

**Regional Workshop on Safety Benefits and Challenges in the
Development of the Adoption of Small Modular Reactors
(EVT2404165)**

Overall Introduction to the SMR Development in Korea

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Innovative SMR Development Agency

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PART I

Background and History

I Background and History

◆ Korea has energy-intensive industries

- Semiconductors, Steel, Shipbuilding, and Batteries.
- Stable electricity power supply is essential to Korea's industrial competitiveness



◆ Necessary of SMR deployment in Korea

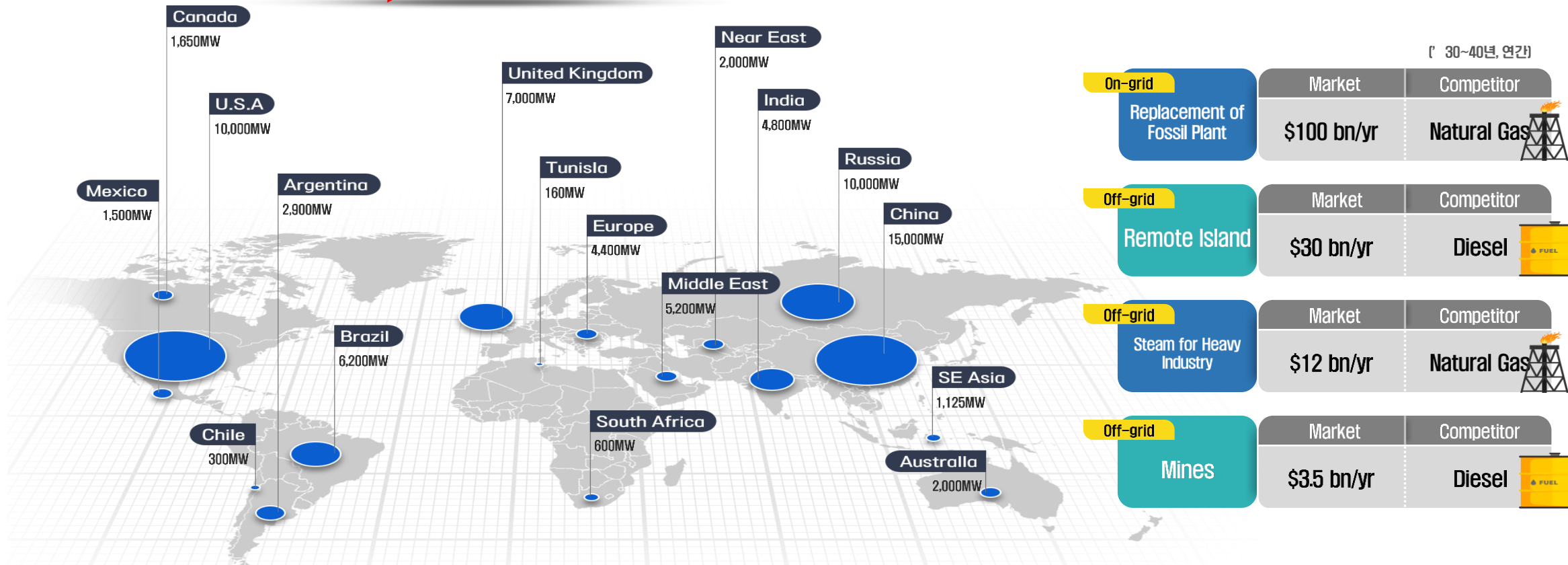
- Replacement of coal fired power plant
- Expanded renewables induces grid instability
- Increased interest and investment in SMR from private companies

< Coal fired power plant location >

I Background and History

◆ Near-term global potential market for SMR

65~85GW Global Potential Market by 2035



※ Source : Small Modular Reactors – once in a lifetime opportunity for the UK (2017)

※ Source : Canadian SMR Roadmap: Economic and Finance Working Group Report (2018)

◆ 11th National Basic Plan for Electricity Supply and Demand

- Finalized in Feb. 2025
- Balanced expansion of nuclear power and renewable energy

