generates the heat of the fission reaction and transfers the generated heat to the reactor coolant. The core consists of 241 fuel assemblies, 93 control element assemblies (CEAs), and 61 in-core instrumentation (ICI) assemblies. The refueling cycle of the core is 18 months with a maximum discharge rod burn-up of 60,000 MWD/MTU and the thermal margin of the core is increased to more than 10%. The economic efficiency and safety of the APR1400 are improved by this core design. The core loading pattern of the APR1400 is shown in Fig. 3.

The fuel assembly is arranged by 236 fuel rods containing UO_2 pellets or the burnable absorber and five guide tubes in a 16 × 16 array. The five guide tubes are four CEA guide tubes and one ICI guide tube. The CEAs are composed of twelve fingers full strength CEAs, four fingers full strength CEAs, and four fingers part strength CEAs. The absorber materials used for full strength control rods and part strength control rods are boron carbide (B_4C) pellets and Inconel 625, respectively.

The advanced fuel assembly PLUS7, which is enhanced in thermal hydraulic and nuclear performance and the structural integrity compared with a conventional fuel assembly, is used in the core of the APR1400. The mixing vanes with high thermal performance, which induce a relatively small pressure loss, are adopted in all mid-grids to increase the thermal margin to more than 10%, which has been confirmed in critical heat flux testing. An advanced Zirlo alloy is used as a fuel clad. Major design parameters of the core and fuel are summarized in Table. 2.

Table 2. Major Parameters of the Core and Fuel

Parameters	Design Value
Number of Fuel Assemblies	241
Maximum Fuel Rod Burn-up (MWD/MTU)	60,000
Fuel Assembly Type	16 × 16
Number of Fuel Rods in Fuel Assembly	236
Number of Guide Tube in Fuel Assembly (CEA/ICI)	5 (4/1)
Fuel Clad Material	Zirlo

2.3 Primary Components

The reactor vessel is a vertically mounted cylindrical vessel with a hemispherical lower head welded to the vessel and a removable hemispherical upper closure head. The internal surfaces, which are in contact with the reactor coolant, are clad with austenitic stainless steel to prevent corrosion. The major design improvements include larger operating margins, enhanced core monitoring capability, a higher power level, and a lower failure rate of fuel elements for higher plant availability and reliability. The RT_{NDT} of the reactor vessel is decreased to -10 °F from 10 °F of conventional reactor vessels, using low-carbon steel which contains lower contents of Cu, Ni, P, and S. This material improvement of the reactor vessel extends its lifetime to 60 years. In addition, the occupational exposure dose is reduced by decreasing the content of Co in the reactor vessel materials.

The reactor vessel internals of conventional plants are fabricated in three parts: an upper guide structure, a core support barrel, and a lower support structure. In contrast, those of the APR1400 are manufactured in two parts by integrating a core support barrel and a lower support structure. The integrated manufacturing of the core support barrel and the lower support structure contributes to the shortening of the construction schedule.

The reactor vessel upper closure head area in conventional plants is composed of a control element drive mechanism cooling system, a cooling shroud assembly, heat junction thermocouples, a missile shielding structure, and a head lift rig. These components are usually disassembled, separately stored, and reassembled during every refueling outage. The APR1400 adopts an integrated head assembly (IHA) to simplify the structural configuration of the reactor vessel upper closure head region and to enhance maintenance convenience, as shown in Fig. 4. Due to the adoption of the IHA, the occupational exposure dose, component storage area, and overhaul duration are reduced.

