INAC 2015 Conference

Introduction of Korean Nuclear Power & APR1400

October 6, 2015

KHNP

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1. Overview of KHNP

Korea Hydro & Nuclear Power Company

NPP EPC supplier & operator with 40yrs experience

As of 2014

KHNP provides
NPP planning
NPP construction
NPP operation & maintenance
Hydro & renewable power EPC

Overview	
Total assets	$ 49 billion
Revenue	$ 9 billion
Credit rating	A+ (S&P), Aa3(Moody's)
Employees	Approx 10,000

Nuclear power operation

24 units

Nuclear power construction

4 units

Hydro power operation

51 units
(Including Pumped Storage)

Nuclear Power Plants in Korea

- In operation
- Under construction
- Planned

In operation

24 units (21,716 MW)

Under construction

4 units (5,600 MW)

Planned

8 units (5,600 MW)

2. Nuclear Power Plants in Korea

Technology Development History

1970s

Foreign Technology Dependence

Turnkey approach

- Led by Foreign Contractors

✓ Kori unit 1 (1978)

1980s

Technology Accumulation

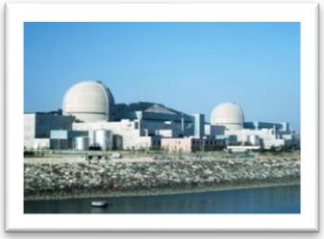
Non-turnkey approach

- Joint Implementation

✓ Localization

1990s

Technology Self-reliance



Development of Korean standard NPP