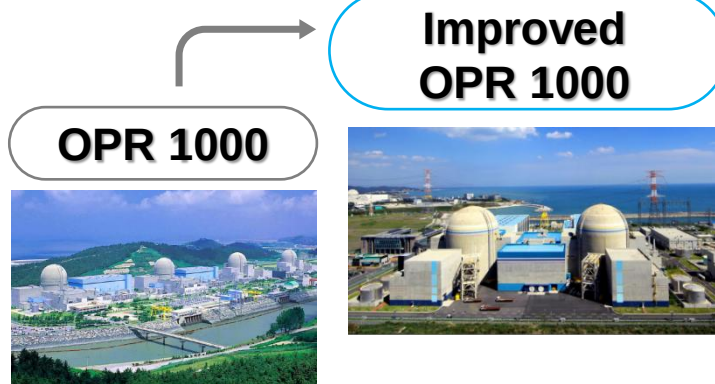
Years	Nuclear(%)	Coal	LNG	Renewables	ETC	Capacity(GW)
2023	30.7	31.4	26.8	9.6	1.5	144
2030	31.8	17.2	25.1	22	3.9	206
2038	35.2	10.1	10.6	30	14	268

- New construction plan of nuclear power plant is included
 - ✓ Large NPP : 1400MWe X 2 unit
 - ✓ SMR : 680MWe (4 modules of i-SMR) ➔ Target commercial operation year = 2035

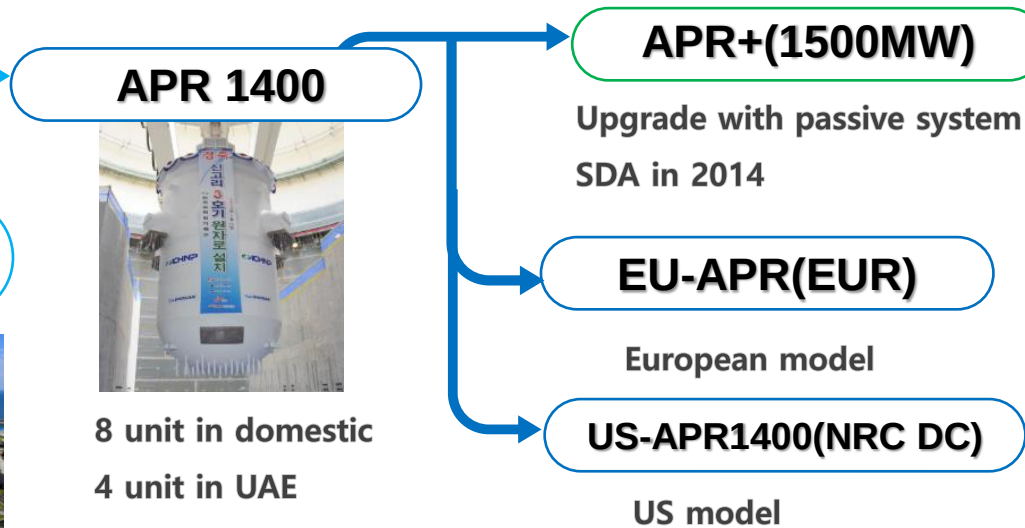
I Background and History

Evolution history of Korean Nuclear Tech.

