International Conference on Opportunities and Challenges for
Water Cooled Reactors in the 21th Century
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THE DESIGN CHARACTERISTICS OF ADVANCED POWER REACTOR 1400

KIM, HAN-GON

Advanced NPP Development Office
Korea Hydro & Nuclear Power Co., Ltd.

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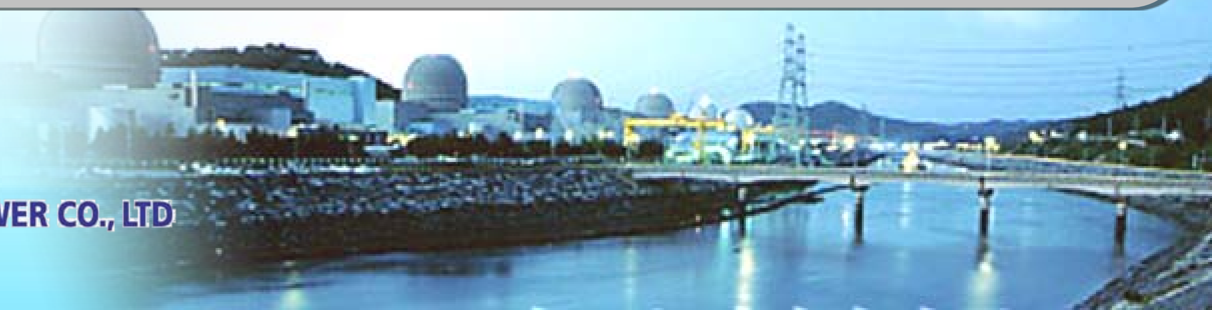


Nuclear Power Plants in Korea

In Operationa 20(17,716) + Under Const 8(9,600) = 23(27,316)

Ulchin Total 8 (8,700)

- In Operation
  Ulchin # 1,2,3,4,5,6
  88.09~05.04
  Units: MW
  6 (5,900)
- Under Const.
  Shin Ulchin #1,2
  Units: MW
  2 (2,800)

Wolsong Total 6 (4,779)

- In Operation
  Wolsong #1,2,3,4
  83.04~99.10
  Units: MW
  4 (2,779)
- Under Const.
  ShinWolsong #1,2
  Units: MW
  2 (2,000)

Yonggwang Total 6 (5,900)

- In Operation
  Yonggwang
  # 1,2,3,4,5,6
  86.08~2002.12
  Units: MW
  6 (5,900)
- Under Const.
  –

Kori Total 8 (7,937)

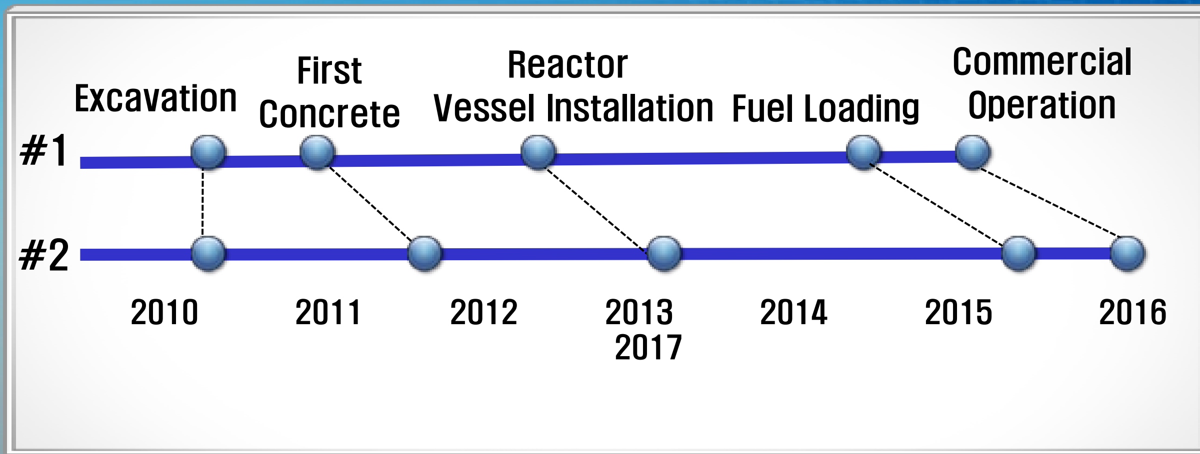
- In Operation
  Kori #1,2,3,4
  78.04~86.04
  Units: MW
  4 (3,137)
- Under Const.
  Shin Kori #1,2,3,4
  Units: MW
  4 (4,800)

(As of Dec.31, 2007)