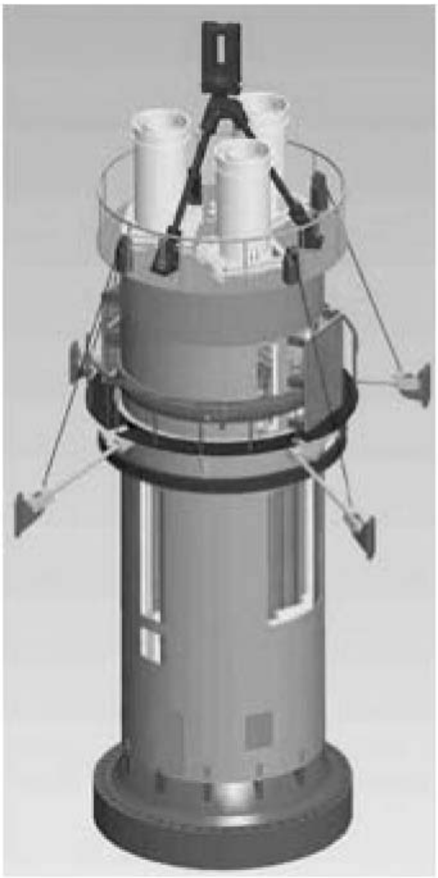

Fig. 4. The APR1400 IHA

The PZR is a vertically mounted, bottom supported, cylindrical pressure vessel with replaceable direct immersion electric heaters to maintain the RCS pressure and inventory. The PZR is equipped with nozzles for sprays, a surge, POSRVs, and pressure and level instrumentation. The PZR volume relative to the power contributes to enhancing the transient response of the RCS to reduce unplanned reactor trips. The POSRVs of the PZR ensure reliable valve operation without chattering and leakage and lower valve stuck-open susceptibility.

The SG is a vertically inverse U-tube heat exchanger with moisture separators, steam dryers, and an integral economizer. It operates with the RCS coolant on the tube side and the secondary coolant on the shell side. Moisture separators and steam dryers on the shell side of the SG limit the moisture content of the exit steam to less than 0.25 w/o during normal operation. The SG tube integrity is enhanced by the following design improvements;

- Inconel 690, which is known to be a corrosion-resistant material, is used as the SG tube material.
- A loose-part trapping feature inside of the feedwater nozzle is included and prevents damage to the internals and SG tubes.
- The upper tube support bar and plate are designed to prevent flow-induced vibration.

Table 3. Major Parameters of the Primary Components

Parameters		Design Value
Reactor Vessel	Inside Diameter at Shell (in)	182.25
	Overall Height of Vessel (in)	576
	RT_{NDT} (°F)	-10
PZR	Design/Operating Pressure (psia)	2500/2250
	Design/Operating temperature (°F)	700/652.7
	Free Volume (ft^3)	2400
	Heater Capacity (kW)	2400
SG	Number of tube per SG	13102
	Tube material	Inconel 690
	Heat Transfer Area (ft^2)	163.67

The SG tube plugging margin is increased to 10%, which improves the operation margin of the SG. The increased feedwater inventory of the SG enhances plant safety and reduces the number of unplanned reactor trips. In addition, the primary outlet nozzle angle of the SG is modified to improve stability during mid-loop operation.

The RCP is a single-stage centrifugal vertical-type pump. Its head and capacity are increased to accommodate the increased power compared with the OPR1000. The shaft seal assembly consists of two face-type mechanical seals to reduce the leakage pressure from the RCS pressure to the volume control tank pressure. A third face-type low-pressure vapor seal at the top is designed to withstand the system operating pressure when the RCP is not operated.

The leak-before-break (LBB) concept is applied to the main coolant lines, the surge lines, the shutdown cooling lines, and the safety injection lines to reduce the need for redundant supports of the piping in the NSSS as well as the design, construction, and maintenance costs. Major design parameters of the primary components are summarized in Table. 3.

3. SECONDARY SYSTEM

The secondary system consists of the main steam, extraction steam, turbine generator, condensate, feedwater, and auxiliary systems. The secondary system is designed to be able to operate at a 3% load for a period of at least four hours without any detrimental effects on the systems and to startup to full load from cold conditions in eight hours, including rotor preheating. Heat balance optimization studies of the secondary system were carried out considering system operability, reliability, and economy.

The main steam supply system transports the steam from the SGs to the power conversion system and removes the heat of the RCS. The main steam lines and the high pressure turbine are designed for a steam pressure of 1000 psia. The turbine generator is composed of a double-flow HP turbine and three double-flow low pressure (LP) turbines driving a direct-coupled generator. Two reheater stages are installed between the HP turbines and the LP turbines. The material used for the LP turbine rotors, which are of mono-block type, is Ni-Cr-Mo-V alloy steel. It is treated to obtain sufficient toughness. The last stage buckets of the LP turbine are 52 inches and are designed to have low stress and increased stiffness. The generator system consists of the generator, which is a three- phase, four-pole unit operating at 1800 rpm, and auxiliary systems that include a stator cooling water system, a gas control system, and a seal oil system. The stator of the generator adopts a very reliable F-class Micapal II insulation system and highly reliable brazing technology. The rotor of the generator also uses the very reliable insulation system and a radial flow cooling method.