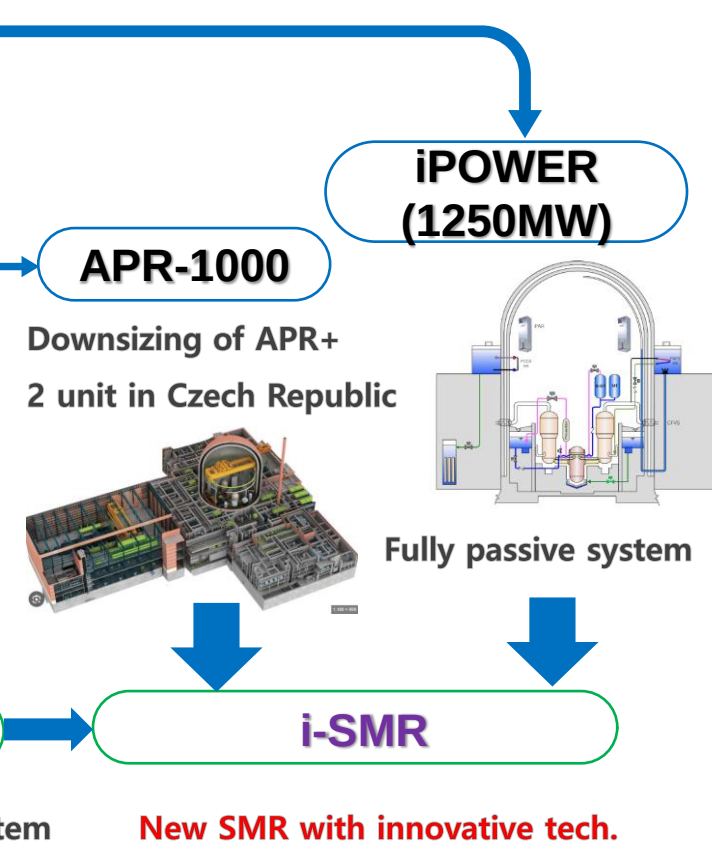
1 Technology Self-reliance



2 Technology Advancement

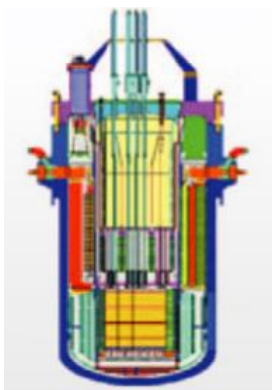


3 Technology Innovation

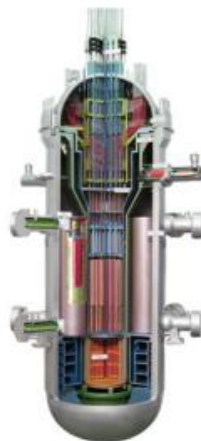


◆ Important Milestone of SMR development history in KOREA

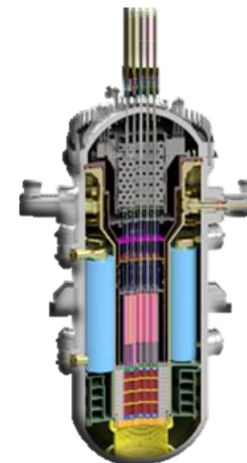
SMART Conceptual Design ('97)



SMART(Active) SDA ('12)



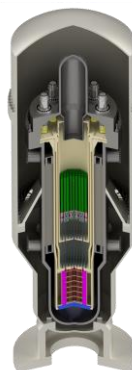
SMART100(Passive) SDA ('24)



i-SMR Conceptual Design ('19)



i-SMR Basic Design ('23)



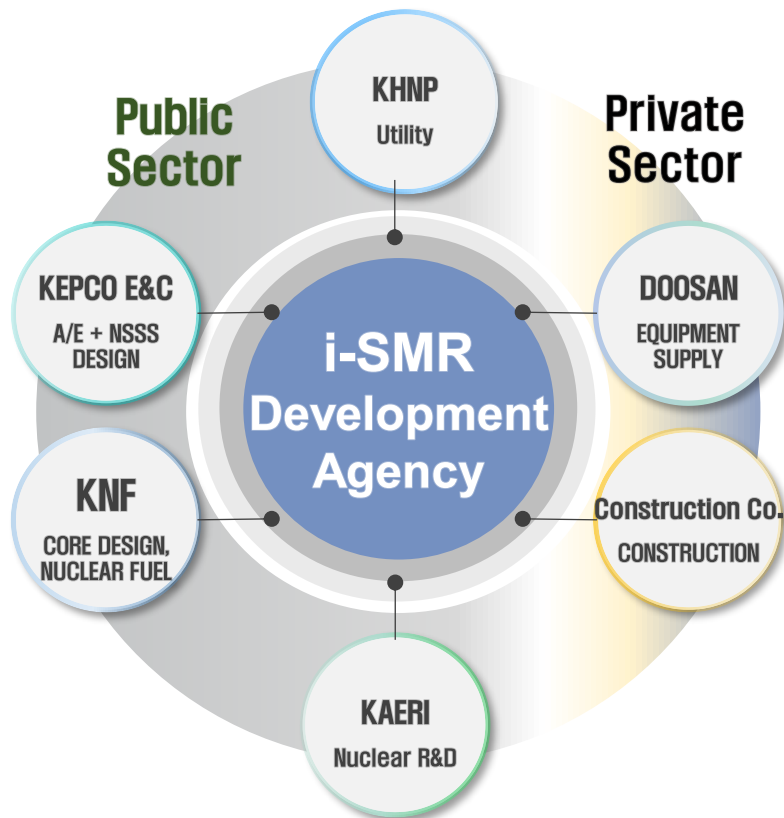
i-SMR Standard Design ('25)