- Led by Korean Industry

✓ OPR 1000

2000s

Technology Advancement

Development of next generation NPP

- Evolutionary GenⅢ ALWR development

✓ APR1400

2010s

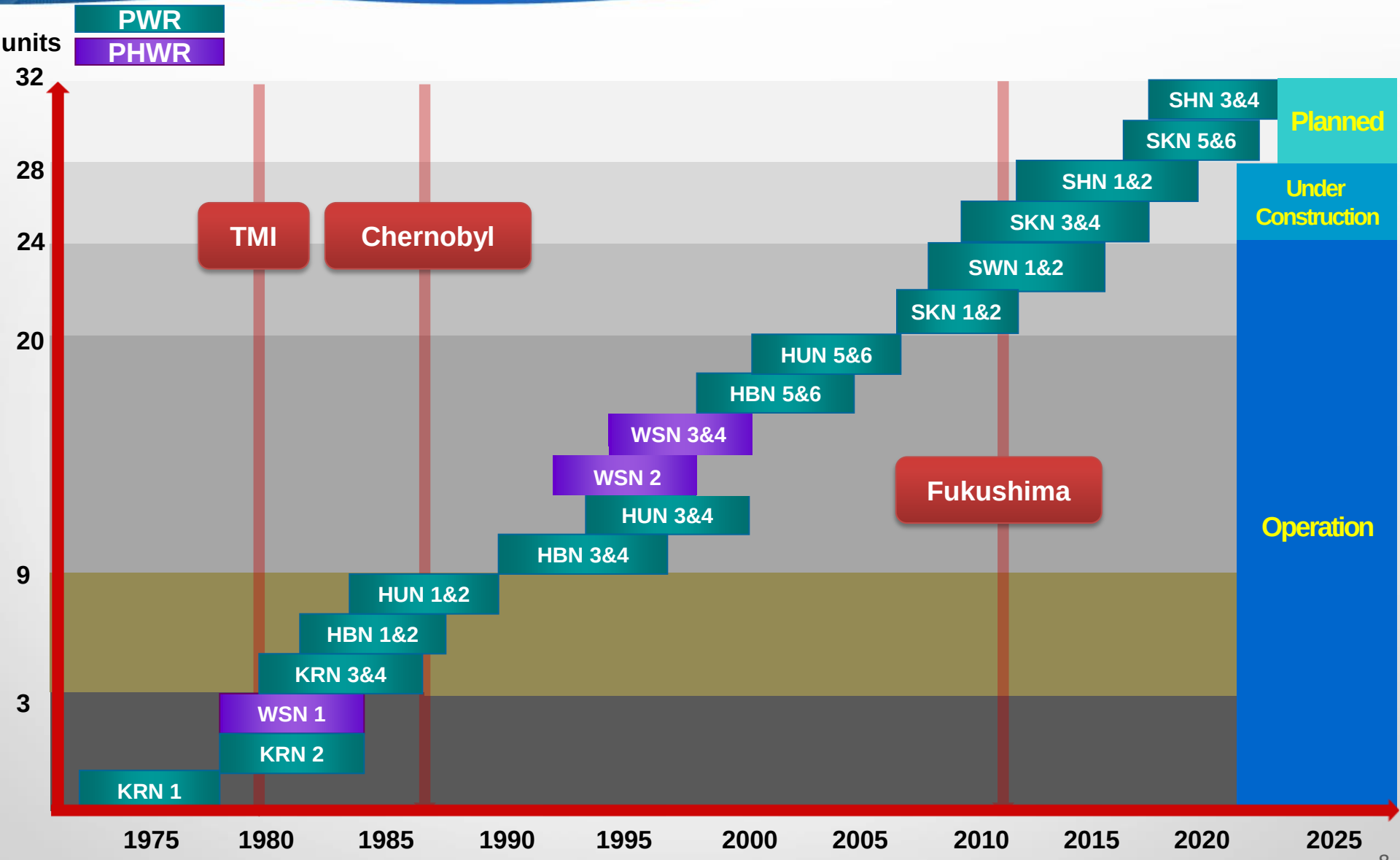
Innovative Technology

Development of Top tier NPP

- Apply global requirements

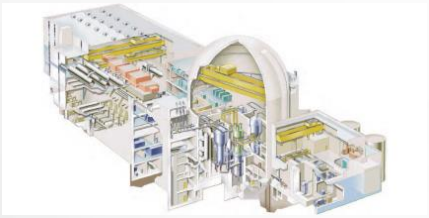
✓ APR +
✓EU-APR

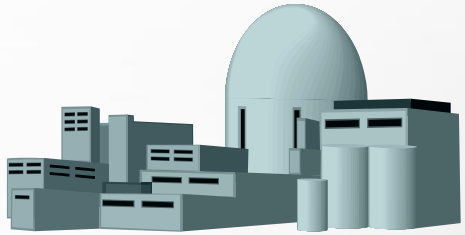
Chronology of NPP Construction



The Lineup of Korean Reactors

1990s → 2020s



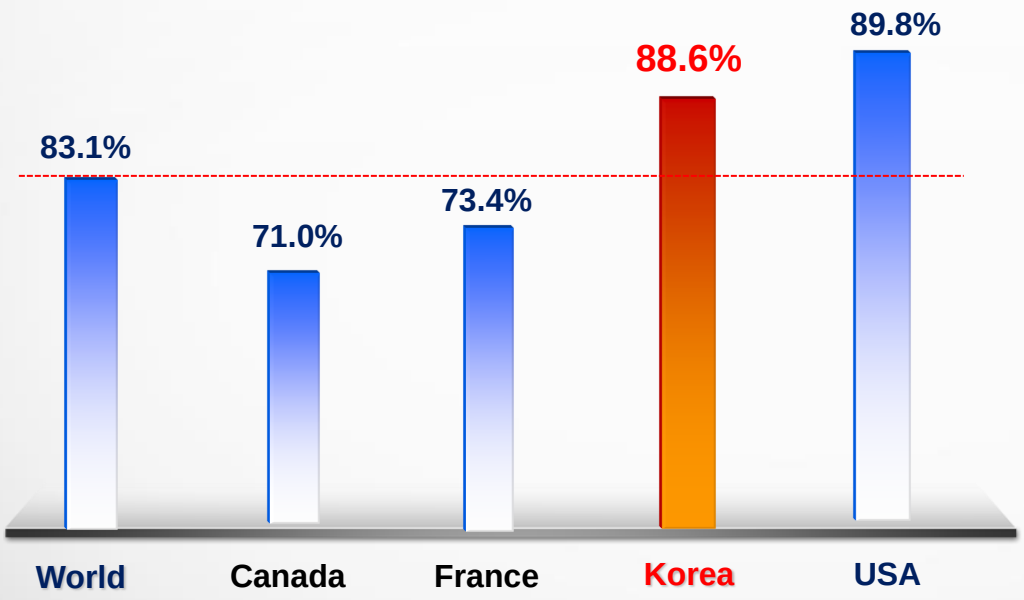



OPR1000 → **APR1400** → **APR+** → **Innovative Reactor**

- **APR1400** → **US-APR1400**
  - Design certification in process by US NRC
- **APR1400** → **EU-APR**
  - EUR certification in process
- **APR+** → **APR1000+**
  - Medium-sized reactor
  - Basic design in process

Operation Performance

WANO 10 Performance Indicators



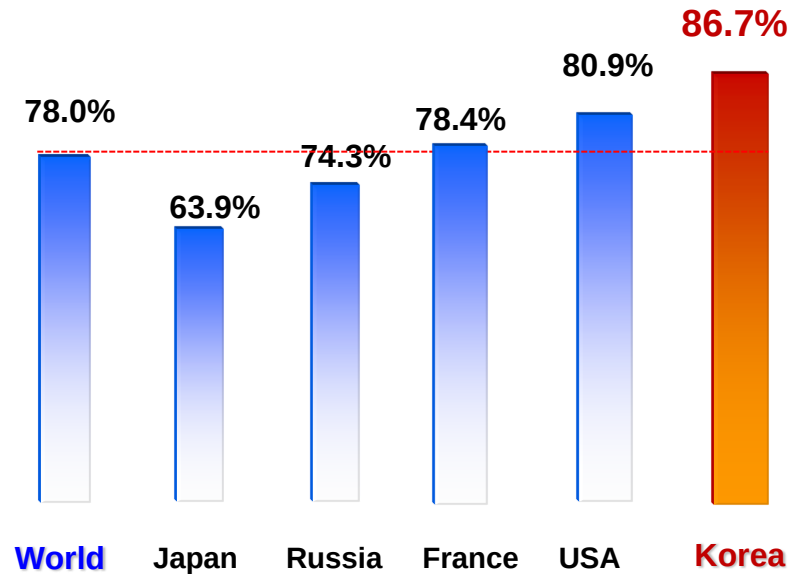
1. Unit capability factor
2. Unplanned capability loss factor
3. Forced loss rate
4. Collective radiation exposure
5. Safety system performance
6. Chemistry performance
7. Fuel reliability
8. Grid related loss factor
9. Unplanned total scrams per 7,000 hours critical
10. Industrial safety accident rate

