KEPCO Overview

Overview

Organization

Present Korean Nuclear Industry

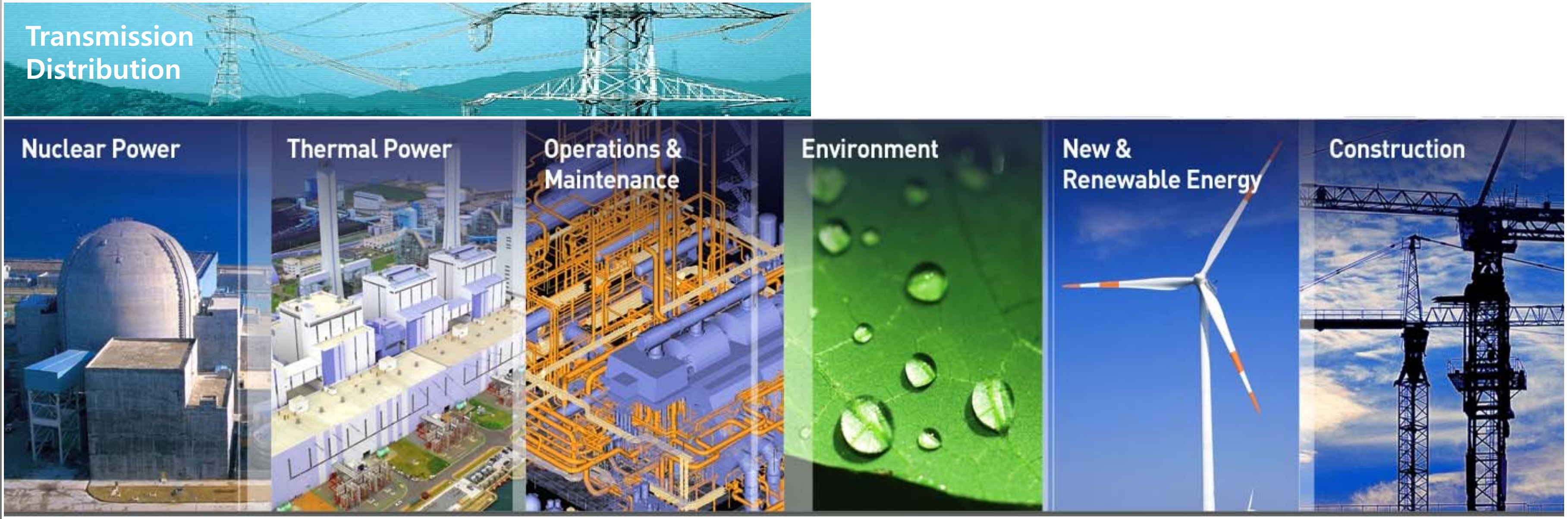
Operation/Construction/Development

Lessons Learned & Prospects

KEPCO - Korea Electric Power Corporation

122 years of advancing with electric power

- **60 billion $ assets**
- **30 billion $ sales**
- **46,000 employees**
- **6 power generating subsidiaries**
- **4 engineering affiliates**



Initial Pre-application Meeting

KEPCO Group
- Leader in Power Plant Engineering

- Korea's leading provider of design, engineering and operation of nuclear, fossil and hydro-electric plants
- 40 years of experience with 20 nuclear power plants
- 100% market share in nuclear power plant design, fuel supply, operation & maintenance in Korea
- Leadership in R&D investment in nuclear industry
- State-of-the-art technology for electricity generation especially nuclear power plants
- Strong position to capture the growing market in Korea and overseas

Owner of Power Plants in Korea





Nuclear	Oil	LNG	Coal	Hydro
20 units	62units	16units	44units	26units
142,000 GWh (18 GW)	16,000GWh (7 GW)	79,000GWh (18 GW)	156,000GWh (24 GW)	5,000GWh (6 GW)
36%	4%	20%	39%	1%

Total : 168 units / 398,000 GWh

KEPCO as a Global Company

Participation in the privatization project of Electric power generation_ **RUSSIA**

Combined-thermal IPP business _ **AGERBAIJAN**

Combined cycle power plant(870MW) _ **LEBANON**

Consulting on enhancing power distribution performance_ **LIBYA**

Gas-fired power plant(2,250MW)
Egbin coal-fired power plant(1,320MW)
Oil field development(2billion barrels)_ **NIGERIA**

CFBC plant in Wuzhi(112MW)
Wind power plant in Gansu(49MW)
Wind power plant in Mongolia(369MW)
Coal-fired power plant in Shanxi(13,439MW)_ **CHINA**

Consulting on electric power facilities Commissioned by Dakan Electric Power Distribution_ **MONGOLIA**

Coal-fired power plant in Malaya(650MW)
Combined cycle plant in Ilijan(1,200MW)
Coal-fired power plant in Naga(205MW)
Coal-fired power Plant in Sebu(200MW)_ **PHILIPPINES**

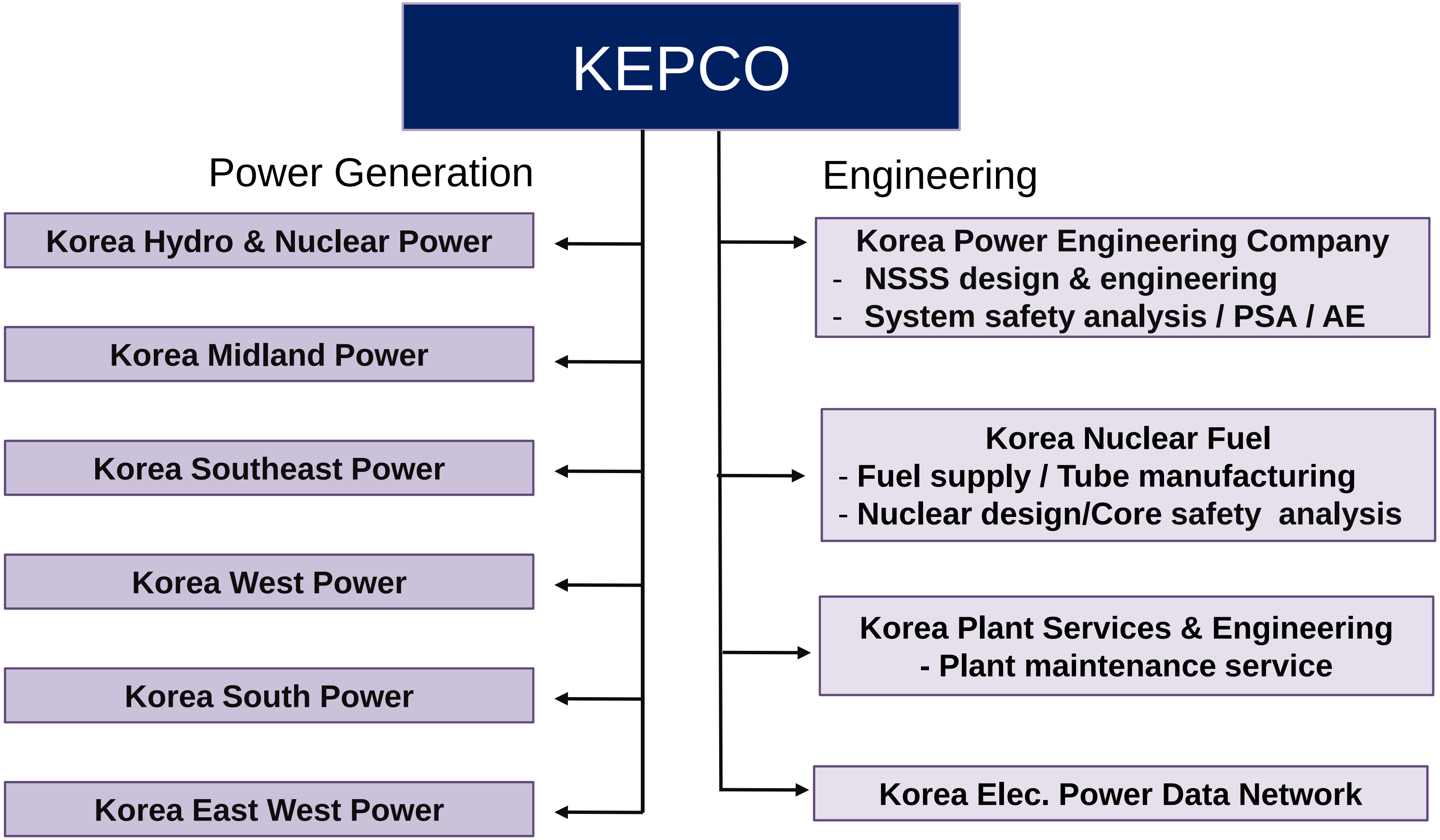
Automation of electric power distribution_ **INDONESIA**

Consulting on construction of plant in the electric power grid_ **INDONESIA**

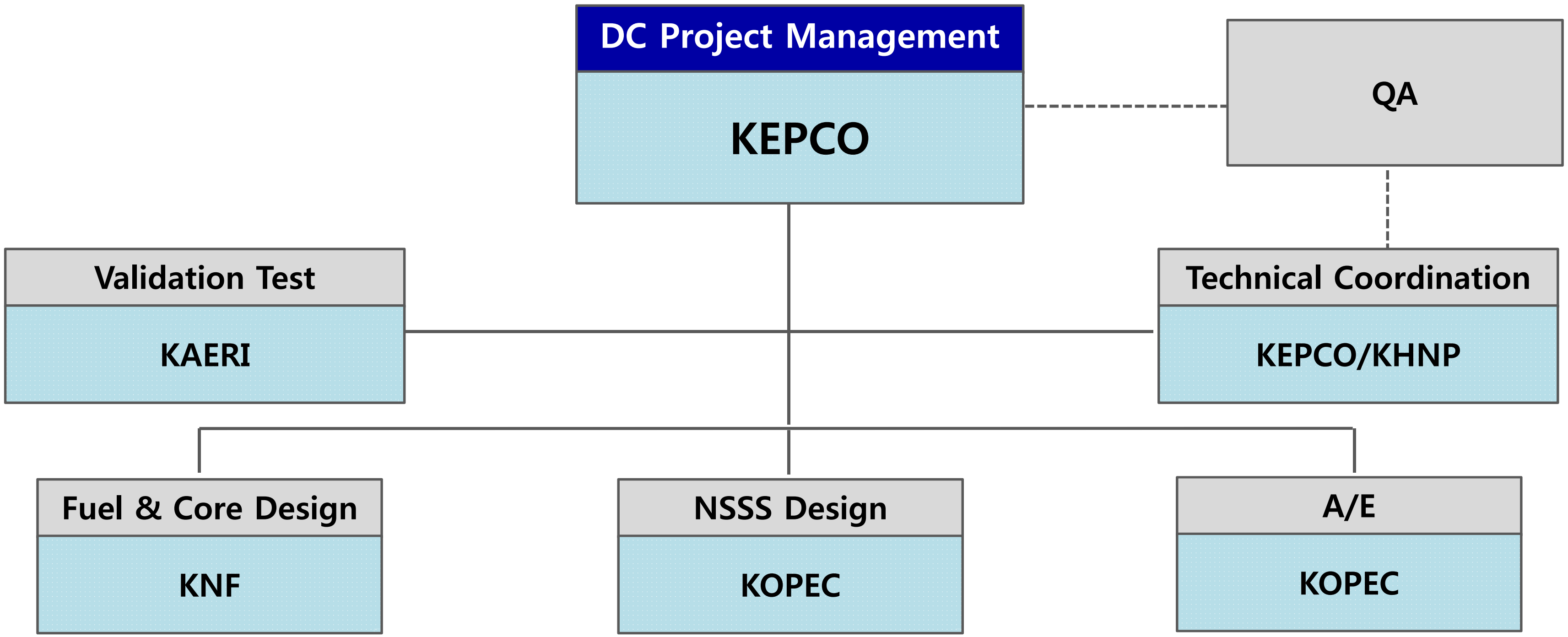
Power plant M&A_**USA**

Initial Pre-application Meeting

Organization – KEPCO & Affiliates



Organization – DC Application



KEPCO : Korea Electric Power Corporation
KHNP : Korea Hydro & Nuclear Power Co., LTD
KOPEC: Korea Power Engineering Co., LTD
KNF : Korea Nuclear Fuel
KAERI : Korea Atomic Energy Research Institute

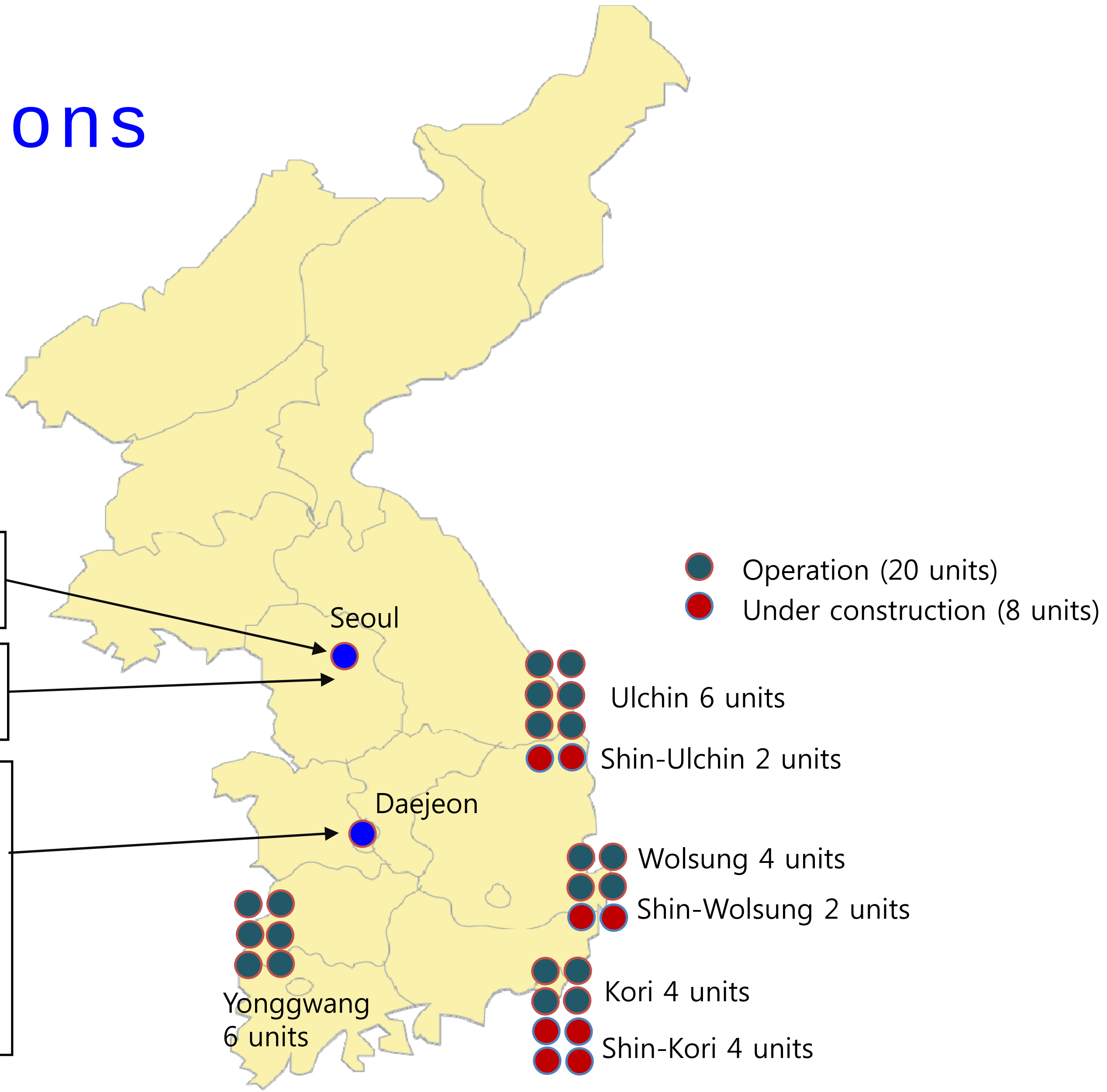
Locations

KEPCO (HQ)
KHNP (HQ)

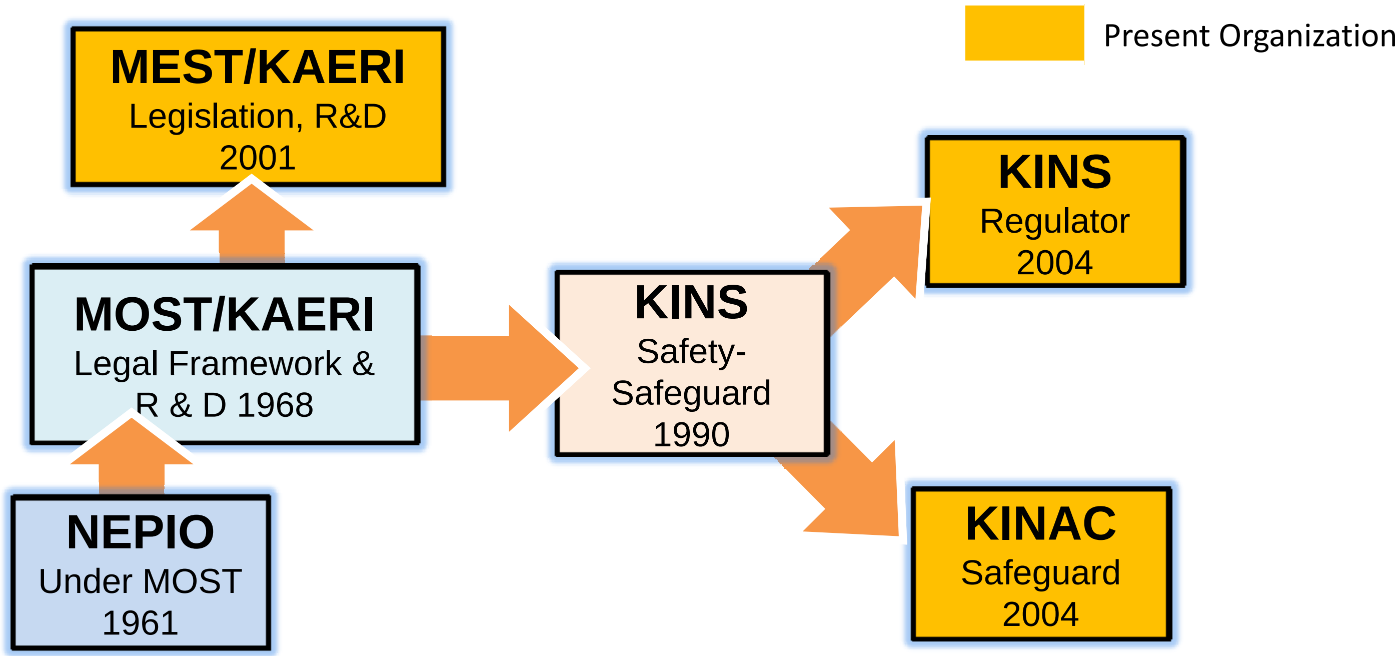
KOPEC (HQ, AE)
KPS

KEPCO(KEPRI)
KHNP(NETEC)
KOPEC(SD)
KNF

KINS
KAERI



Nuclear Regulation in Korea



NEPIO : Nuclear Energy Program Implementing Office

MOST : Ministry of Science & Technology

MEST : Ministry of Education, Science & Technology

KAERI : Korea Atomic Energy Research Institute

KINS : Korea Institute of Nuclear Safety

KINAC : Korea Institute of Nuclear Nonproliferation & Control

Robust Supply Chain

Initial Pre-application Meeting

Main Equipment

Manufacturing

main equipments

Annual Production Capacity :

4 units

BOP Equipment

Manufacturing BOP equipment (185 items)

► **Over 300 suppliers in Korea**

Construction Capability

OPR-1000 Project

APR-1400 Project

GS E&C
HYUNDAI ENGINEERING & CONSTRUCTION CO., LTD.
DAELIM Best Value, Better Life
SK E&C
SAMSUNG C&T
DOOSAN Doosan Heavy Industries & Construction
DAEWOO E&C

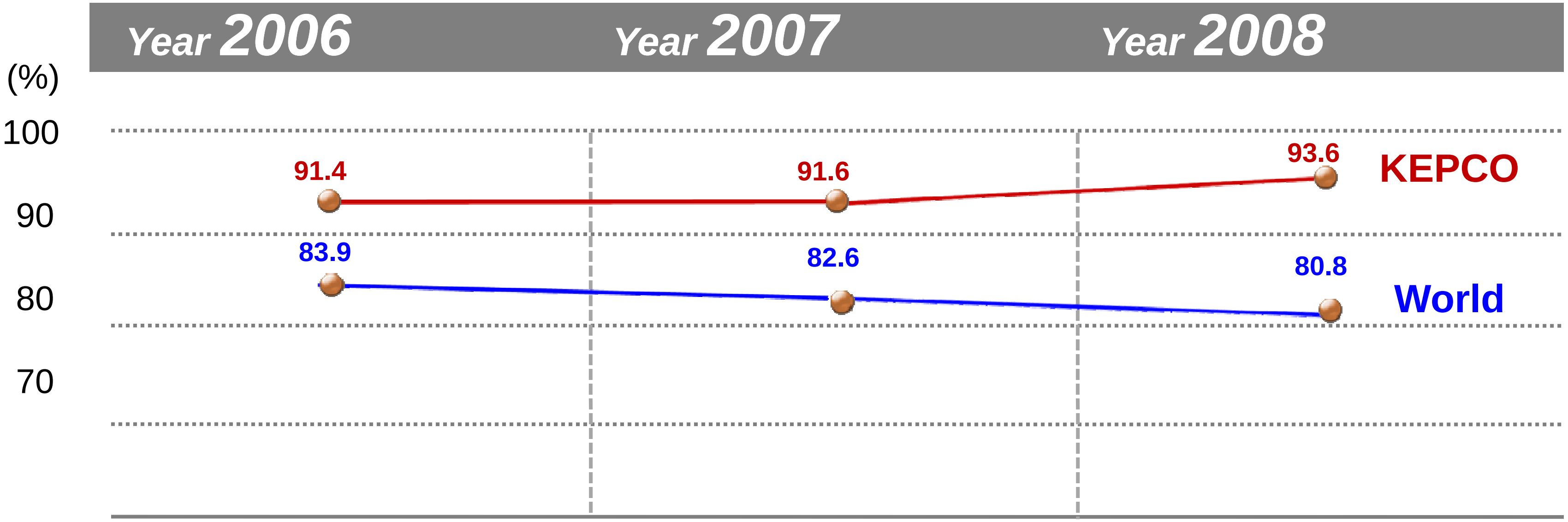
Seven qualified & experienced Korean construction companies with capability to build NPPs independently

Initial Pre-application Meeting

Operating NPPs in KOREA

Site		Reactor Type	Capacity (MWe)	Owner	NSSS Supplier	Commercial Operation
Kori	1 2 3 4	PWR	587 650 950 950	KEPCO/ KHNP	Westinghouse	1978 1983 1985 1986
Wolsong	1 2 3 4	PHWR	679 700 700 700	KEPCO/ KHNP	AECL AECL AECL/KHI AECL/KHI	1983 1997 1998 1999
Yonggwang	1 2 3 4 5 6	PWR	950 950 1000(OPR) 1000(OPR) 1000(OPR) 1000(OPR)	KEPCO/ KHNP	Westinghouse Westinghouse KHIC/ABB-CE KHIC/ABB-CE KHIC/KOPEC KHIC/KOPEC	1986 1987 1995 1996 2002 2002
Ulchin	1 2 3 4 5 6	PWR	950 950 1000(OPR) 1000(OPR) 1000(OPR) 1000(OPR)	KEPCO/ KHNP	Framatome Framatome KHIC KHIC DHIC/KOPEC DHIC/KOPEC	1988 1989 1998 1999 2004 2005

Operation Performance - Capacity factor



3-Year Average(%)

KEPCO	World Average
92.2	*82.4*

# of Unplanned Scram : 0.8/yr (2006 – 2008)

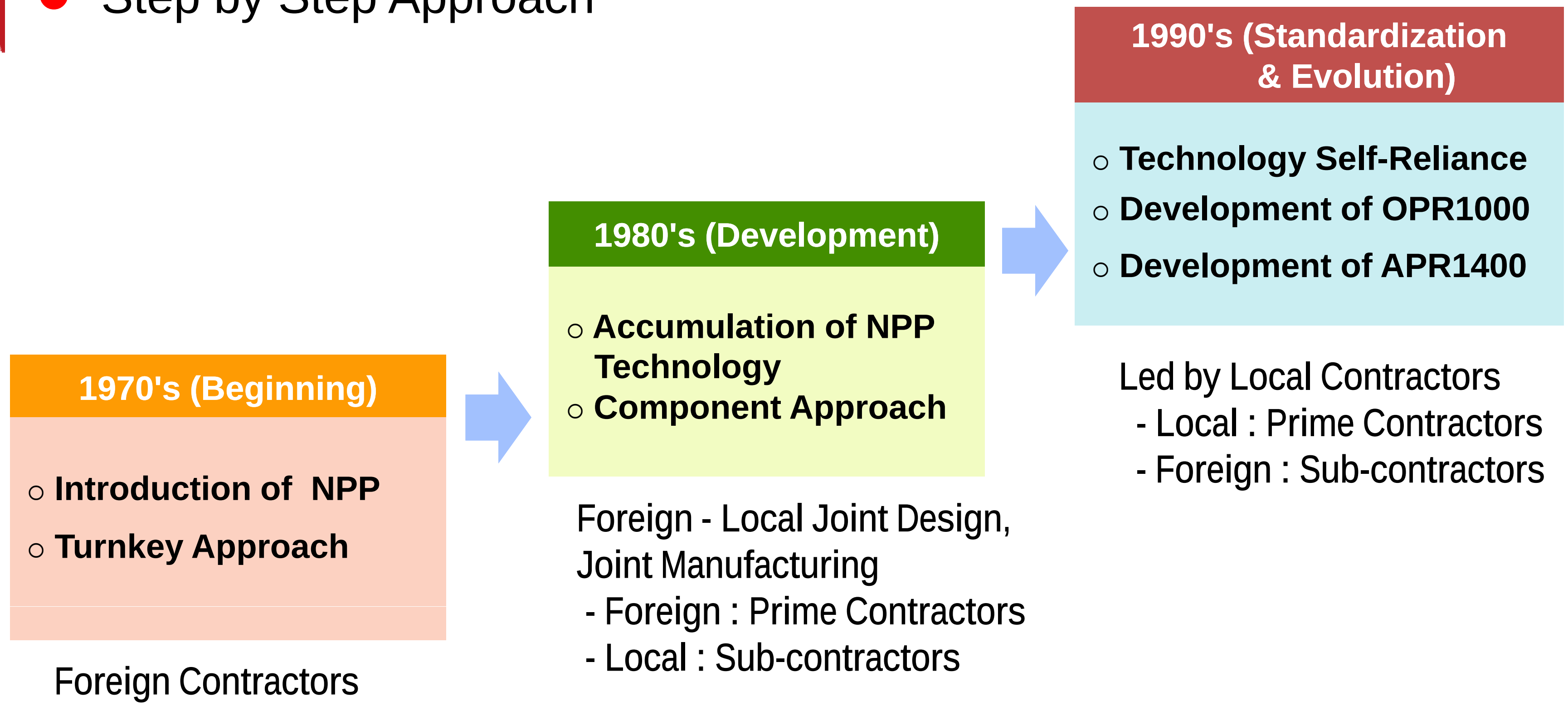
NPPs under Construction in KOREA

Plant	Reactor Type	Capacity (MWe)	Licensing Status	Commercial Operation
Shin-Kori 1&2	PWR (OPR1000)	1000	OL issued (July 2005 CP)	Dec. 2010, 2011 (planned)
Shin-Wolsong 1&2	PWR (OPR1000)	1000	June 2007 CP	Jan. 2012, 2013 (planned)
Shin-Kori 3&4	PWR (APR1400)	1400	April 2008 CP	Mid. of 2013, 2014 (planned)
Shin-Ulchin 1&2	PWR (APR1400)	1400	CP issued	End of 2015, 2016 (planned)

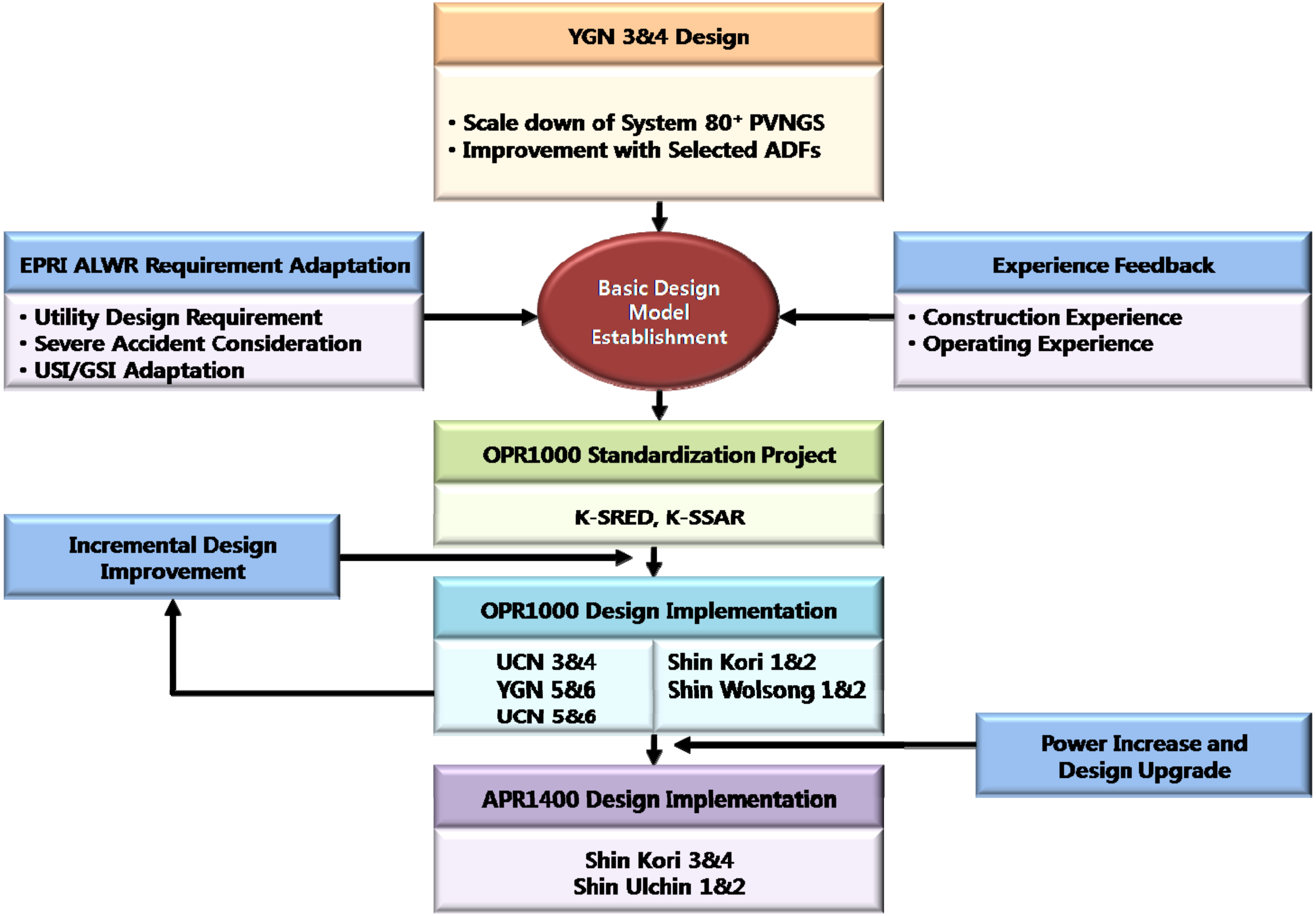
OL : Operation License
CP : Construction Permit

Nuclear Power Development Process

- Step by Step Approach



Evolution of Nuclear Power Plant Design



Construction Status – APR1400

Shin-Kori Units 3&4 Project

- **Reactor Type: PWR (APR1400)**
- **Capacity: 1,400MW X 2 units**
- **Construction Period: Sep. 2007 – Sep. 2014 (from Site Grading to COD of Unit 4)**

  - Construction Progress Rate: 40%

- **Contractor**

  - NSSS Supplier: Doosan Heavy Industries & Construction Co.
  - Architect Engineering (A/E): Korea Power Engineering Co. (KOPEC)
  - Construction: Hyundai/Doosan/SK Consortium

- **Project Milestone**

2007	2008	2009	2010	2012	2013	2014

- Sep. – Site Grading
- Oct. – **#3 First Concrete**
- Nov. – #4 First Concrete
- Aug. – #3 Rx Installation
- Jan. – #3 Fuel Loading
- Sept. – **#3 COD**
- Sept. – #4 COD

Initial Pre-application Meeting

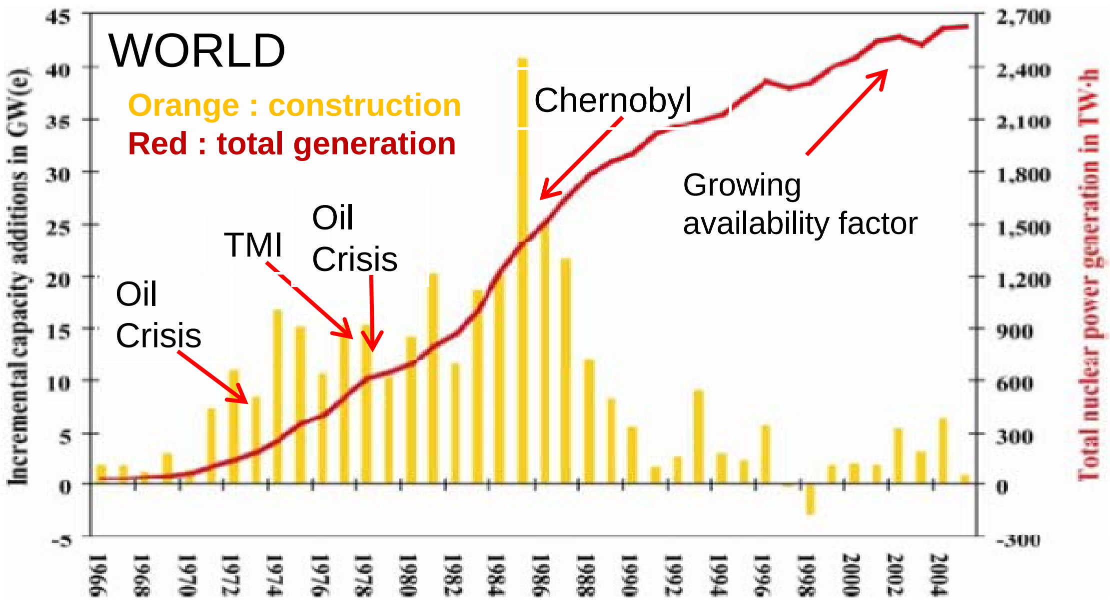
Construction Status – APR1400

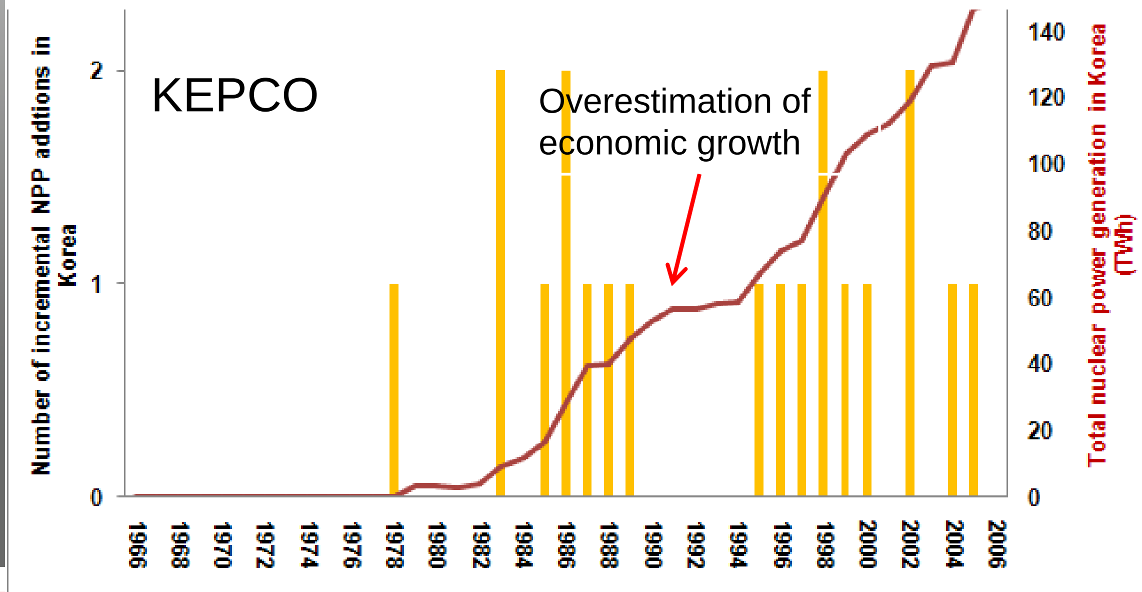
Shin-Ulchin Units 1&2 Project

- **Reactor Type: PWR (APR1400)**
- **Capacity: 1,400MW** X **2 units**
- **Construction Period: Aug. 2009 – Dec. 2016 (Site Grading - COD of Unit 2)**
- **Contractor**
  - **- Completed Preliminary Work Contract**
  - **- Main Contract is under Negotiation**
- **Project Milestone**