I Background and History

◆ i-SMR Development Agency

- Established by Korean Government ( Ministry of Science and ICT  Ministry of Trade, Industry and Energy)
- leading the development of the i-SMR and aims to obtain the Standard Design Approval (SDA) from the Korean regulatory body by 2028.





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PART II

SMART Development Status

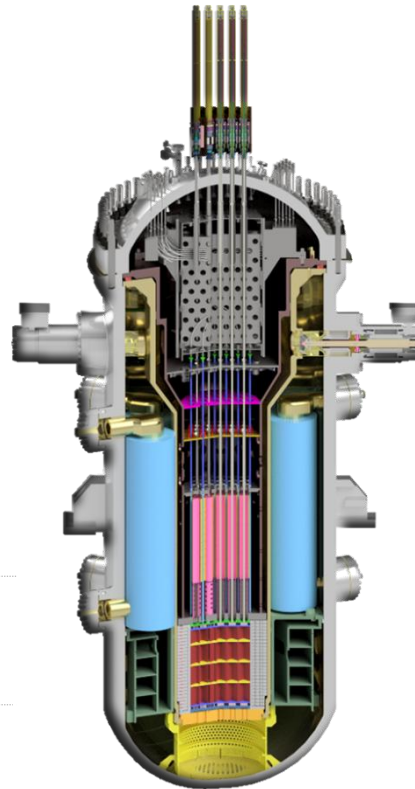
◆ SMART (System-integrated Modular Advanced Reactor)

SMART features

Development	KOREA, KAERI, KHNP and Others
Power	Thermal : 365 MWt Electricity : 110 MWe
Lifetime	60 years
Purpose	Electricity, Heating, Desalination, Hydrogen

Modularity & Economics

Economics	Comparable to commercial large plant
Construction period	36 months

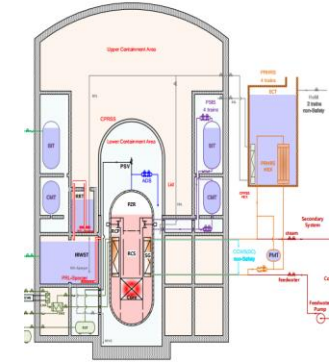


Enhanced Safety

Integrated Primary System

Fully Passive Safety Systems

- PSIS, PRHRS, CPRSS



Licensed Technology

World's First Standard Design
Approved SMR (2012)

Harmonizing Innovative Concept
& Proven Technology for
Licensability and Market
Acceptability