APR1400 Construction Schedules

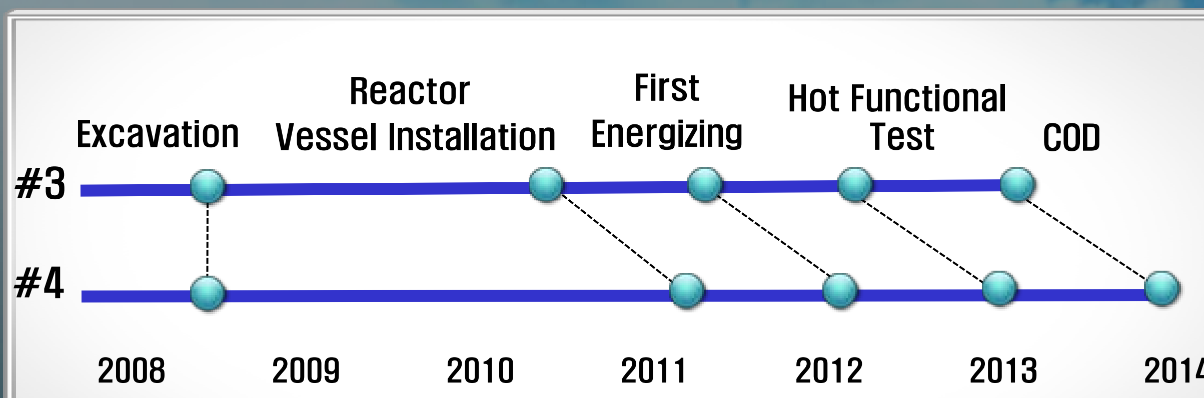
Shin-Ulchin

Construction Plans of Shin-Ulchin #1,2



Shin- Kori

Key Milestones of Shin-Kori 3&4



Overview of APR1400

Development History of APR1400

- Evolutionary ALWR in Korea based on current OPR1000 Design
- Design Certification for the Standard Design

General Requirement

- Rated Power : 4000 MWth
- Plant Life time : 60 years for major components
- Seismic Design : SSE 0.3g
- Safety Goal : CDF $< 10^{-5}$, CFF $< 10^{-6}$

Performance & Economic Goals

- Plant Availability : 90%
- Construction Period : 48 Months for Nth Plant
- Economic Goal : 20% advantage over coal

Overall Description

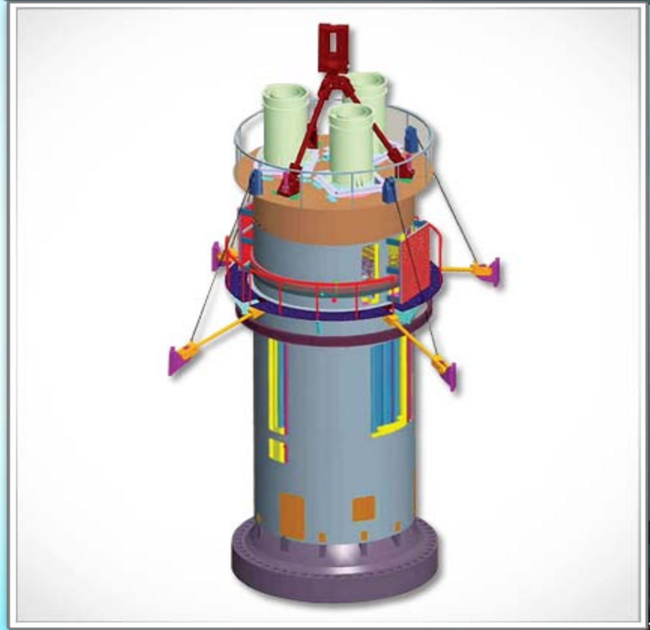
- Rated Power : 4000 MWth
- 2-Loop PWR :
  - One Reactor Vessel
  - Two Steam Generators
  - Four Reactor Coolant Pumps
  - One Pressurizer
- Thermal Margin > 10%

RCS Design Characteristics

Hot Leg Temperature Reduction

- 621°F → 615°F
- To prevent SG tube corrosion

Integrated Head Assembly



- Integration of
  - Cooling shroud assembly
  - CEDM cooling system
  - Missile shielding material
- Expected effects of IHA
  - Reducing refueling time
  - Reducing occupational dose
  - Reducing comp. storage area
  - Improving safety for workers