2009	2010	2011	2012	2014	2015		2016
Aug.	Jun.	Mar.	Dec.	Apr.	Dec.		Dec.
Site Grading	Excavation	**#1 First Concrete**	#1 Rx Installation	#1 Fuel Loading	**#1 COD**		#2 COD

Preserving State-of-the-art Technology





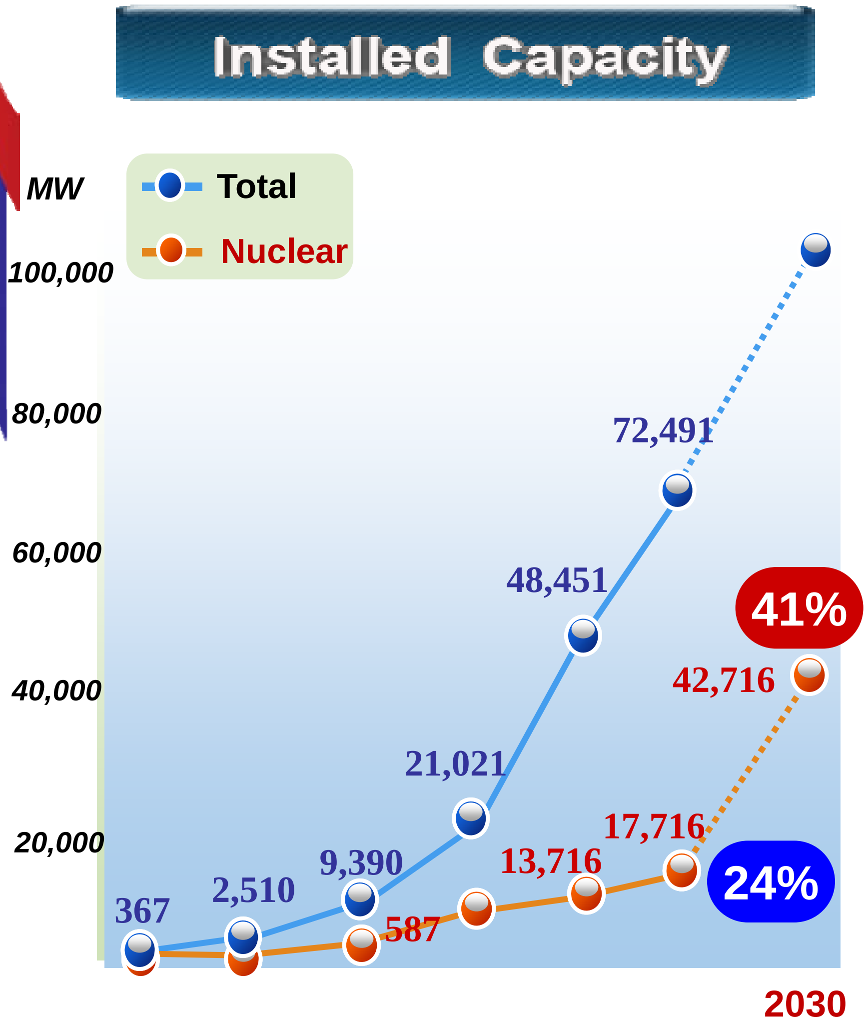
Continuous investment with enhancing safety feature after TMI & Chernobyl accident but limited construction

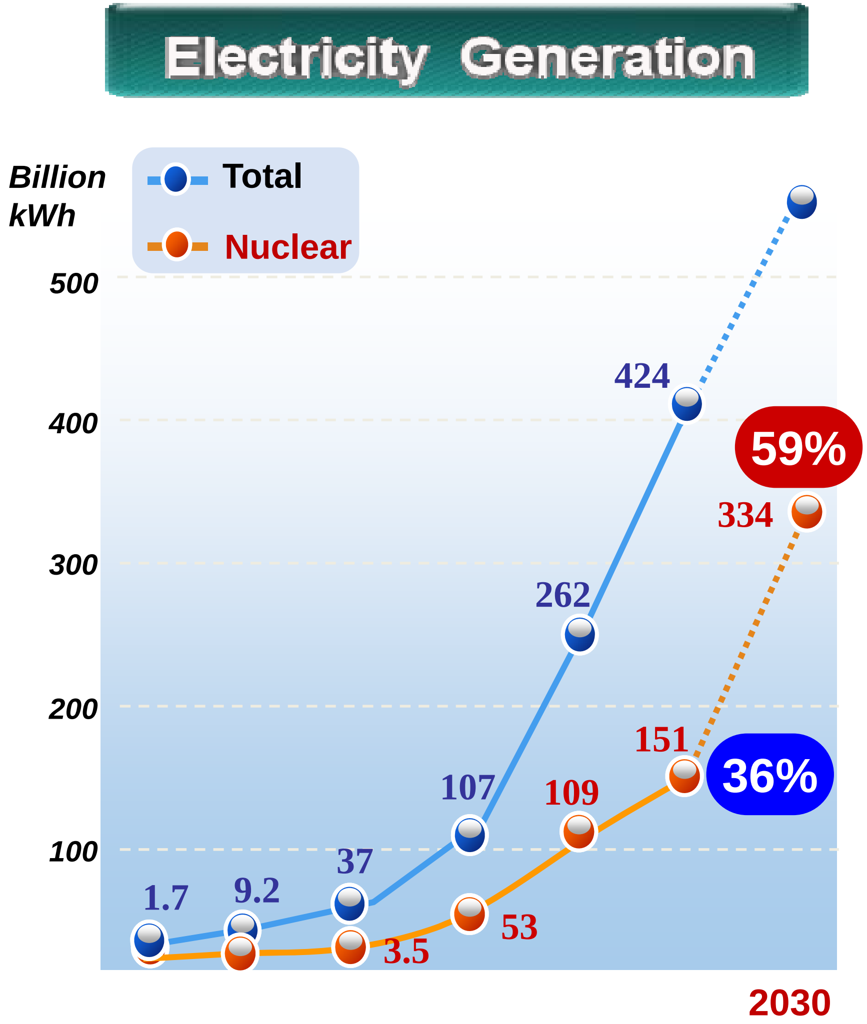
Continuous construction & Technology development

- **Human resources for EPC**
- **Manufacturing**
- **Construction technology**
- **R&D, Test Facilities**

APR1400

Prospects of Nuclear Power in Korea





Initial Pre-application Meeting

General Design Overview

Design Development

NSSS Design

Secondary System Design

Containment Design

MMIS

Plant Layout

Safety Analysis

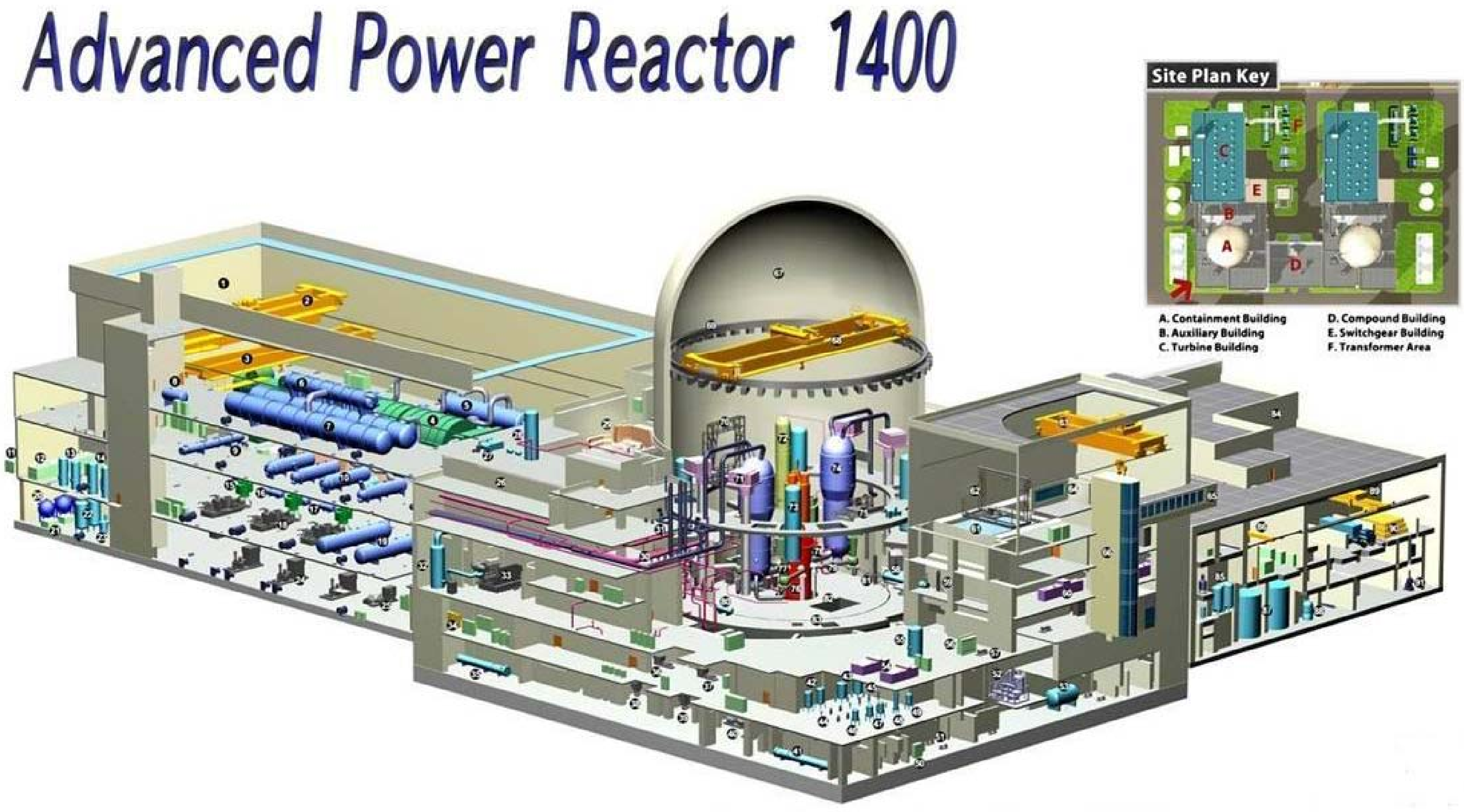
Summary

Design Development

What is APR1400 ?

- **Evolutionary PWR – 1,400 MWe**
- **2 Loop / 4 Pump NSSS**
- **Prestressed Containment Building**

Design Development



Design Development

Design Development

APR1400 Development Strategy

- **Uprate power to 4,000 MWth (1,450 MWe) based on OPR1000's 2,825 MWth (1,050 MWe) technology**
- **Incorporate Advanced Design Features to enhance safety and operational flexibility**
- **Meet the Utility Requirements (domestic & world-wide)**
  - – Proven Technology
  - – Constructability
  - – Maintainability
  - – Regulatory Stabilization

Design Development

EPRI URD
System 80+

APR 1400
1,400 MWe
Under Construction
- SKN # 3,4, SUN # 1,2

System 80+

ADF/PDF
Latest Codes
& Standards

* OPR1000 :
Optimized Power
Reactor 1000

Improved OPR1000
1,000 MWe
- In Operation - YGN #5,6 ('02/'02) - UCN #5,6 ('04/'05)
- Under Construction - SKN #1,2 - SWN #1,2

*APR1400 :
Advanced Power
Reactor 1400

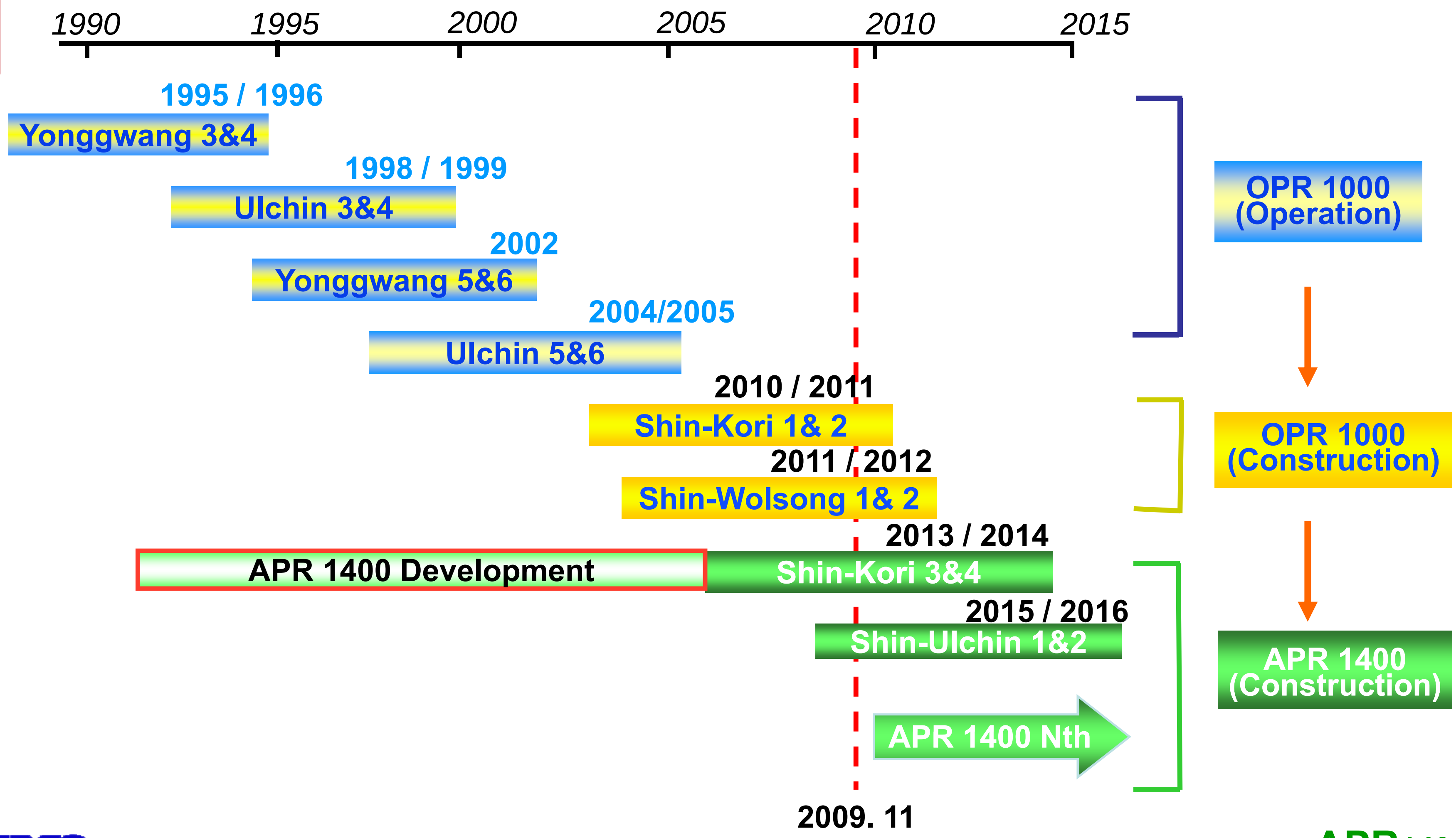
OPR1000
1,000 MWe
- In Operation - YGN #3,4 ('95/'96) - UCN #3,4 ('98/'99)

NSSS Design
Palo Verde #2 (CE,1300MWe)

Core Design
ANO #2 (CE,1000MWe)

Design Development

Evolution of Advanced NPPs



Design Development

Development Phases

Phase I ('92.12 – '94.12): ***Conceptual Design***

- Reactor Type Selection
- Development of Top-Tier Design Requirements
- Comparative Study on Major Systems and Components

Phase II ('95.3 – '99.2): ***Basic Design***

- Development of Detailed Design Requirements
- Development of Design Specifications for NSSS Major Components
- Preparation of Standard Safety Analysis Report

Phase III ('99.3 – '01.12): ***Optimization and Licensing***

- Design Optimization
- Detailed Design of Long-Lead Items
- Licensing of the Standard Design

Design Development

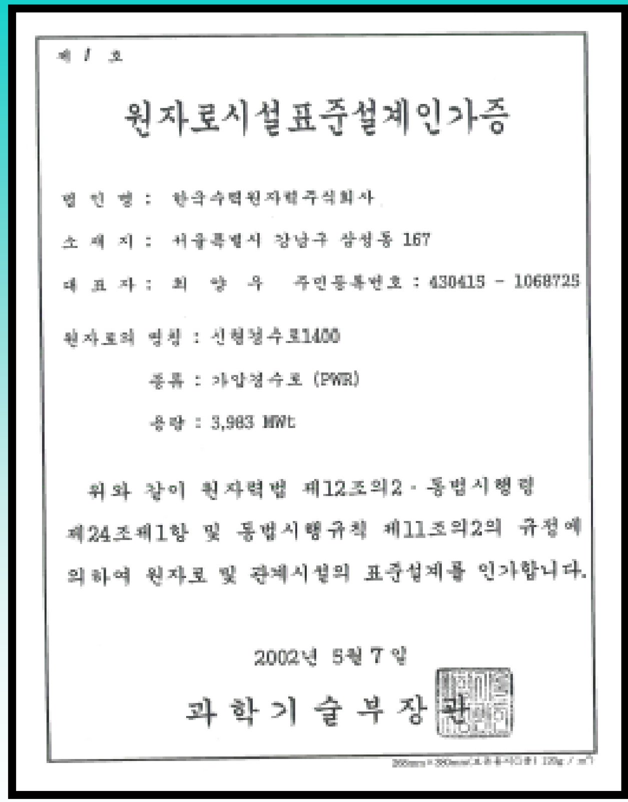
Licensing of Standard Design

- **Pre-Application Safety Review : Dec. 99 - June 01**
  - SSAR (Standard Safety Analysis Report)
  - CDM (Certified Design Material inclusive of ITAAC)
  - EOG (Emergency Operating Guidelines)
- **Application for Standard Design Approval : July 2001**
- **Requests for Additional Information : 2,251**
  - Man-machine interface and digital I&C system design
  - Performance of safety injection system based on DVI
  - Design features related to severe accident mitigation
- **Issuance of Standard Design Approval : *May 2002***

APR1400 Licensing

Standard Design Approval by KINS in 2002

Standard Safety Analysis Report



제 1 호

원자로시설표준설계인가증

법 인 명 : 한국수력원자력주식회사

소 재 지 : 서울특별시 강남구 삼성동 167

대 표 자 : 최 양 우 주민등록번호 : 430415 - 1068725

원자로의 명칭 : 신형경수로1400

종류 : 가압경수로 (PWR)

용량 : 3,983 MWt

위와 같이 원자력법 제12조의2 · 동법시행령 제24조제1항 및 동법시행규칙 제11조의2의 규정에 의하여 원자로 및 관계시설의 표준설계를 인가합니다.

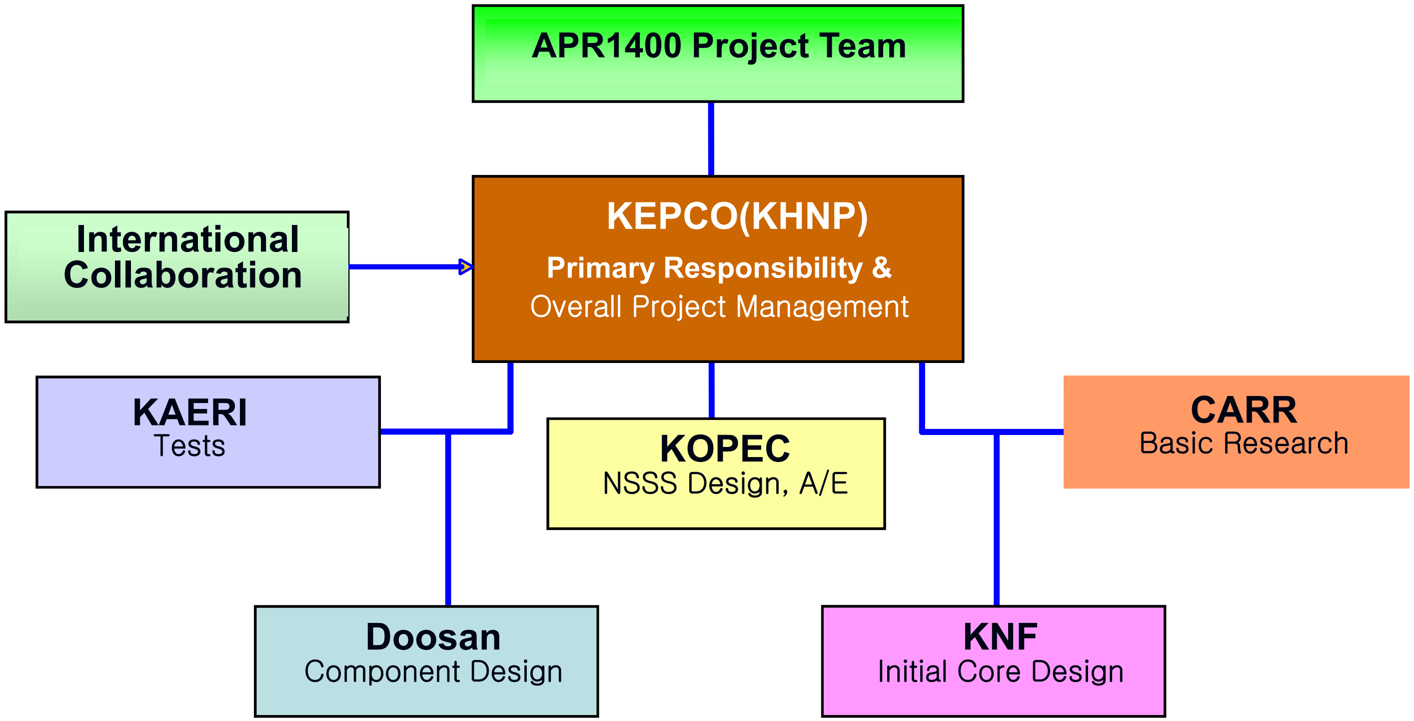
2002년 5월 7일

과 학 기 술 부 장 관

Standard Design Approval
of APR1400

Design Development

Organizations for APR1400 Development



- KOPEC : Korea Power Engineering Company
- KNF : Korea Nuclear Fuel Company
- Doosan : Doosan Heavy Industries & Construction
- KAERI : Korea Atomic Energy Research Institute
- CARR : Center for Advanced Reactor Research

Design Development

Design Principles and Goals

Design Principles

Adoption of ADF based on proven technology

- Thermal Margin (is greater than) > 10 %
- Direct Vessel Injection of Safety Injection System
- Passive Flow Regulator or Fluidic Device in Safety Injection Tank
- In-containment Refueling Water Storage Tank
- Fully Digitalized I&C and Operator-Friendly Man-Machine Interface

Enhanced Plant Safety and Cost Effectiveness

- Improved Severe Accident Mitigation System
- Reinforced Seismic Design Basis (0.3 g)
- Extended plant design lifetime (60 years)
- Reduced construction time (48 months for Nth unit)

Improved O & M Convenience

- Extended operator response time
- Reduced occupational exposure
- Easier In-Service Inspection and maintenance for components

APR 1400

Design Goals

Safety

- Core Damage Frequency less than 10^{-5}/yr
- Containment Failure Frequency less than 10^{-6}/yr
- Seismic Design Basis : 0.3 g
- Occupational radiation exposure< 1 man·Sv/RY

Performance

- Thermal Margin (is greate than) > 10 %
- Plant Availability > 90 %
- Unplanned Trip (less than) < 0.8/RY

Economy

- Plant Capacity (Gross) : 1,455 Mwe
- Plant Lifetime : 60 years
- Refueling Cycle ≥ 18 months
- Construction Period : 48 months (Nth Unit)

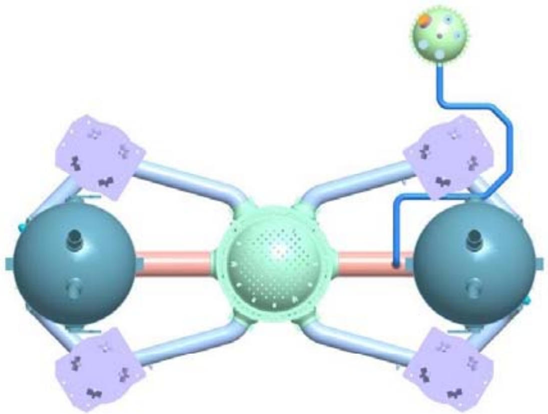
Design Development

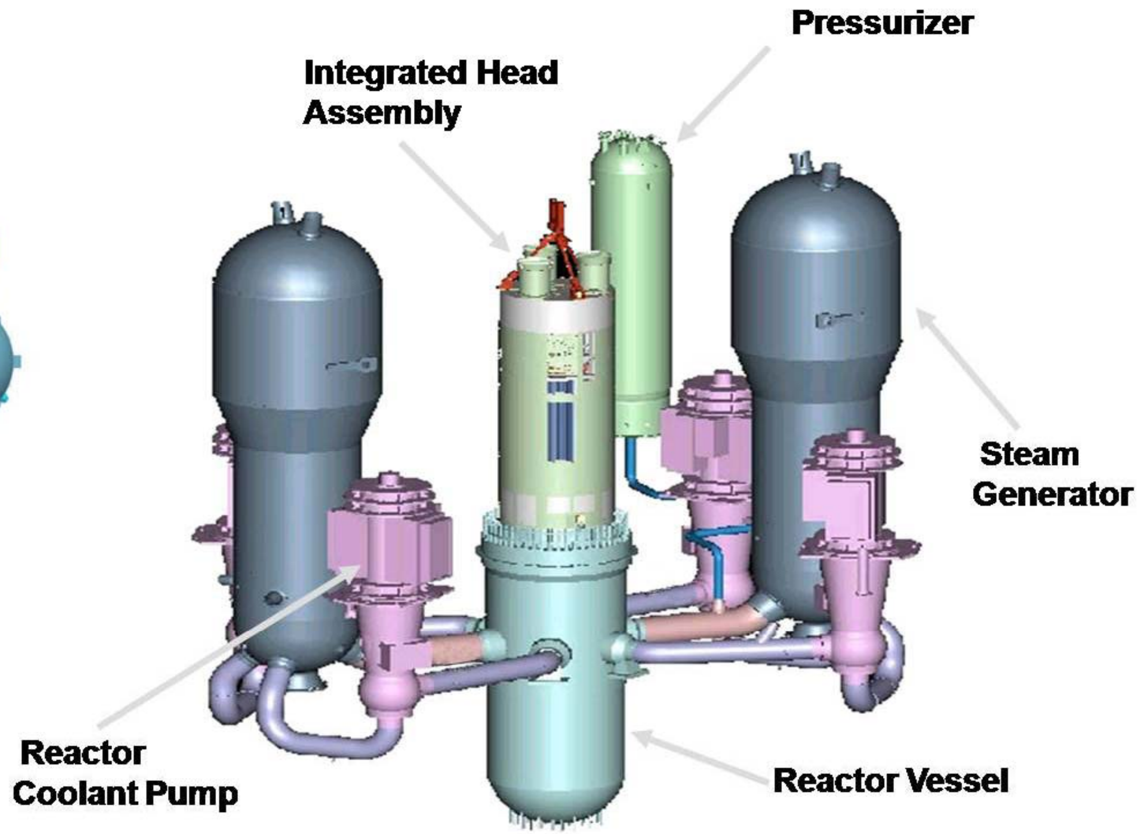
Design Parameters

Parameters	APR1400
Thermal/ Elec. Power	4,000 MWt / 1,450 MWe
Design Life	60 Years
Seismic Acceleration	0.3 g
Operating Parameters	
- Thot / Tcold	615 / 555 ^{O}F
- Operating Pressure	2250 psia
- RCS Flow Rate	1.66 x 10^{6} lb/hr
- Main Steam Pressure (@Full Power)	1000 psia
- Main Steam Flow Rate	8.975 x 10^{6} lb/hr
Safety Parameters	
- CDF	2.25 x 10^{-6} < 10^{-5}/RY
- Containment Failure Frequency	7.19 x 10^{-7} < 10^{-6}/RY
- Thermal Margin	>10%
- Emergency Core Cooling System	4-train, DVI, Fluidic Device in SIT
Performance Requirements	
- Plant availability	More than 90 %
- Unplanned trip	Less than 0.8/year
- Refueling cycle	18 ~ 24 months

NSSS Design

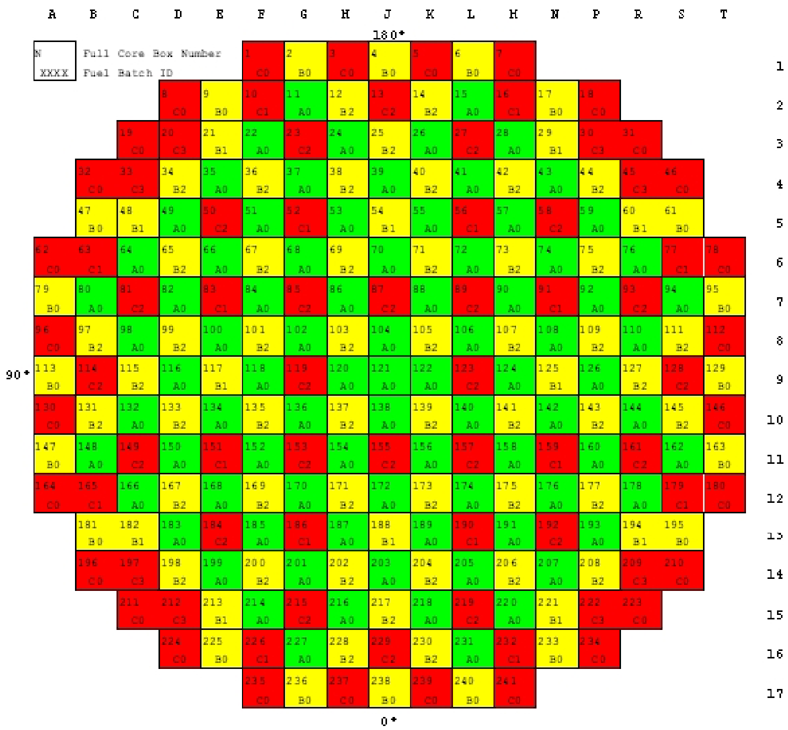
RCS Configuration





NSSS Design

Reactor Core



Number of assemblies : 241

Thermal margin : above 10 %

Refueling cycle : over 18 months

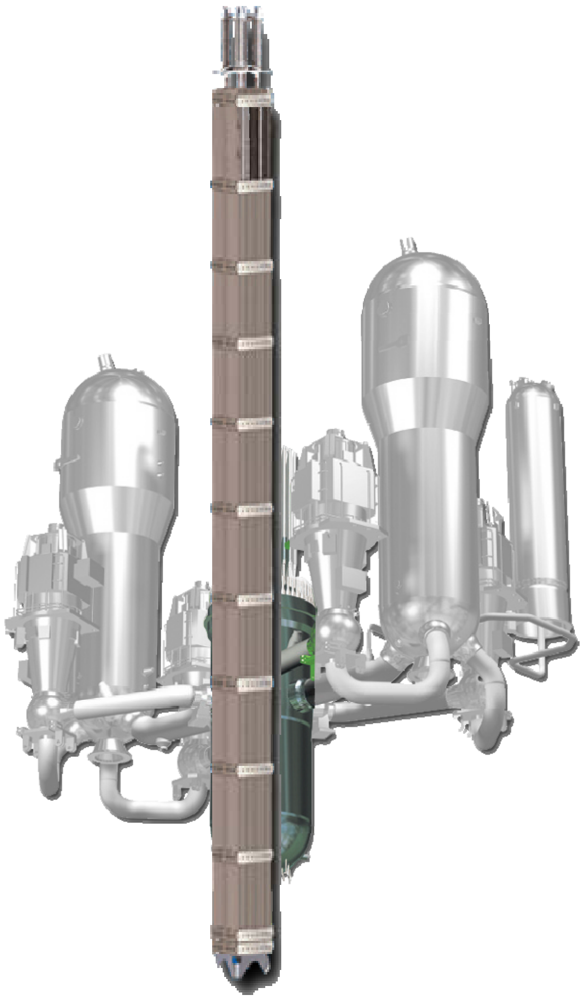
Batch average burn-up : 55,000 MWD/MTU

Enhanced operational flexibility

- **Daily load follow operation capability**
- **MOX loading capability up to 1/3 core**

NSSS Design

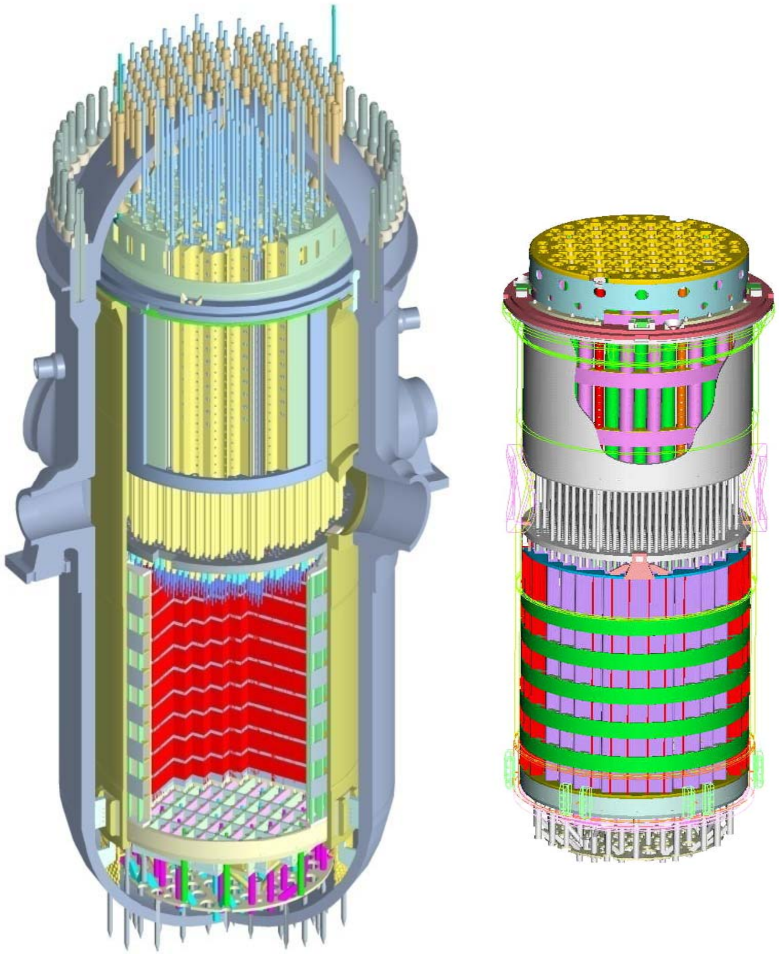
Fuel Assembly – Plus7™



- Enhanced thermal margin
- High burn-up
- Improved neutron economy
- Improved seismic resistance
- Reduced grid-to-rod fretting wear susceptibility
- Increased debris filtering efficiency
- Improved fuel productivity

NSSS Design

Reactor Vessel & Internal



Enhanced RV integrity

- No weld seam in fuel region shell
- Using low Copper contents material

Reduced radiation exposure

- Reduced Cobalt contents in base material

Integrated Inner Barrel Assembly

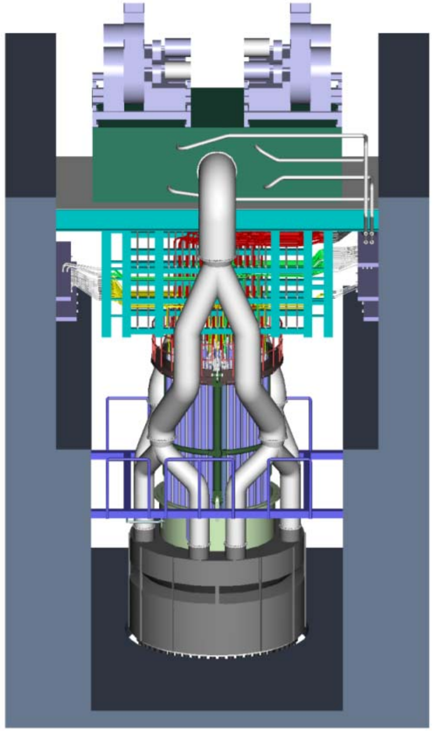
- Welded IBA to UGS upper flange
  - Eliminate tie rods, round nuts, snubber flange & Block

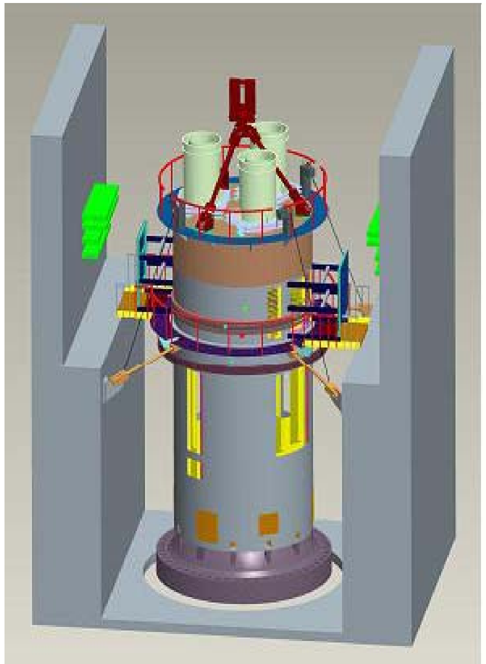
Integrated Lower Internal Assembly

- Integrated core support barrel, core shroud, and lower support structure in one assembly

NSSS Design

Integrated Head Assembly (IHA)





Integrated Components

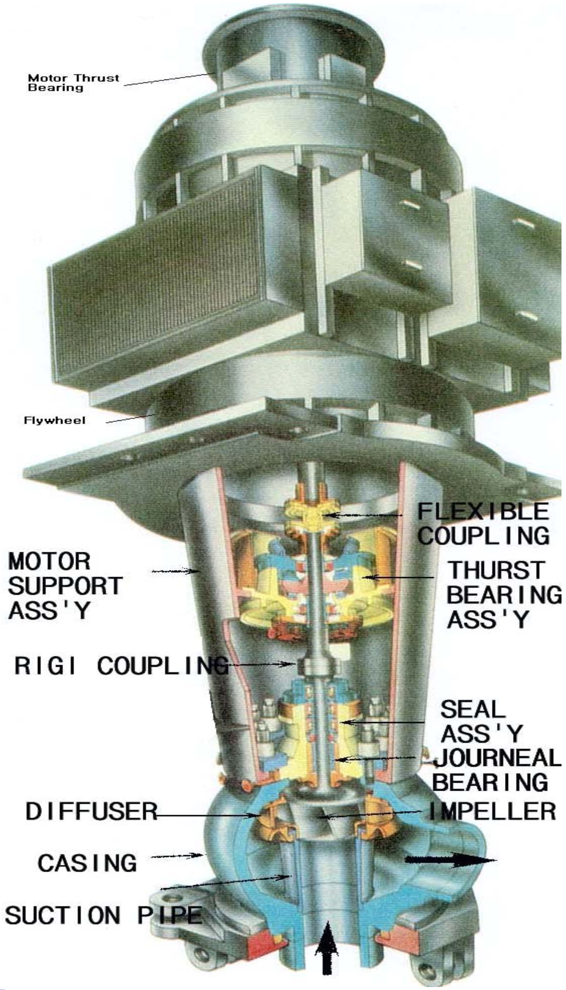
- Head area cable tray system, CEDM air handling unit, cooling duct, cooling manifold and head lift rig, etc.