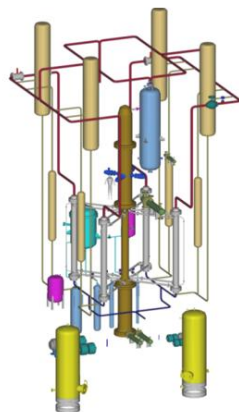
◆ Validation of SMART



<CHF Measurement Test>

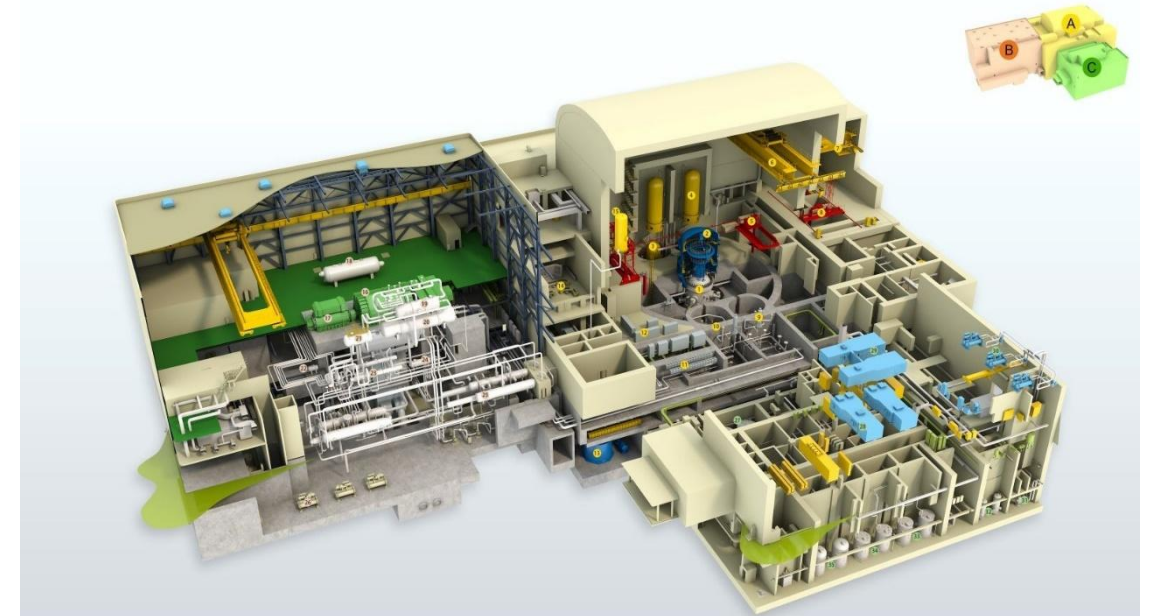


<Fuel Performance Tests>



<SMART-ITL>

General Arrangement of SMART



II

SMART Development Status

◆ Deployment of SMART

KSA (15.12~)

- ▶ SMART Partnership Cooperation
- ▶ Joint FOAK deployment and global commercialization

Jordan (17.7~18.8)

- ▶ Joint feasibility study (JAEC, KAERI, K.A.CARE) for two Units of SMART Construction in Majdal site

The Philippines (19.3~19.12)

- ▶ Pre-joint feasibility study (NEPIO, KHNP, KAERI, K.A.CARE) for SMART deployment in the Philippines Cagayan economic zone

Indonesia (20.1)

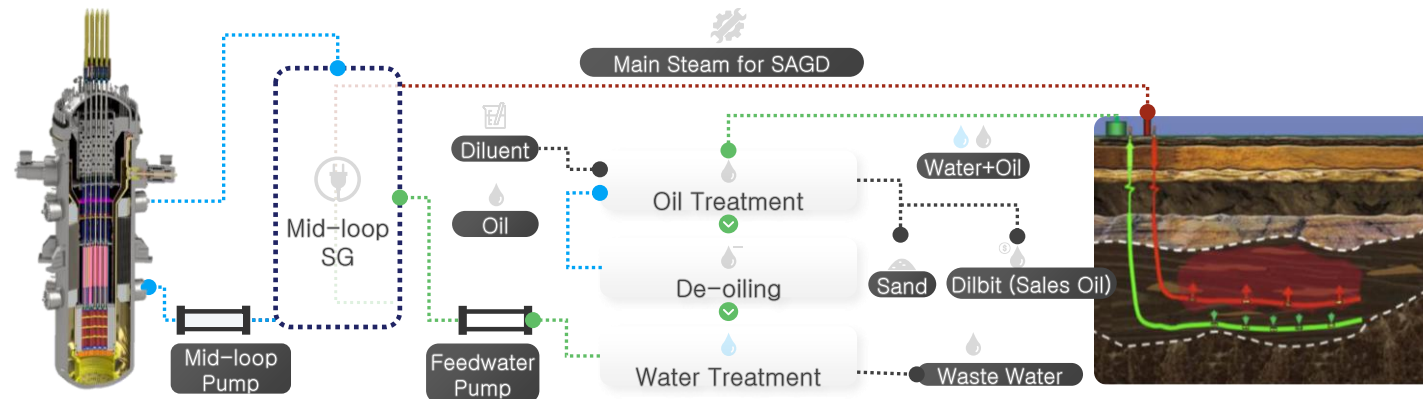
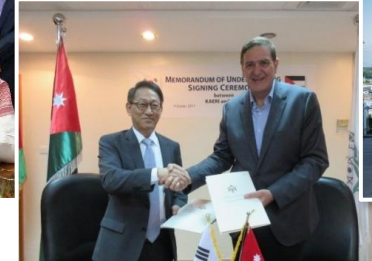
- ▶ RFIs from Indonesia (RISTEKDIKT)