※ Source: WANO, Sep. 2014

Operation Performance

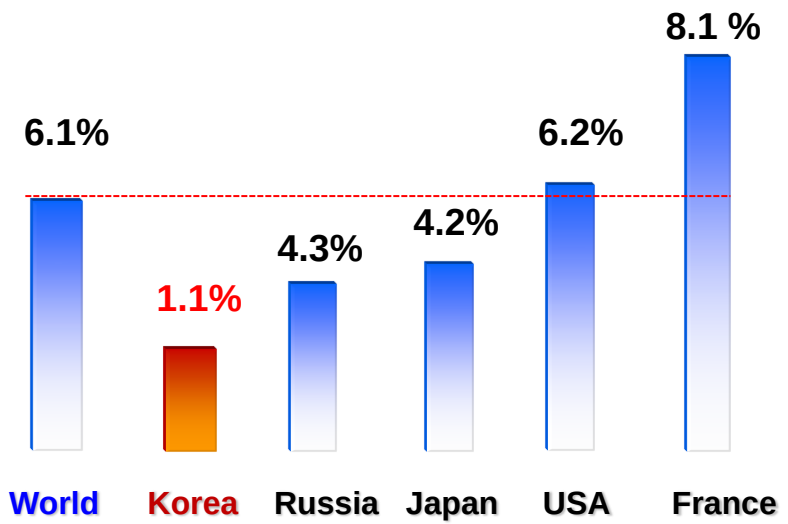
Unit capacity factor

Lifetime Average (COD~2014)



Unplanned capability loss factor

Lifetime Average (COD~2014)

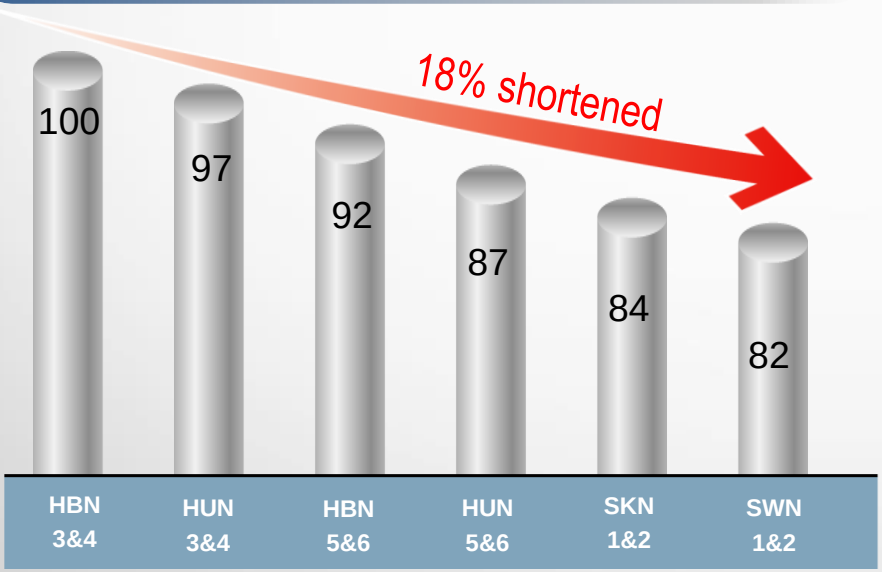


※ Source: IAEA, PRIS, 2014

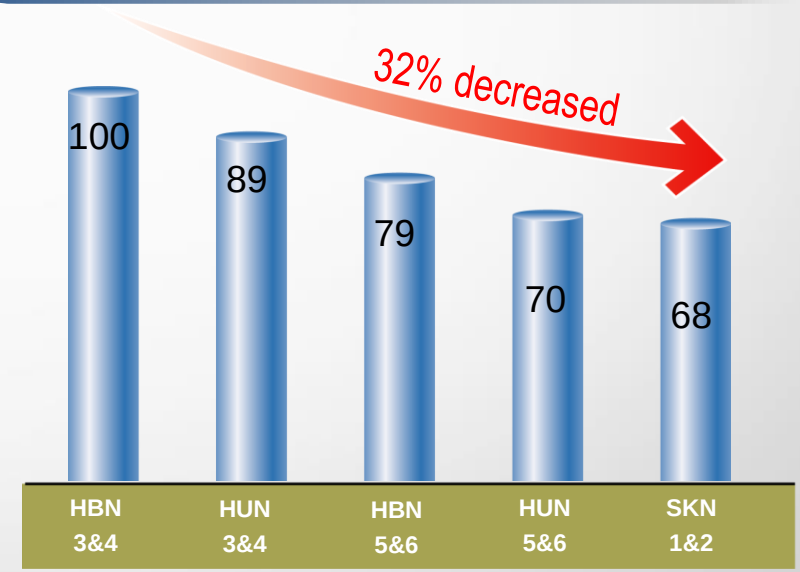
Within schedule, budget and resources

- Optimized construction management
- Rigid & proven supply chain
- Experienced engineers