IHA Reduces

- Refueling Time
- Occupational Radiation Exposure
- Component Storage Area
- Seismic Load

NSSS Design

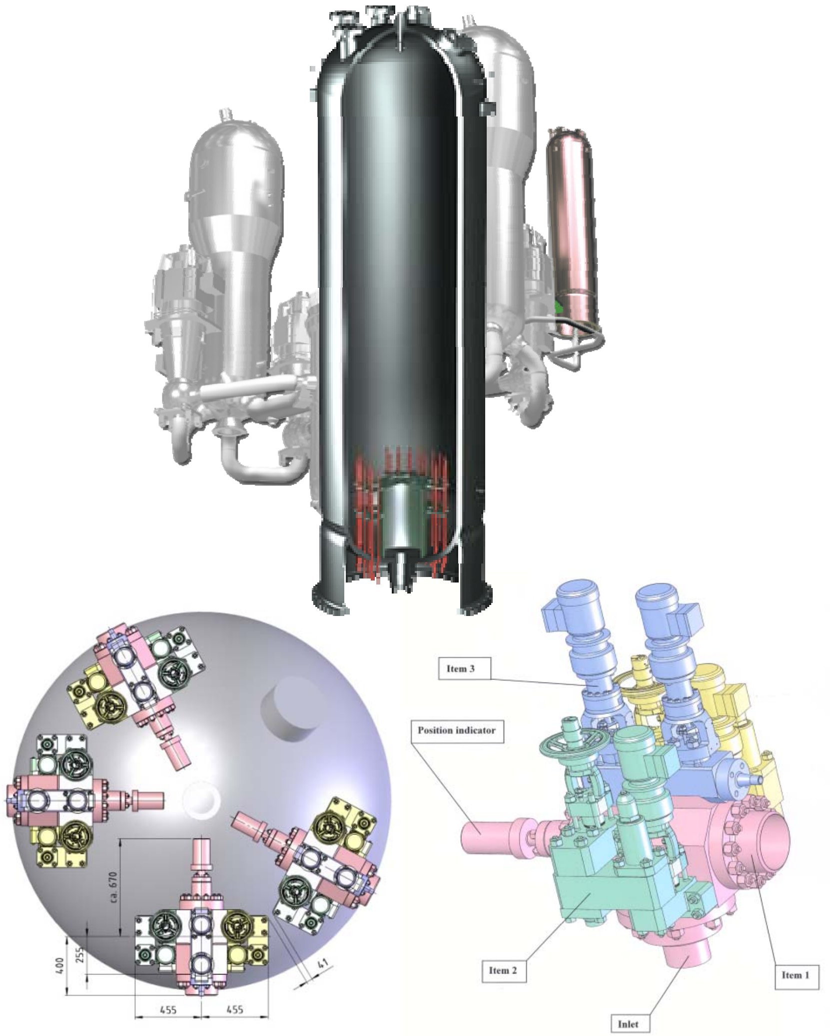
Reactor Coolant Pump



- Vertical pump
- Motor-driven centrifugal pump
- Bottom suction & horizontal discharge
- Single stage impeller

NSSS Design

Pressurizer with POSRV



Increased Volume

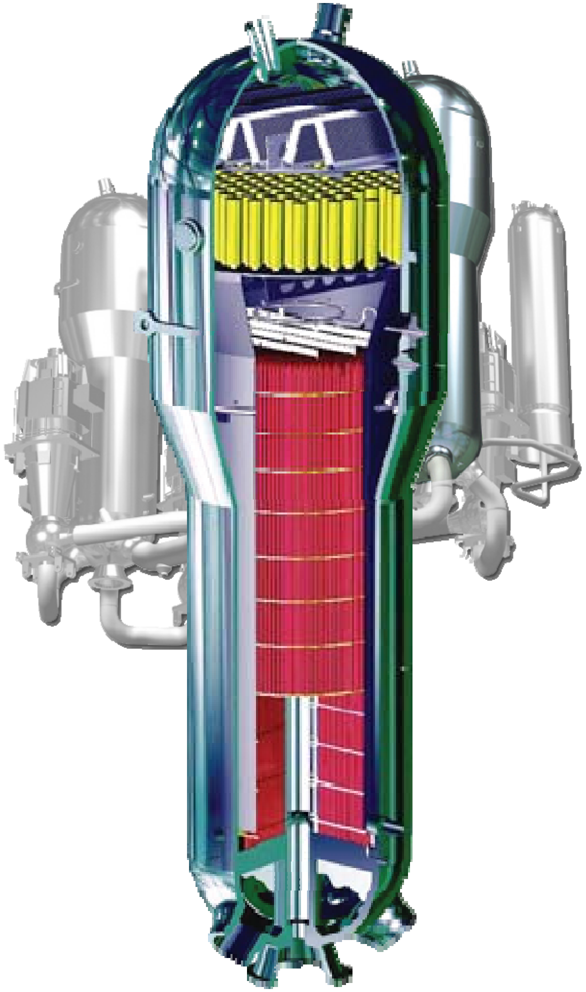
- Total volume : 2,400 ft^3
- Enhancing coping capability against plant transients

Pilot Operated Safety Relief Valve

- Performing over-pressure protection and safety depressurization
- Main valve open by pilot valve actuation
- Steam/Water/Two-Phase discharge
- No drift of the opening set-point
- Reliable valve operation without chattering and leakage
- Low susceptibility for valve stuck-open

NSSS Design

Steam Generator



Design Parameters

- Integral Economizer
- Number of tubes : 13,102 / SG
- Plugging margin : 10 %
- Tube material : Inconel 690

Improved Tube Support Bars and Plate

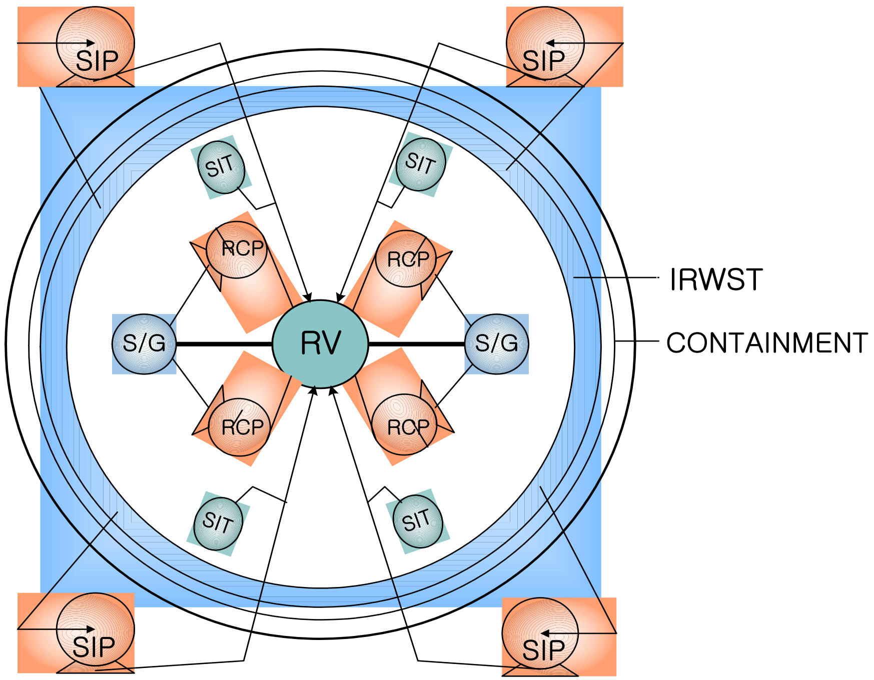
- Increased anti-vibration bars
  - Reducing flow-induced tube vibration

Modified SG Inlet Nozzle Angle

- Increasing space to install SG nozzle dam
  - Improving stability in mid-loop operation

NSSS Design Features

Safety Injection System



Simplified Design

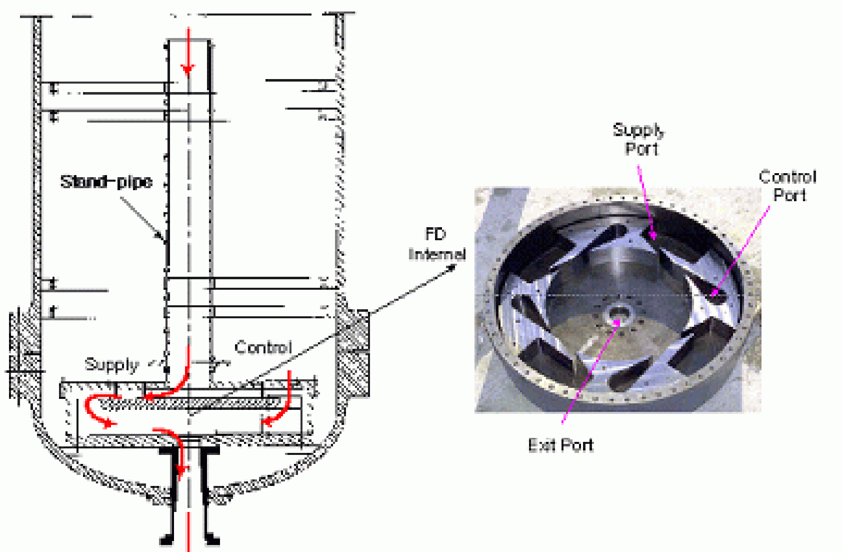
- Mechanically independent 4 train
- 1 SIP/train
- 1 SIT/train
- No low pressure pumps
- One injection mode

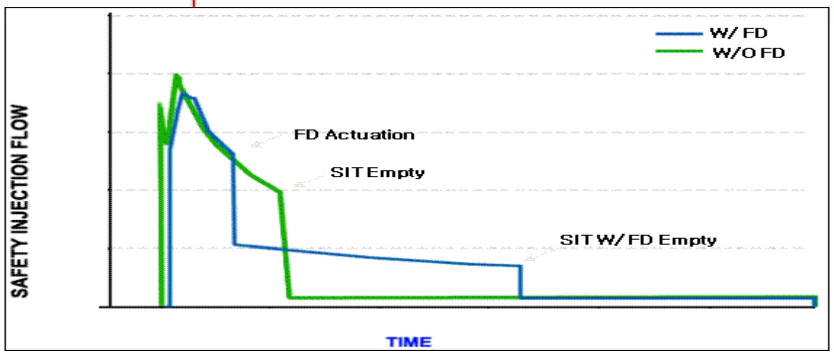
Direct Vessel Injection

- No safety injection water spillage in cold-leg break LOCA
- Increase the reliability of the injection during LOCA

NSSS Design Features

Safety Injection Tank with Fluidic Device





Safety Injection Tank

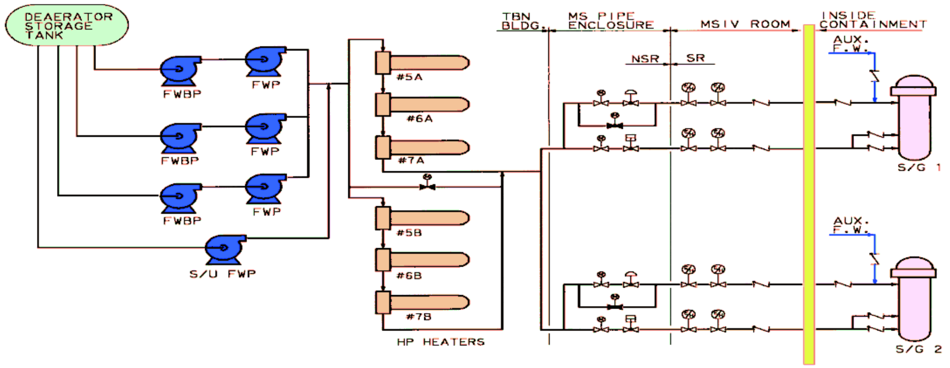
- Design pressure : 700 psig
- Volume : 18000 gal (1 ea)

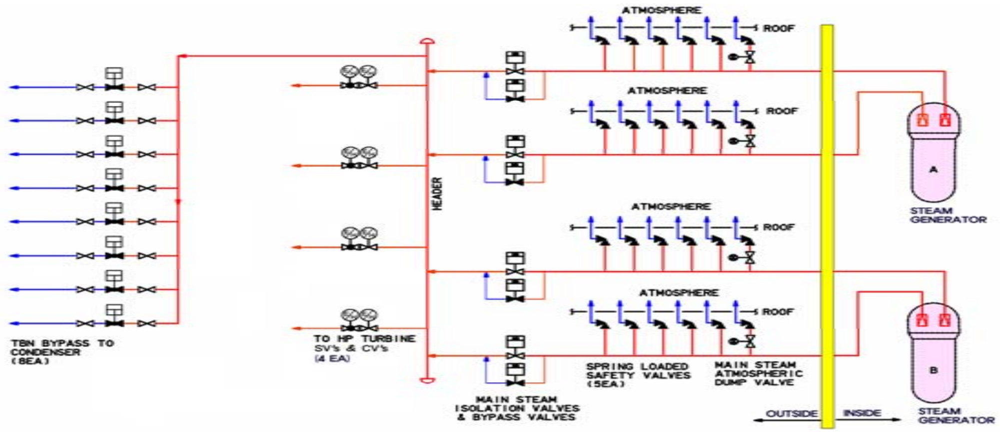
Fluidic Device

- Extend injection duration of SIT
- Playing a role of low pressure SIP
- Flow rate depends on the Stand Pipe height and resistance of Supply Port & Control Port

Secondary System Design

Main Feedwater / Main Steam System





Main Feedwater System

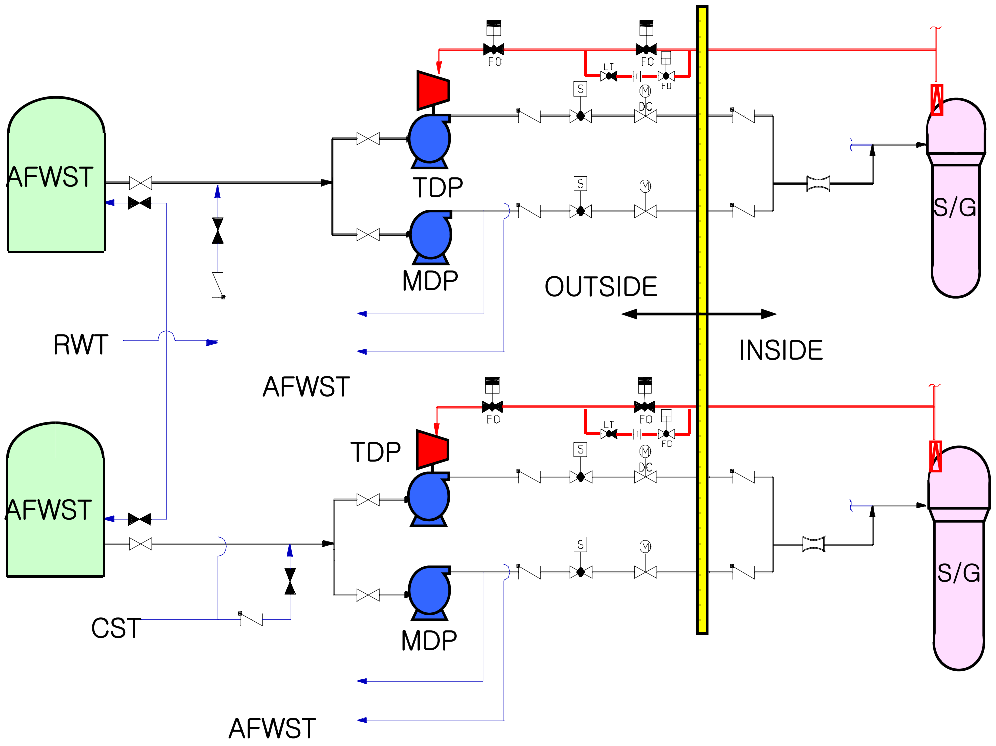
- Normal Full Power Operation
  - 90% flow to economizer
  - 10% flow to downcomer
- MFIV to isolate SG

Main Steam System

- 5 MSSVs & 1 MSADV per steam line
- MSIV to isolate SG
- 8 SBVs to dump excess steam to condenser

Secondary System Design

Auxiliary Feedwater System



Design Characteristics

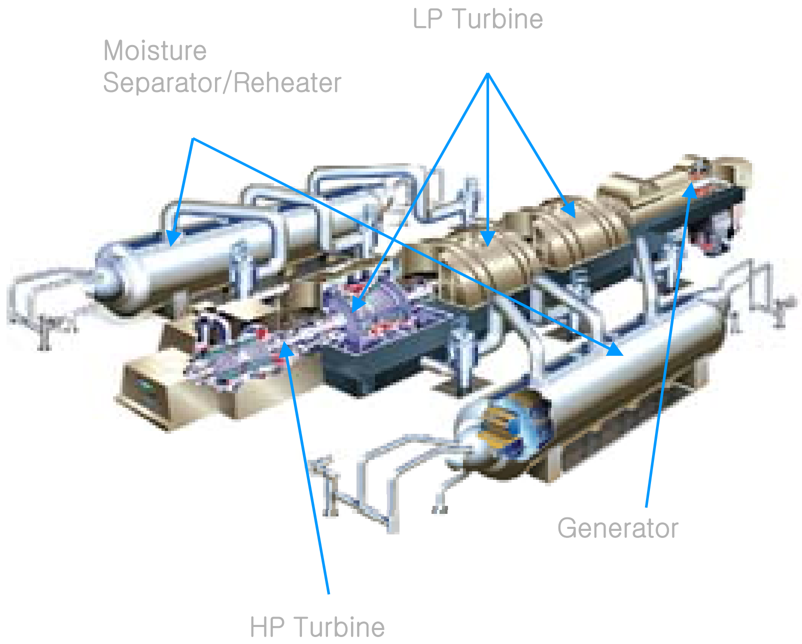
- Redundantly actuated by ESFAS and Diverse Protection System

System Configuration

- 2 × 100 % motor driven pumps
- 2 × 100 % turbine driven pumps
- 2 × 100 % dedicated tanks housed in auxiliary building

Secondary System Design

Turbine Generator



Turbine

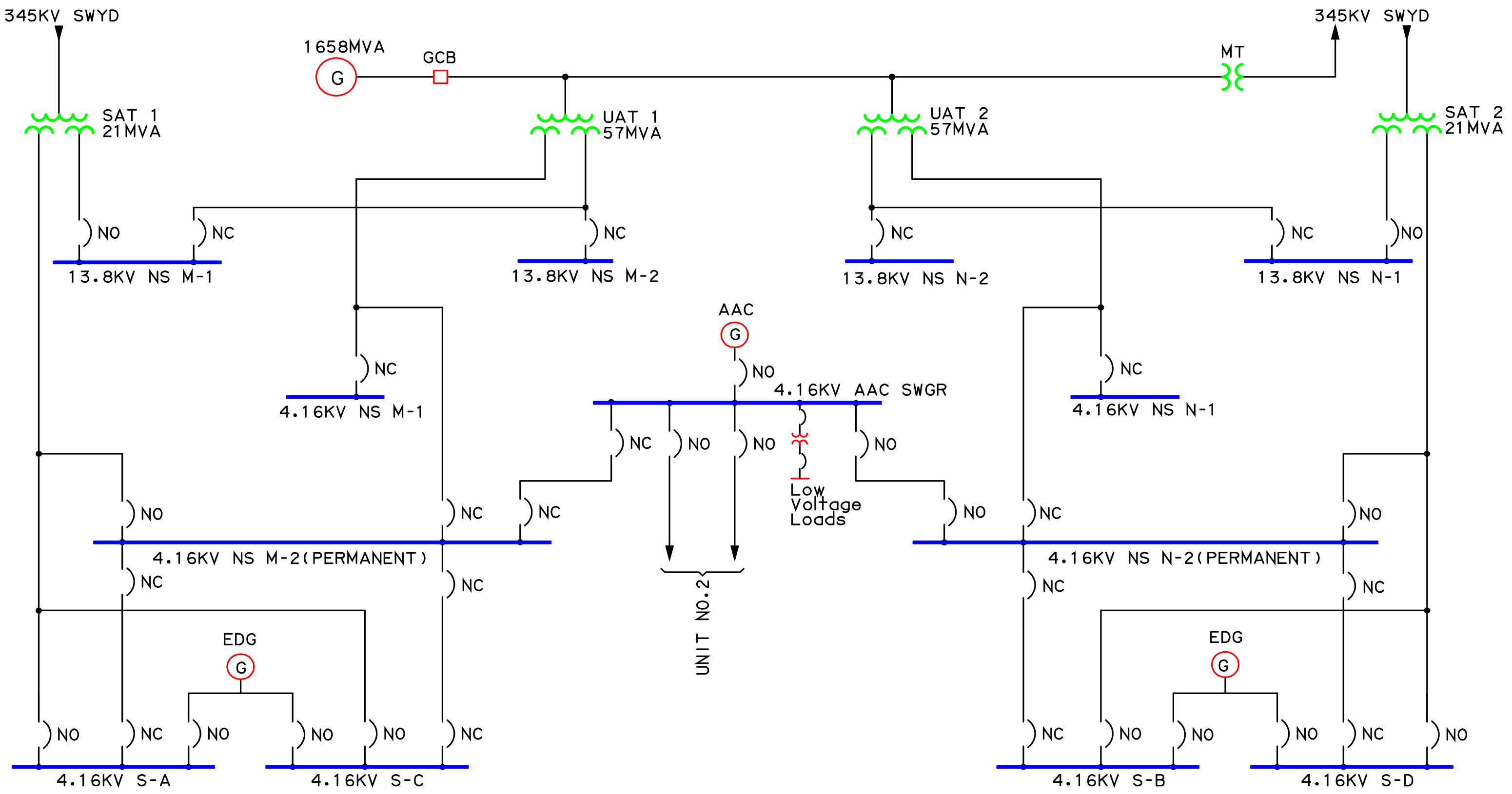
- 1 HP TBN & 3 LP TBNs
- Type : Tandem-compound
- Turbine speed : 1,800 rpm
- Output : 1,455 MWe
- Last stage blade : 52 inch

Generator

- Cooling
  - Stator winding : Water
  - Stator core, Rotor : Hydrogen
- Voltage : 24 kV, 3 Phase
- Frequency : 60 Hz

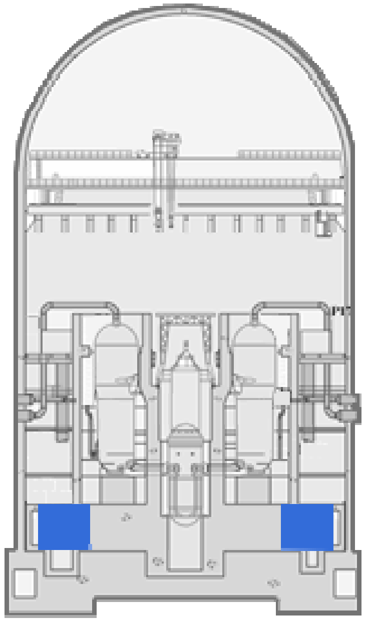
Secondary System Design

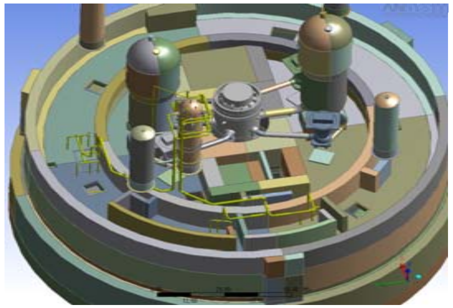
AC Power System



Containment Design

Cylindrical Containment with IRWST





Pre-stressed concrete structure

- **Height: 229.5 ft, Diameter: 150 ft, Thickness: 4 ft**
- **Design Pressure: 60 psig**

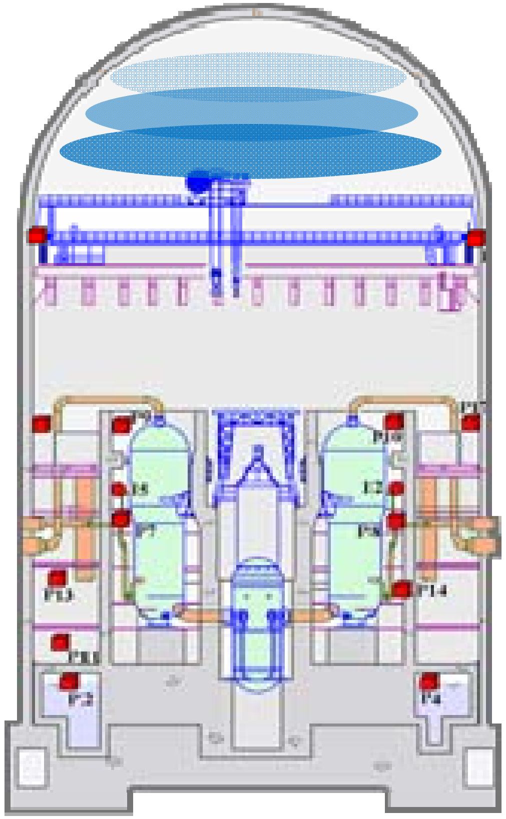
Steel-lined inner surface for leak-tightness

In-containment Refueling Water Storage Tank (IRWST)

- **Eliminates switch-over operation during LOCA**
- **Heat sink for feed and bleed operation**
- **Minimizes contamination of Reactor Containment Building**

Containment Design

Containment Protection System



Containment Spray System

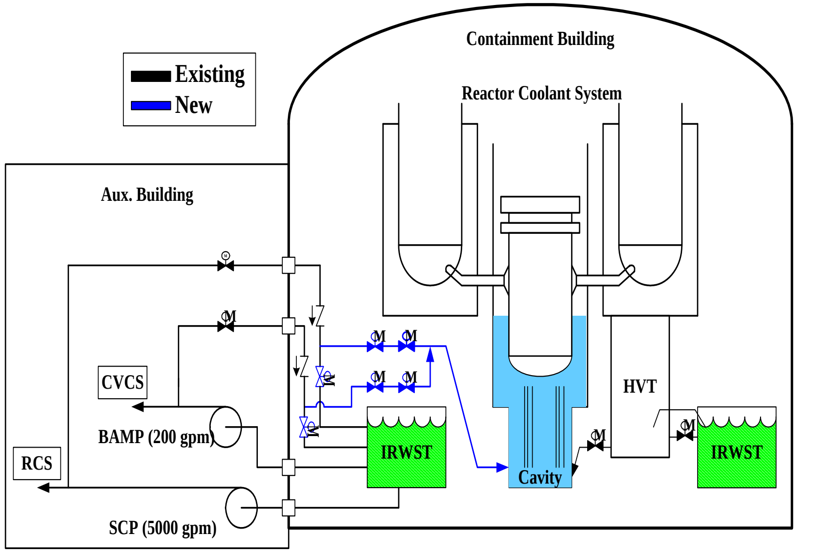
- Design characteristics
  - 2 pumps (Backed up by 2 SCPs)
  - Water source : IRWST

Containment Hydrogen Control System

- Functions
  - Maintaining hydrogen concentration below design criterion
- Design characteristics
  - 30 Passive Autocatalytic Recombiners(PAR)
  - 10 Glow plug type igniters

Containment Design

Severe Accident Mitigation System



External Reactor Vessel Cooling System for In-Vessel Retension (Active Feature)

Gravity Driven Cavity Flooding System for Ex-Vessel Coooling (Passive Feature)

Reactor Cavity Flooding System

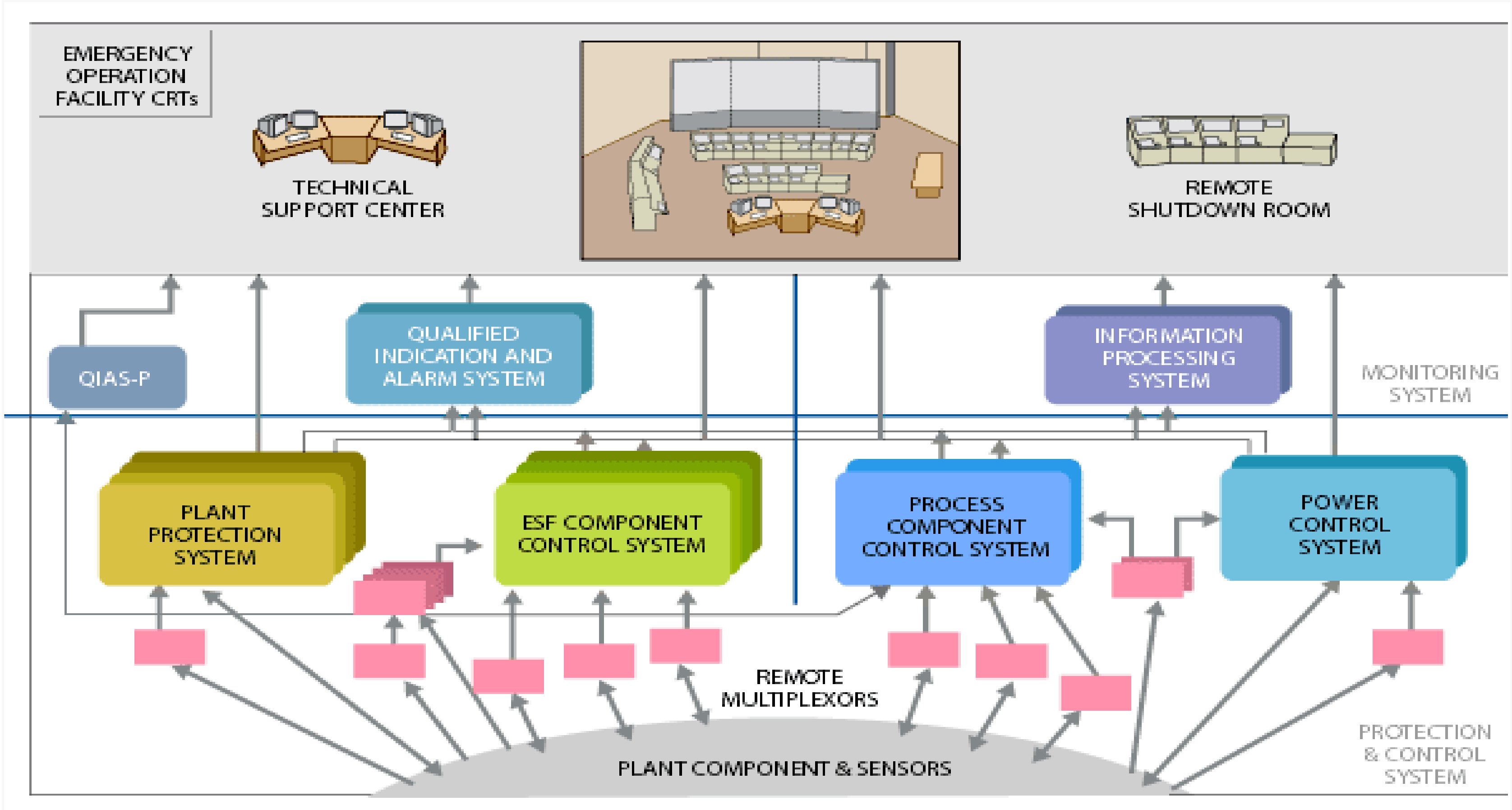
- Flooding reactor cavity to cool molten core
- Water Source : IRWST
- Water driving force : Gravity
- Designed in accordance with SECY-93-087
  - Cavity floor area > 0.02 ㎡/MW_t

In-Vessel Retention – ERVC strategy

- Submerging reactor vessel lower head to cool and to retain molten core in reactor vessel
- Water source : IRWST
- Water driving force : SCP, BAMP

MMIS

MMIS Overview



MMIS

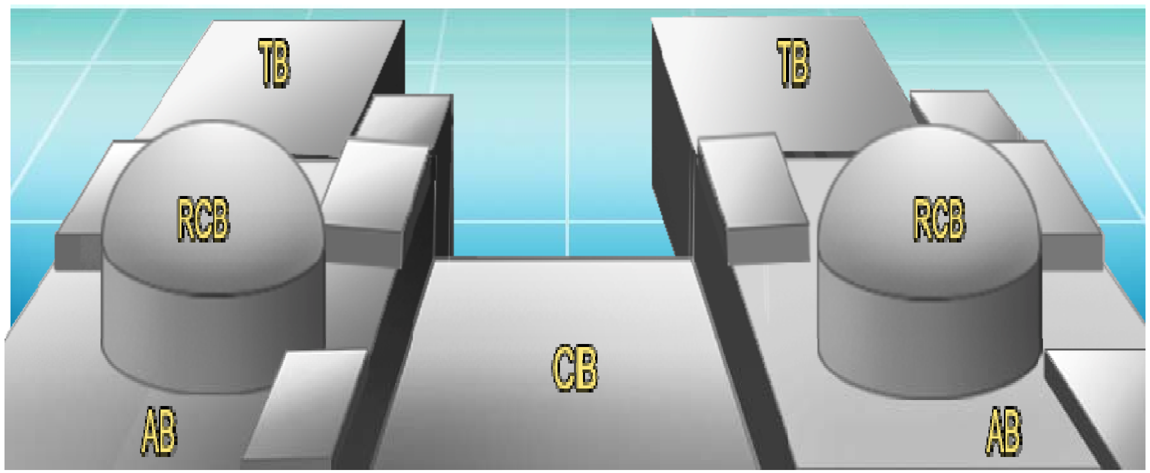
Major Characteristics

- Fully Digitalized Control System
- Remote Multiplexer for both Safety and Non-Safety Related Control Systems
- Redundant Compact Workstations
- Large Display Panel
- Safety Console to Backup Workstations
- Computerized Procedure System for Normal and Emergency Operations