The condensate and feedwater systems transfer condensate from the main condenser hotwells to the SGs. The feedwater heaters are installed in six stages and are arranged horizontally for easy maintenance and reliability. They raise the condensate temperature by using extraction steam and a deaerator removes the entrained oxygen and non-condensable gases. The configuration design of the main feed water pump (MFWP) is 3 × 50 % to allow more reliable operation. Even if one MFWP is tripped under a full power condition with all three MFWPs operating, the other two MFWPs can recover the total feedwater flow to the nominal value of the full power condition, allowing the plant to be restored to the full power condition. This design contributes to a reduction of unnecessary power cutbacks and unplanned turbine trips.

The auxiliary feed water system (AFWS) supplies feedwater to the SGs for events that result in a loss of normal feedwater and require heat removal through the SGs. The AFWS is actuated by an auxiliary feedwater actuation signal (AFAS) from the engineered safety features actuation system (ESFAS) or the diverse protection system (DPS). The AFW storage tank is located in the auxiliary building, separated from the condensate tank to enhance system reliability during transients.

4. MAN-MACHINE INTERFACE AND ELECTRICAL SYSTEMS

4.1 Man-Machine Interface System

The Man-Machine Interface System (MMIS) of the APR1400 is designed to meet demanding human factors, reliability, and licensing requirements. It is characterized by state-of-the-art technologies such as distributed digital processing, fiber optic data communications, and touch sensitive video displays. The MMIS features a distributed

Fig. 5. The APR1400 MCR

digital architecture with a fully digitalized computer-based advanced main control room (MCR). Software-based digital protection and control systems are used with extensive data networks to make the best use of digital technology. Human factors engineering processes and principles are applied to the MMIS.

The MCR of the APR1400 is characterized by compact workstations, a large display panel (LDP), a safety console, a computerized procedure system, and human factors engineering. It is shown in Fig. 5.

The workstations are identical and reconfigurable so that an operator has a backup workstation to use when different types of workstation failures are encountered. The MMI design adopts a system and function based display as well as a diverse information display for operation. The enhanced display includes a dynamic logic display, a P&ID, CCTV video data, and design data. In addition, the compact workstation is designed to provide all operational means, including computerized operator support functions such as critical function monitoring, success path monitoring, signal validation, and computerized procedures. This integrated compact workstation design is expected to reduce workload of the operating crew.

The LDP is large enough to be viewed from anywhere in the MCR. It displays the plant level indications and alarms, which enable the operating crew to assess the plant state related to critical safety and the power production functions. It is designed to direct the operators' attention quickly to the exact source of trouble and to allow them to diagnose the severity of plant incidents. It also continuously displays critical function performance and success path availability.

The safety console is provided as a backup for safe operation against a total distributed control system failure. The safety console indications are designed to provide qualified information and alarms in a similar format to that of the LDP display to enhance the level of familiarity of operators with the display.

The computerized procedure system (CPS) provides an integrated presentation of procedural instructions and related process information required for proper execution of applicable procedures instead of paper procedures.

The extensive human factors engineering program is incorporated to reduce the possibility of human errors in the MCR. The MMI design has been analyzed and evaluated in an iteratively expanding manner in order to optimize the design. During the development of the APR1400, an evaluation of the MMI design was performed with full scope dynamic mockups and an APR1400 specific dynamic mockup. The evaluation verified that the MMI design is suitable for the human factor principles and guidelines.

4.2 Electrical System

The plant electrical system of the APR1400 is composed of the generator, its circuit breaker, the main transformer (MT), the unit auxiliary transformers (UATs) and the stand-by auxiliary transformers (SATs).

The electric power sources for the safety-related systems are supplied in the following four alternative methods: the normal power source of normal off-site power through the MT or on-site power through UATs generated by the in-house generator, stand-by off-site power connected through the SATs to the grid, on-site stand-by power supply from two emergency diesel generators (EDGs), and an alternative alternate current (AAC) source from a backup diesel generator. Under normal operating conditions, the electric power source for the safety-related systems is supplied by the normal power source of normal off-site power through the MT or on-site power through the UATs. If the normal power source is unavailable, the safety loads are covered by the off-site power source via the SATs. If the off-site power source to the safety-related systems is interrupted, the safety loads are then backed up by two independent Class 1E EDG sets. Each of these sets is located in a separate room of the auxiliary building and each is connected to two 4.16 kV safety buses.