Czech (20.3~)

- ▶ RFIs from Czech (CEZ)

Canada (22.10~)

- ▶ Feasibility study in Canada (Alberta)





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PART III

i-SMR Development Status

◆ Top-tier Requirement of i-SMR

General

- ❖ **PWR**
- ❖ **170MWe POWER**
- ❖ 80 years design life

Economics

- ❖ Overnight cost : \$3,500 /kWe
- ❖ LCOE : LCOE \$65 /MWh
- ❖ **Modular design and Factory manufacturing**
- ❖ Construction time ≤ 42 month (4 modules)



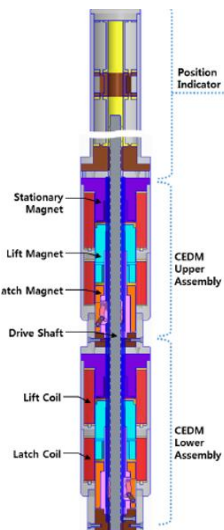
Safety

- ❖ **CDF : 1.0×10^{-9} /M·Y**
- ❖ **Fully Passive Safety System**
- ❖ EPZ : Within site boundary

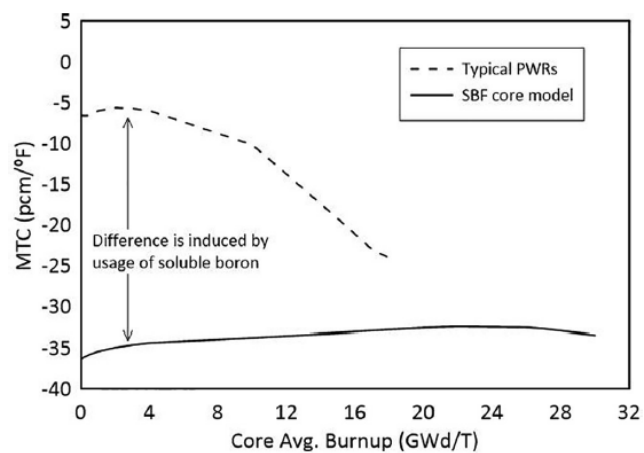
Flexibility

- ❖ **Boron Free Operation**
- ❖ Multipurpose Utilization
- ❖ Load Following Operation

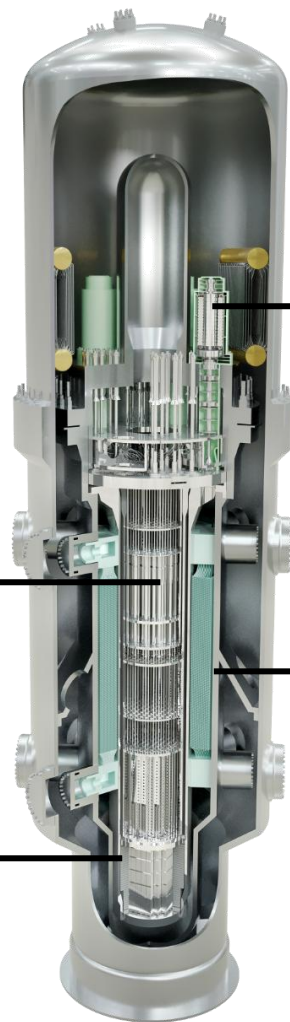
◆ Design Characteristics of i-SMR (1/2)