Plant Layout

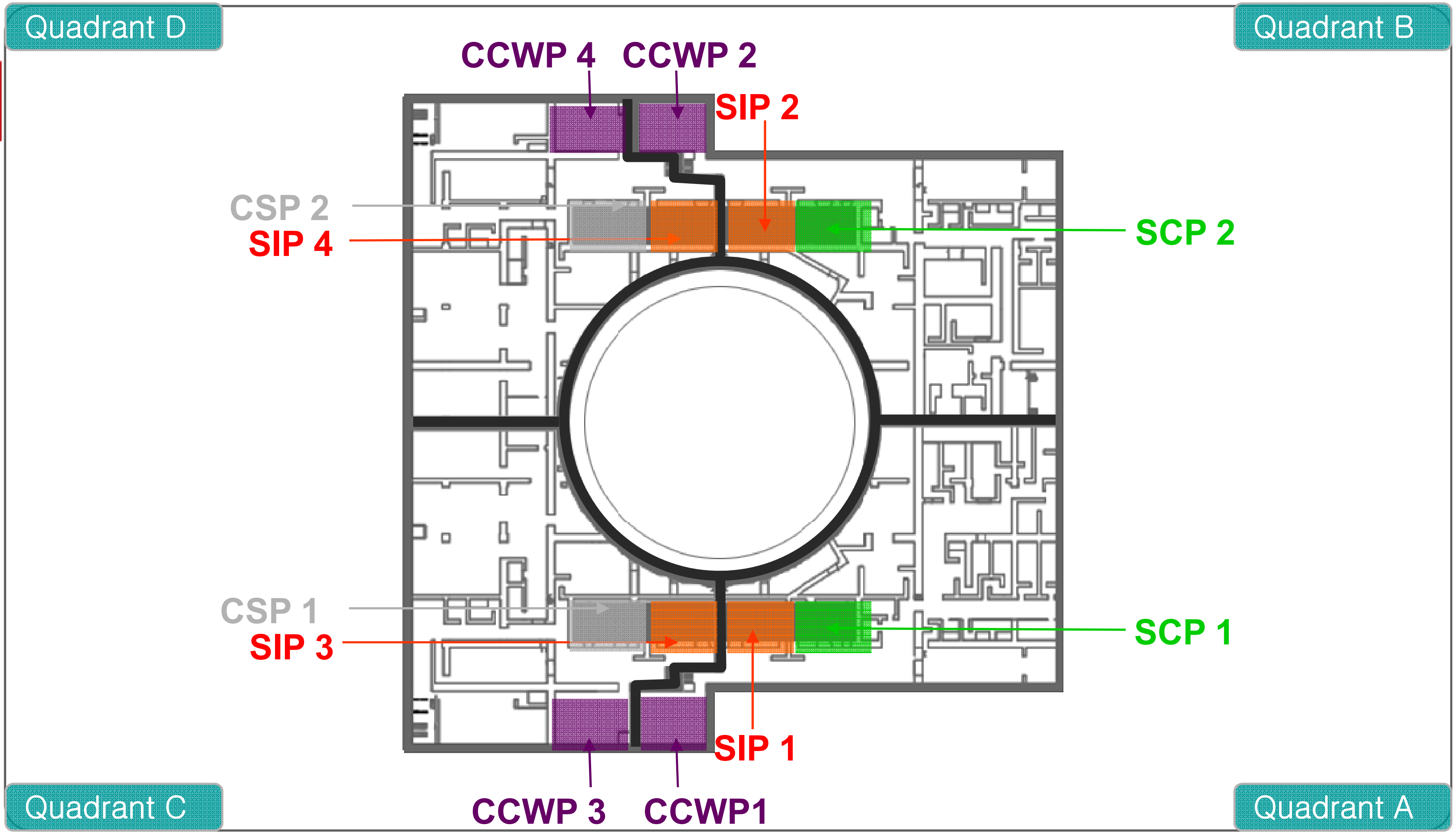
Slide-along Arrangement (2 units)

- **Reactor Containment Building (RCB)**
  - Pre-stressed cylindrical wall and hemi-spherical dome concrete structure
  - Wrapped around by auxiliary building
- **Auxiliary Building (AB)**
  - Quadrant arrangement to enhance safety
  - Accommodating MCR, Emergency D/G, Fuel handling facilities
- **Compound Building (CB)**
  - Accessible from both units
  - Housing common facilities of Access control, Radwaste treatment, Hot machine shop, etc
- **Turbine Building (TB)**
  - Steel structure with reinforced concrete turbine pedestal
  - Common tunnel for all underground facilities



Plant Layout

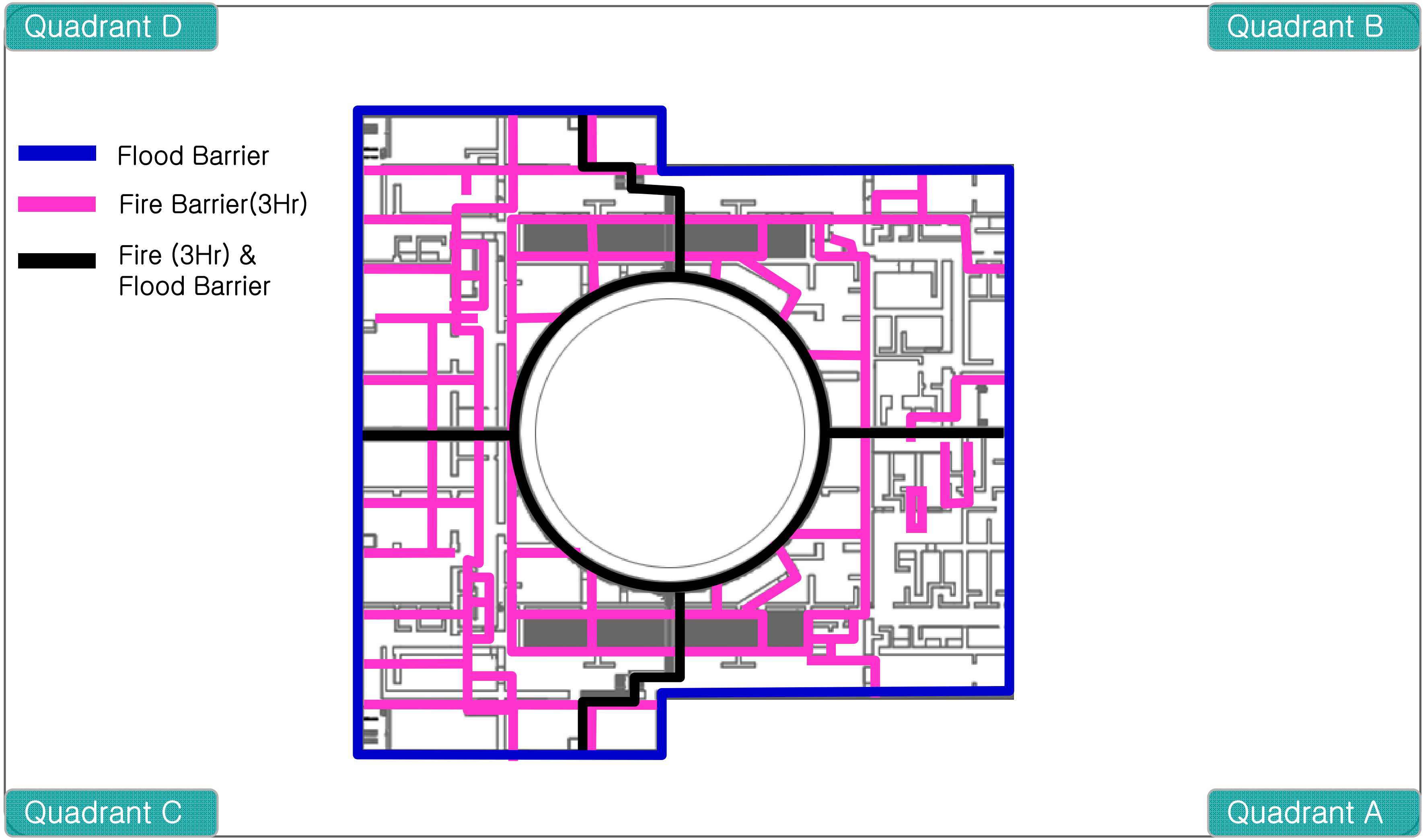
Quadrant Arrangement of Safety Components



SIP (Safety Injection Pump)   SCP (Shutdown Cooling Pump)   CSP (Containment Spray Pump)   CCWP (Component Cooling Water Pump)

Plant Layout

Fire and Flood Protection Design

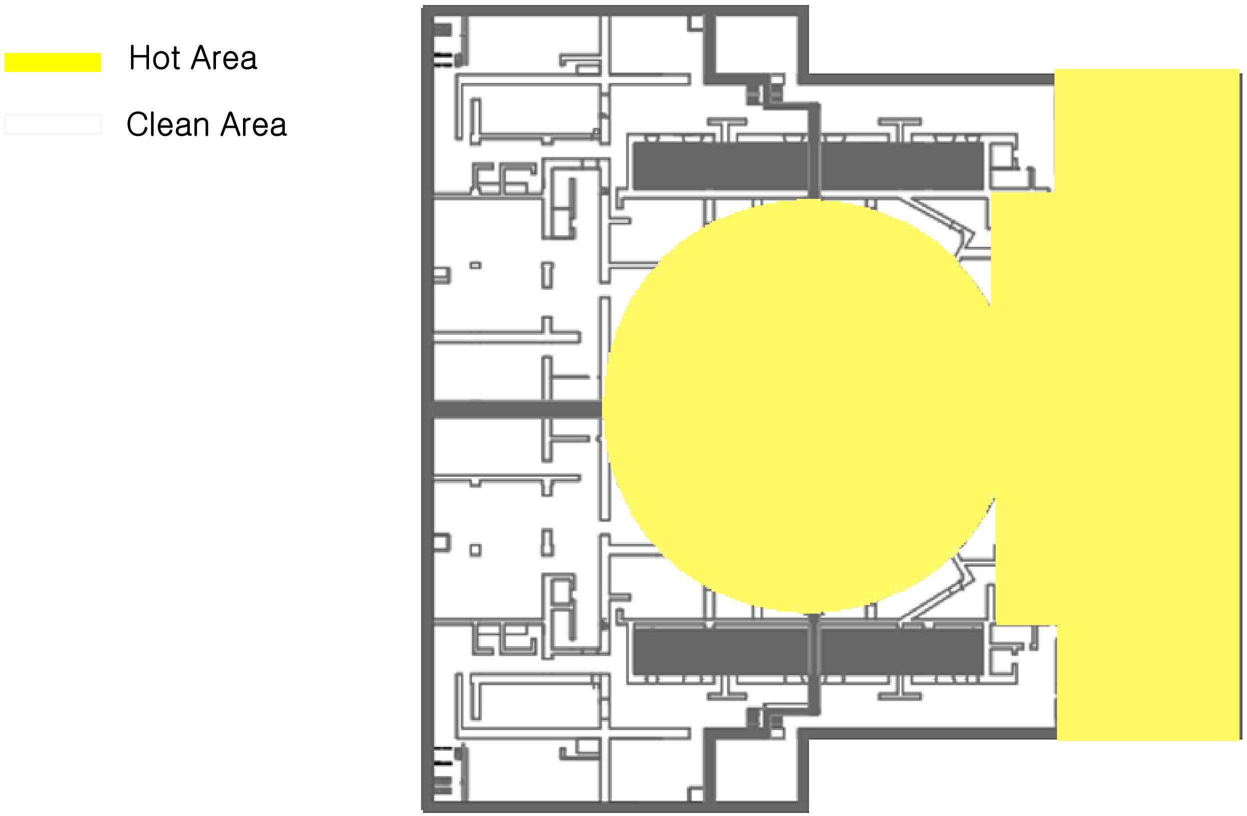


Plant Layout

Radiation Protection Design

Quadrant D

Quadrant B



Quadrant C

Quadrant A

Safety Analysis

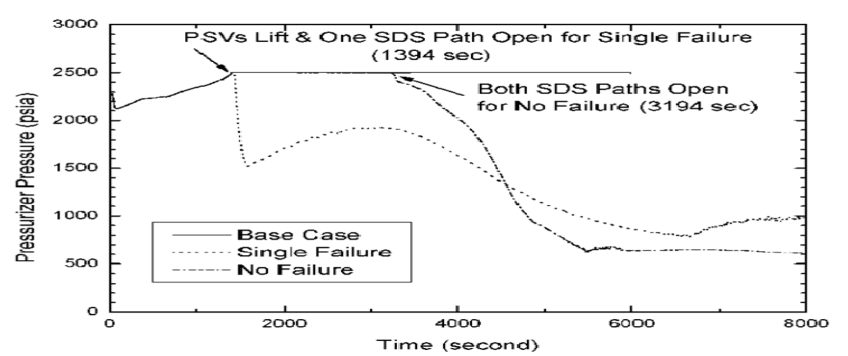
Deterministic Analysis

Design Basis Accidents (DBAs)

- **Pre-approved Conservative Analysis Methodology**
- **All Chapter 15 Accidents meet Acceptance Criteria with adequate Margin**

Beyond Design Basis Accidents (BDBA s)

- **Best Estimate Analysis Methodology**
- **APR1400 BDBAs**
  - **MSGTR (Multiple Steam Generator Tube Rupture)**
  - **TLOFW (Total Loss of Feedwater Flow)**
  - **ATWS (Anticipated Transient Without Scram)**
  - **CMF (Common Mode Failure)**



Safety Analysis

Deterministic Analysis

Shutdown Risk Evaluation

- **DBA & BDBA occurred during Operating Modes 2~6**
- **Quantitative Evaluation has been performed**
- **APR1400 Safety Analysis during Shutdown Mode**

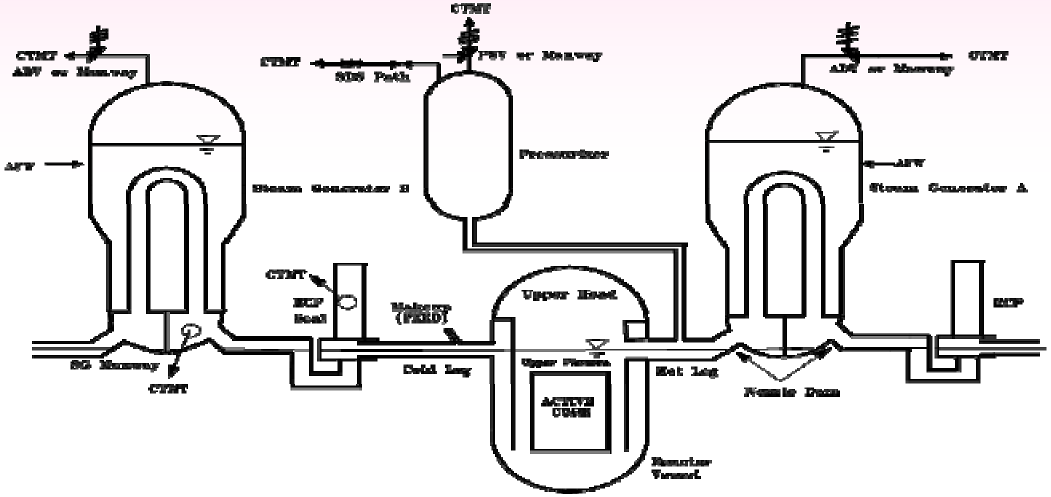
- Loss of Residual Heat Removal during Reduced Inventory Operation

- Loss of Residual Heat Removal during Refueling Operation

- Rapid Boron Dilution

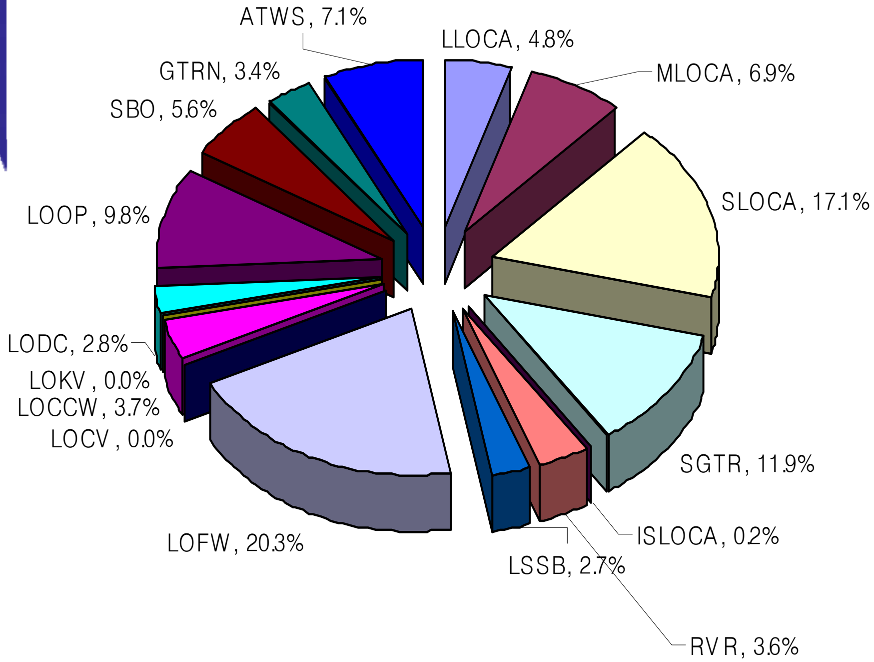
- Non-LOCA

- LOCA/MSLB Mass & Energy Release Analysis



Safety Analysis

PSA



No significant vulnerability

- **For all considered initiating events, the risk is not significant.**

Reduced the risk

- **4-train safety systems**
- **Quadrant separation**
- **Advanced design features**

Lower risk of APR1400

- **The CDF is 1/3~1/4 of conventional PWR**
- **The CFF is 1/4~1/5 of conventional PWR**

Summary

Enhanced Safety

- Increased thermal margin
- Physically separated quadrant arrangement of safety systems
- Adoption of new design features confirmed through design validation program
- Reinforced seismic design basis

Improved Cost Effectiveness

- Increased capacity factor and reduced unplanned trips
- Reduced construction time by advanced technologies
- Extended plant design life

Convenient Operation & Maintenance

- Full digitalized I&C system and operator-friendly man-machine interface
- Increased operator action time
- Reduced occupational radiation exposure

Unique Design Features

New Design Features

SIS and Supporting Experiments

PLUS7 Advanced Fuel

Digital I&C and MMIS

Human Factors Engineering Program

Severe Accident Mitigation

Summary

Initial Pre-application Meeting

New Design Features of APR1400 (1)

- **APR1400 is an evolutionary PWR**
- **Design features of System80+ that are improved from the operating plants are maintained and improved**
  - 4 train safety injection system
  - IRWST
  - Digital I&C
  - Severe accident mitigation evaluation

New Design Features of APR1400 (2)

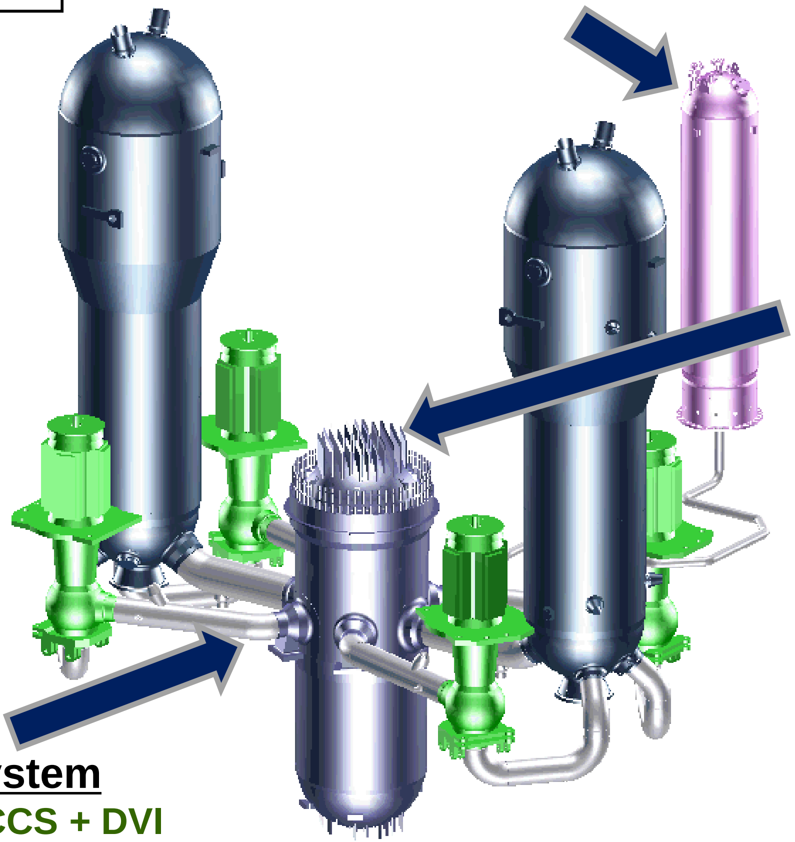
❑ Design features that are different from System 80+

- Prestressed concrete cylindrical containment
- Fluidic device in SIT to further enhance safety injection system performance
- Improved digital I&C and advanced control room design
- Plus 7 fuel
- Use of PAR/igniter for Hydrogen mitigation
- Design enhancement to better execute SAM strategies such as ERVC

Comparison with System 80$^+$

● **Thermal Power**
- System80$^+$: 3,931 MWt
- APR1400 : 4,000 MWt

● **RCS Depressurization Equipment**
- System80$^+$: 3 spring loaded PSV + 2 SDS
- APR1400 : 4 POSRV



● **RV Upper Structure**
- System80$^+$: Conventional
- APR1400 : IHA

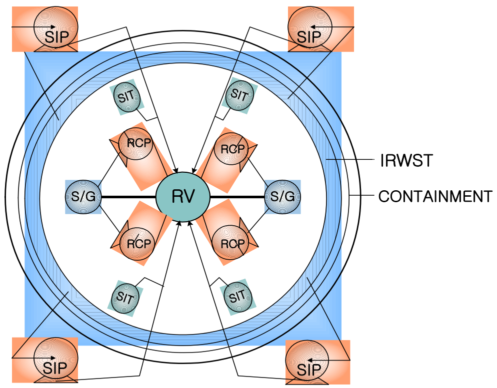
● **Safety Injection System**
- System80$^+$: 4 train ECCS + DVI
- APR1400 : 4 train ECCS + DVI + Fluidic Device

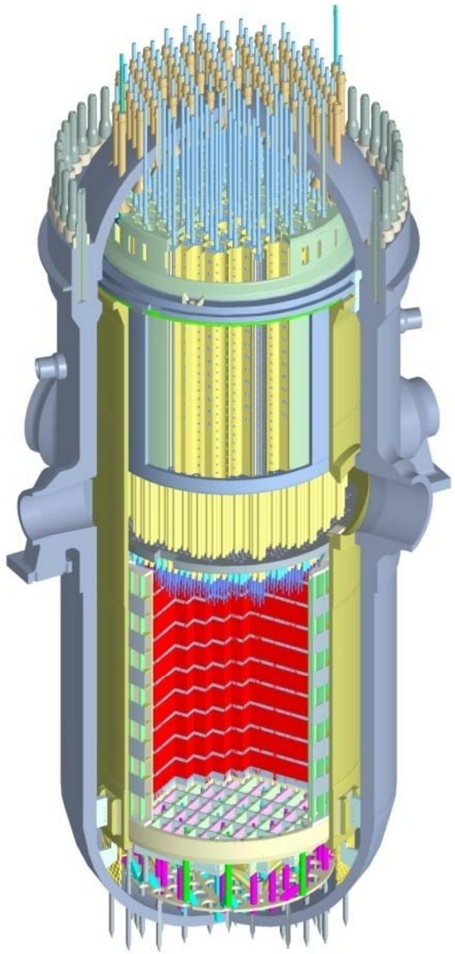
Safety Injection System and Supporting Experiments

- **4 train direct vessel injection system**
  - 4 safety injection tanks and pumps
  - Passive flow regulator in safety injection tank (fluidic device)
- **Test performed**
  - MIDAS test: ECC bypass during LBLOCA reflood phase
  - ATLAS test: LBLOCA integral test
  - VAPER test: full-scale performance test of the fluidic device
- **ECCS performance evaluation using BE + uncertainty quantification (RELAP5/Mod3.3) at the request of KINS**

Safety Injection System (1)

Direct Vessel Injection (DVI)



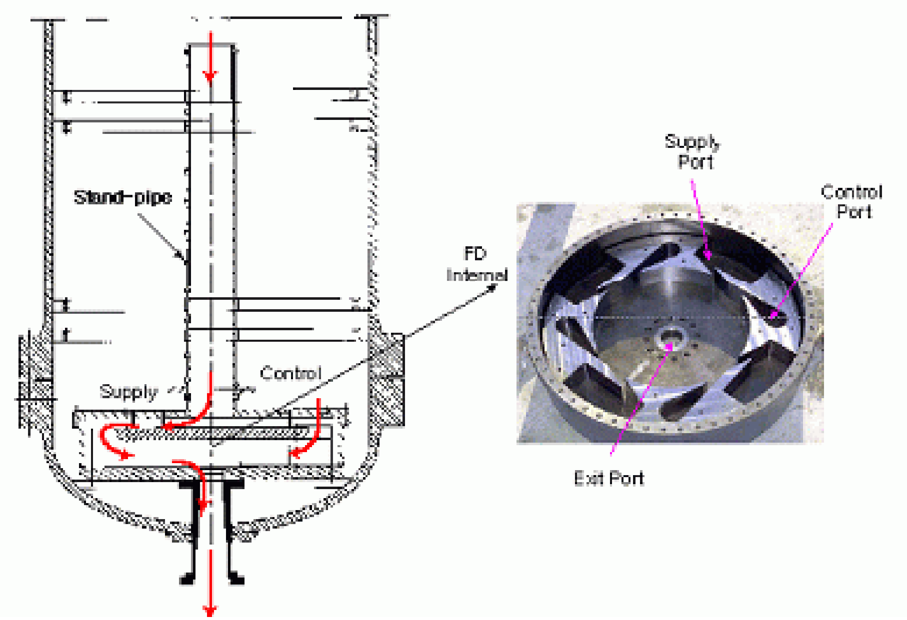


Direct Vessel Injection

- Unique T/H phenomena of ECC water
- ECC water bypass and downcomer boiling during LBLOCA

Safety Injection System (2)

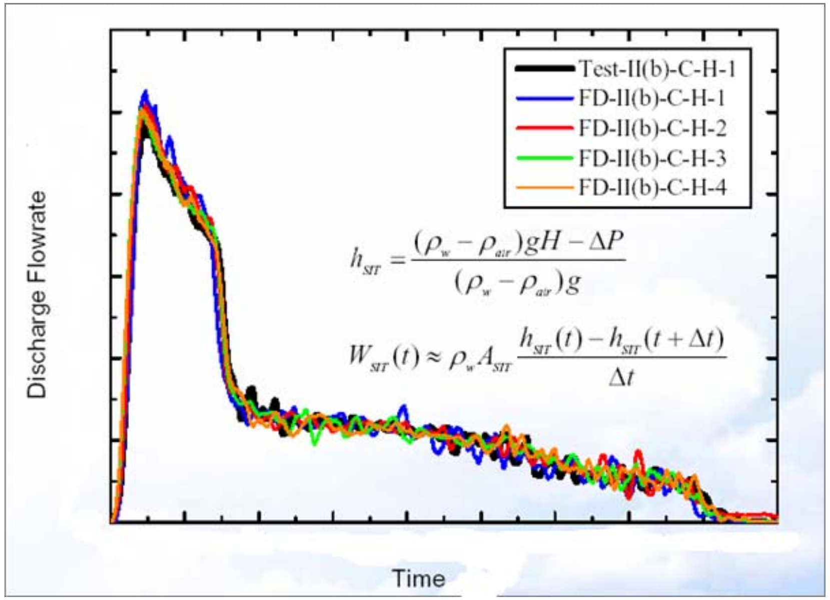
Fluidic Device (FD)



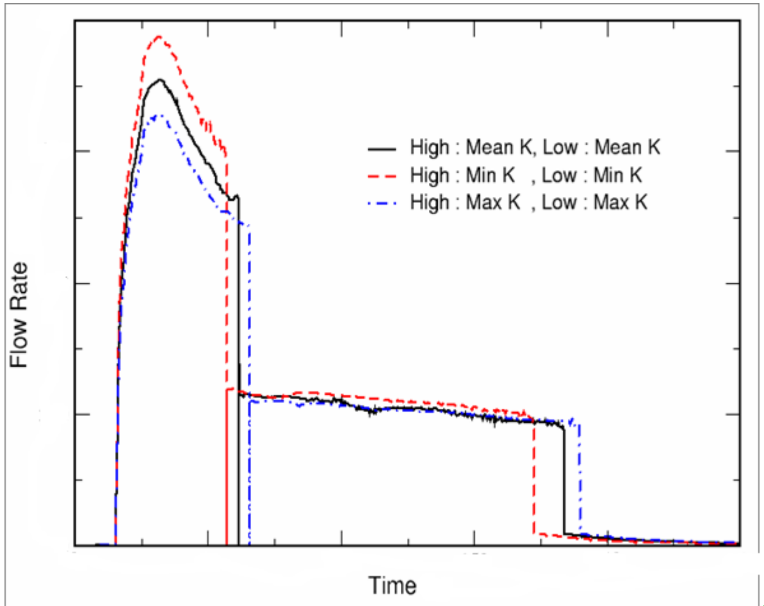
Fluidic Device

- Extend injection duration of SIT
- Based on vortex flow resistance
  - Standpipe: low resistance
  - Control port: high resistance
- Effect: Low pressure SIP removal

VAPOR: Performance Verification of Fluidic Device

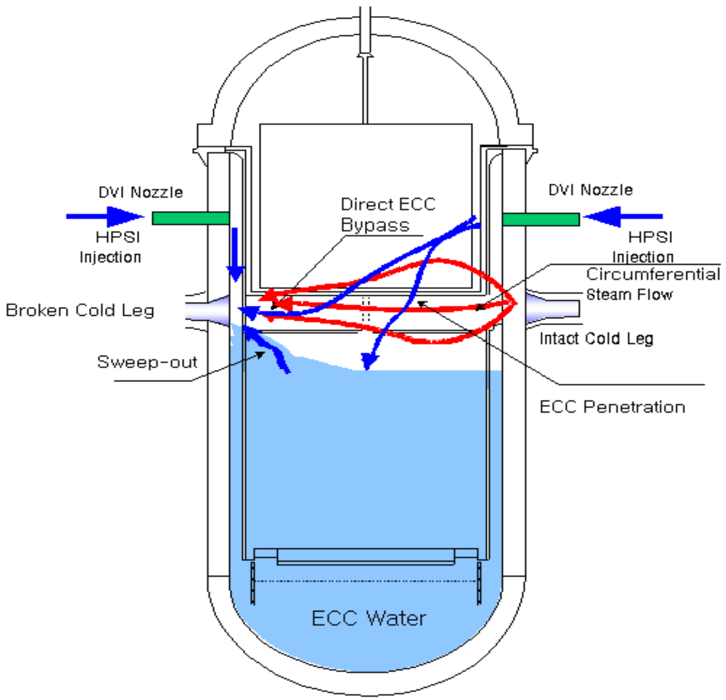


- **Scale : Full Dimension (18,000gallon), Full Pressure (600psia)**
- **K-factors for high/low flow are measured using tests**
  - Plant K-factors are calculated according to the pipe size



MIDAS Tests

Multi-dimensional Investigation in Downcomer Annulus Simulation

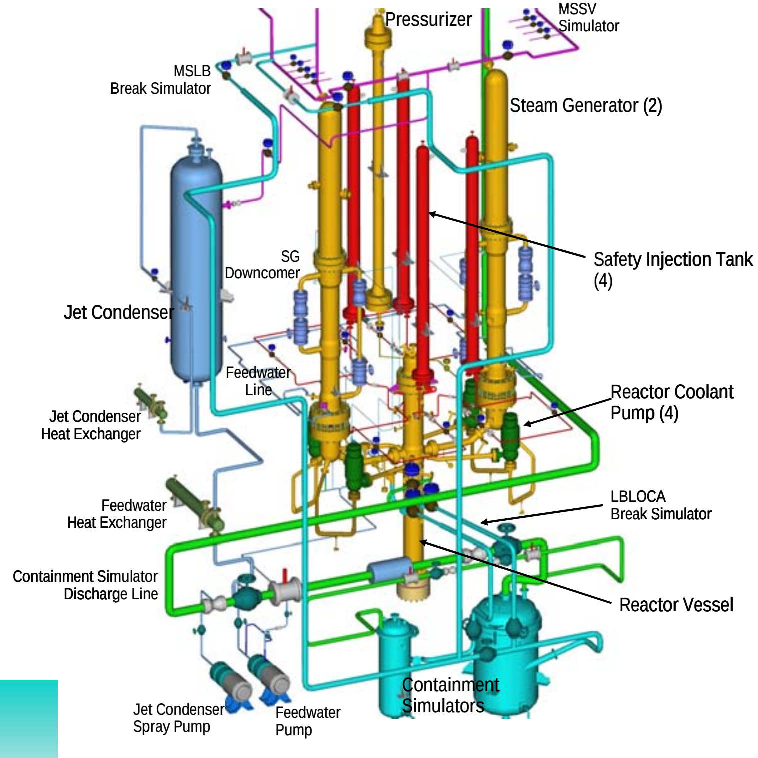


Examine/measure ECC bypass in reflood phase of cold-leg large break LOCA

- 1/5 linear scale (UPTF:1/4.08 linear scale)
- Steam-water (superheated and saturated steam) tests

ATLAS tests (1)

Integral Test Loop of APR1400



- State-of-the-art integral loop test facility
- Scale:1/2-height & 1/144-area of APR1400
- Test data useful for code benchmarking

ATLAS tests (2)

ATLAS LBLOCA Reflood Tests

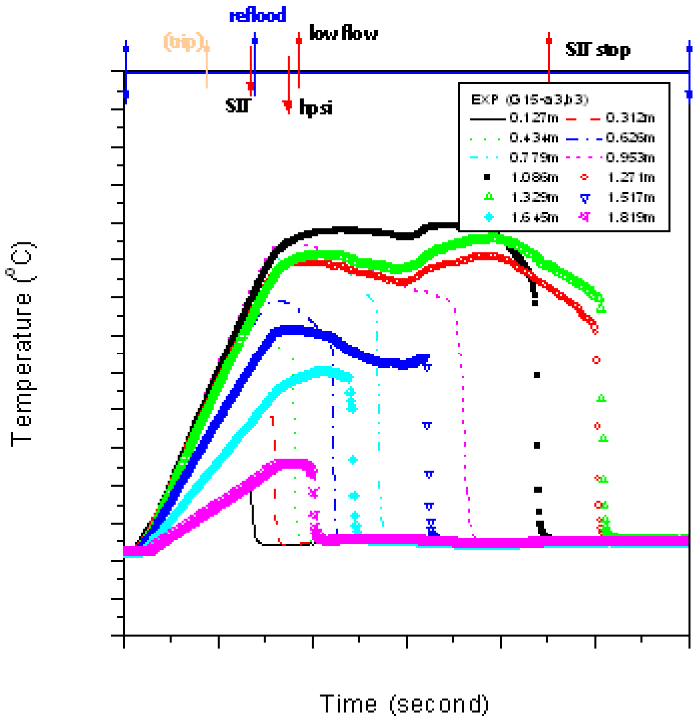
Phase Classification	Objectives	Test No.
Phase 1 :	Parametric effects on downcomer boiling at late reflood phase	Test No.1 ~ No.7
Phase 2 :	APR 1400 LBLOCA reflood test	Test No.8 ~ No.15