Construction period

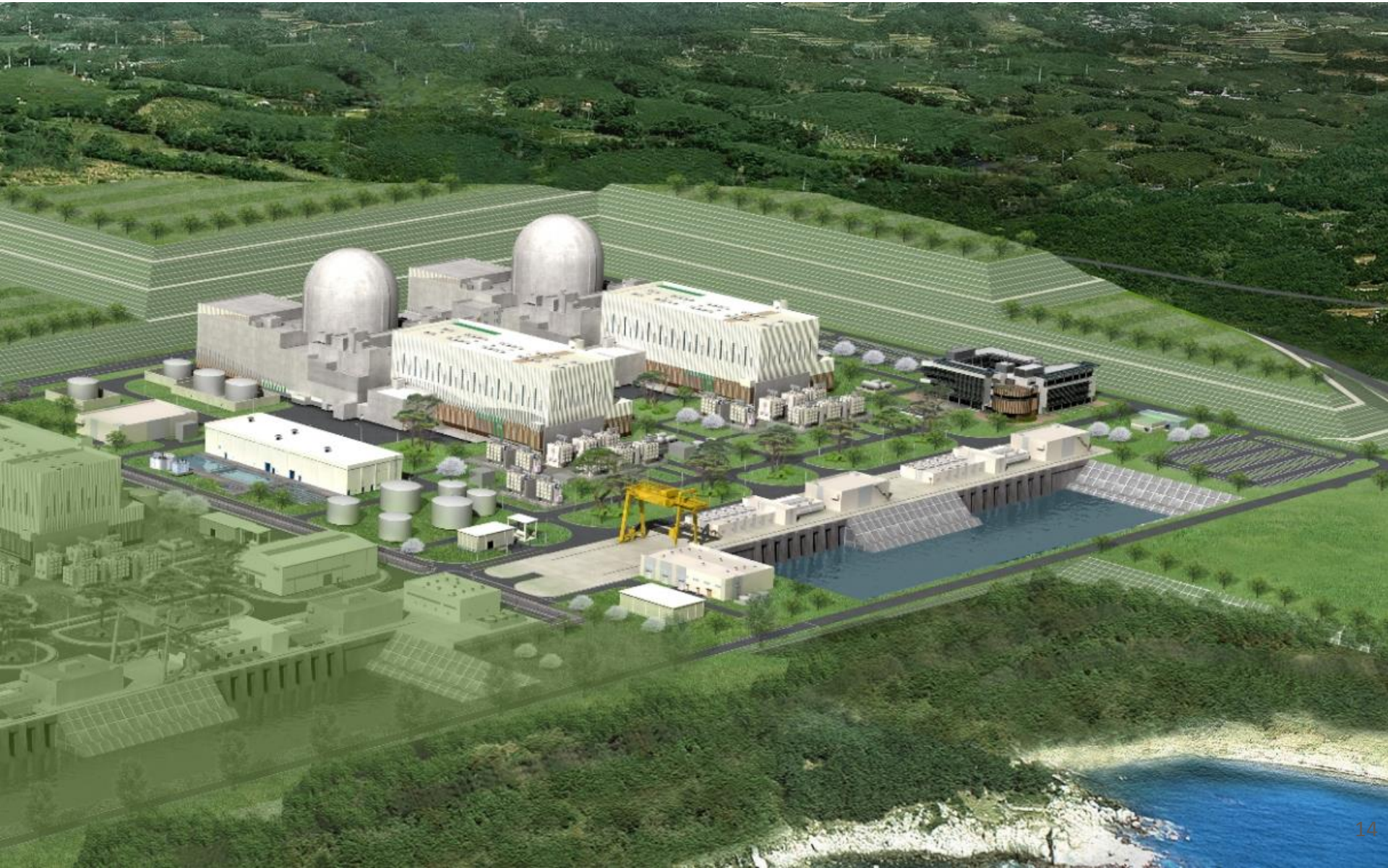


Construction cost



3. The APR1400

The Bird-eye view of APR1400



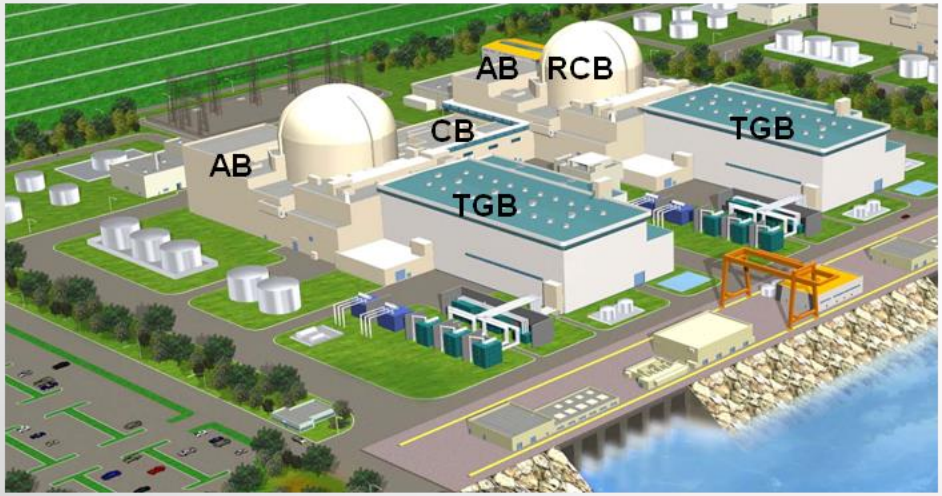
Basic Information

- 1,400MWe Gen Ⅲ reactor
- 60-year design lifetime
- World top level safety system
- Advanced design features
- SA mitigation systems
- Fukushima countermeasures
- Protection from hazards

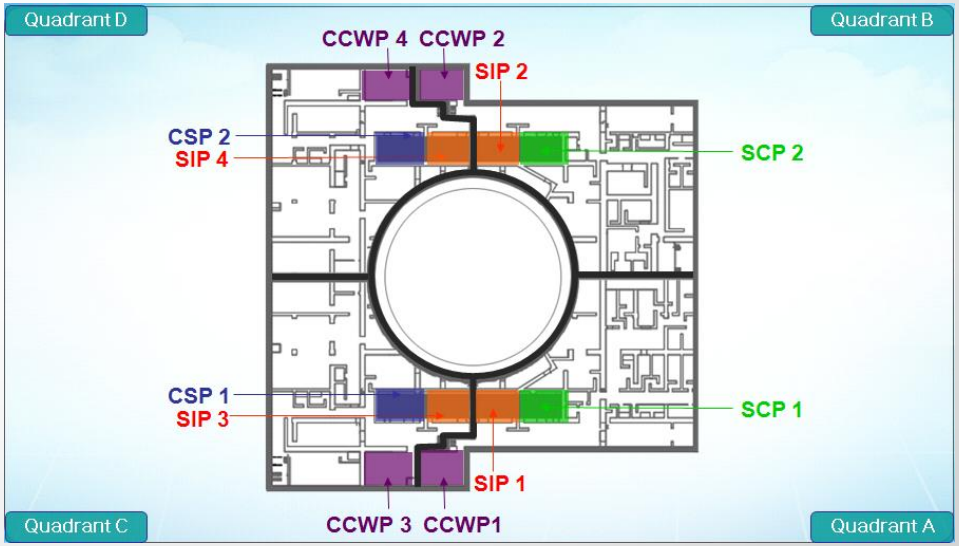
* SA : Severe accident

Building Arrangement

- Twin-units and slide-along arrangement
- Compound building shared between two units
- Common base mat of containment and auxiliary buildings for seismic resistance
- Auxiliary building consisting of 4-quadrants surrounding the containment building