RCS Design Characteristics

Steam Generator

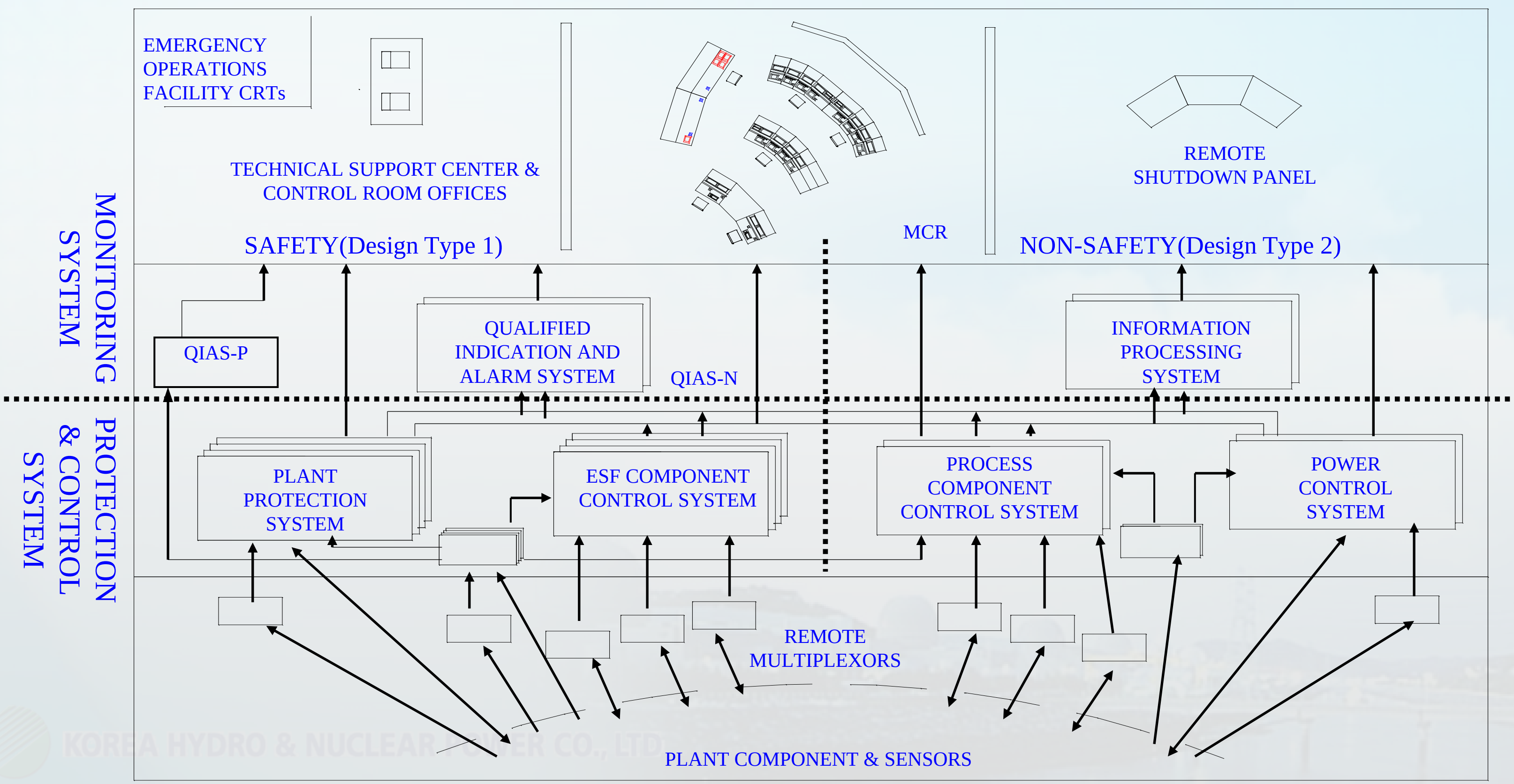
- Increased tube plugging margin : 8 → 10%
- Corrosion resistant tube material : I600 → I690
- Increased secondary inventory to prolong SG dryout time
- Automatic level control for all power level

Pressurizer

- Larger steam space to accommodate RCS transients
- Adoption of POSRV instead of PSV + SDS
  - 4 PSVs + 2 SDS → 4 POSRVs
  - Over pressure protection + Safety depressurization function
  - High reliability

Design Characteristics of I&C Systems

- Digital Technology & Data communication network
- Open & Standard Architecture
- Defense on Common mode failure
- Operability & Maintenance : Auto test, Self-diagnosis



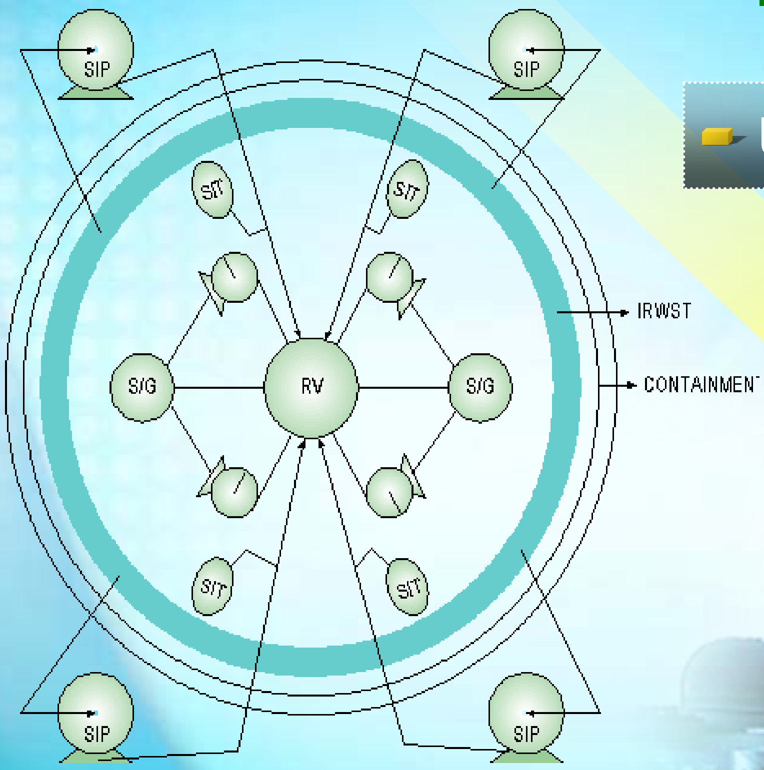
Characteristics of MCR Design

- Multiple Compact Workstation MCR
- Large Display Panel
- Soft-Controller : Safety & Non-safety control
- Computerized Procedure Systems
- Adoption of Human Factor Engineering