The normal power sources for non-safety loads are the off-site power through the main transformer and the on-site power through the UATs from the generator.

The non-class 1E AAC source adds more redundancy to the electric power supply for the safety systems. It is provided to cope with station blackout (SBO) situation, which has a high potential of transients that can lead to severe accidents. The AAC source has sufficient capacity to accommodate loads on the safety.

5. SAFETY SYSTEMS

The safety systems consist of the safety injection system (SIS), the in-containment refueling water storage tank (IRWST), the safety depressurization and vent system (SDVS), the containment spray system (CSS), and the auxiliary feedwater system (AFWS).

The main design concept of the SIS is simplification and redundancy to achieve higher reliability and better performance. The SIS is composed of four independent mechanical trains without a tie line among the injection paths and two electrical divisions. Each train has one active safety injection pump (SIP) and one passive safety injection tank (SIT) equipped with a fluidic device (FD). The common header installed in the SIS lines of conventional plants is eliminated for simplicity and independence. Additionally, the SIS is designed for safety water to be injected directly into the reactor vessel, as shown in Fig. 6. The functions of the SIS and the shutdown cooling system (SCS) are separated.

The basic concept of the FD is vortex flow resistance. When water flows through a stand pipe, it creates a low vortex resistance condition at a high flow rate. When the water level is below the top of the stand pipe, the inlet flow is switched to control ports and it creates a high vortex

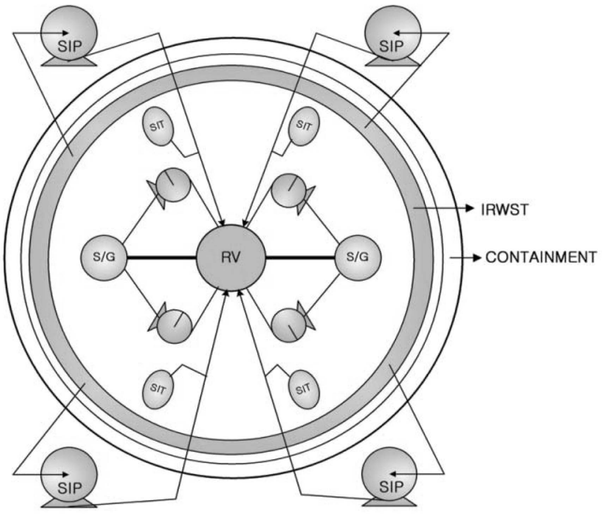

Fig. 6. The APR1400 SIS

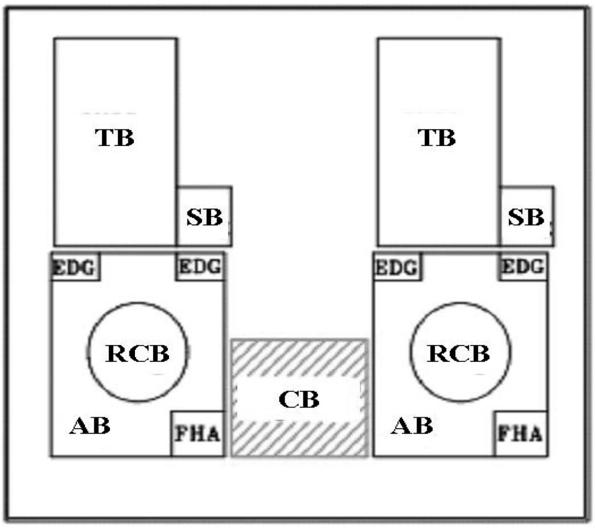

Fig. 7. General Arrangement of APR1400

resistance condition at a low flow rate. Consequently, the SIT discharges a large amount of water to fill the lower plenum of the reactor vessel rapidly when the water level is above the stand pipe. However, when the water level is below the stand pipe, the SIT injects a relatively small amount of water for a long time. The FD installed in the SIT substitutes for the low pressure SIPs such that the low pressure SIP is eliminated.