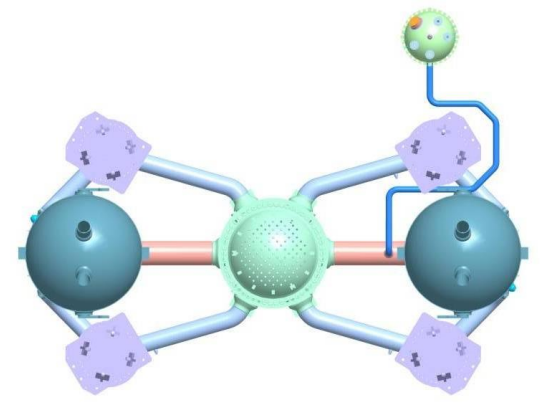


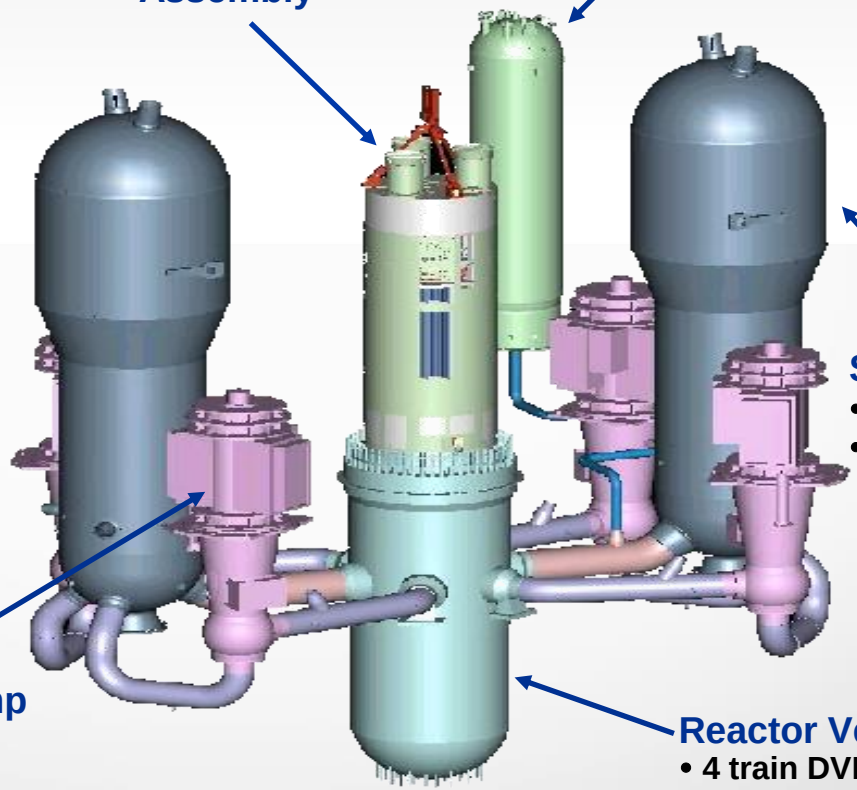
RCB : Reactor Containment Bldg.
CB : Compound Bldg.
AB : Aux. Bldg.
TGB : TG Bldg.



Reactor Coolant System

- Thermal Power: 4,000 MW
- Two-loop system





Pressurizer
- Large volume
- 4 POSRVs

Integrated Head Assembly

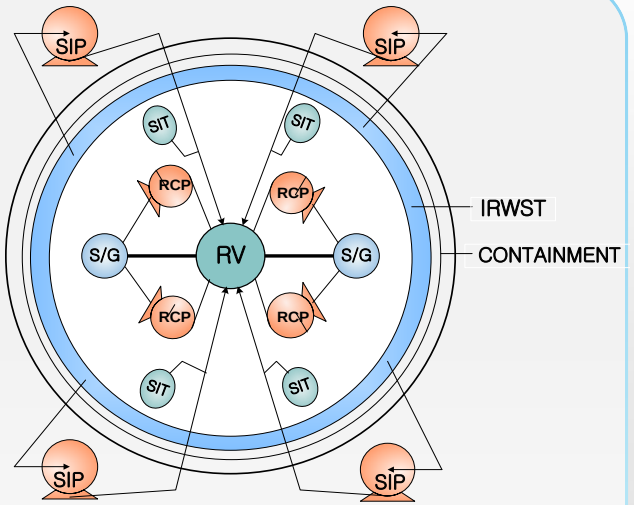
Steam Generator
- Plugging Margin : 10%
- Tube Material : I-690