Safety Injection System

Design Characteristics

- 4 independent trains (Each train consists of 1 SIP and 1 SIT)
  - ▪▪▶ No cross tie between trains



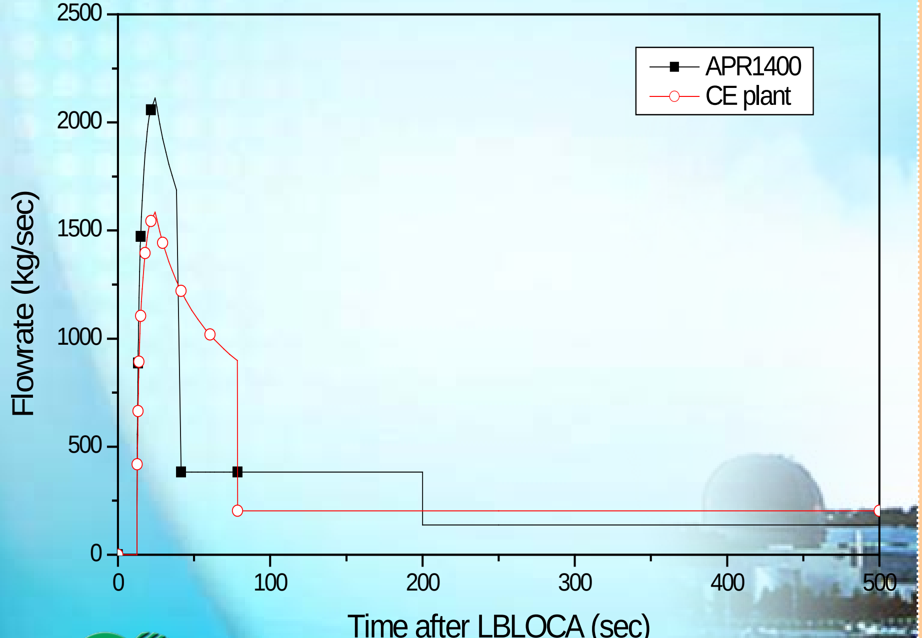
- Unified water source from IRWST
  - ▪▪▶ No re-circulation mode during LOCA
- Fluidic Device installed in SIT
  - ▪▪▶ Elimination of LPSIP

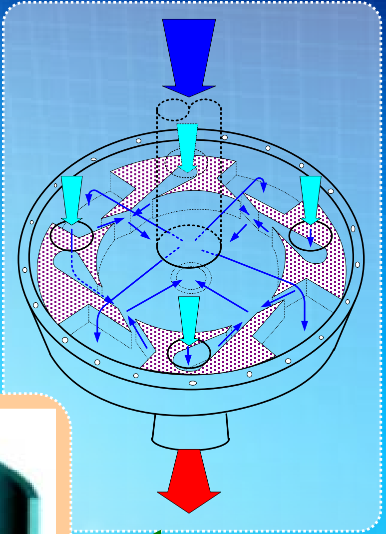
Effective use of ECC water and Better response to Transient and SBLOCA

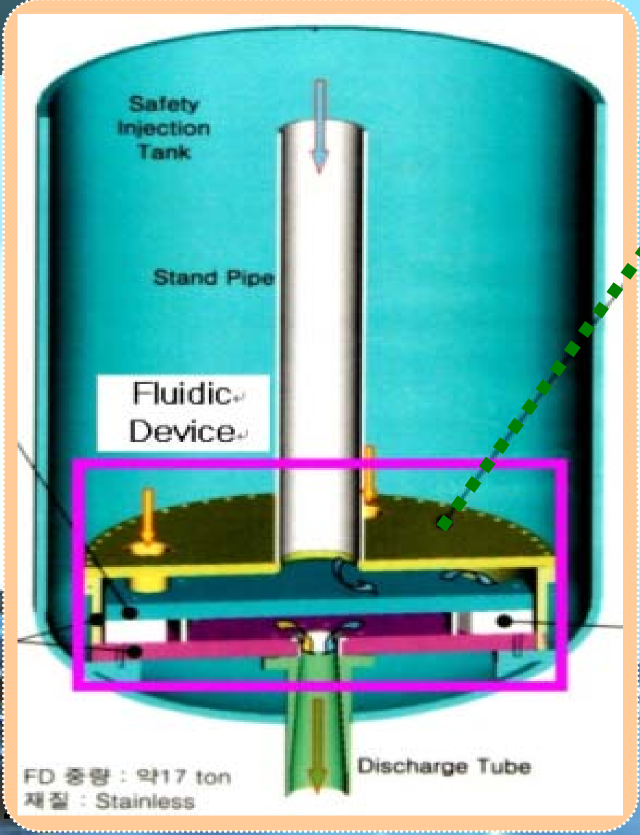
Verification of Fluidic Device

Design Characteristics

- Principles : Vortex flow resistance
  - Stand pipe : Low resistance
  - Control port : high resistance
- Purpose : Extending SIT injection period during LOCA
- Effect : Removal of LPSIPs