The IRWST is located in the containment building and the arrangement is made in such a way that the injected emergency cooling water returns to the IRWST. This design removes the operator action to switch the SIP suction from the IRWST to the containment recirculation sump. This new design lowers the susceptibility of the IRWST to external hazards. The functions of the IRWST are as follows;

- The storage of refueling water
- A water source for the SIS, the SCS, and the CSS
- A heat sink to condense steam discharged from the PZR for rapid depressurization if necessary in order to prevent high pressure core melting or to enable a feed and bleed operation
- A coolant supply for the cavity flooding system in case of severe accidents in order to protect the core against melting

By adopting the advanced features of the FD in the SIT and the IRWST, the high pressure injection, low pressure injection, and recirculation modes of the conventional SIS are merged into one operation mode of safety injection.

The SDVS is a dedicated safety system designed to provide a safety grade means of depressurizing the RCS if the PZR spray is unavailable during plant cooldown to a cold shutdown and to rapidly depressurize the RCS to initiate the feed and bleed method of plant cooldown following a total loss of feedwater event. POSRVs are adopted for the feed and bleed operation. This system establishes a flow path from the PZR steam space to the IRWST.

The CSS is composed of two trains and takes the suction of its pump from the IRWST to reduce the temperature and pressure of the containment during accidents that occur in the containment. The CSS is designed to be interconnected with the SCS; the pumps of the CSS and the SCS are designed to have the same type and capacity. These characteristics give the CSS higher reliability.

The AFWS is designed to supply feedwater to the SGs for RCS heat removal in a case of loss of main feedwater. In addition, the AFWS refills the SGs following a LOCA to minimize leakage through pre-existing tube leaks. The AFWS is a system of two divisions and four trains. The reliability of the AFWS is increased through the use of two motor-driven pumps, two turbine-driven pumps, and two independent safety-related emergency feedwater storage tanks located in the auxiliary building.

In addition, to improve plant safety, severe accidents have been fully considered in the APR1400 design. The measures of the APR1400 to cope with severe accidents are divided into prevention and mitigation.

Severe accident prevention features are summarized as follows:

- Increased design margins such as a larger PZR, larger SGs, and an increased thermal margin
- Reliable engineered safety features (ESF) including the SIS, the AFWS, and the CSS
- Extended ESFs such as the SDVS with IRWST, alternate AC power, and a diverse protection system
- Containment bypass prevention

Severe accident mitigation features are summarized as follows:

- Hydrogen mitigation system such as a passive auto-catalytic recombiner and a glow plug igniter
- Reactor cavity and cavity cooling system
- External reactor vessel cooling system
- The SDVS and the IRWST
- Emergency containment spray backup system
- Robust containment with a large volume

6. PLANT LAYOUT

The general arrangement of the APR1400 was developed based on the twin-unit concept using a slide-along arrangement with common facilities, as shown in Fig. 7. The layout of the APR1400 can be divided into a nuclear island (NI) and a turbine island (TI). The NI consists of the reactor containment building (RCB), the auxiliary building (AB), and the compound building (CB). The TI consists of the turbine building (TB) and the switchgear building (SB).

The RCB is wrapped around by the AB and is founded on a common basemat with the AB. The AB accommodates emergency diesel generators (EDGs) and the fuel handling area (FHA). The layout of the AB, particularly the physical separation of the safety equipment, is designed to improve plant safety. As examples, four-train SISs and two sets of EDGs are arranged so that each one is placed in a physically separated division of the AB. This configuration design prevents the propagation of system damage by internal and external events such as fire, flooding, security incidents, and sabotage. Other internal structures are also arranged to improve maintainability, accessibility, and convenience of equipment replacement. The layout of the NI improves the structural safety margin against external events such as a seismic event.

6.1 Reactor Containment Building

The RCB of the APR1400 is a pre-stressed concrete structure in the shape of a cylinder with a hemispherical dome specified as seismic category I. It is placed on a common basemat with the AB, as shown in Fig. 8. The interior surface of the RCB is steel-lined for leak-tightness. A protective layer of concrete covers the portion of the liner over the foundation slab. The IRWST is situated in the RCB in an annular-shape configuration between the secondary shield wall and the containment wall. The SIPs always take water from the IRWST without switching its suction from the IRWST to the containment sump for long-term cooling following a LOCA.