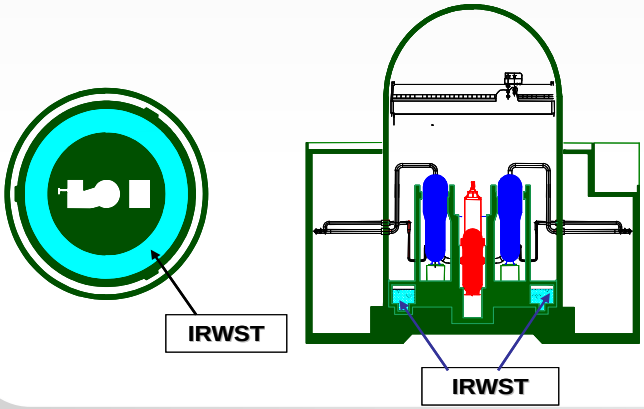
Reactor Coolant Pump

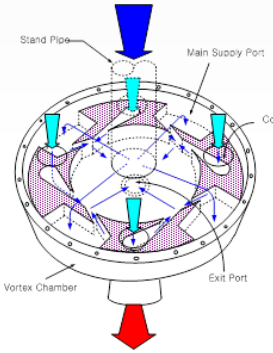
Reactor Vessel
- 4 train DVI
- Low RTNDT
- ERVC

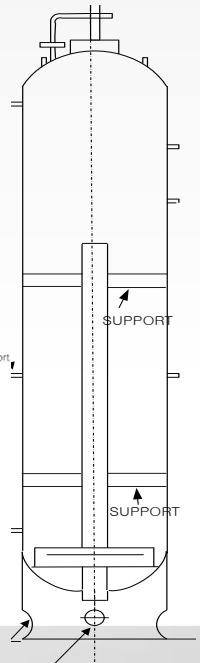
Safety Systems

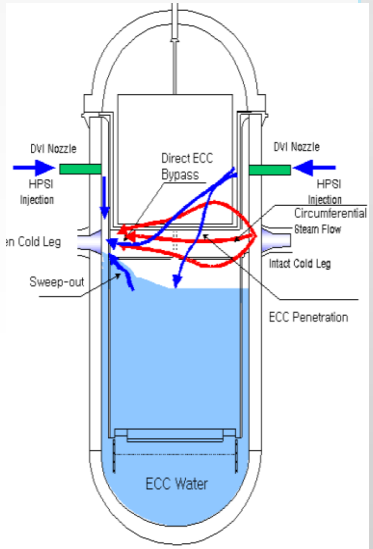
- **Mechanically Independent 4 Trains**
  - ✓ 1 SIP and 1 SIT for each train
- **DVI** (Direct Vessel Injection)
  - ✓ Minimum spillage of injected water in LOCA
- **Fluidic Device in SIT**
  - ✓ Effective use of cooling water
  - ✓ No need of Low Pressure SIP
- **IRWST** (In-containment Refueling Water Tank)
  - ✓ No switchover for long-term cooling in LOCA



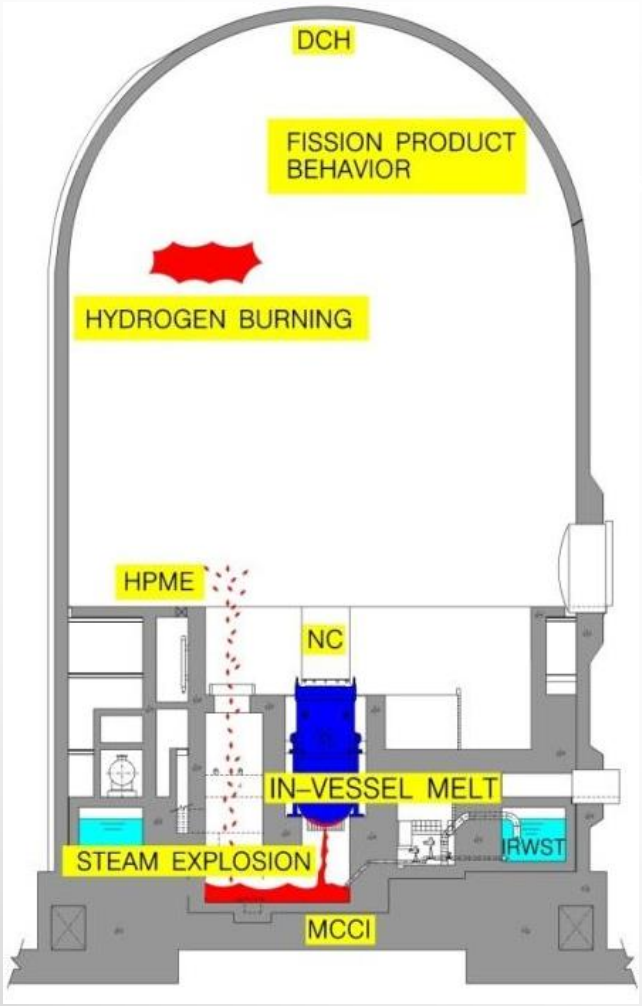








Severe Accident Mitigation System



Severe accident

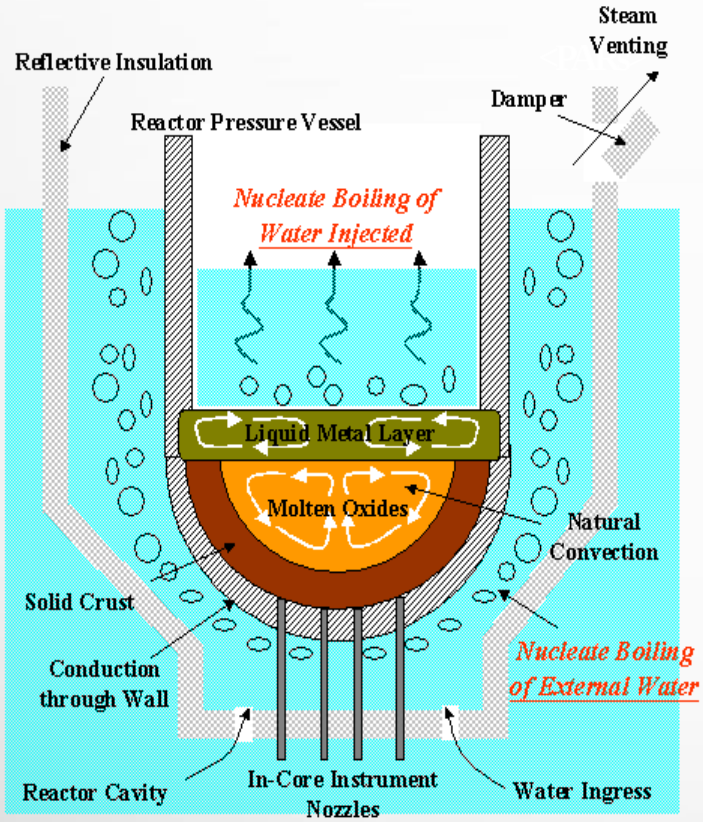
- **Beyond design basis accidents**
- **Molten corium**
  - ✓ **In-vessel & ex-vessel cooling**
  - ✓ **Hydrogen management**