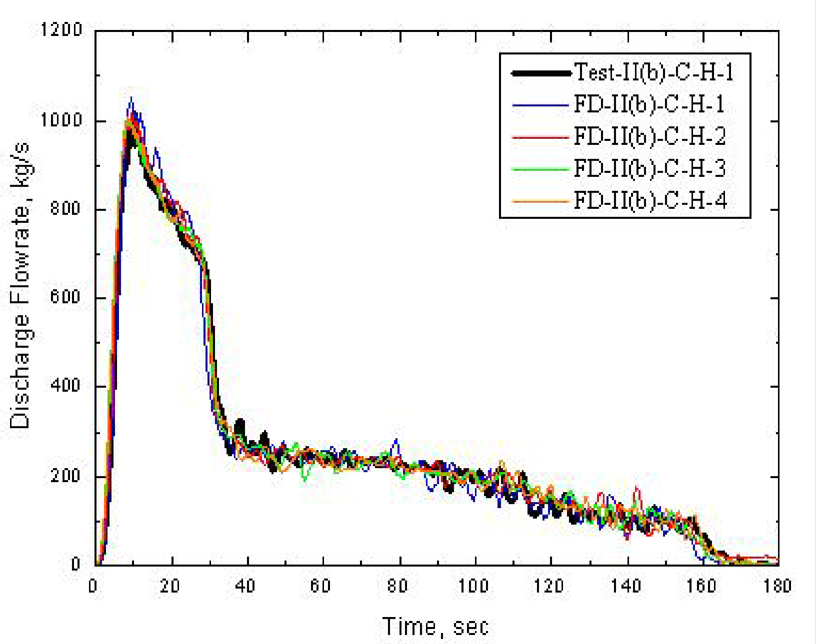
Verification of Fluidic Device

Test Facility

- Actual physical dimension
  - Inside diameter : 2.74 m
  - Total Height : 12.0 m
- Full Pressure : 50 bar

Test Results

- Test Results
  - Total 28 tests has been performed
  - Performance is fully verified
  - Detailed design spec. is finalized