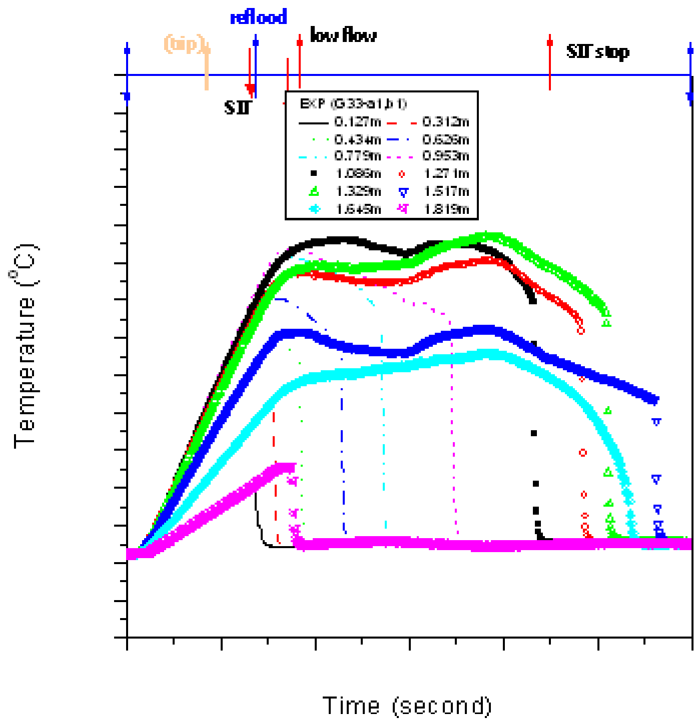
Test ID	Experimental conditions
Test No.9	APR1400 reflood test under conservative conditions (ANS-73*120%, lowest back pressure)
Test No.11	APR1400 reflood test under realistic conditions (ANS-79*102%, realistic back pressure)
Test No.15 (SET)	Typical reflood test with low reflooding rate

ATLAS tests (3)

LBLOCA Reflood Test

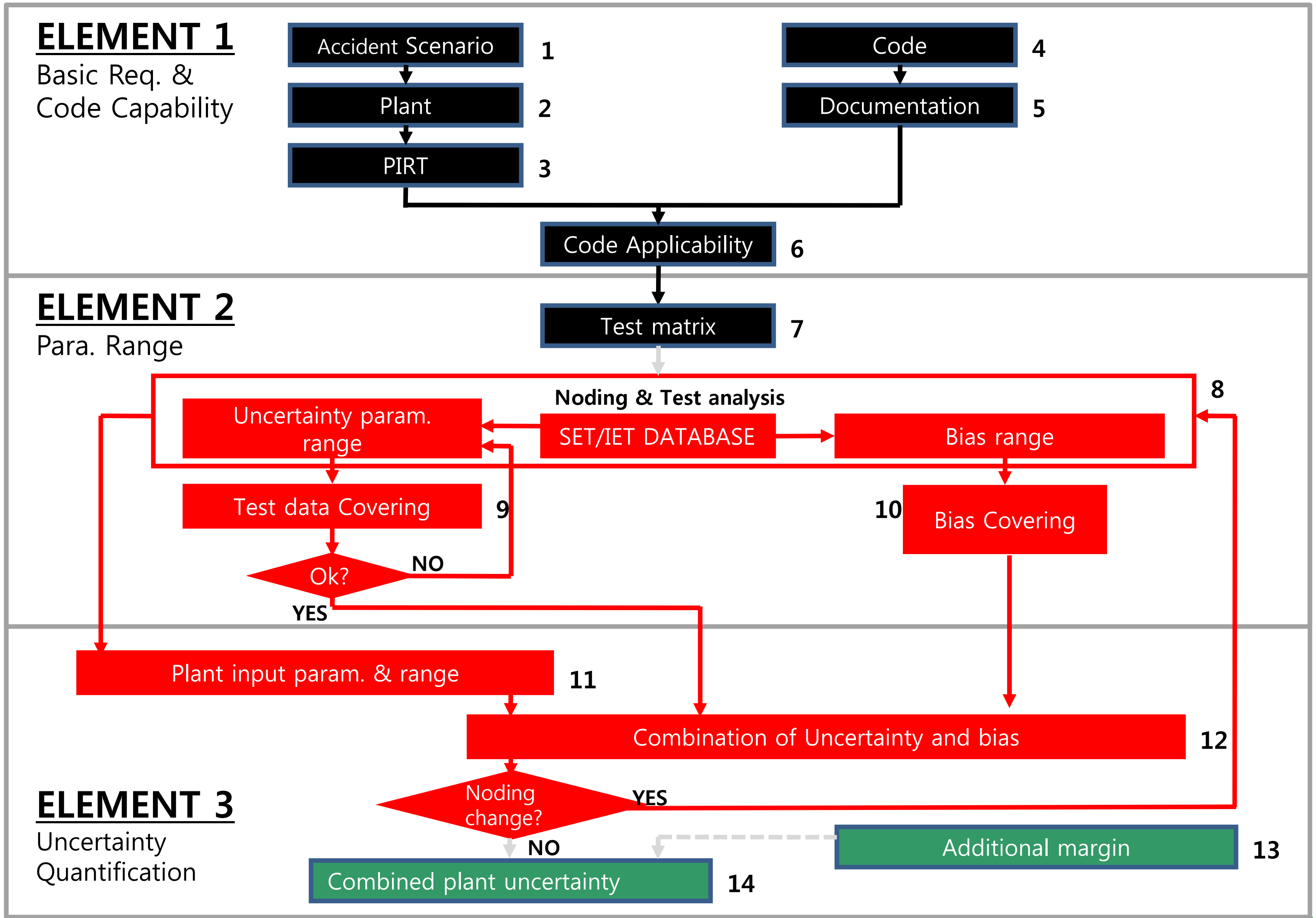
ATLAS - LBLOCA TEST





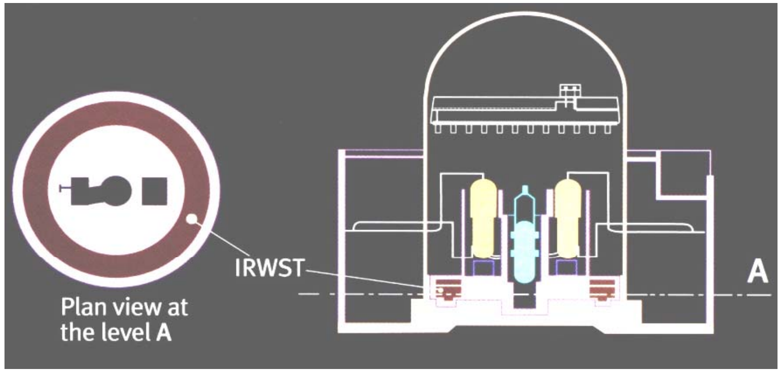
ECCS Performance Evaluation using BE + uncertainty quantification

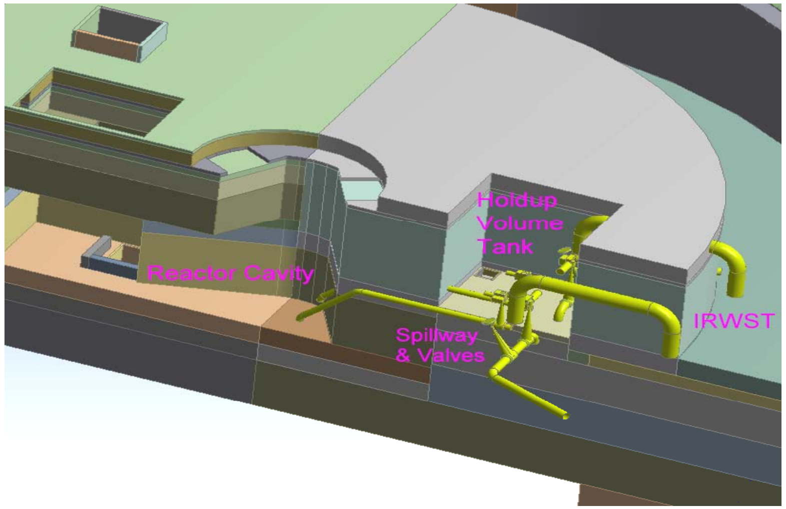
RELAP5/Mod3.3 + CONTEMPT (Base code), REM (Methodology)



IRWST Design and Sparger

In-containment Refueling Water Storage Tank (IRWST)





Functions

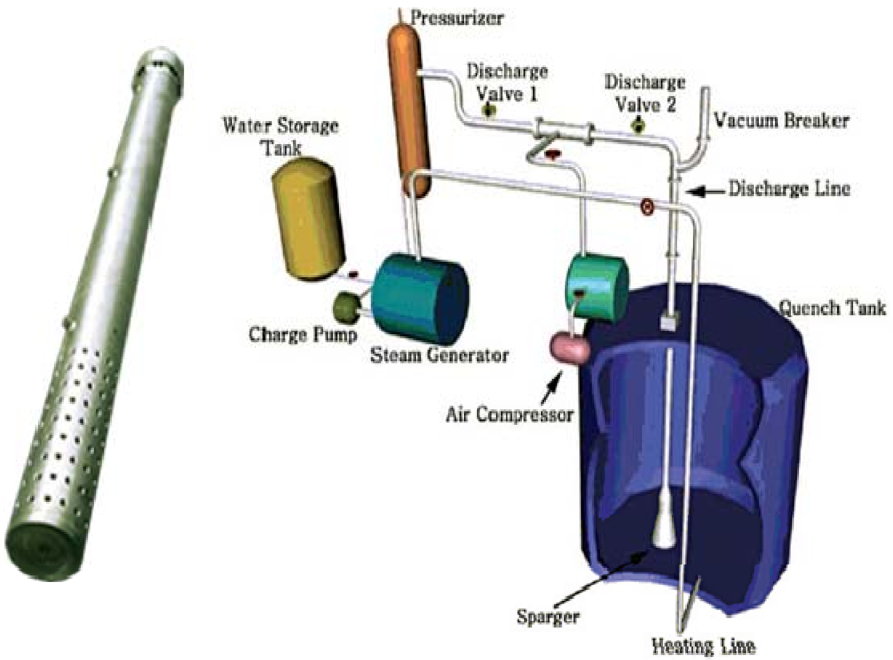
- **Borated Water Source for Refueling Pool**
- **Safety-Grade Water Source for Safety Injection and Containment Spray**
- **Heat Sink for Feed and Bleed Operation and Rapid RCS Depressurization**
- **Water Source for Reactor Cavity Flooding and External Reactor Vessel Cooling Systems**

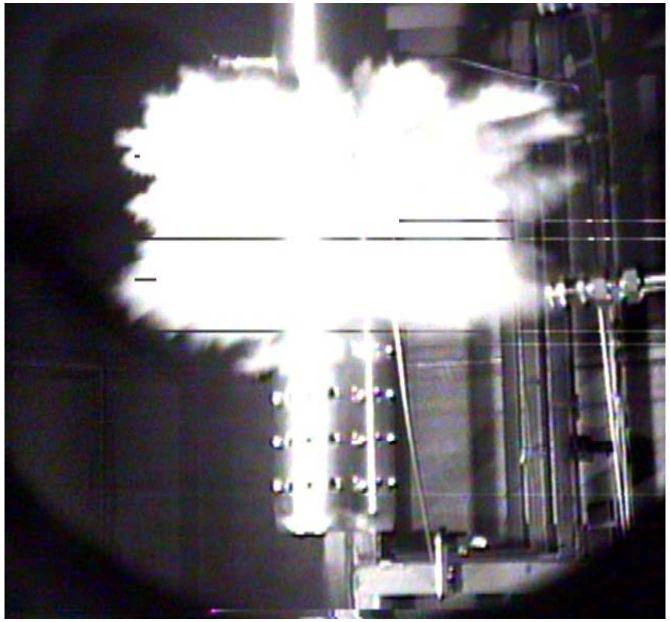
Eliminates switch-over operation during LOCA

Minimizes contamination of Reactor Containment Building

IRWST/Sparger Performance

Blowdown & Condensation Loop

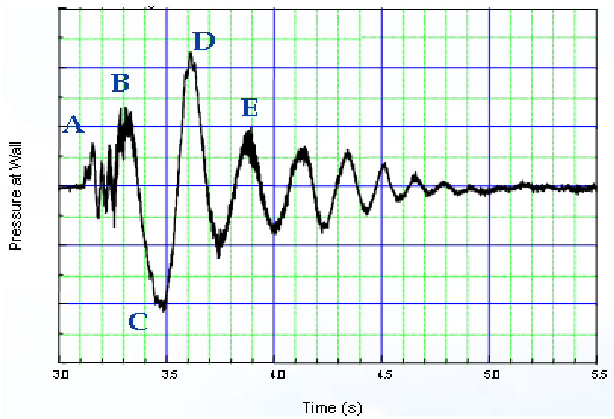




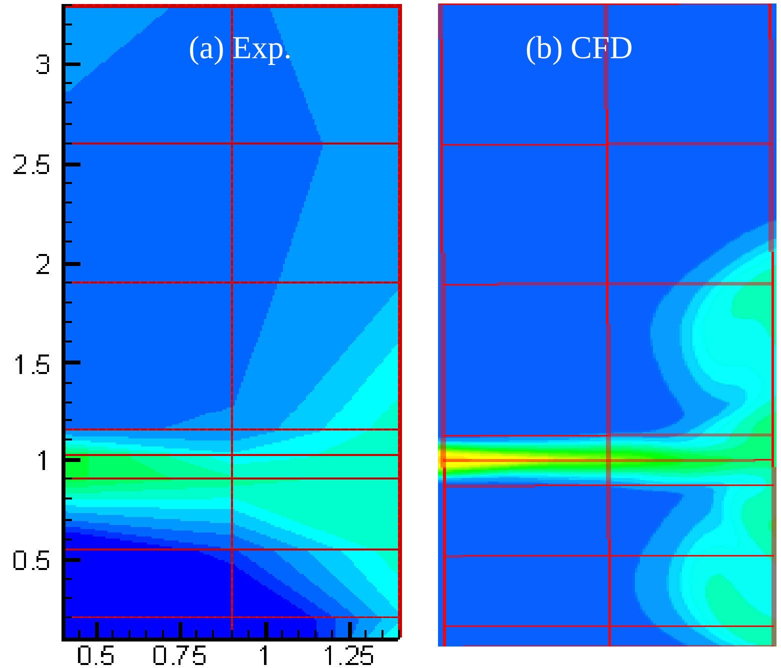
- Measure air, steam, and water blowdown load on SDVS & IRWST structures
- Investigate thermal mixing between discharged fluid and water in IRWST

IRWST/Sparger Tests

Test data used for code validation



Dynamic Load Test



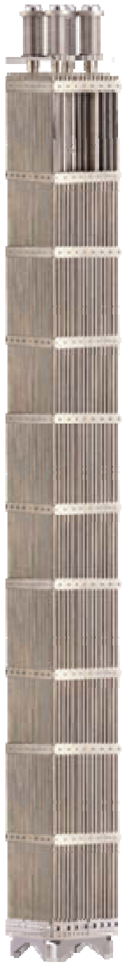
Thermal Mixing Test

PLUS7 Advanced Fuel (1)

Fuel Assembly

PLUS7
(16 x 16)

- Fuel Rods : 236
- Guide Tubes : 4
- Instr. Tube : 1
- Top Nozzle : 1
- Bot. Nozzle : 1
- Zry S/G : 10
- Inconel S/G : 1



- Enhanced Thermal Margin
- High Burn up
- Improved Neutron Economy
- Improved Seismic Resistance
- Reduced Grid-to-Rod Fretting Wear Susceptibility
- Increased Debris Filtering Efficiency
- Improved Fuel Productivity

PLUS7 Advanced Fuel (2)

Fuel Assembly – PLUS7

- **NPP for Use**
  - YGN 3,4,5,6 / UCN 3,4,5,6/ S-Kori 1,2/ SWN 1,2 (OPR1000)
  - Shin-Kori 3,4 (APR1400)
- **History**
  - Development Program Initiation : April 1999
  - Design & Out-of-pile Verification : March 2002
  - LTA In-Reactor Verification : September 2005
  - License and Region Application : July 2006
- **Proven in Operation**
  - 16 Batch Reloads for 8 Units

PLUS7 Advanced Fuel (3)

CHF Correlation

- **CHF Test**
  - Heat Transfer Research Facility at Columbia Univ., New York
- **Test Bundles**
  - Two 6x6 typical cell & thimble cell bundles
  - 11 mid-grids (9 Mixing vane grids)
- **Measured CHF Data : Total 219 CHF data**
- **Development of CHF Correlation**
  - The functional form : the same as CE-1 CHF correlation
  - The coefficients : determined based on the PLUS7 CHF data
- **KINS licensed the CHF correlation (2004. 05)**

Digital I&C and MMIS (1)

APR1400 MMIS Major Design Feature

- **Computer-based Advanced MCR**
- **Fully Digitalized NSSS and BOP I&C Systems**
- **PLC for safety and DCS for non-safety I&C Systems**
- **Human Factors Engineering Verification & Validation**
- **Computerized Operating Procedures**

Digital I&C and MMIS (2)

Advanced Control Room

- **Major components**
  - **- Redundant compact workstation with soft control**
  - **- Large display panel**
  - **- Advanced alarm system**
  - **- Safety console**
    - **· Backup for common mode failure**
  - **- Computerized procedure system**

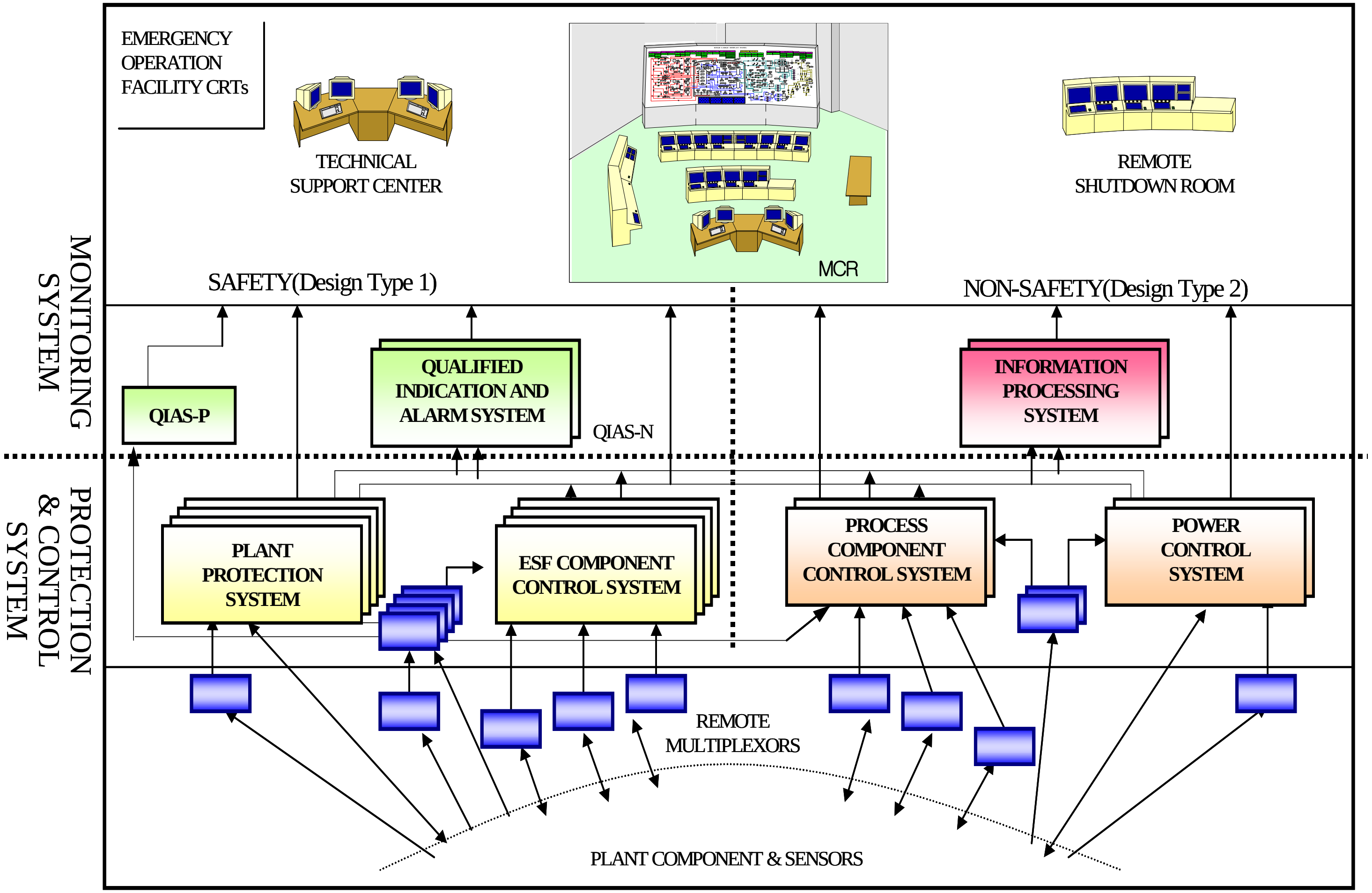
Digital I&C and MMIS (5)

APR1400 MMIS Major Design Feature

- **Monitoring System**
  - IPS (Information Processing System)
  - QIAS (Qualified Indication and Alarm System)
- **Control System**
  - ESF-CCS (Engineered Safety Feature-Component Control System)
  - P-CCS (Process-Component Control System)
  - PCS (Power Control System)
- **Protection System**
  - PPS (Plant Protection System)
  - CPCS (Core Protection Calculator System)
  - DPS (Diverse Protection System)

Digital I&C and MMIS (4)

APR1400 MMIS Architecture



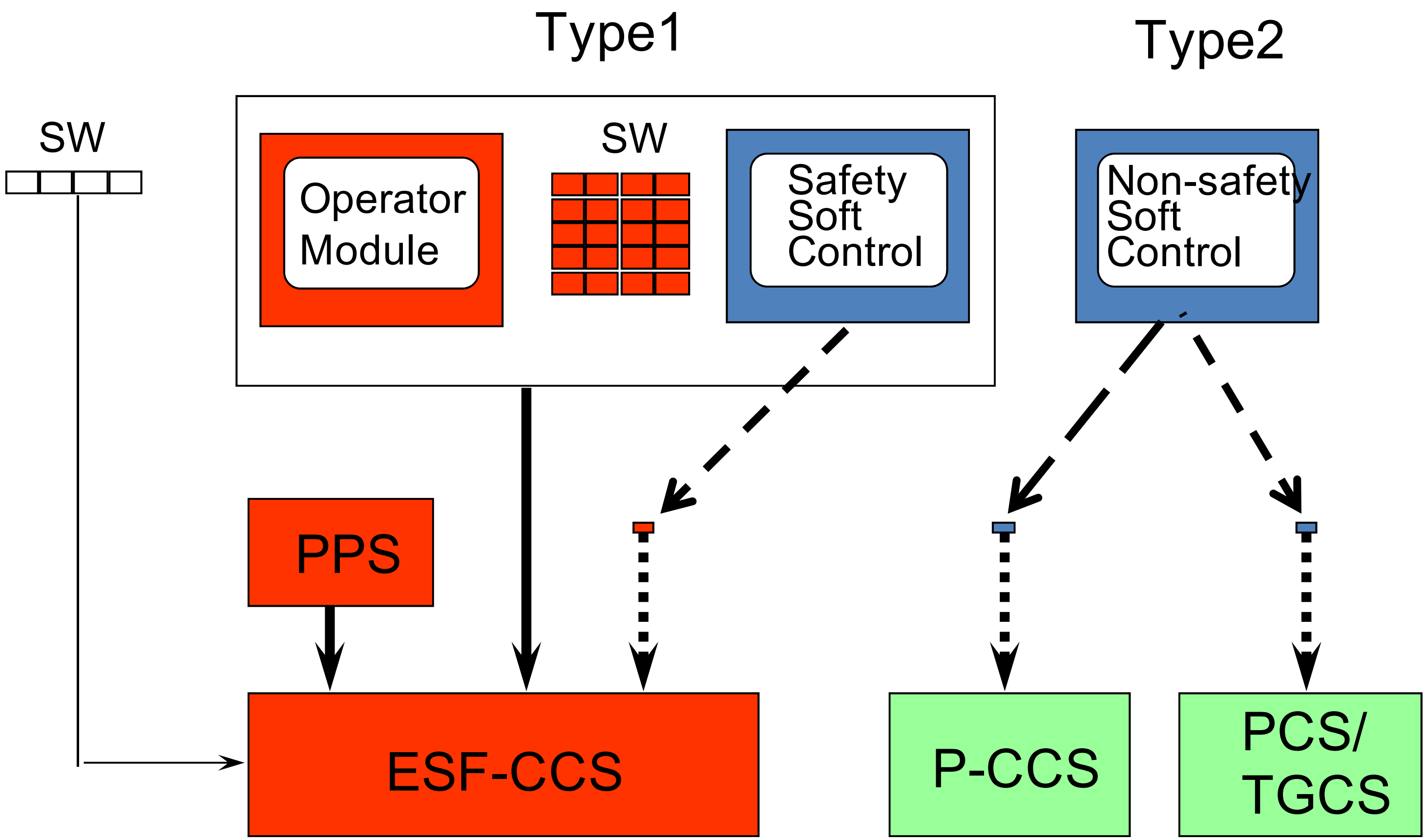
Digital I&C and MMIS (6)

Soft Control

- Replaces the conventional dedicated pushbuttons and M/A stations
- Allows operators to conveniently access all components for safety systems as well as non-safety systems during normal operation
- Safety related Soft Control is implemented on the ESF-CCS FPDs
- Non-safety related Soft Control is implemented on the information FPDs by selecting the corresponding control template on a display screen window

Digital I&C and MMIS (7)

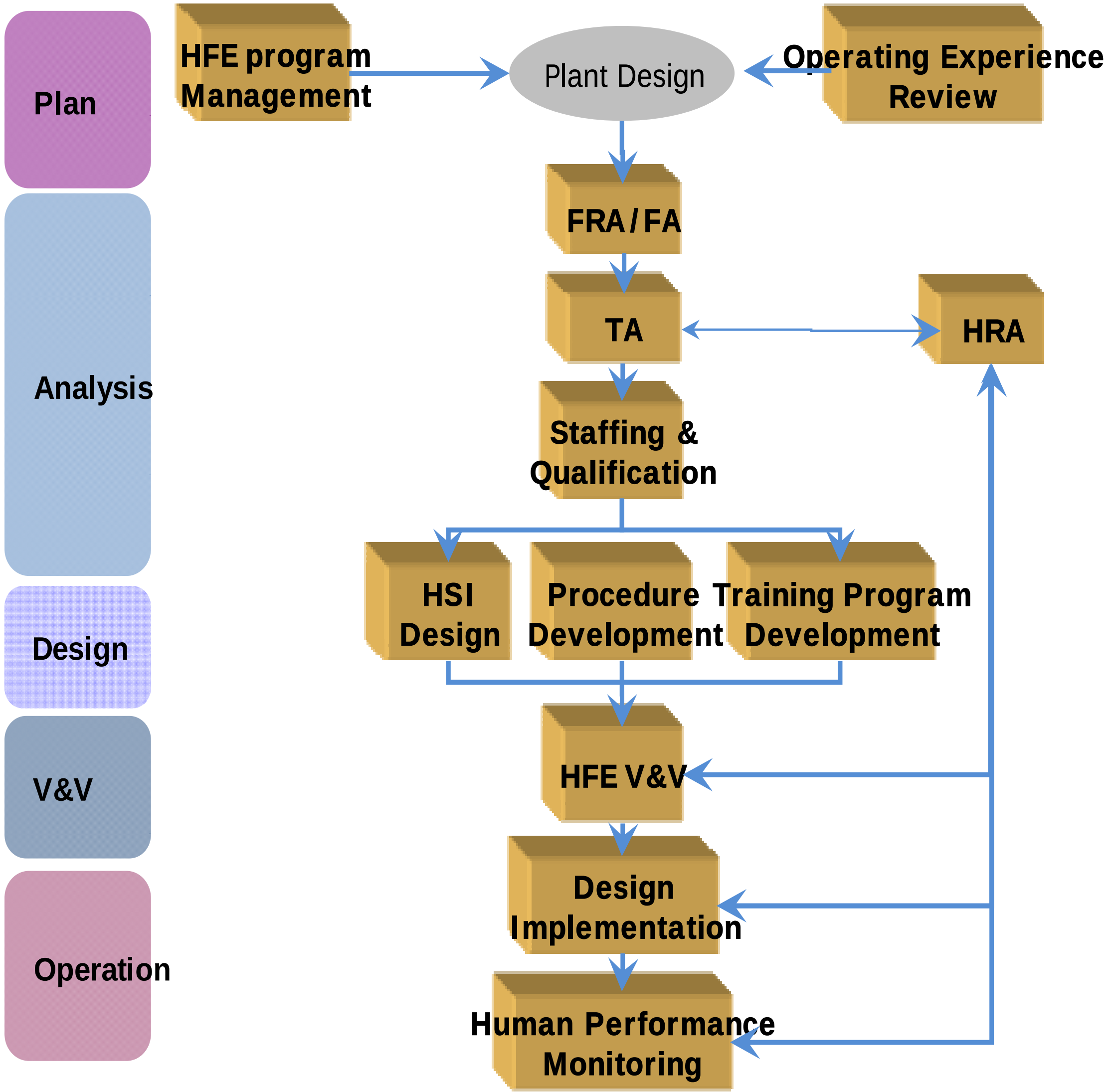
Control System



Human Factors Engineering Program (1)

HFE Verification and Validation (V&V)

- ❑ **HFE Program Review Model- NUREG-0711 requests HFE V&V to ensure**
  - that the design conforms to HFE design principles.
  - that operator performance and reliability are acceptably supported in order to achieve safe operation of the plant.

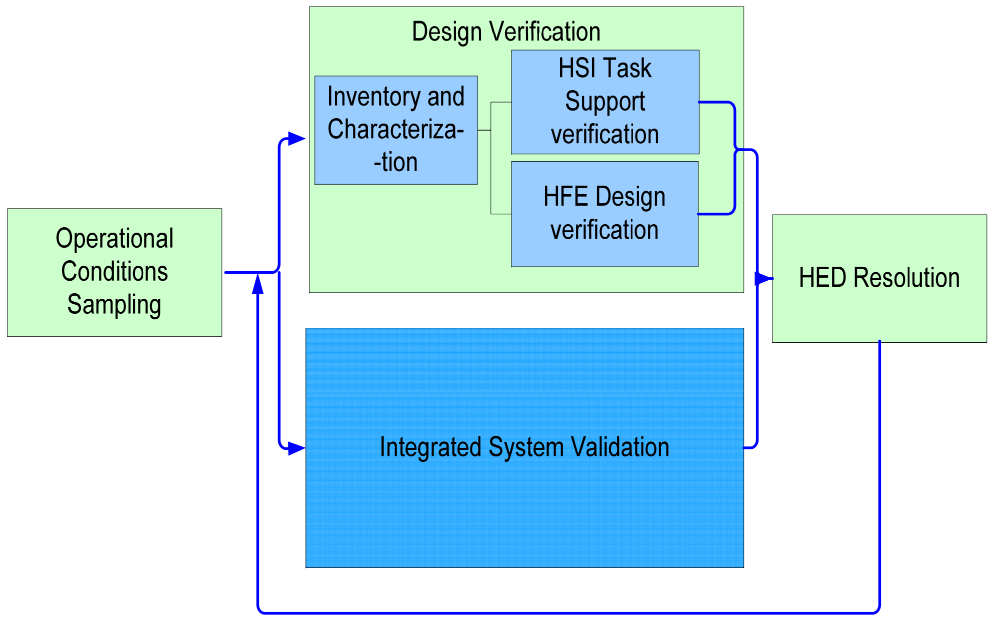


Human Factors Engineering Program (2)

Integrated System Validation (ISV)

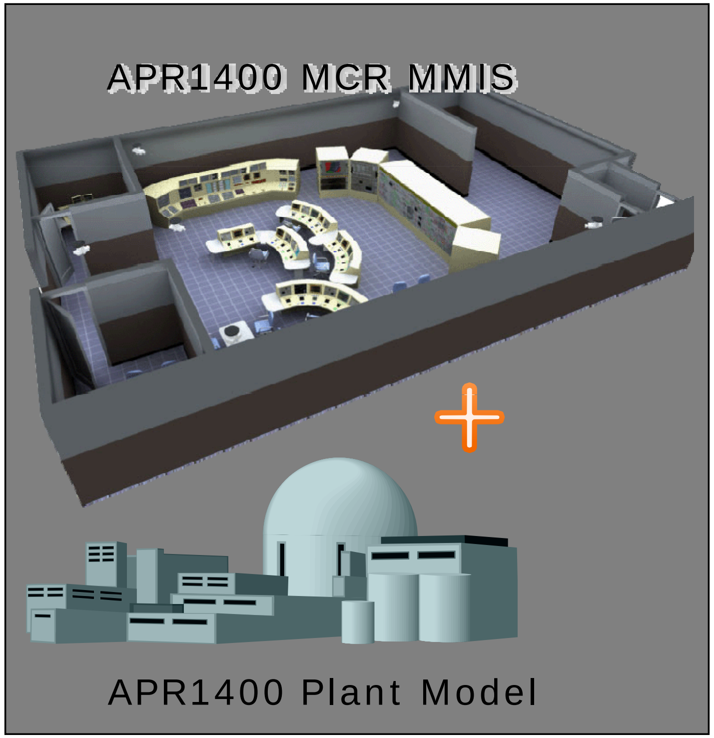
❑ HFE Program Review Model- NUREG-0711

- **To ensure that the HSI inventory and characterization accurately describes all HSI displays, controls, and related equipment.**
- **To ensure that the HSI provides all alarms, information, and control capabilities required for personnel tasks.**
- **To ensure that the characteristic and design of the HSI conform to HFE guideline**
- **To ensure that the HSI designs are effectively, safely operated by plant operators within all performance requirements.**



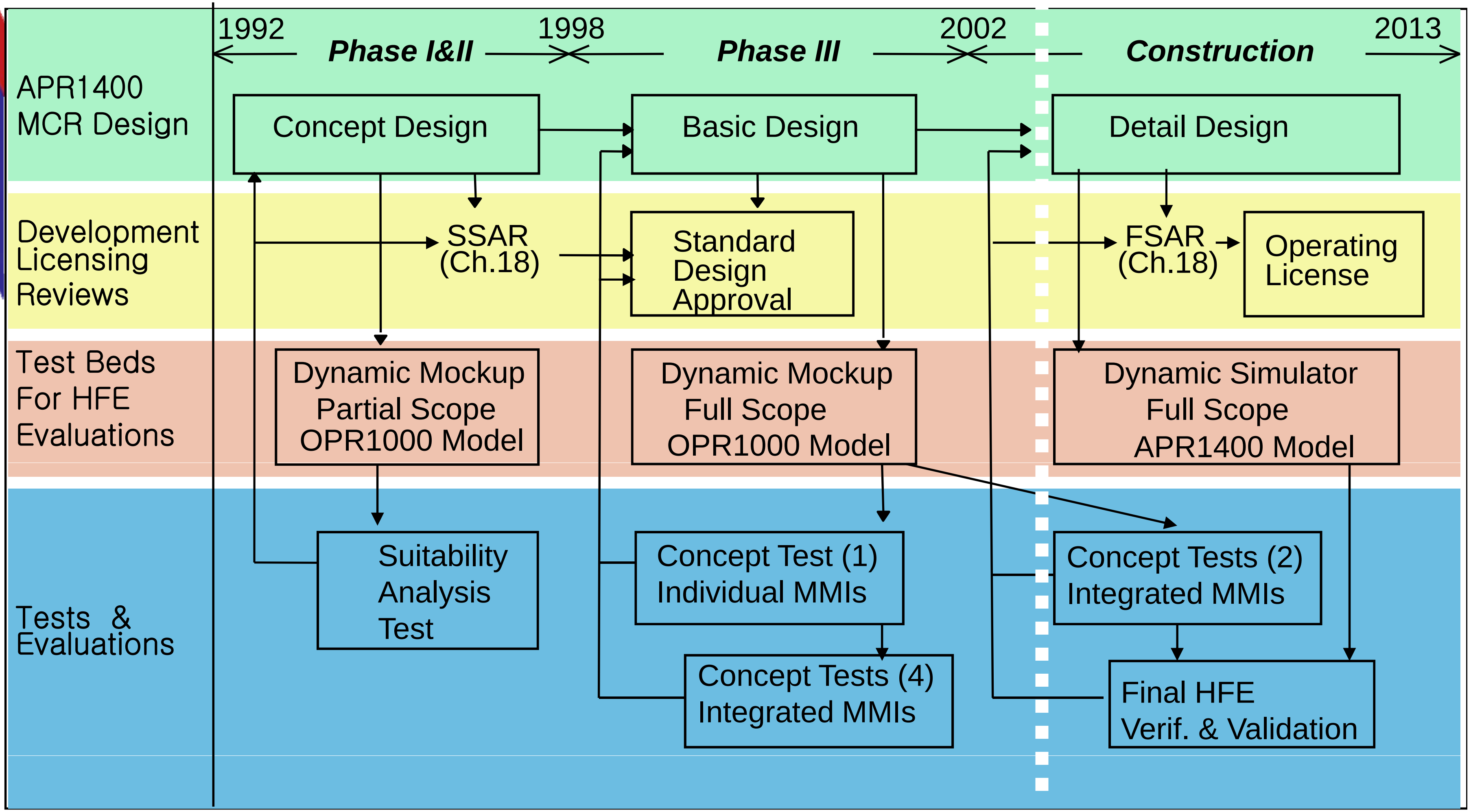
Human Factors Engineering Program (3)