As measures to mitigate severe accidents, the reactor vessel cavity is designed in a manner that allows the molten core materials to spread out so that the heat transfer area is not less than 0.02 m^2/MW and so that these materials are

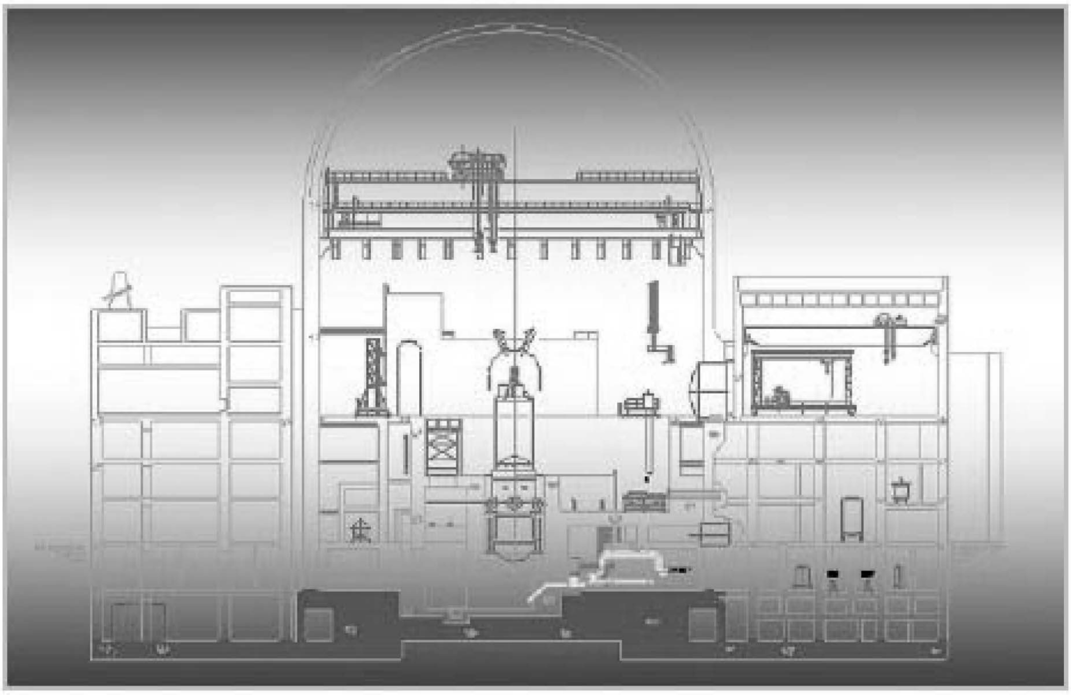

Fig. 8. The Common Basemat of the RCB and the AB

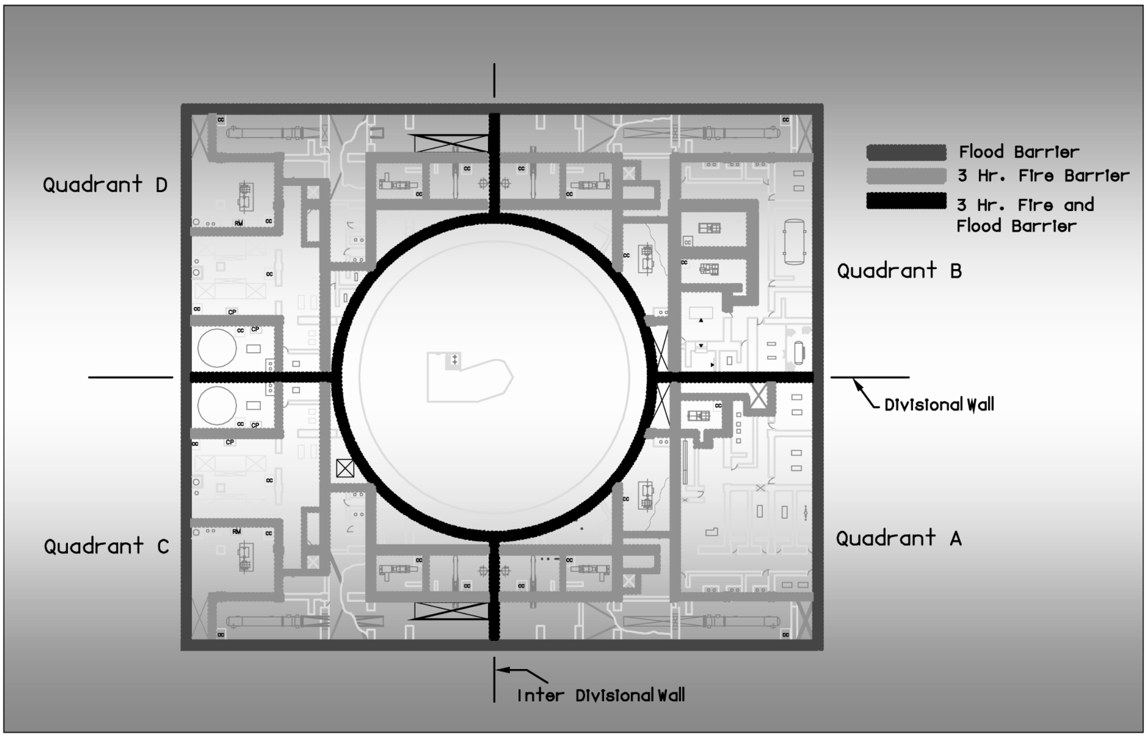

Fig. 9. Quadrant Arrangement of the AB

cooled and solidified on the cavity floor. In addition, the convoluted vent path of the reactor vessel cavity prevents molten core debris from being released into the containment atmosphere. In order to improve the convenience of maintenance, an equipment hatch, the structural arrangement, and a polar bridge crane are designed so that an SG can be replaced in one piece. Work platforms are installed to enhance the convenience of in-service inspections of the SGs and maintenance of the RCPs.

6.2 Auxiliary Building

The AB is a reinforced concrete structure specified as seismic category I. It wraps around the RCB in a quadrant arrangement, as shown in Fig. 9. The AB houses the MCR, EDGs room, FHA, and the various components related to safety, such as the SIS.

The systems and internal structures in the AB are arranged to provide physical separation so as to minimize the danger from internal and external events such as fire and flooding without adversely affecting accessibility. To improve the actuation reliability, the safety equipment is spatially separated. Each train of the SIS which consists of four trains is located in a separate division. The EDGs are also separated on opposite sides. The internal layout of the AB is designed to provide sufficient space and a lifting rig to replace heat exchangers and to replace a generator of the EDG without removing the outer wall. This design improves the convenience of operation and maintenance. The internal arrangement of components is divided into a radiation area and a clean area to reduce the occupational exposure dose.