Mitigation system

1. **In-vessel corium retention- External reactor vessel cooling system**
2. **Cavity flooding system**
3. **Hydrogen mitigation system - PARs**

DCH: Direct Containment Heating
FCI: Fuel Coolant Interaction
MCCI: Molten Corium-Containment Interaction
DCC: Degraded Core Coolability

Severe Accident Mitigation System



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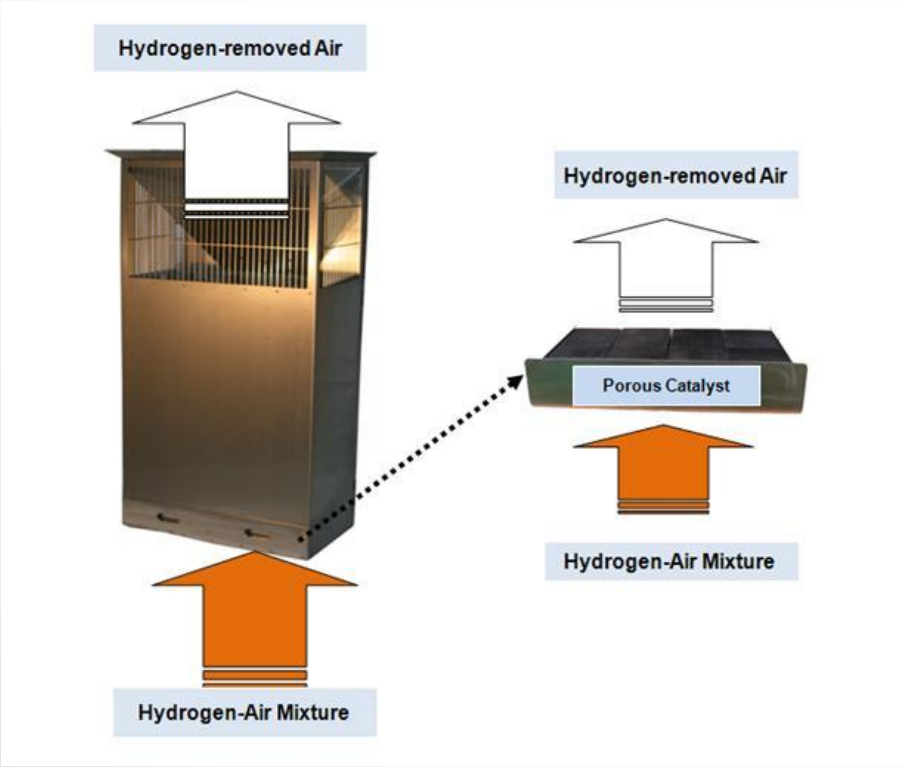

Passive Auto-catalytic Recombiners (PARs)

Severe accident

- **Beyond design basis accidents**
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  - ✓ Hydrogen management

Mitigation system

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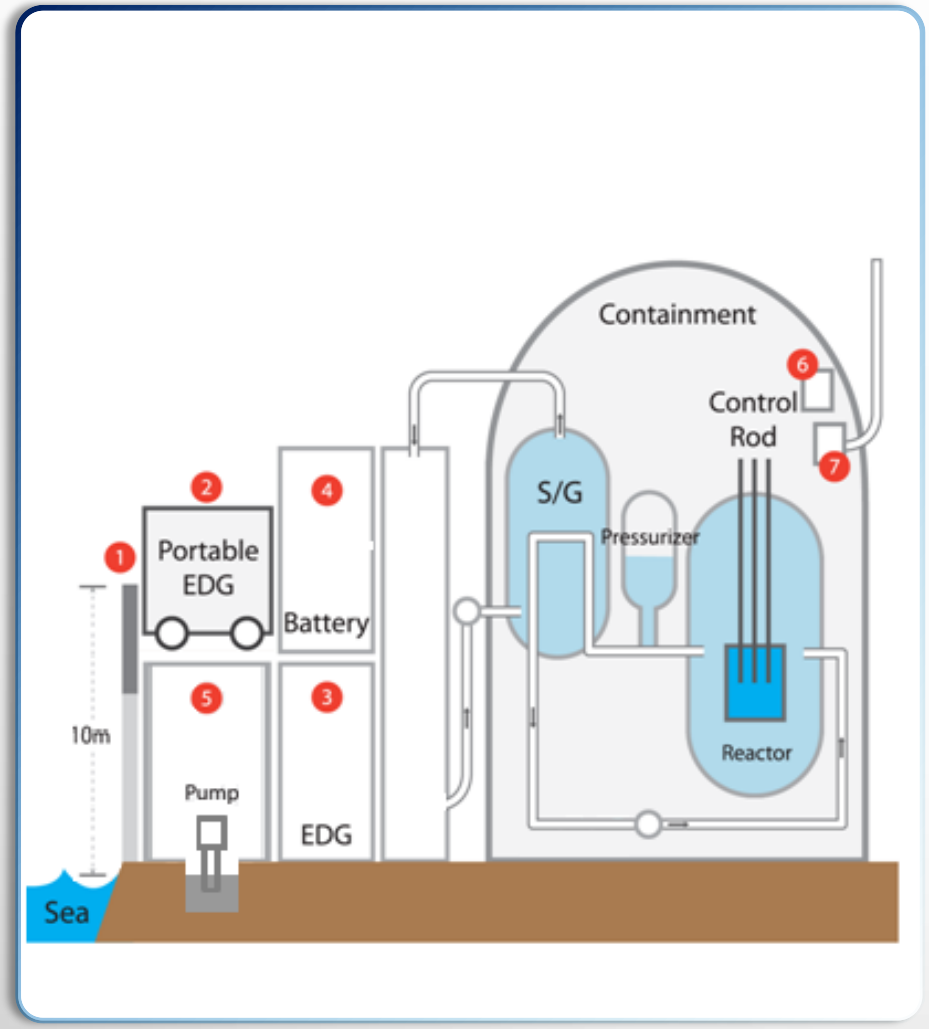
Post Fukushima Countermeasure