Integrated System Validation (ISV)



Human Factors Engineering Program (4)

HFE Evaluation Activities (V&V)



Severe Accident Mitigation (1)

- **Severe accident mitigation features are evaluated based on SECY93-087 as a part of standard DA in Korea**
  - SSAR Chap 19.2
  - System 80+ approach was adopted for most cases
- **HPME**
  - Safety depressurization system that depressurize to 250 psi
  - Cavity design: convoluted flow path, corium chamber
  - Evaluation using MAAP4 and TCE model/Contain1.2
- **H2 Mitigation**
  - PARs with igniters to meet the 10CFR50.34f
  - Evaluation using MAAP4 with GOTHIC code

Severe Accident Mitigation (2)

- **Steam explosion**
  - Tracer2 code used for the steam explosion load consideration

- **Debris cooling and containment response**
  - Cavity flooding system is provided with the gravity feed from IRWST
  - Corium concrete attack is evaluated using MAAP4 and MELCOR

Severe Accident Mitigation (3)

- **Equipment Survivability**
  - Equipment important to severe accident management is examined against accident environment including hydrogen burn
- **Severe Accident Management Guidance**
  - All nuclear power plants in Korea have implemented SAMG
  - It is based on EPRI TBR and WOG SAMG
  - For APR1400, we strengthened the capability of external cooling of RPV by making design improvement

Summary

- ❑ **New Advanced Design Features have been Successfully Incorporated into APR1400 Design.**

- ❑ **Advanced Design Features have been validated through rigorous Validation Programs.**

- ❑ **Plant Safety and Operation & Maintenance have been Enhanced with Advanced Design Features.**

High Performance Fuel

Nuclear Fuel Supply System

Fuel Supply History

Fuel Performance

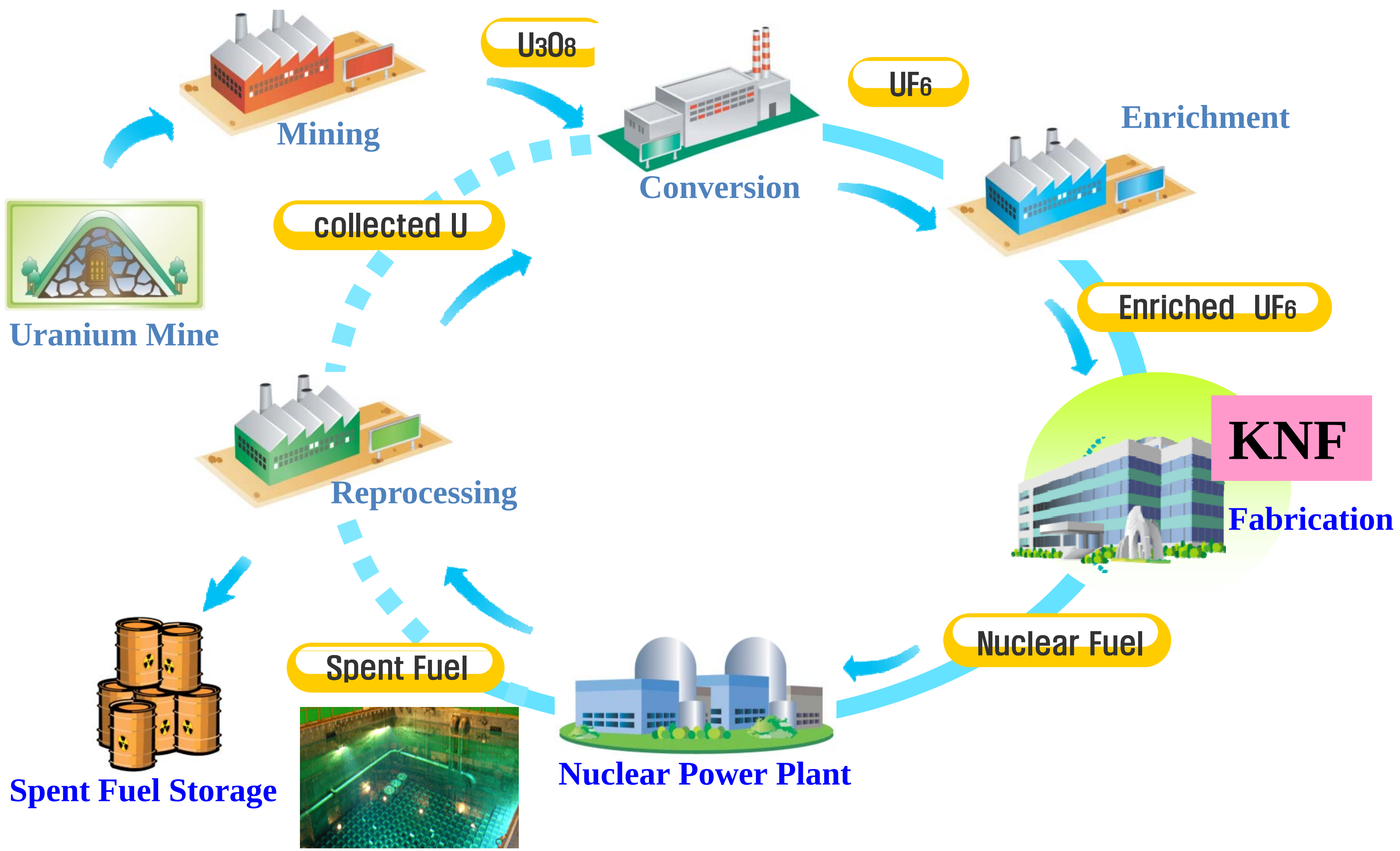
Fuel Fabrication Plants

Tube Mill

Fuel Technology

Nuclear Fuel Supply System

Nuclear Fuel Cycle

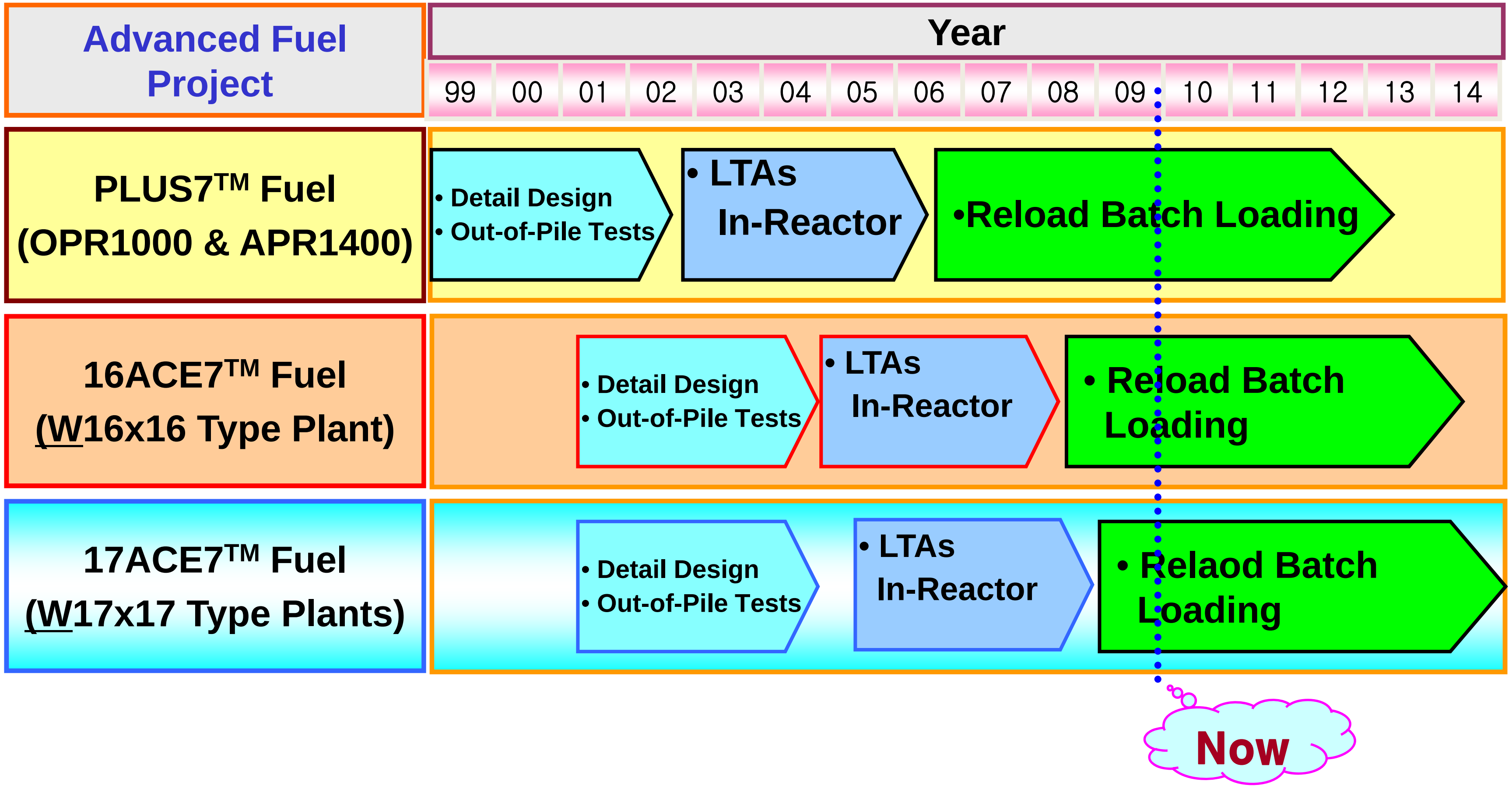


Fuel Supply History

NPP type		Plant	FA type	1990 – 1995 – 2000 – 2005 – 2010 – 2016 – 2020
PWR	W Type	Kori 1	14x14	Fuel Import → KOFA → OFA
		Kori 2	16x16	Fuel Import → KOFA → STD → 16ACE7 → X_3-Gen
		Kori 3/4	17x17	Fuel Import → KOFA → V5H → RFA → 17ACE7 → X_2-Gen
		YGN 1/2	17x17	Fuel Import → KOFA → V5H → RFA → 17ACE7 → X_2-Gen
		UCN 1/2	17x17	Fuel Import → KOFA → V5H → RFA → 17ACE7 → X_2-Gen
	OPR1000 (CE Type)	YGN 3/4	16x16	STD → Guardian → PLUS7 → HIPER
		YGN 5/6	16x16	STD → Guardian → PLUS7 → HIPER
		UCN 3/4	16x16	STD → Guardian → PLUS7 → HIPER
		UCN 5/6	16x16	Guardian → PLUS7 → HIPER
		SKN 1/2	16x16	Gu → PLUS7 → HIPER
		SWN 1/2	16x16	Gu → PLUS7 → HIPER
	APR1400	SKN 3/4	16x16	PLUS7 → HIPER
PHWR		WSN 1/2/3/4	-	Standard CANDU → CANFLEX

Now

PLUS7 ™ & ACE7 ™ Fuel Supply

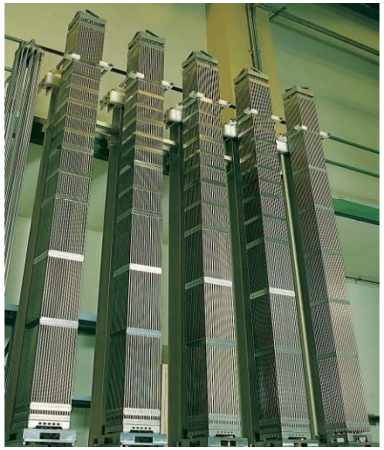


- **The irradiation data , experiences and VOC will be feedback continuously to upgrade PLUS7 and ACE7**

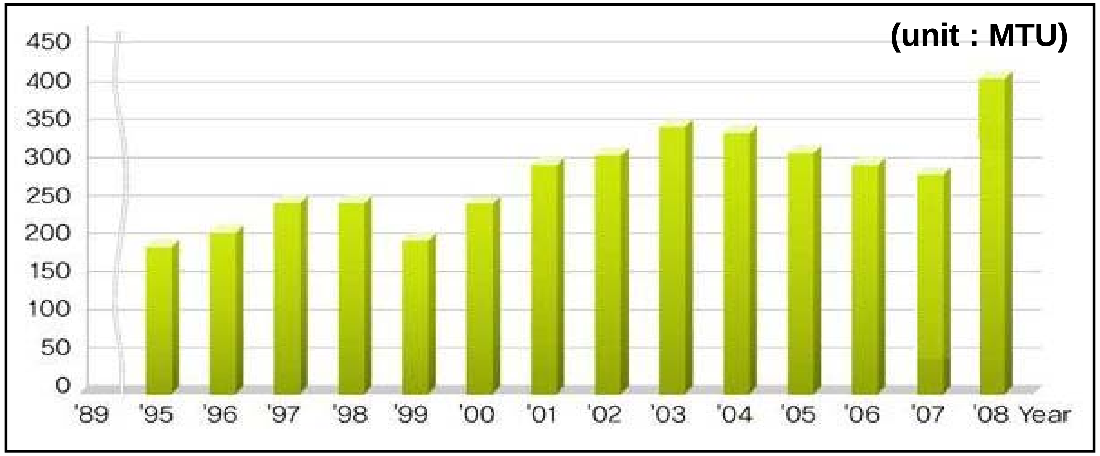
Fuel Supply History

Fuel Fabrication

PWR

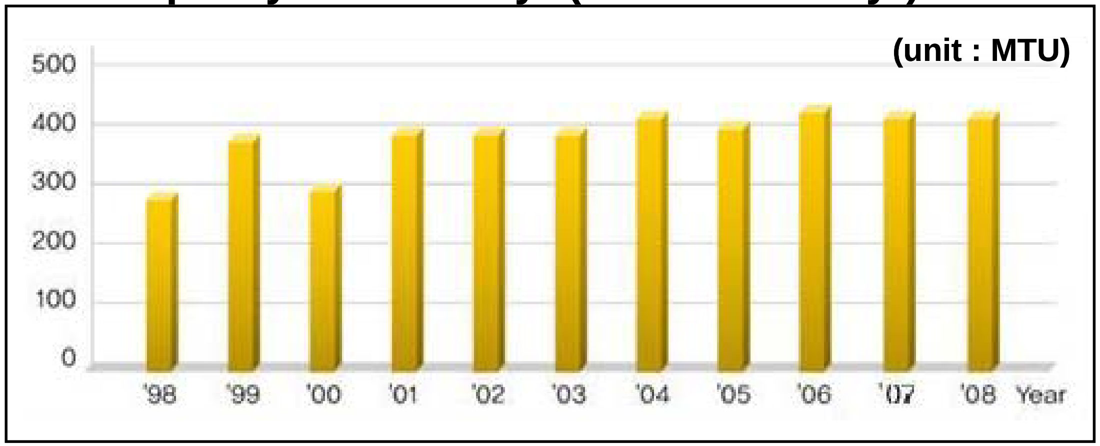


Capacity : 550 MTU/yr (max. 700MTU/yr)

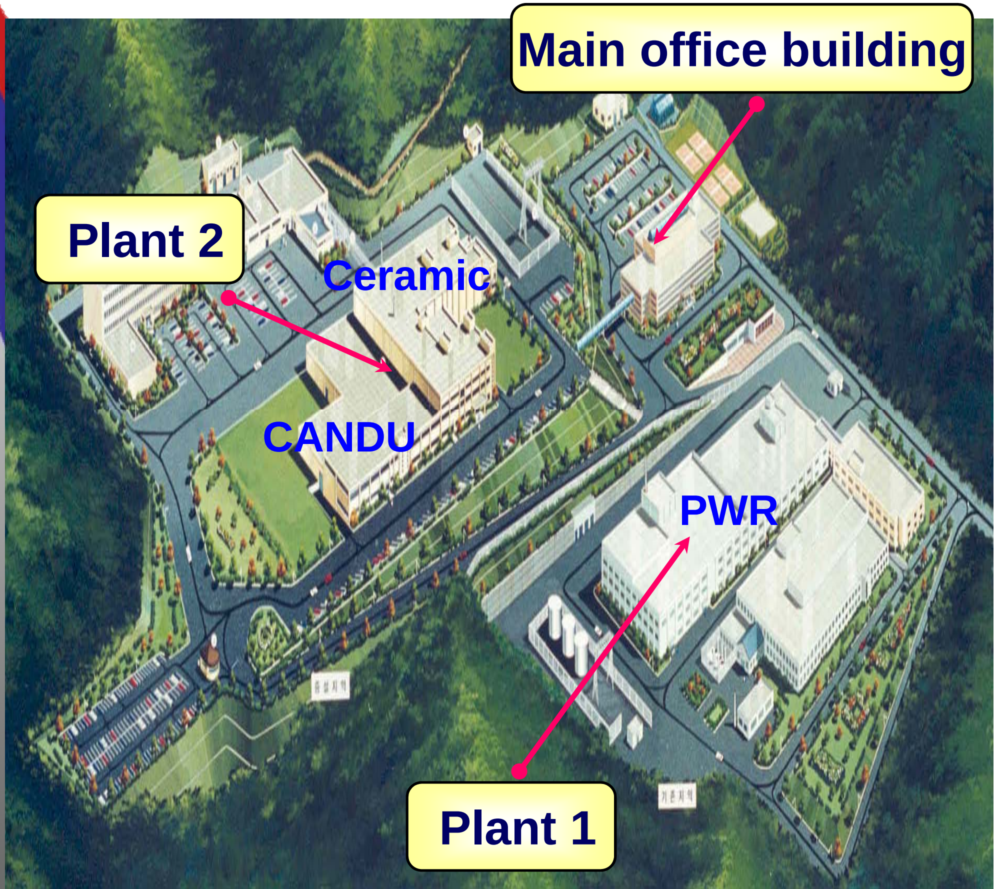


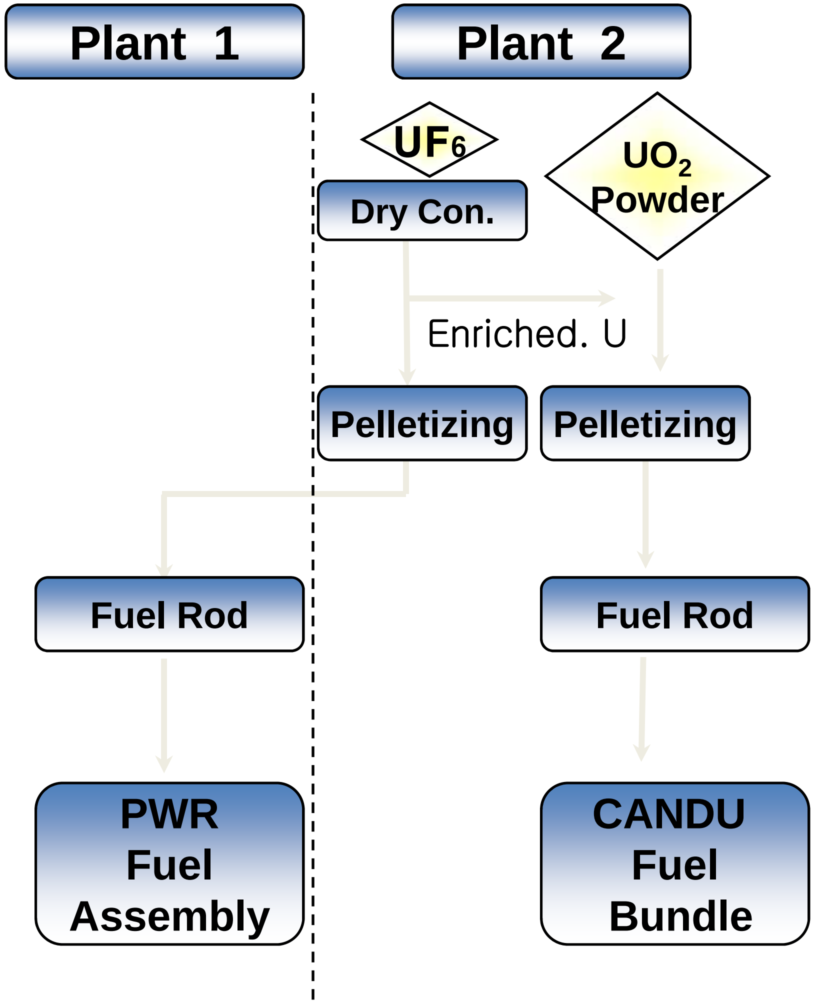
PHWR

Capacity : 400 MTU/yr (max. 600MTU/yr)



Fuel Fabrication Plants



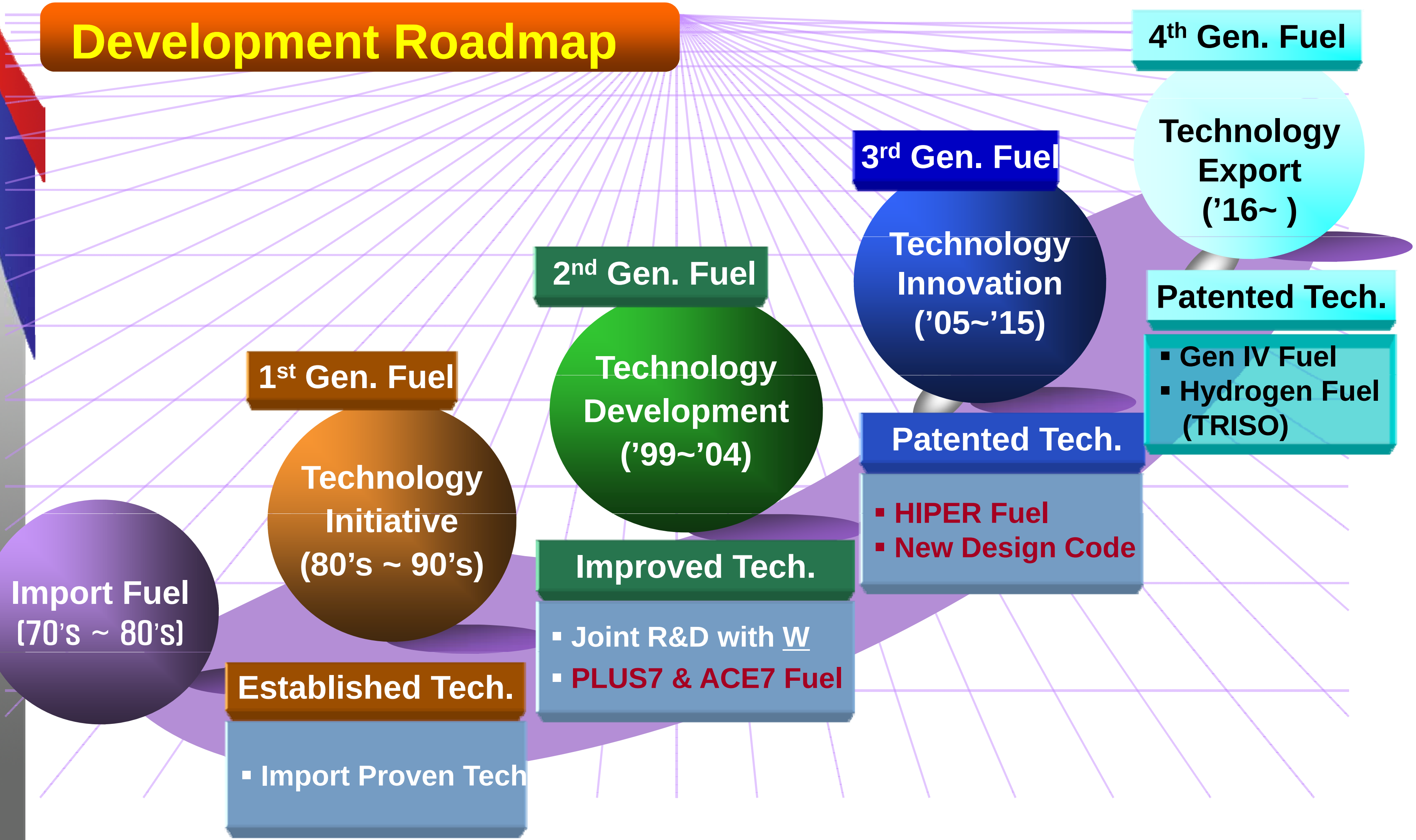


Zircaloy Tube Mill (TSA)

- **TSA : Techno Special Alloy**
- **Area : 16,529 m^2**
- **Capacities : 1,400 km/yr**
- **Operated from Nov. 2008**

- **Current Products : All tubes for PWR**
  - Fuel Tubes : 6 Types
  - Thimble Tubes : 7 Types
  - Instrument Tubes : 5 Types
  - Sleeve/Flange : 7 Types
- **Future Products : Tubes for CANDU, CANFLEX-NU or ACR**

Fuel Technology History



PLUS7 TM Overview

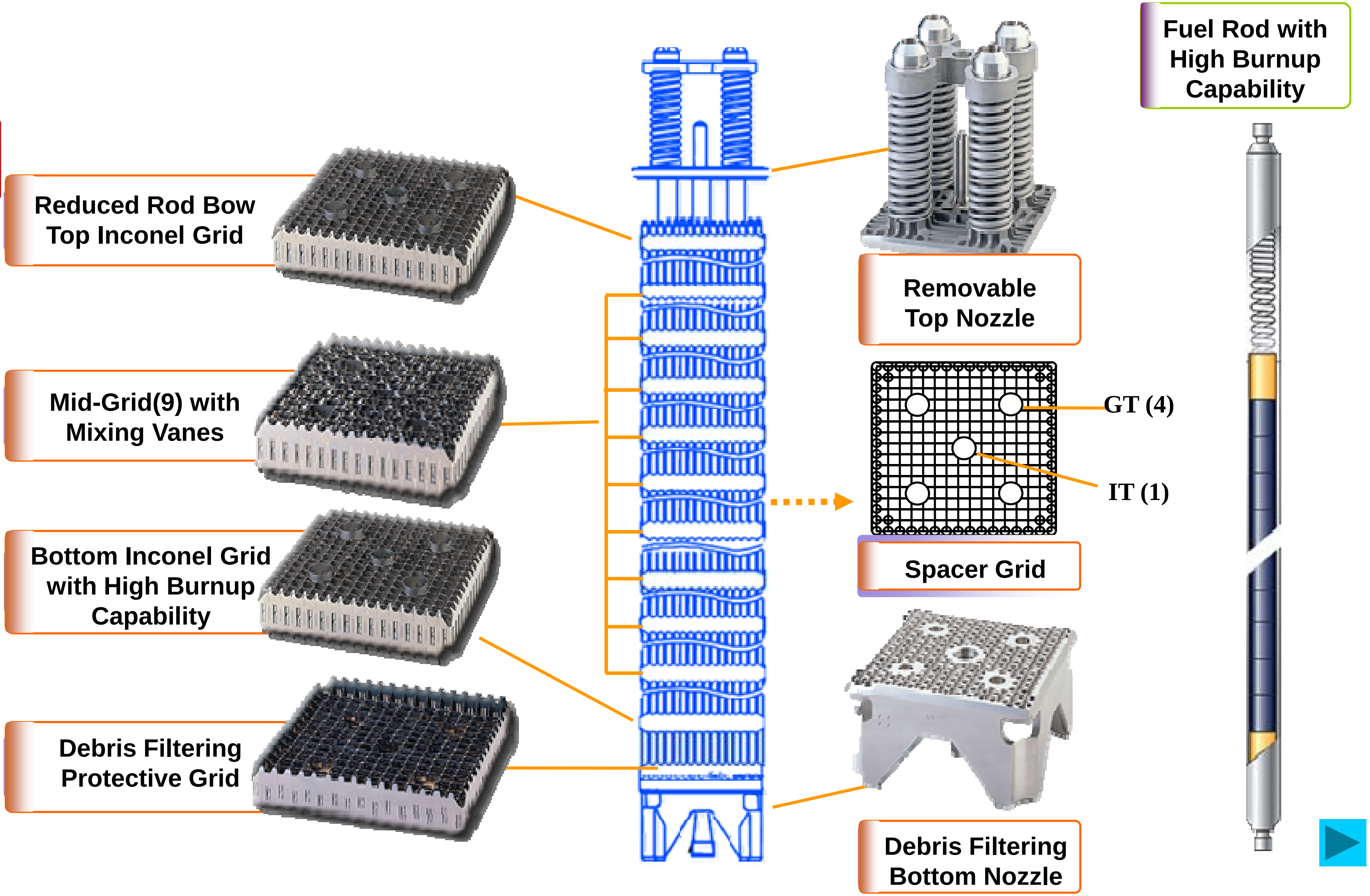
CE 16x16 type

- [OPR 1000] YGN 3/4/5/6 UCN 3/4/5/6 SKN 1/2 SWN 1/2
- [APR 1400] SKN 3/4 SKN 5/6 SUN 1/2

Performance

- Batch Average Discharge Burnup > 55 GWD/MTU
- Overpower Margin Increase to Current Fuel > 10%
- Integrity Maintenance even at 0.3g Seismic Load
- No Debris-Induced and Rod Fretting Wear-Induced Failure

PLUS7 TM Main Design Features



Summary

1) Nuclear Fuel supplier

- 20 existing NPP (PWR, PHWR)

2) Develop advanced Fuel

- cladding tube, hardware, software

Equipment Manufacturing

DOOSAN Manufacturing Facilities

Supply Experience

Key Manufacturing Operation

Quality Assurance

- **DOOSAN Manufacturing Facilities**

Initial Pre-application Meeting

HISTORY

1962 : Established by Hyundai Yanghaeng

1980 : Become a State-own Company named Korea Heavy Industries & Construction Co., Ltd. (HANJUNG)

1981 : ASME Certificate (N, NPT) acquired

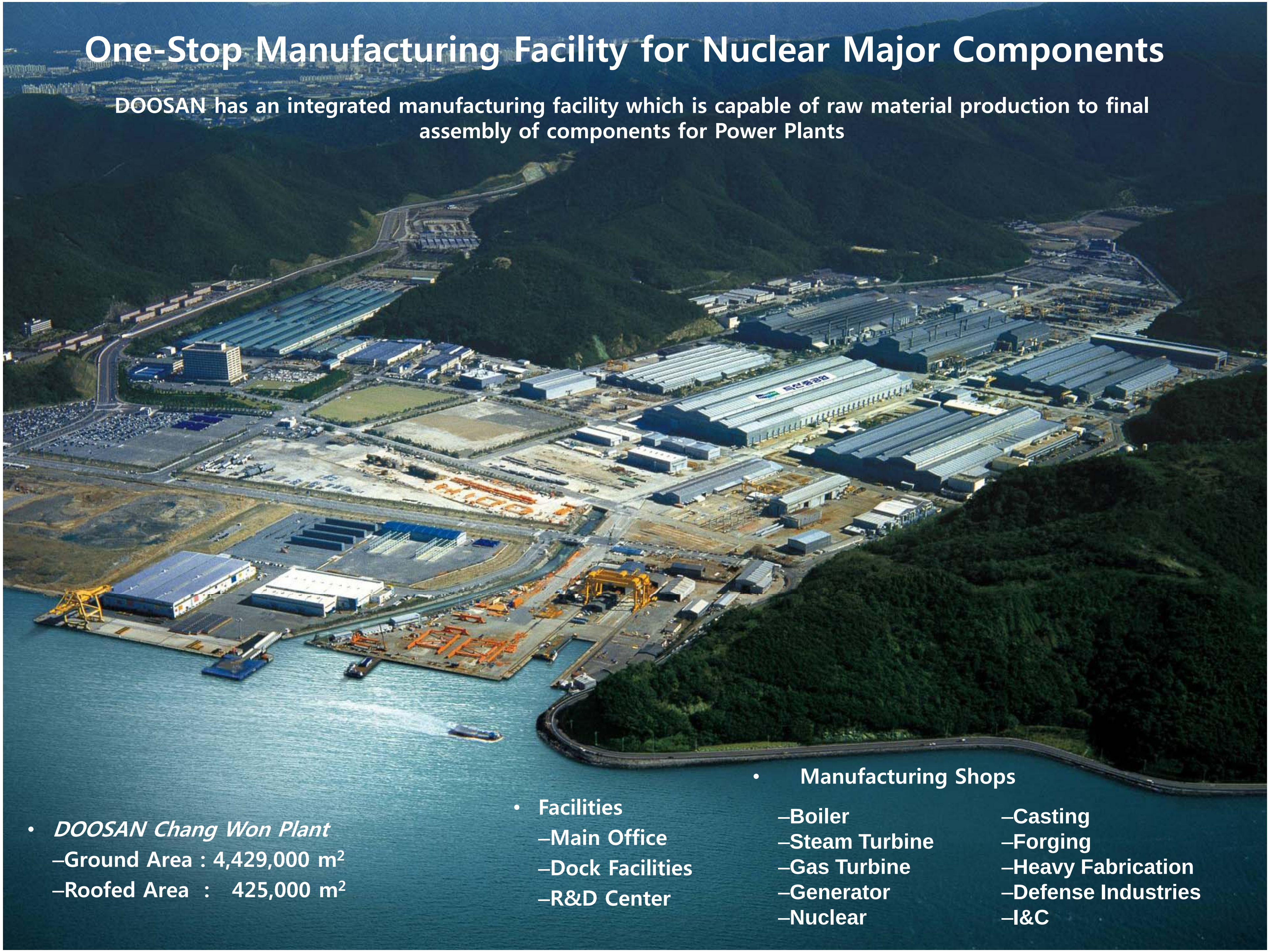
1982 : Changwon Integrated Machinery Plant Completed

1999 : Acquisition of Power Business from SAMSUNG and HYUNDAI

2001 : Privatized and Renamed to DOOSAN Heavy Industries & Construction Co., Ltd.