6.3 Turbine Building

The TI consists of the TB and the SB arranged in a direction radial to the RCB. Both buildings are situated on a common basemat and are designed with a steel structure and a reinforced concrete turbine pedestal specified as seismic category II. The TB encloses the components that constitute the heat cycle and produce the electricity. The SB houses the electrical distribution equipment. To reduce the construction schedule, an underground common tunnel is designed to accommodate underground facilities in the base floor of the TB. In addition, demineralizers are arranged at the same level for effective maintenance.

6.4 Compound Building

As a common facility for both units, the CB is designed with a reinforced concrete structure specified as seismic category II. It accommodates an access control area, a radwaste treatment area, primary and secondary sampling laboratories, and a hot machine shop. This arrangement makes access from each unit more convenient and contributes to reducing the size of the power block due to its compact design.

7. CONCLUSIONS

The construction permit for Shin-Kori units 3 and 4, which are the first APR1400 plants, was issued in April of 2008. First concrete for Shin-Kori unit 3 was poured in October of 2008. Reactor vessel installation, a cold hydrostatic test, and fuel loading for Shin-Kori unit 3 have been scheduled sequentially. Project progress of Shin-Kori units 3 and 4 is about 39% complete as of August of 2009. Commercial operation of Shin-Kori units 3 and 4 will be in September of 2013 and September of 2014, respectively. The second APR1400 project for Shin-Ulchin units 1 and 2 is underway.

The APR1400 projects (Shin-Kori units 3 and 4 and Shin-Ulchin units 1 and 2) will be enhanced by making great efforts for safety, economics, and reliability compared with conventional plants. Plant design lifetime and availability are also significantly increased.

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