Integral Test Loop

ATLAS Facility

Characteristics

① ½ height and 1/144 scaled down based on flow area

② NSSS and safety systems of APR1400 are modeled

Purpose

① Major system behavior for LBLOCA,
DVI Break, MSLB, MFLB, SGTR, TLOFW and so on

Milestone

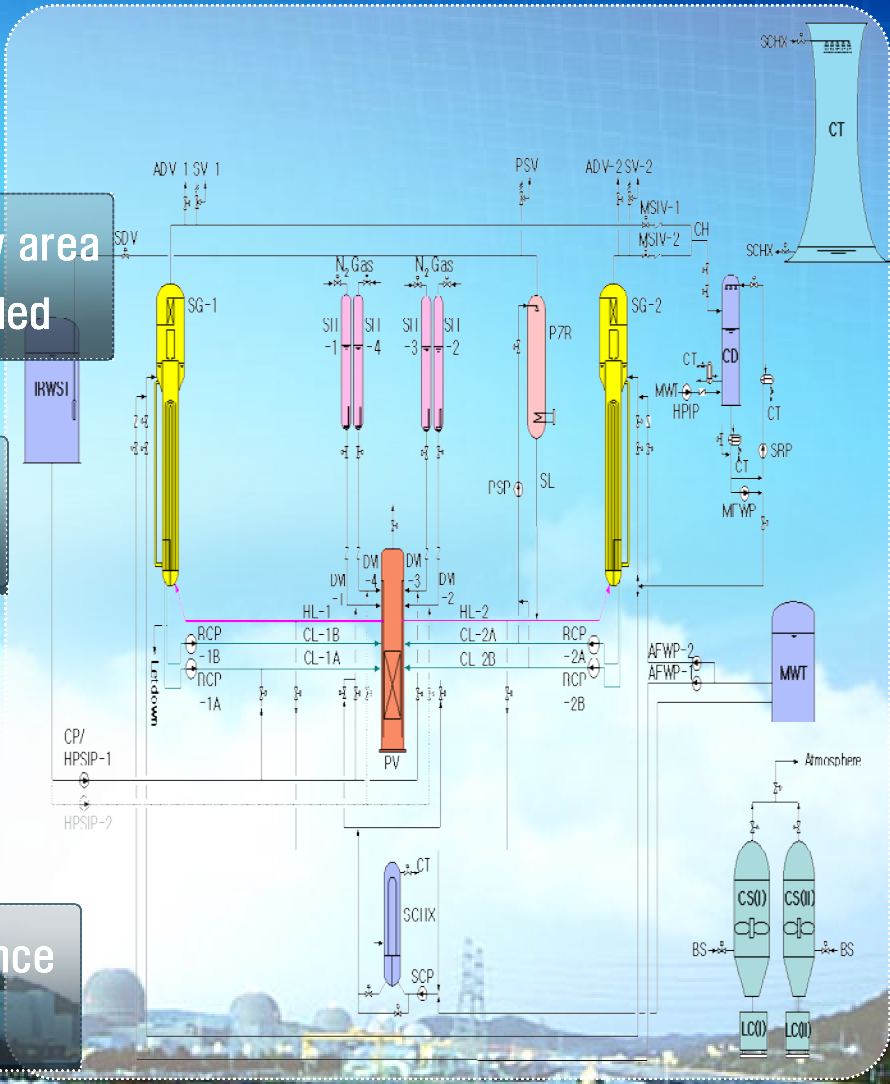
① Construction Completion : '06.5

② LBLOCA Tests : '06.9 ~

Effects

① Better understanding of APR1400 SIS Performance

② Benchmarking safety analysis codes



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IRWST

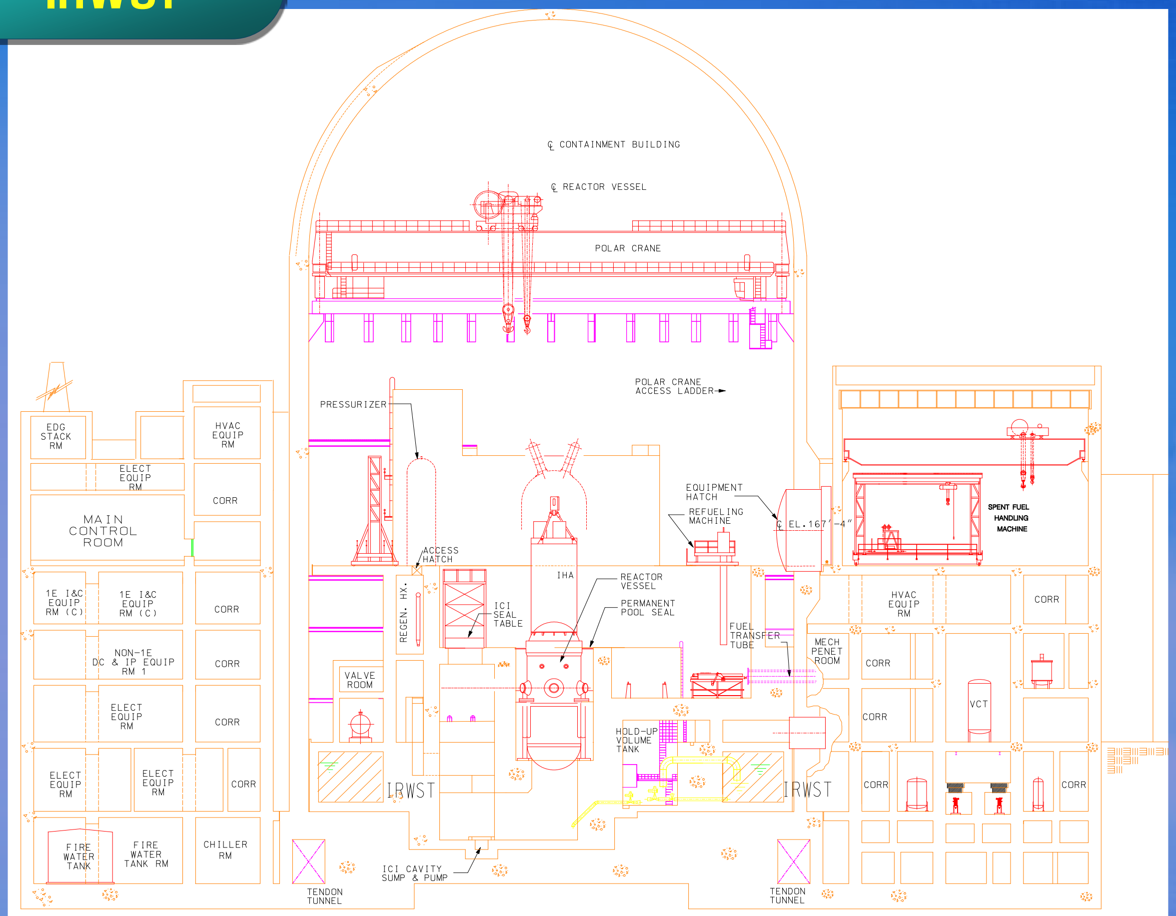
Functions

- Supply cooling water during refueling
- Supply the water source to safety injection and containment spray systems during DBA
- Removed recirculation mode because bleeded coolant is collected in IRWST through HVT (Hold-up Volume Tank)
- Supply heat sink during rapid depressurization of RCS and feed and bleed operation
- Supply water source for reactor cavity flooding system

Design characteristics

- Collect the coolant from POSRV to IRWST through sparger
- Removing of Pressurizer Relief Tank (PRT)
- Reduce operator's burden with simplified operation mode
- Reduce containment penetrations

IRWST


CONTAINMENT BUILDING
REACTOR VESSEL
POLAR CRANE
POLAR CRANE ACCESS LADDER
PRESSURIZER
EQUIPMENT HATCH
REFUELING MACHINE
SPENT FUEL HANDLING MACHINE
ACCESS HATCH
IHA
REACTOR VESSEL
PERMANENT POOL SEAL
ICI SEAL TABLE
FUEL TRANSFER TUBE
REGEN. HX.
VALVE ROOM
HOLD-UP VOLUME TANK
IRWST
IRWST
ICI CAVITY SUMP & PUMP
TENDON TUNNEL
TENDON TUNNEL
EDG STACK RM
HVAC EQUIP RM
ELECT EQUIP RM
CORR
MAIN CONTROL ROOM
1E I&C EQUIP RM (C)
1E I&C EQUIP RM (C)
NON-1E DC & IP EQUIP RM 1
ELECT EQUIP RM
ELECT EQUIP RM
ELECT EQUIP RM
FIRE WATER TANK
FIRE WATER TANK RM
CHILLER RM
HVAC EQUIP RM
MECH PENET ROOM
VCT