One-Stop Manufacturing Facility for Nuclear Major Components

DOOSAN has an integrated manufacturing facility which is capable of raw material production to final assembly of components for Power Plants



- ***DOOSAN Chang Won Plant***
  - –Ground Area : 4,429,000 m²
  - –Roofed Area : 425,000 m²

- **Facilities**
  - –Main Office
  - –Dock Facilities
  - –R&D Center

- **Manufacturing Shops**
  - –Boiler
  - –Steam Turbine
  - –Gas Turbine
  - –Generator
  - –Nuclear
  - –Casting
  - –Forging
  - –Heavy Fabrication
  - –Defense Industries
  - –I&C

Forging and foundry shops

(1) Forging Press : 13,000 tons
(2) Forging Press : 4,200 tons
(3) Forging Press : 1,600 tons
(4) Forging Manipulator : Max. 400 tons

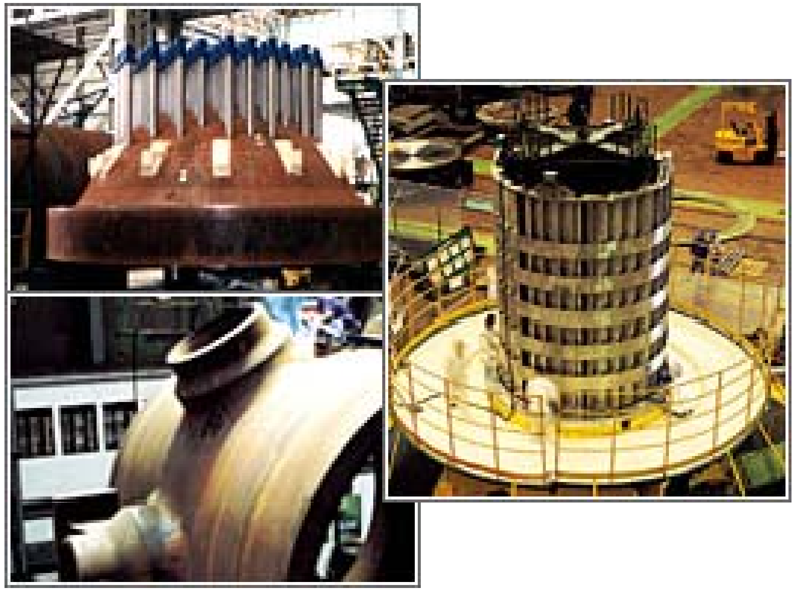
(1) Electric Arc Furnace : 100/120 tons
(2) Electric Arc Furnace : 30/35 tons
(3) Vacuum Ladle Refining & Holding Furnace : 20/155 tons
(4) Vacuum Stream Degassing Equipment : 30/530 tons

Heavy machinery shops

(11) Horizontal Lathe : 3,000 Dia. x 18,000 L x 250 t
(11) Vertical Boring Machine : 10,000 x 2,200 H x 400 t
(11) Horizontal Boring Machine : 400 Dia. x 3,800
(9) Plano Miller Machine : 7,100 x 7,000 x 500 t

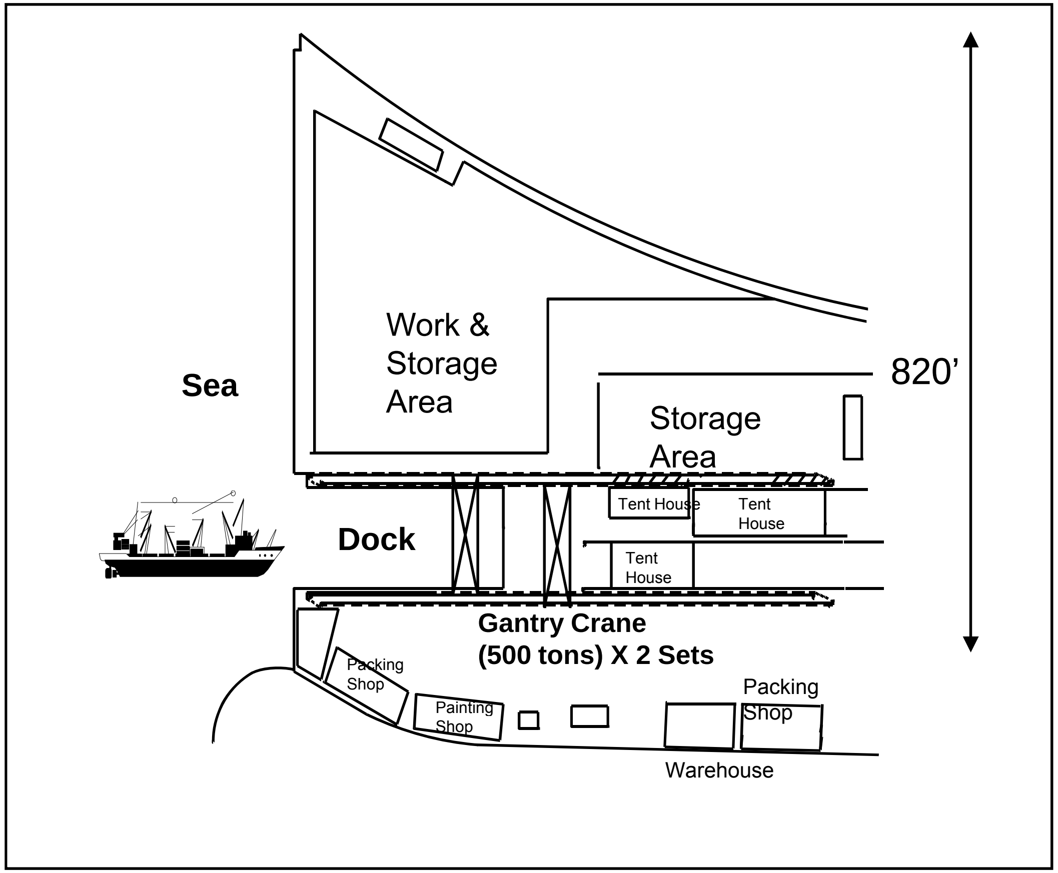
(10) Horizontal Lathe : 1,000 Dia. x 4,000 L x 5 tons
(9) Vertical Boring Machine : 2,800 Dia. x 2,500 x 25 tons
(4) Horizontal Boring Machine : 125 Dia. x 1,250 x 1,600

Nuclear shops



- (1) 800 tons Over Head Crane
- (1) Semi Gantry Welding Machine
- (7) SAW Strip Cladding Machine : 4", 2", 1"
- (1) 3 Spindle Deep Hole Drilling Machine : 19'8"(X) x 11'10"(Y) x 3'7"(Z)
- (1) Vertical Boring Machine : 72'2" Dia x 26'3" H x 500 tons
- (1) Horizontal Boring Machine : 49'2"(X) x 26'3"(Y) x 8'10"(Z)

Dedicated dock facilities

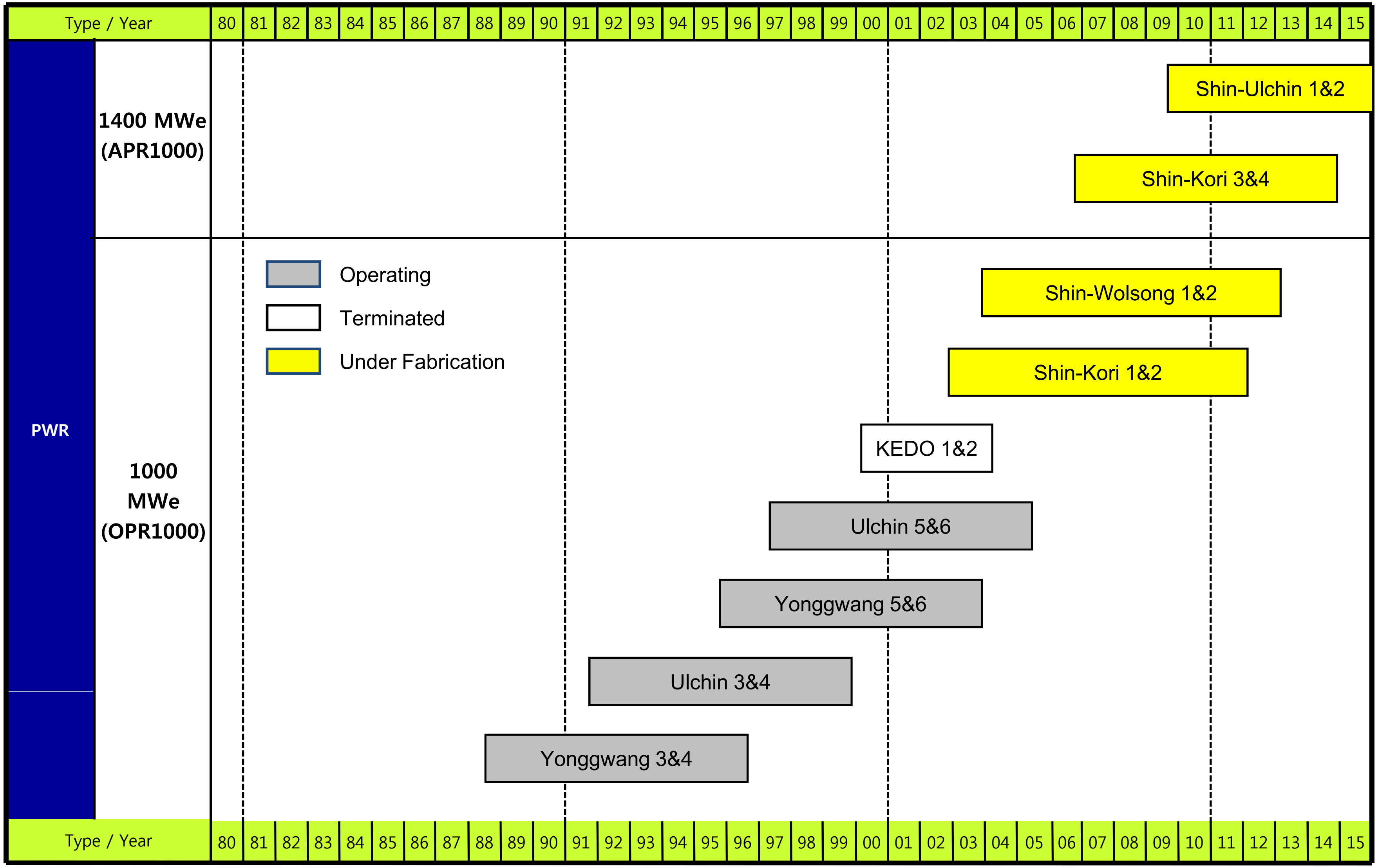


Gantry Crane : 500 tons X 2 sets
→ 1,000 tons
Transporter :
Multi-wheel Loader 560 tons (1),
450 tons (1), 250 tons (1), 150 tons (3)

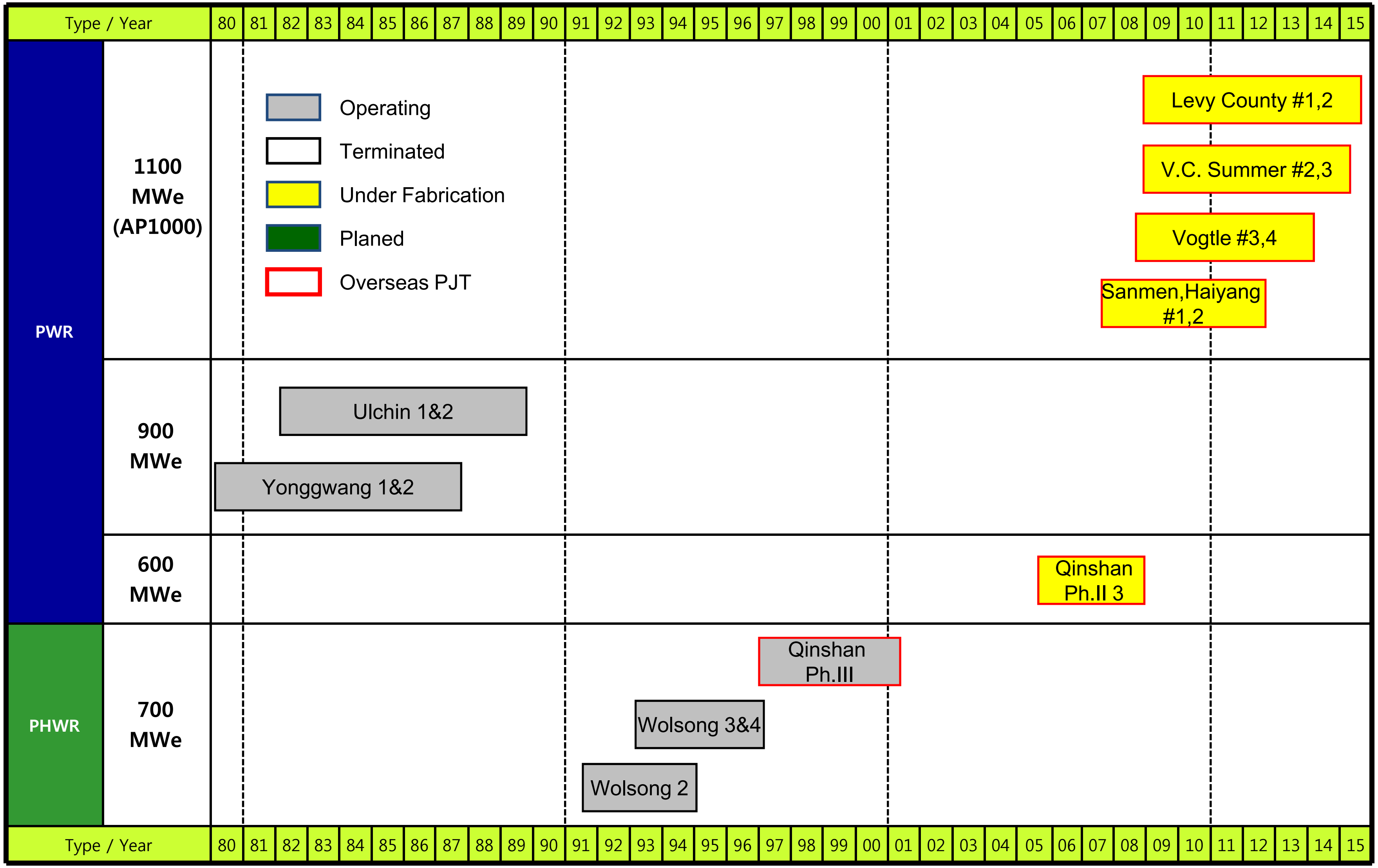
Crawler Crane : 400 tons (2)

- **Supply Experience**

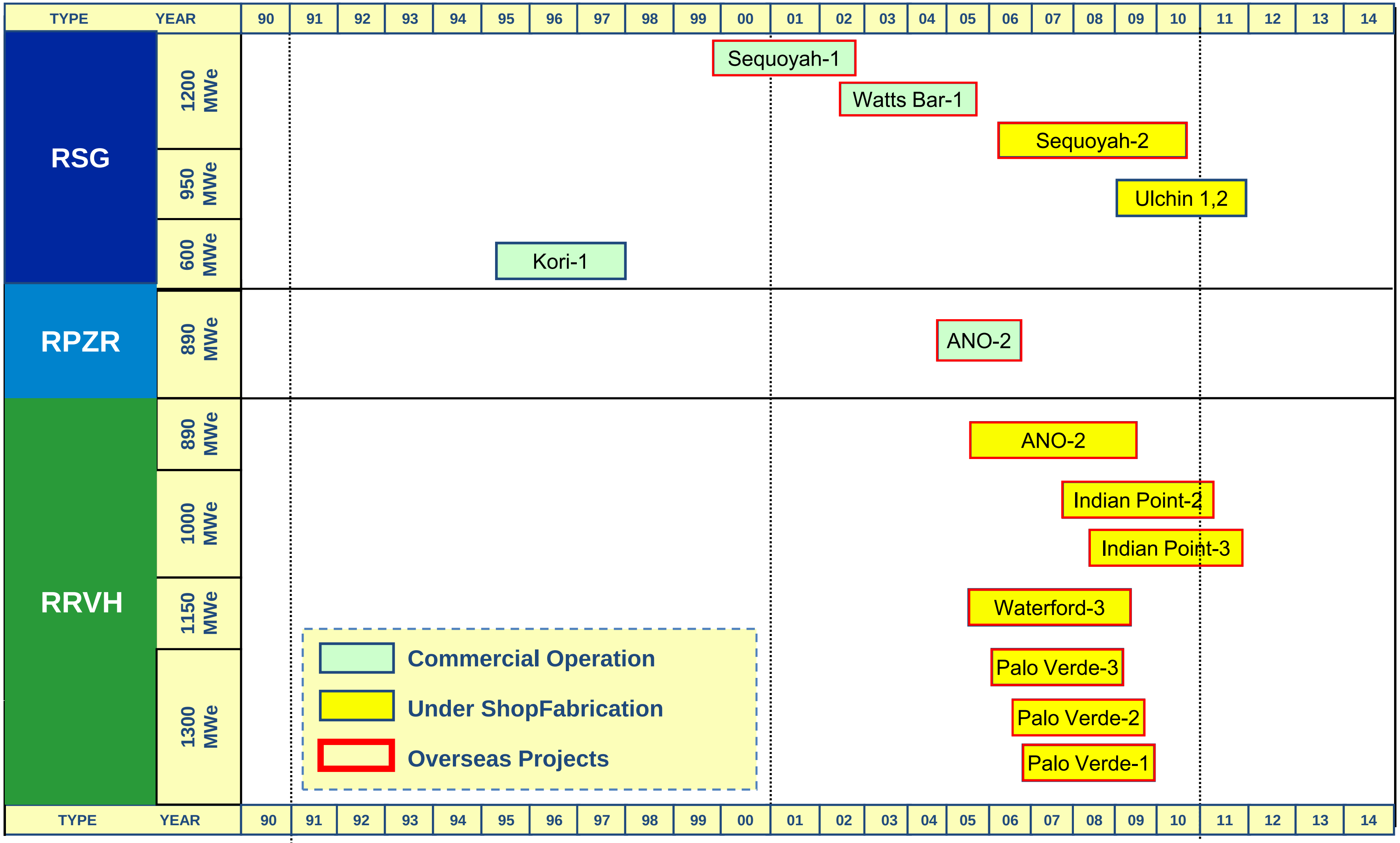
Experiences in New NPPs (1 of 2)



Experiences in New NPPs (2 of 2)



Experiences In Replacement NPPs



- RSG: Replacement Steam Generator
- RPZR: Replacement Pressurizer
- RRVH: Replacement Reactor Vessel Head

Major Experiences of Supplying Nuclear Components

♦ Ulchin #5 Reactor Vessel

♦ Shin Kori #1 Steam Generator

♦ Qinshan #1 Steam Generator

♦ Qinshan Phase II #3 Reactor Vessel

Major Experiences of Supplying Nuclear Components

♦ Arkansas Nuclear One #2 Pressurizer

♦ Sequoyah #1 Steam Generator

♦ Watts Bar #1 Steam Generator

♦ Palo Verde #3 Reactor Vessel Head

Korean New Nuclear Power Plants Equipments under manufacturing

Project	Type	Capacity	Contract Date	COD
Shin Kori 1&2	OPR1000	1,000MWe x 2	2002.08.09	2010.12 / 2011.12
Shin Wolsong 1&2	OPR1000	1,000MWe x 2	2002.08.09	2011.10 / 2012.10
Shin Kori 3&4	APR1400	1,400MWe x 2	2006.08.31	2013.09 / 2014.09
Shin Ulchin 1&2	APR1400	1,400MWe x 2	2009.07.31	2015.12 / 2016.12

Shin Kori 1&2

Shin Wolsong 1&2

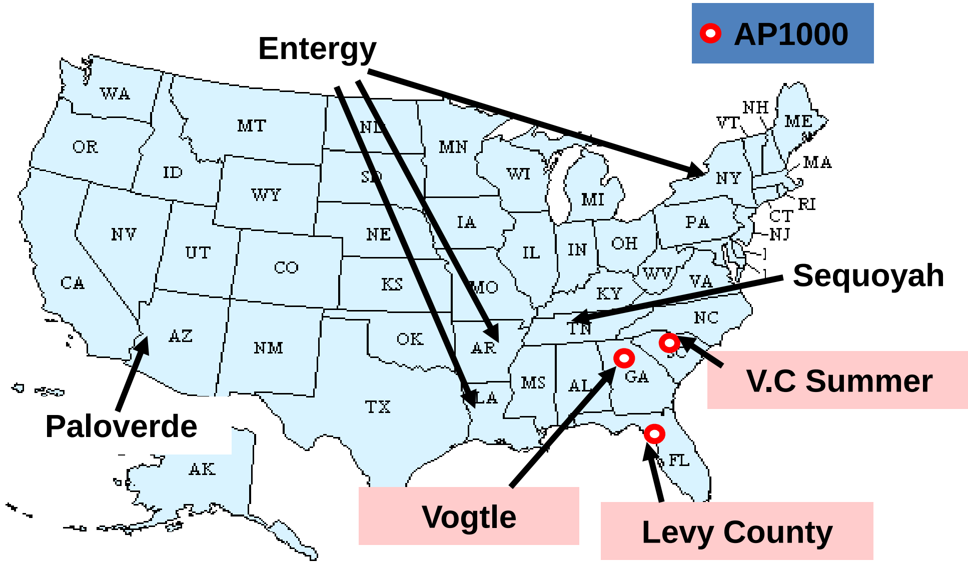
Shin Kori 3&4

*OPR1000 : Optimized Power Reactor , APR1400 : Advanced Power Reactor

AP1000 & Other Components under manufacturing

Project	Owner	Products	Unit
China, AP1000	CNNC /CPI	RV,SG. RVI,IHP	2
USA, AP1000	Southern SCANA Progress	RV,SG	6
Palo Verde	APS	RRVH, CEDM	3
Sequoyah	TVA	RSG	1
ANO Waterford Indian Point	Entergy	RVH	4
TEPCO	RFS	Cask	100*

* : EA



Initial Pre-application Meeting

Appreciation Awards from Customers

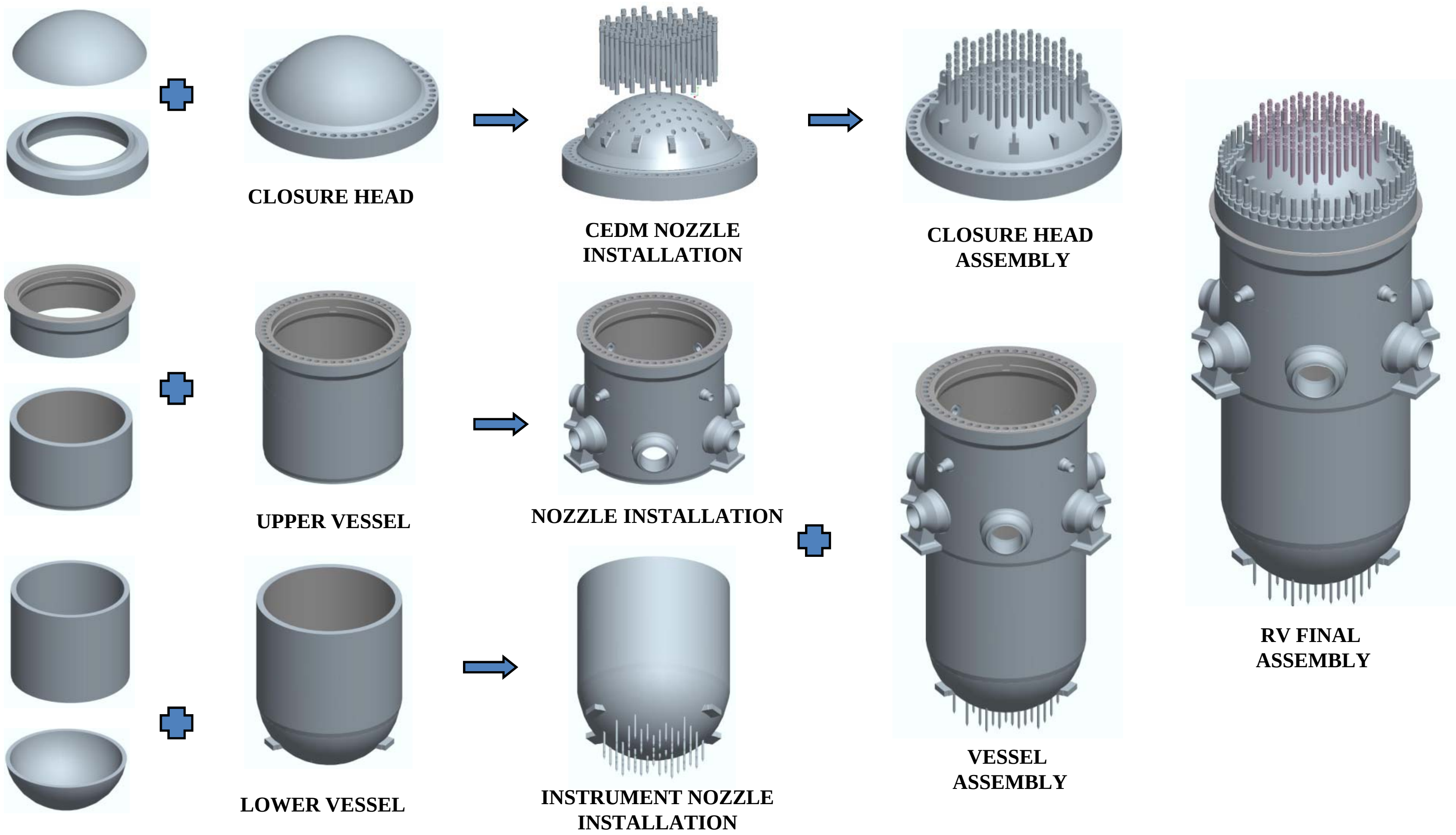
In Commemoration and Appreciation for the participation of DOOSAN in the Entergy Waterford 3 Replacement RVH Project

In appreciation of your leadership and lasting contribution to Palo Verde Nuclear Generating Station RVH Replacement Project

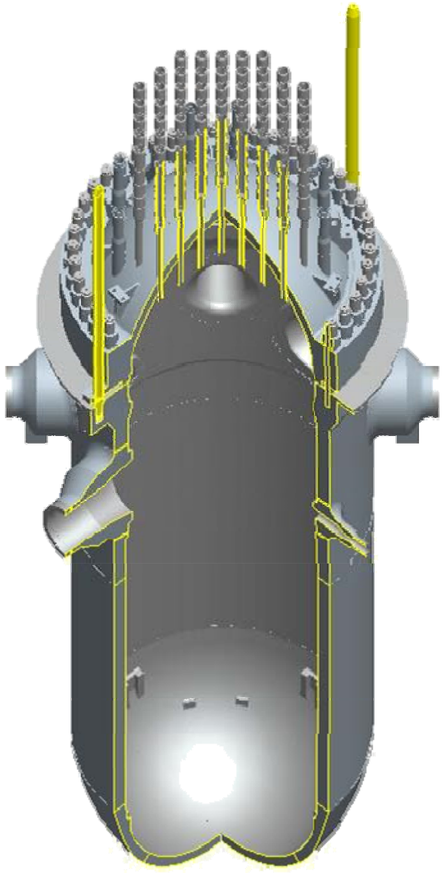
Initial Pre-application Meeting

- **Key Manufacturing Operation**

RV Manufacturing Sequence



Key Manufacturing Operations - Reactor Vessel



Closure Head Assembly

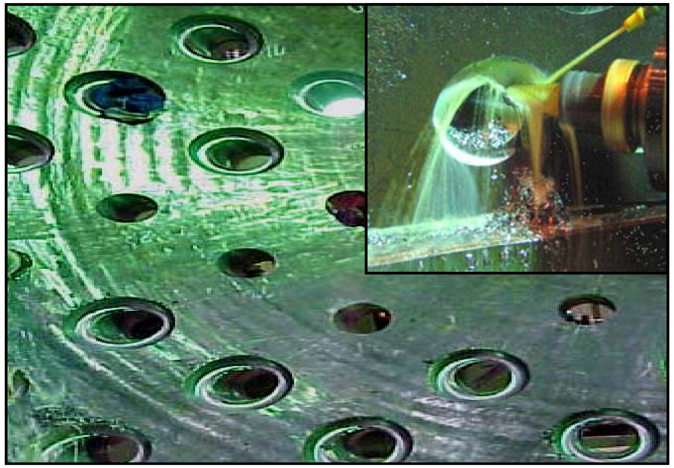
Upper Vessel Assembly

Lower Vessel Assembly

Reactor Vessel – Closure Head Assembly

1. Closure Head Cladding

2. J-Groove Hole M/C

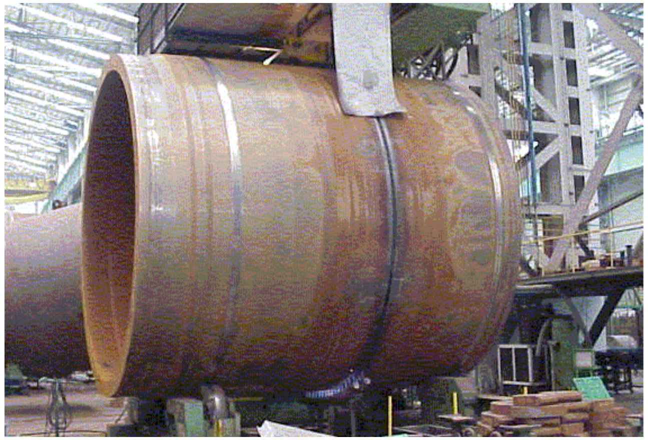


3. CRDM Nozzle Shrink Fitting

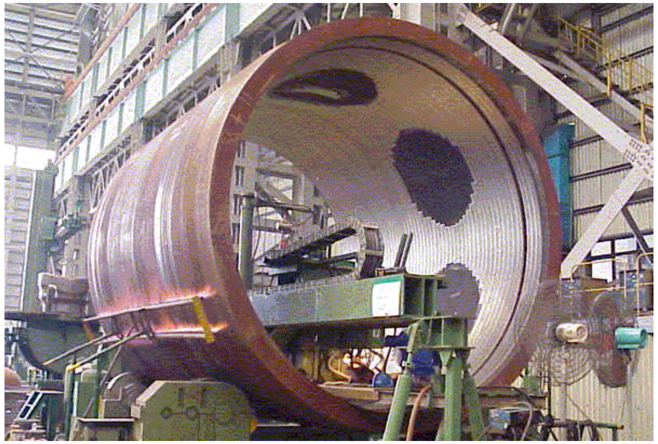
4. CEDM NOZZLE WELDING

Reactor Vessel – Upper Vessel Assembly

1. UPPER + INTERMEDIATE SHELL GIRTH SEAM WD

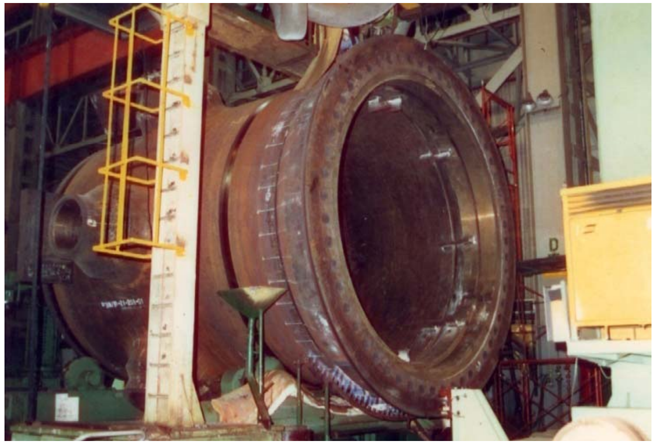


2. UPPER SHELL CLADDING



3. UPPER SHELL TO INLET NOZ. ASS'Y

4. UPPER VESSEL TO VESSEL FLANGE ASS'Y



Reactor Vessel – Lower Vessel Assembly

1. BOTTOM HEAD CLADDING

2. J-GROOVE MACHINING

3. LOWER SHELL TO BOTTOM HEAD ASS'Y

4. INSTRUMENT TUBE INSTALLATION & FINAL M/C

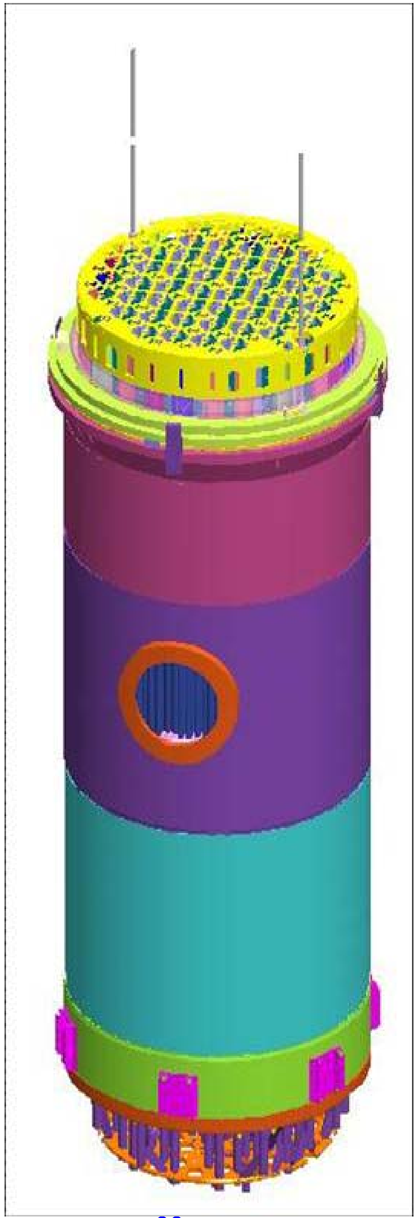
Key Manufacturing Operations - Reactor Vessel Internal

CS Machining

LSS Beam Welding

LSS Support Plate Welding

Core Shroud to LSS Welding



UGS Tube Rolling

UGS Machining

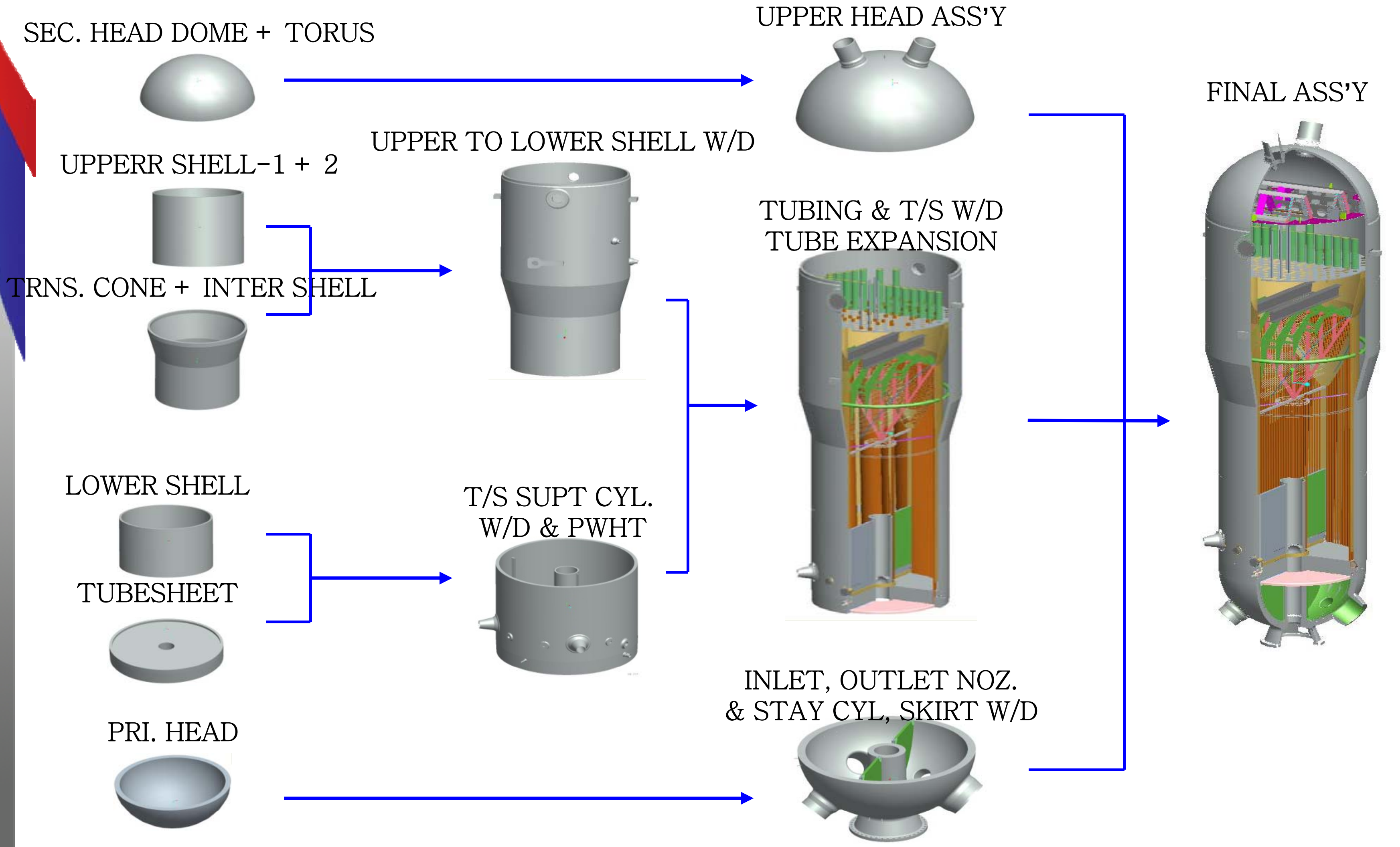
CSB Cylinder Welding

CSB Assembly

- CS : Core Shroud
- LSS : Lower Support Structure

- UGS : Upper Guide Structure
- CSB : Core Support Structure

SG Manufacturing Sequence



Initial Pre-application Meeting

Key Manufacturing Operations (in the Shop) – Steam Generator

Top Head Assembly

Upper Vessel Assembly

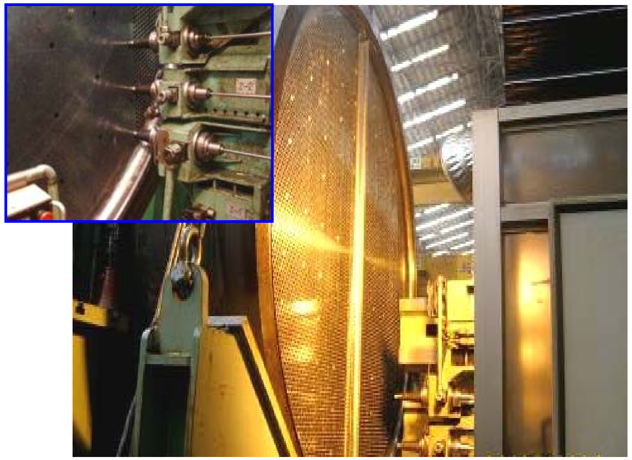
Primary Head Assembly

Steam Generator – Tubesheet

1. TUBESHEET CLADDING

2. TUBESHEET TO LOWER SHELL WELDING

3. TUBESHEET DRILLING



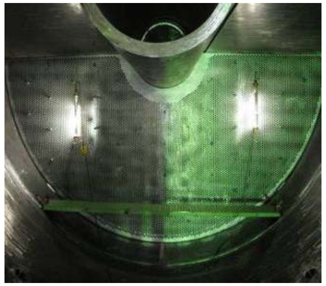
4. LOWER TO UPPER SHELL WELDING

Semi-Gantry WD M/C

Steam Generator – Tubing

Tube Vertical Support+ Tube Installation

Tube Installation



Eggcrate Installation

Tube-to-Tubesheet Welding

- All critical operations requiring cleanliness are performed in the tubing room.
- Foreign material control is strictly performed in accordance with approved FME (Foreign Material Exclusion) Control Procedure.