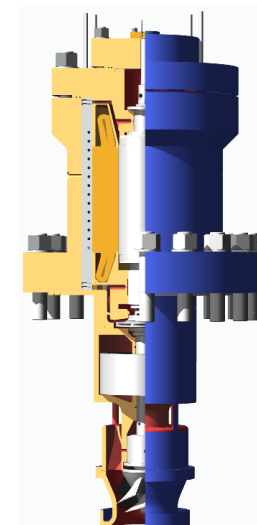
< In-Vessel CRDM >



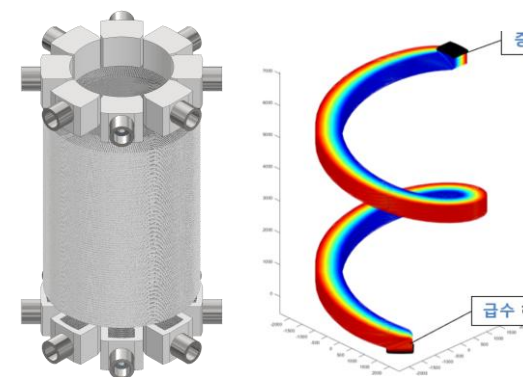
< MTC feedback for boron-free core >



< i-SMR >



< Canned Motor RCP >



< Helical SG >

III

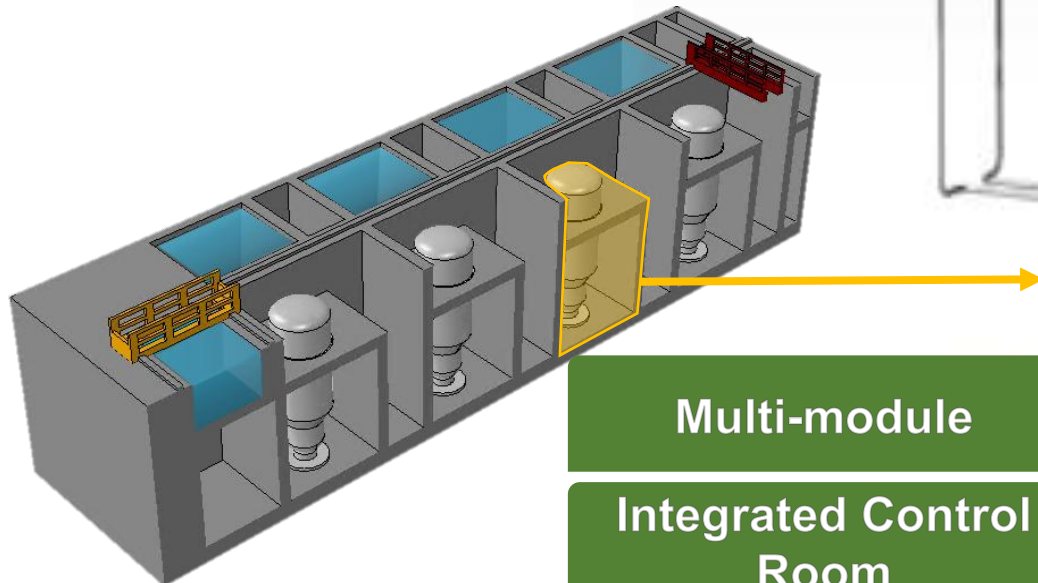
i-SMR Development Status

◆ Design Characteristics of i-SMR (2/2)