External Cooling of RPV (ERVC)

ERVC

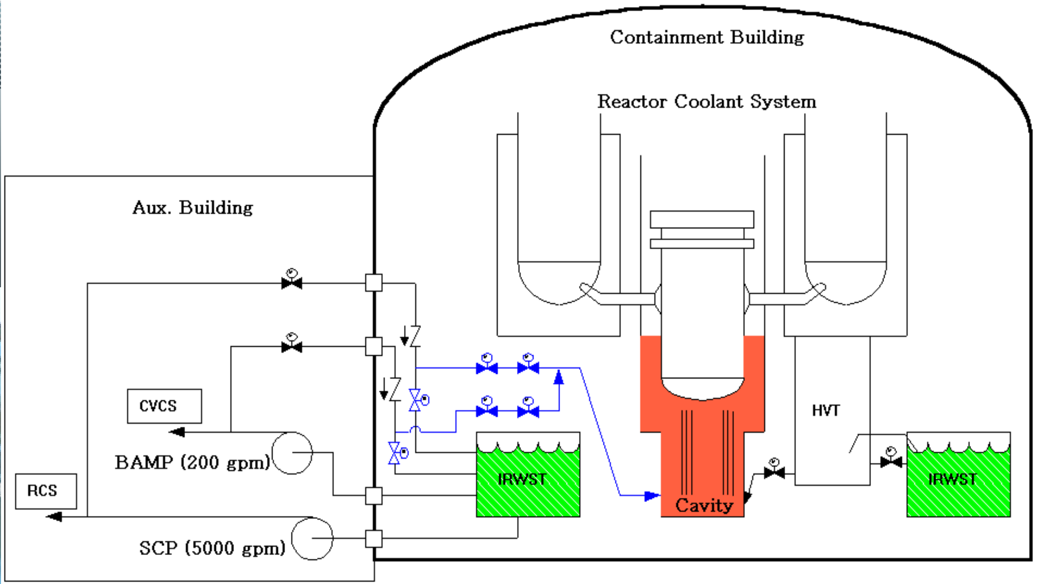
- Strategy to retain corium in vessel by submerging reactor vessel exterior with water
- Used in Lovisa and AP600 and AP1000
- Theofanous conducted a structured study on its performance
- Chosen as a key accident management strategy for APR1400

Accident Management Strategy of APR1400

- If water can be injected to reactor cavity : ERVC
- If not (eg. SBO): corium spread to reactor cavity and cooling from IRWST using gravity head.

ERVC Concept of APR1400

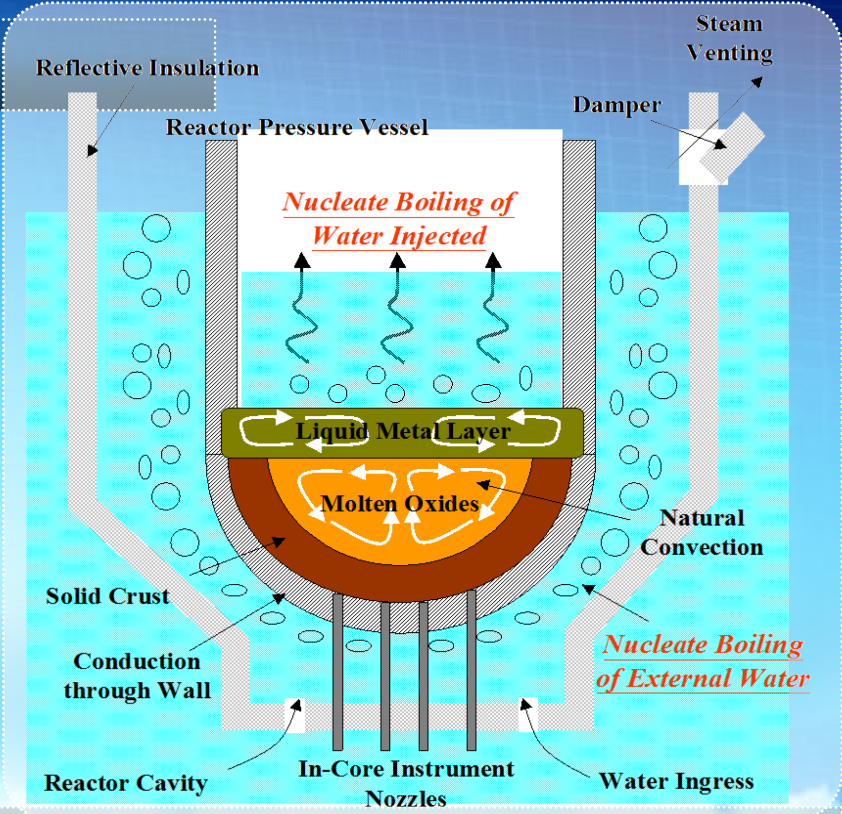
- One train of SCP + BAMP
- Associated system is already included in APR1400 design.