Hydraulic Expansion

- **Quality Assurance**

Quality Assurance – Quality Policy and Objectives

Policy

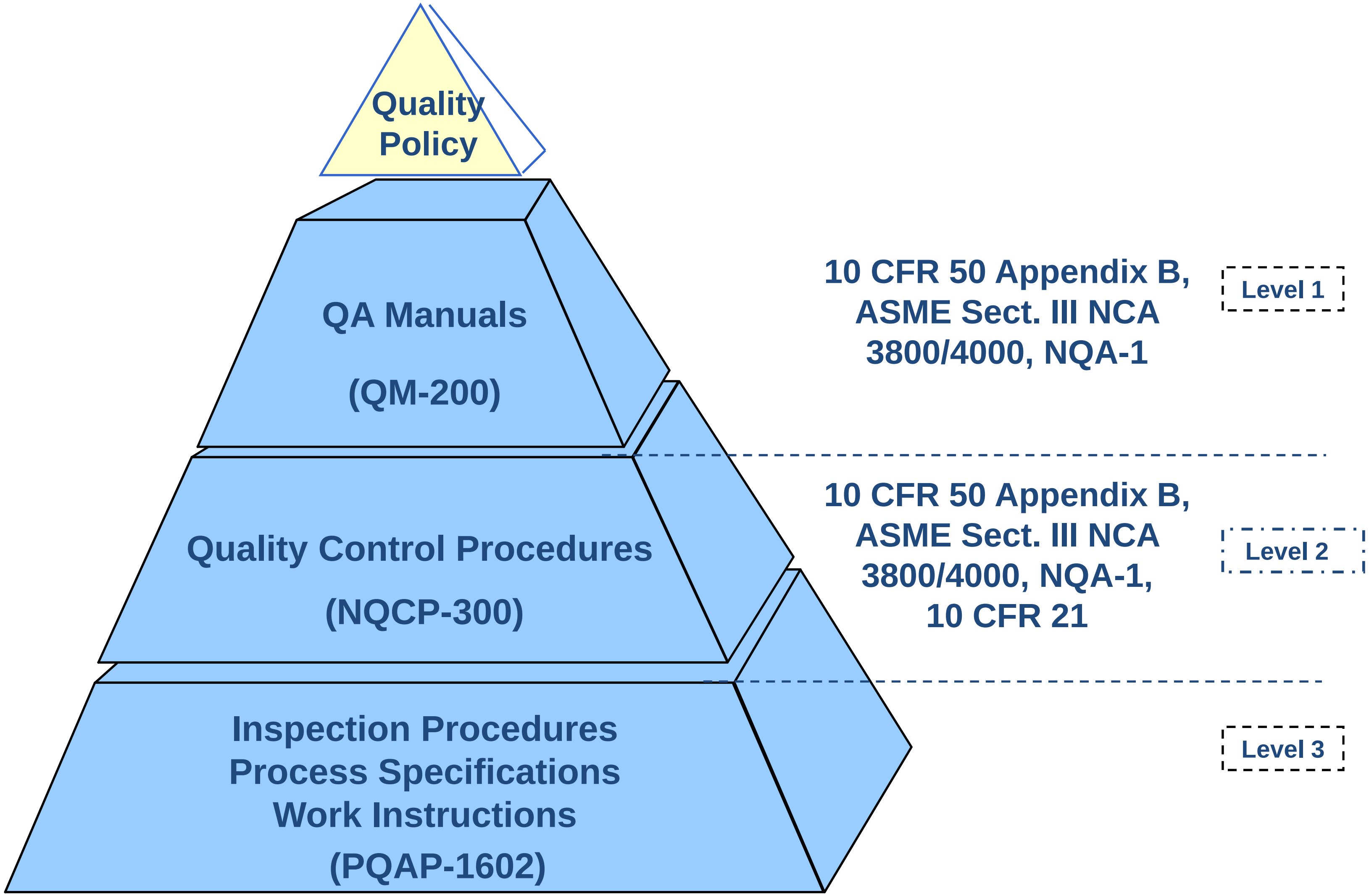
- Complete customer's contractual requirements
- Conform to the applicable codes & standards
- Meet jurisdictional regulations
- Achieve "Zero Defect"

Objectives

Each Business Group establish their measurable Quality Objectives to include followings, as applicable

- Customer Satisfaction
- Product Conformity
- Process Conformity
- Supplier related Conformity

Quality Assurance – Hierarchy



Quality Assurance – Certificates

Category		Certificates	Quantity
ASME	Nuclear	N, NPT, NS, N3, NA,	7
	Non-nuclear	U, U2, S, A, PP, H, R	7
KEPIC*		MN, SN, EN, DN	7
ISO		9001:2008, 14001:2004	3
PED		H, H1 Module	2
Others		OHSAS, Shipping Registers, etc.	23
Total			49

*KEPIC : Korea Electric Power Industry Code

Quality Assurance – Certificates and Stamp

Quality Assurance – Experiences

Codes & Standards	Projects	QA Program
▪ ASME Section III ▪ 10 CFR 50 Appendix B ▪ ASME NQA-1	▪ YGN #1,2,3,4,5,6 (Domestic) ▪ UCN #3,4,5,6 (Domestic) ▪ Sequoyah #1 RSG (USA) ▪ Watts Bar #1 RSG (USA) ▪ AP 1000 USA/ China	▪ ASME III / KEPIC QA Manual
▪ RCC-M (IAEA 50-C-QA)	▪ UCN #1,2 (Domestic) ▪ QSN Phase II (China)	▪ RCCM QA Manual
▪ CSA Z299 Series	▪ WSN #2,3,4 (Domestic) ▪ QSN Phase III (China)	▪ ASME III QA Manual + CSA Addendum
▪ KEPIC	▪ SKN #1,2,3,4 (Domestic) ▪ SWN #1,2 (Domestic)	▪ ASME III / KEPIC QA Manual
▪ ISO 9001 : 2000	▪ Tokyo Electric NEO Model Cask (Japan)	▪ ISO 9001 Quality Management System

Construction Activities

Construction Schedules

Advanced Construction Technologies

Demonstration of 4D Simulation

Pictures of SKN Unit 3 Construction

APR1400 Projects on Construction

Shin-Kori Units 3&4

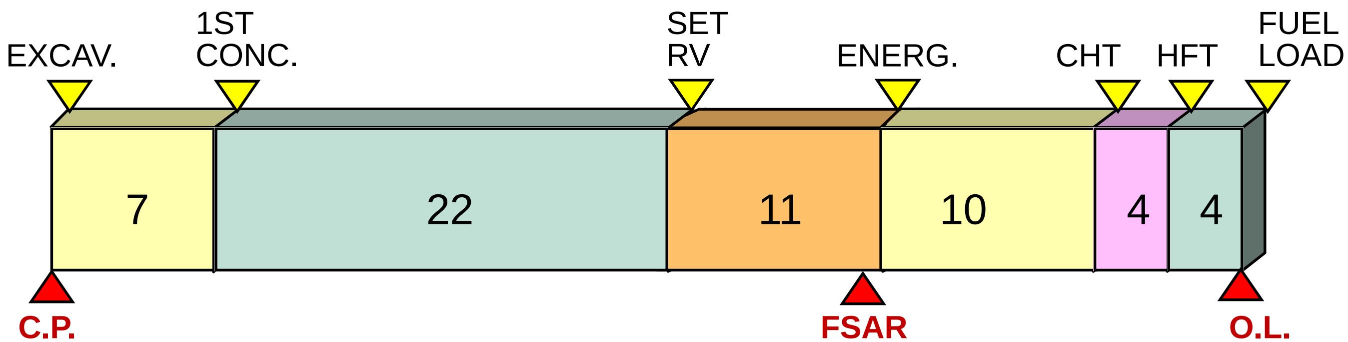
Site Grading: Apr. 2007
First Concrete: Oct. 2008
Fuel Load: Jan. 2013
Current status: Erected CLP 19 Rings

Shin-Ulchin Units 1&2

Site Grading: Aug. 2009
First Concrete: Mar. 2011
Fuel Load: Apr. 2015
Current status: Under Site Grading

Project Key Milestone Dates

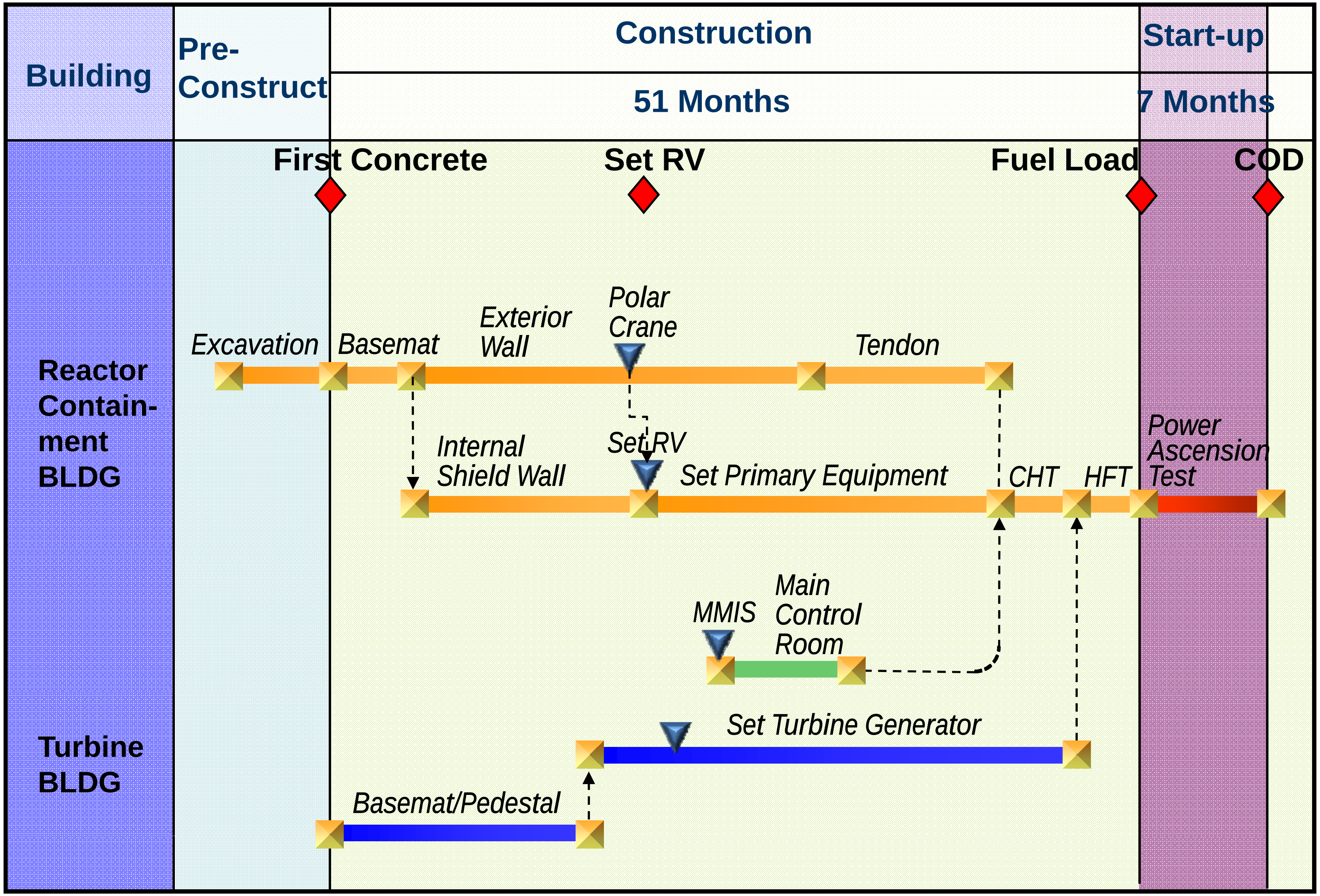
Key Milestones	Month after 1st Concrete
Submit PSAR	D-29
Construction Permit	D -7
Start of Excavation	D -7
First Concrete	D+0
Set Reactor Vessel	22
Submit FSAR	31
Energize Start-up Transformer	33
RCS Cold Hydro Test	43
Hot functional Test	47
Operation License	51
Fuel Loading	51



Reference :Shin-Kori NPP unit 3

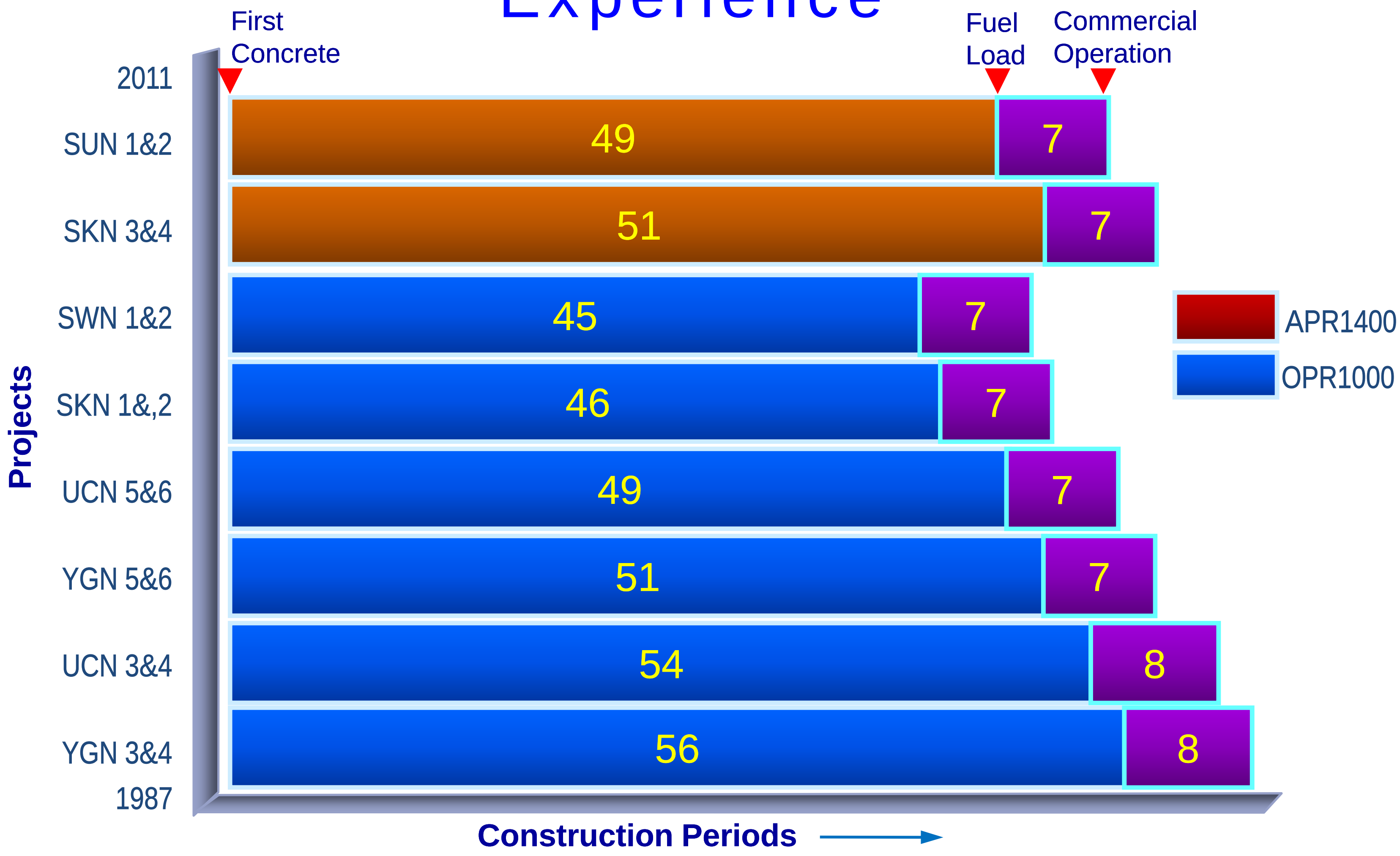
Unit : Month

Critical Paths



Reference :Shin-Kori NPP unit 3

Schedule Reduction with Increased Experience



As a result of 30 years of uninterrupted construction, construction schedule has been reduced by nearly 20%.

Advanced Construction Technologies

Pre-fabrication & Modularization

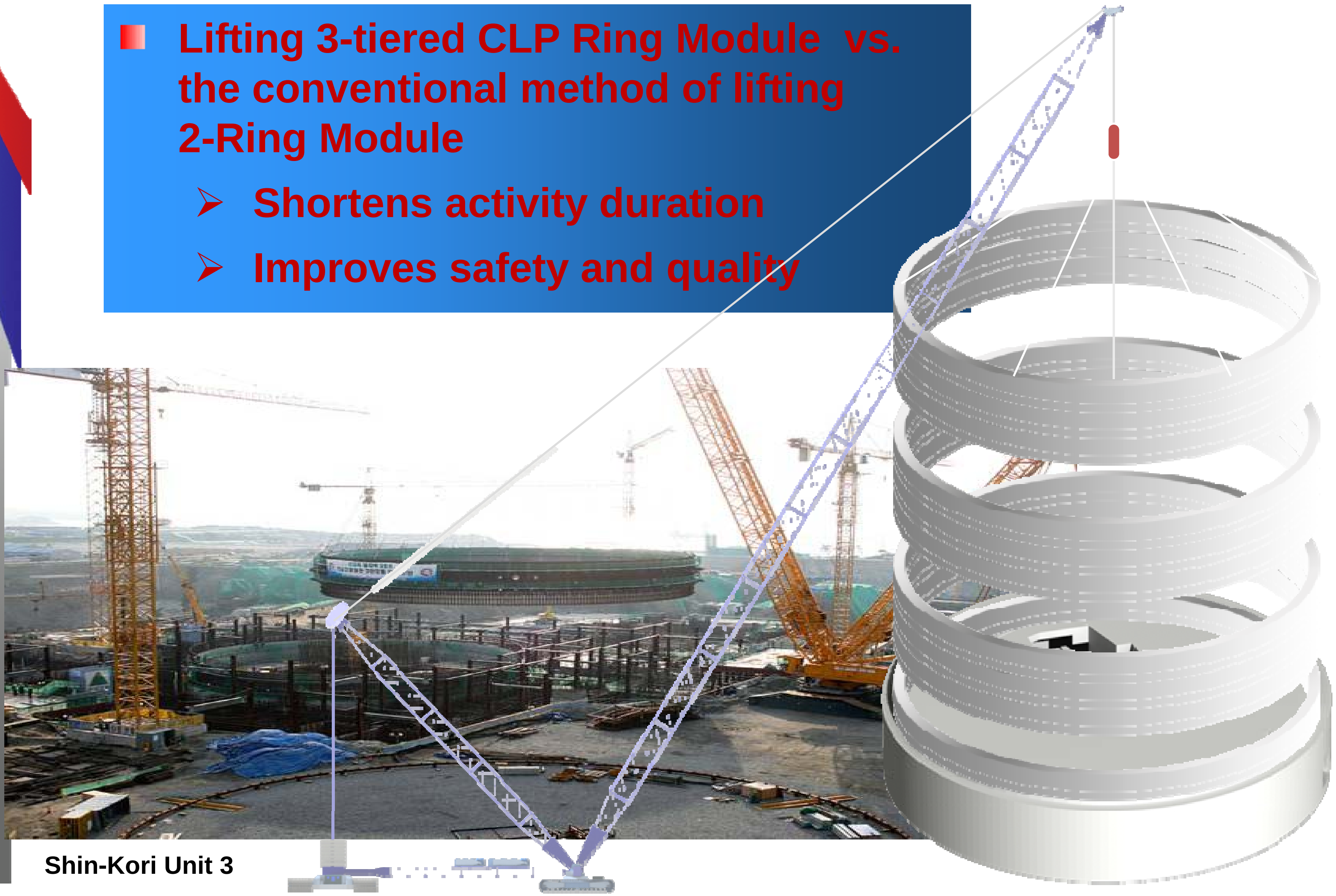
- Reinforcing Bar of Basemat
- Structural Steel
- MSIV Room Piping & Valve
- RCB Exterior Wall 3-tiered CLP Module
- Installation of Single or 2 Pieces-Dome Liner Plate
- MCR Ceiling Structural Steel, etc

Other Advanced & Optimized Process

- Steel Deck Plate Method
- Automatic Welding of Reactor Coolant Loop
- Concurrent Installation of RC Loop Pipe & RV Internals
- Shortened Installation Period of TBN LP Hood & IHA
- Improvement of TBN Sole Plate Chipping
- Shortened Post-Tensioning Period
- 3D CAD Models for Construction
- 4D Simulation, etc

RCB Exterior Wall 3-tiered CLP Module

- **Lifting 3-tiered CLP Ring Module vs. the conventional method of lifting 2-Ring Module**
  - **Shortens activity duration**
  - **Improves safety and quality**



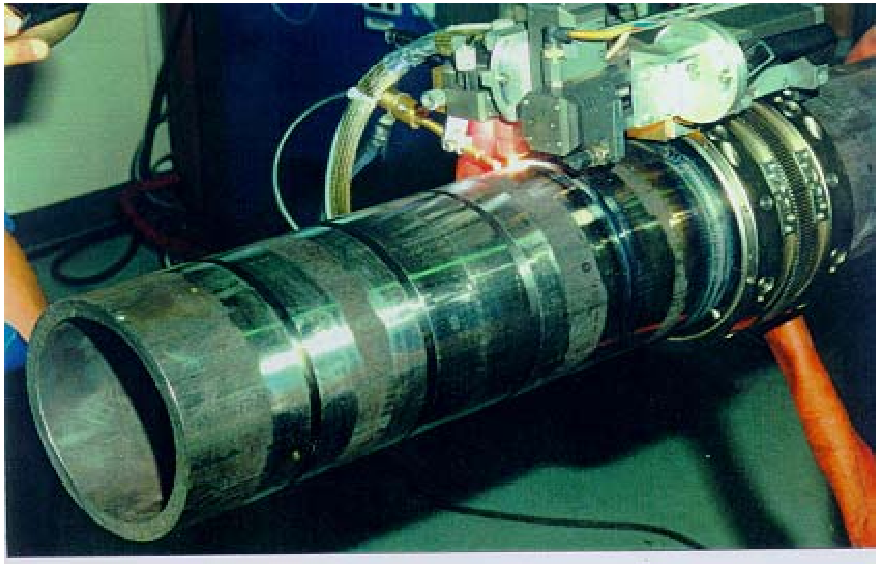
Shin-Kori Unit 3

Single or 2 Piece-Dome Liner Plate Erection

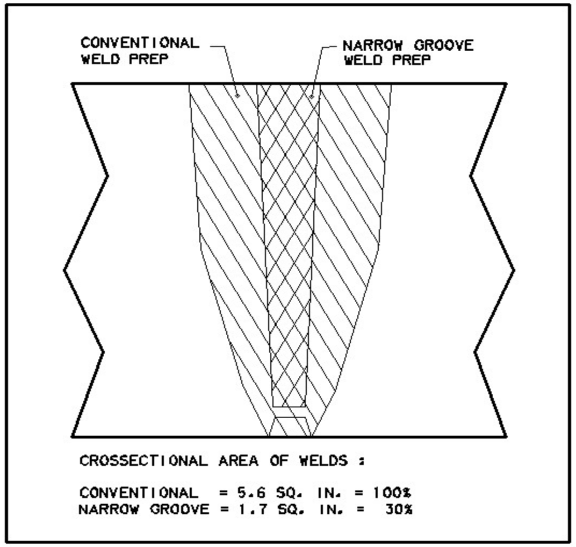
- **Erection of a Single or 2 Piece-Dome Liner Plate vs. the traditional 3 Piece-Dome Liner Plate lifting method**
  - **Shortens activity duration**
  - **Improves Safety and Constructability**

Automatic Welding of Reactor Coolant Loop

- **Automatic Welding of the Reactor Coolant Loop vs. the Conventional Manual Welding**
  - **Shortens activity duration**
  - **Improves quality and productivity**



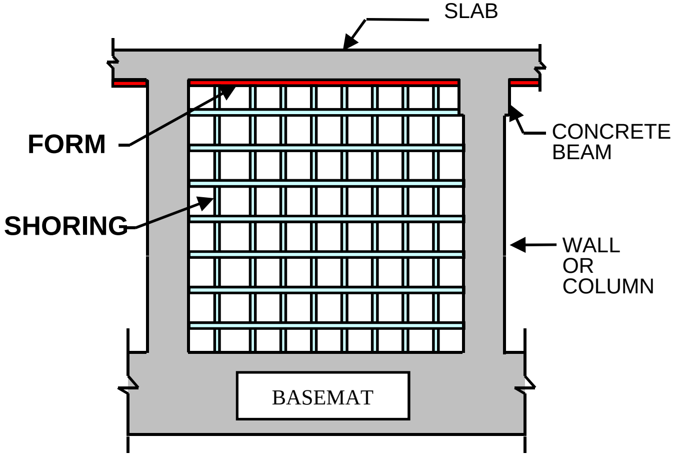
Remote Automatic Welding System



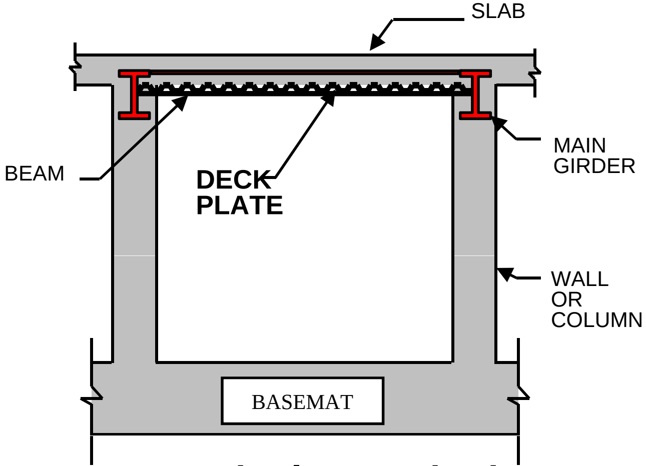
Narrow Groove Welding Configuration

Deck Plate Method

- **Steel Deck Plate Method instead of the conventional reinforced concrete slab**
  - **No form and shoring support required**
  - **Improved constructability for mechanical and electrical work**



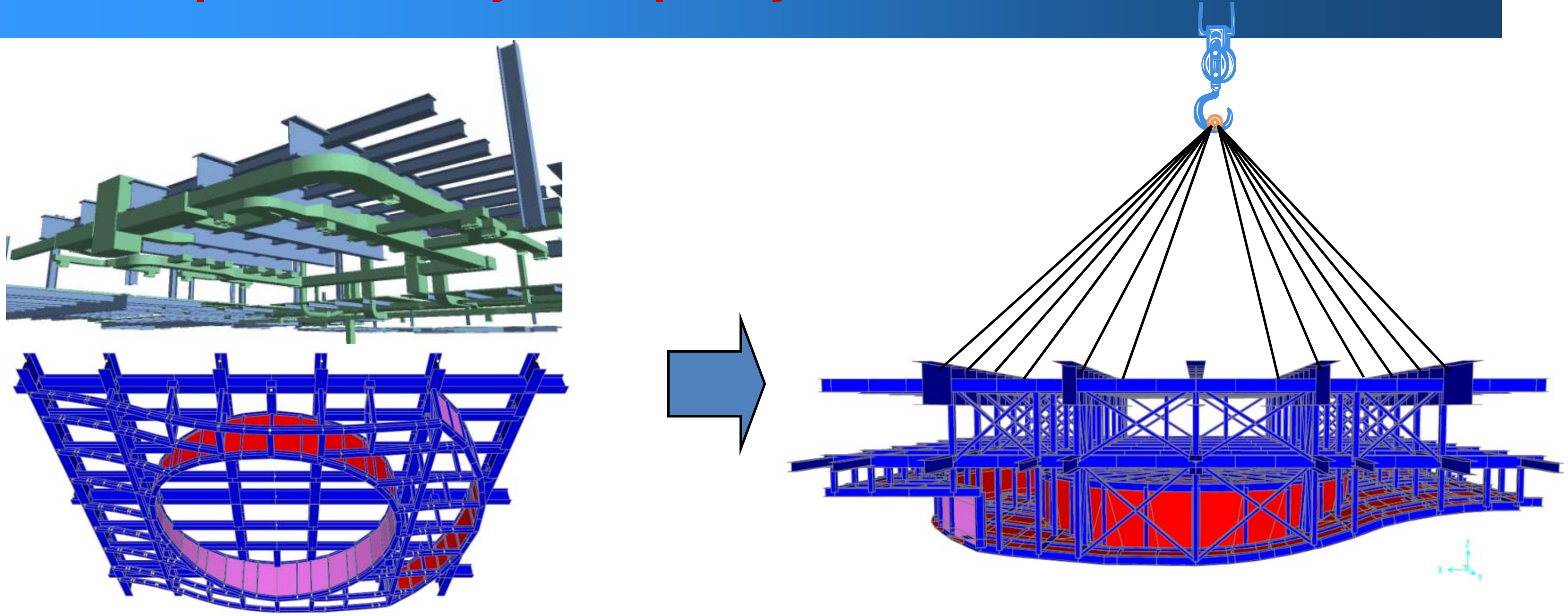
Form and Shoring Support Method



Deck Plate Method

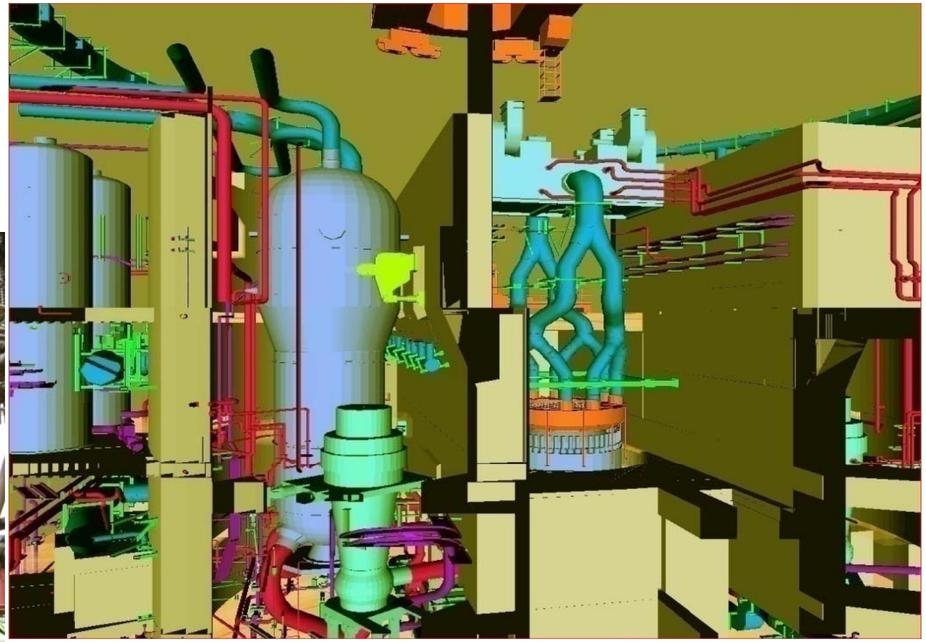
Modularization Technology

- **Modularized Main Control Room (MCR) Ceiling Structural Steel with pre-installed HVAC Duct, Elec. Conduit and Process Pipe**
  - **Shortens activity duration**
  - **Remove activities on critical paths**
  - **Improves safety and quality**



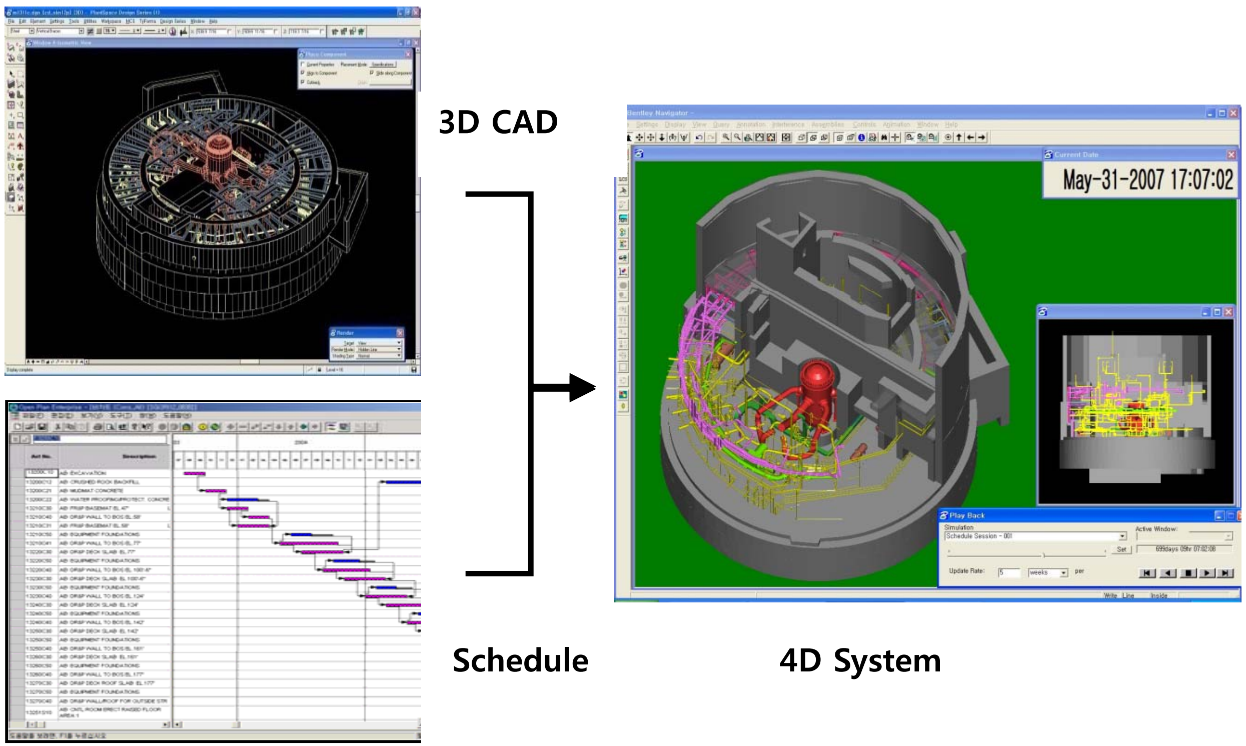
3D CAD Models for Construction

- **Introduction to 3D CAD for construction work**
  - **Helps visualize a shape to be done with drawings**
  - **Helps construction team coordinate the flow of work and space use on site**



4D Simulation

- **Integration of CAD and schedule for providing optimized construction schedule, visualization, and information management**
  - **Improves constructability**
  - **Shortens the construction period**



Demonstration of 4D Simulation

Pictures of SKN Unit 3 Construction