Improvement Areas

1. Elevating the **coastal barrier**
2. Preparing **portable EDG vehicles**
3. Installing **watertight doors** at major buildings
4. Securing the safety of **emergency battery power** from flooding
5. **Water-proofing drainage pumps**
6. Installing **passive hydrogen removal systems**
7. Installing **exhaust and decompression equipment**

Protect Against External Hazards

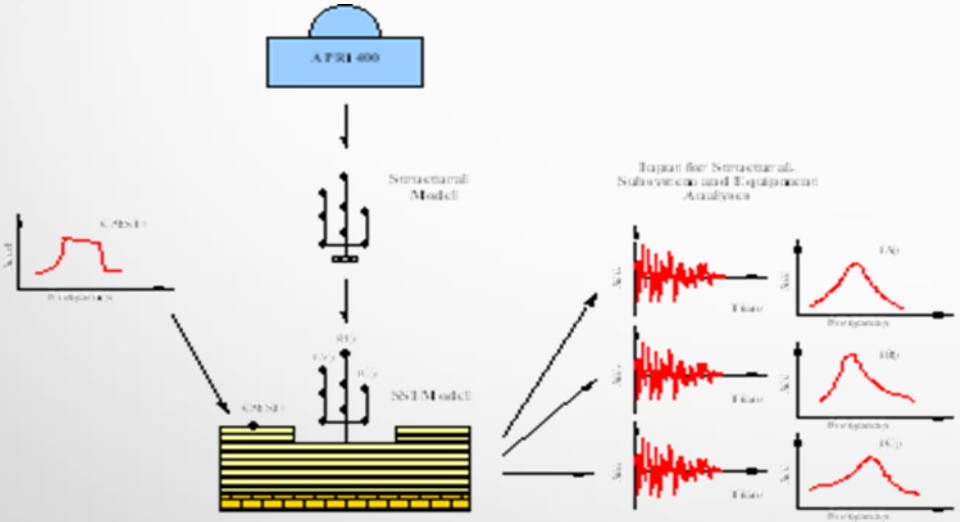
Natural Disasters

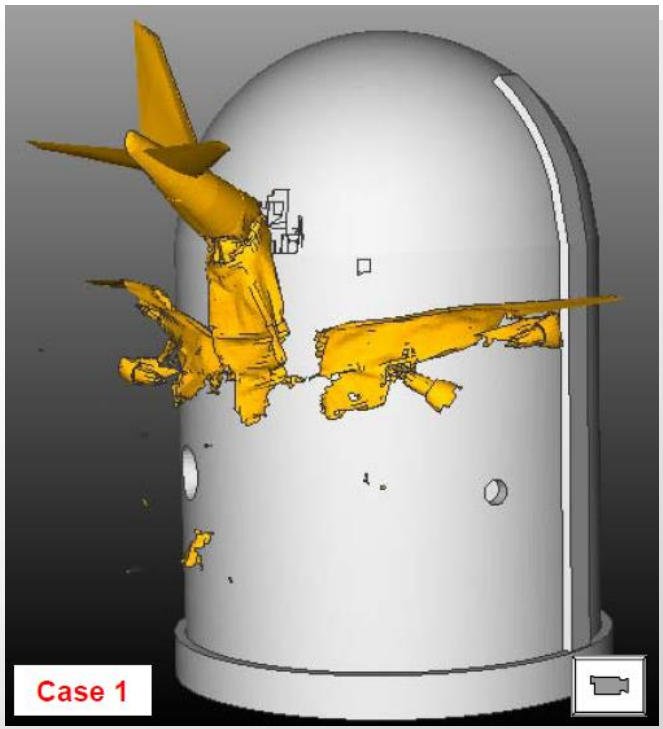
- **Earthquake** (0.3g SSE)**, Floods** (site specific; e.g. 6.5m)**, Tornadoes** (EF5)
- **Sand storm** (100 mg/m^3)**, etc.**

* EF : Enhanced Fujita scale of Tornado

Man-made Hazards

- **Aircraft crash** (impact of large commercial aircraft)
- **Fire** (3-hour rated resistance)**, etc.**





4. Summary

Summary

Korean Nuclear Power

- Continuous experience in design, construction & operation for 40 years
- Achievement of world-class safety & performance
- Construction competitiveness with proven technology

APR1400

- User friendly reactor based on KHNP's unique & abundant experience
- World top level safety with advanced technology
- Optimized design with credential licensability and cost effectiveness

Thank you