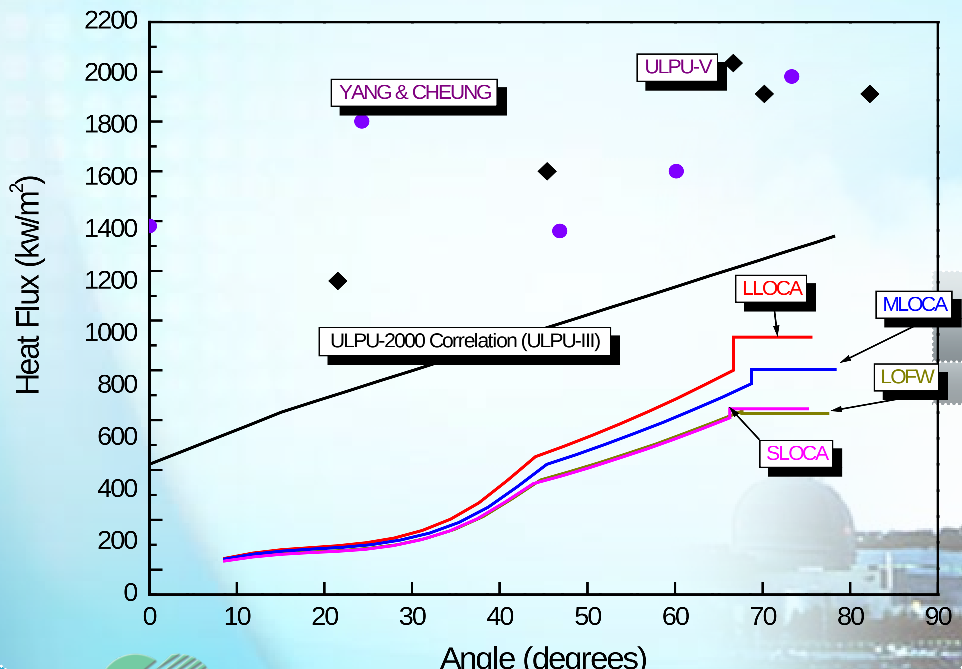


Performance of ERVC in APR1400

RPV Insulation

- Passage way for the water to cool the hot reactor vessel
- Natural circulation path for the two-phase flow and influence CHF
- Streamlined insulation design for APR1400 is in progress





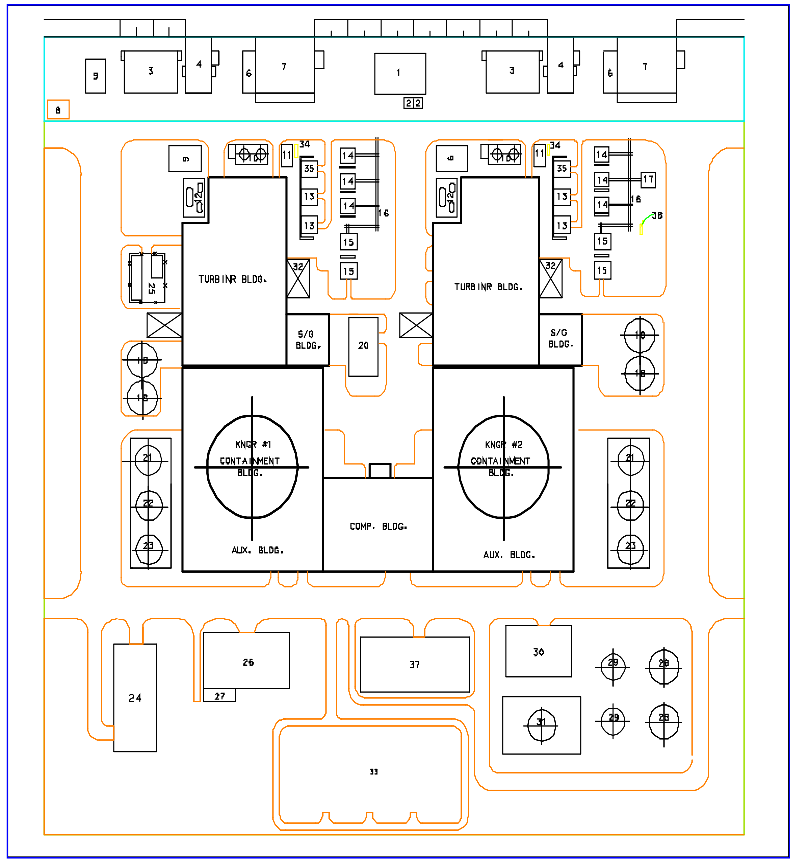
Feasibility Study

- 4 Major scenarios using MAAP
- Margin for APR1400 shows the usefulness of the ERVC strategy

Power Block : NI & TI

NI : Reactor Building,
Aux. Building,
Compound Building

TI : Turbine Building,
SwitchGear



Basic Design Concept

2 Units reference

Parallel Sliding Type

Aux. Building
: Quadrant structure

Ⅵ. Conclusions

First commercial NPPs of APR1400
[Shin-Kori 3&4 are in progress]

Basic Design of APR1400 has been finished

Commercial Operation

1999
2000
2001
2002
2008
2013

Design Optimization process to enhance economics

APR+

Design Certification (May 2002)

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Thank you !