Fully passive safety system

Fail-safe with non-safety
grade electrical power

Reactor protection with
FPGA platform



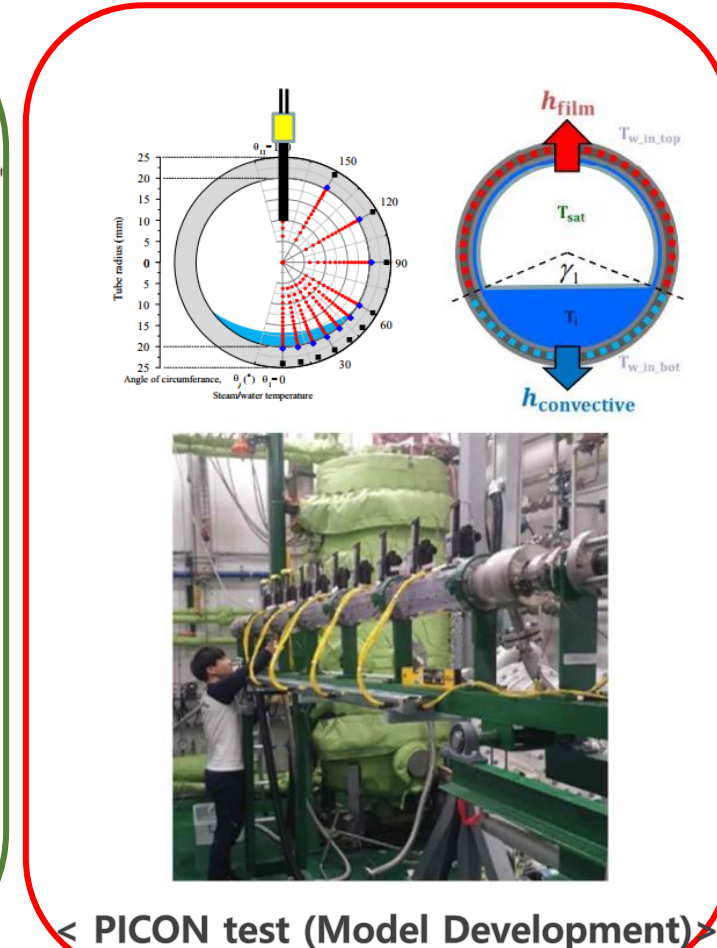
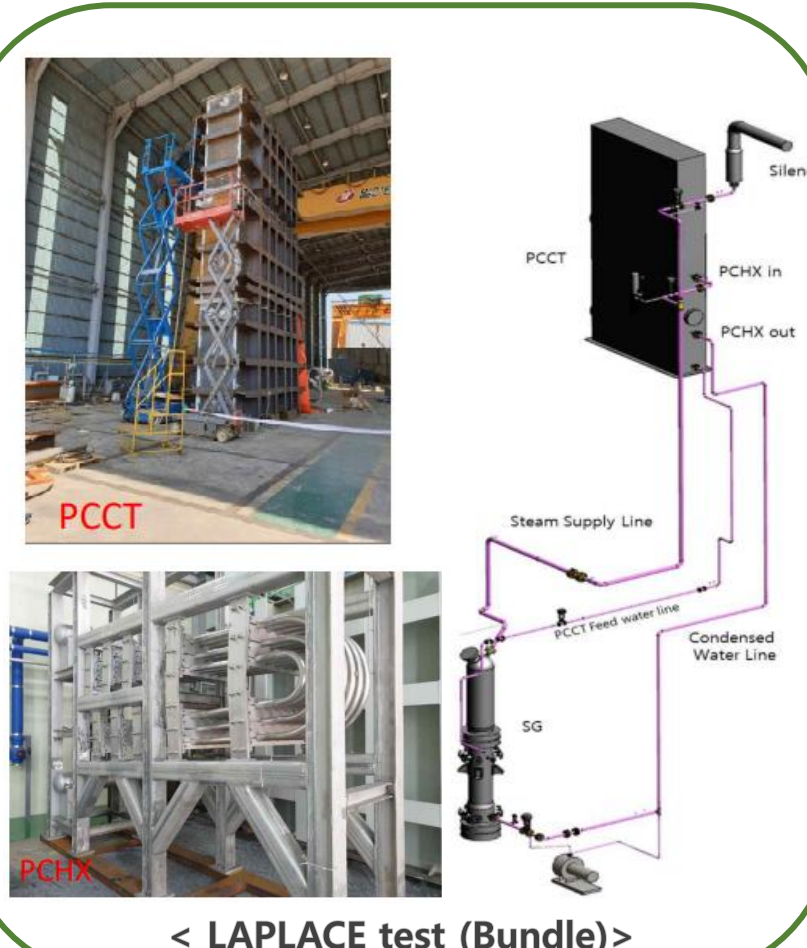
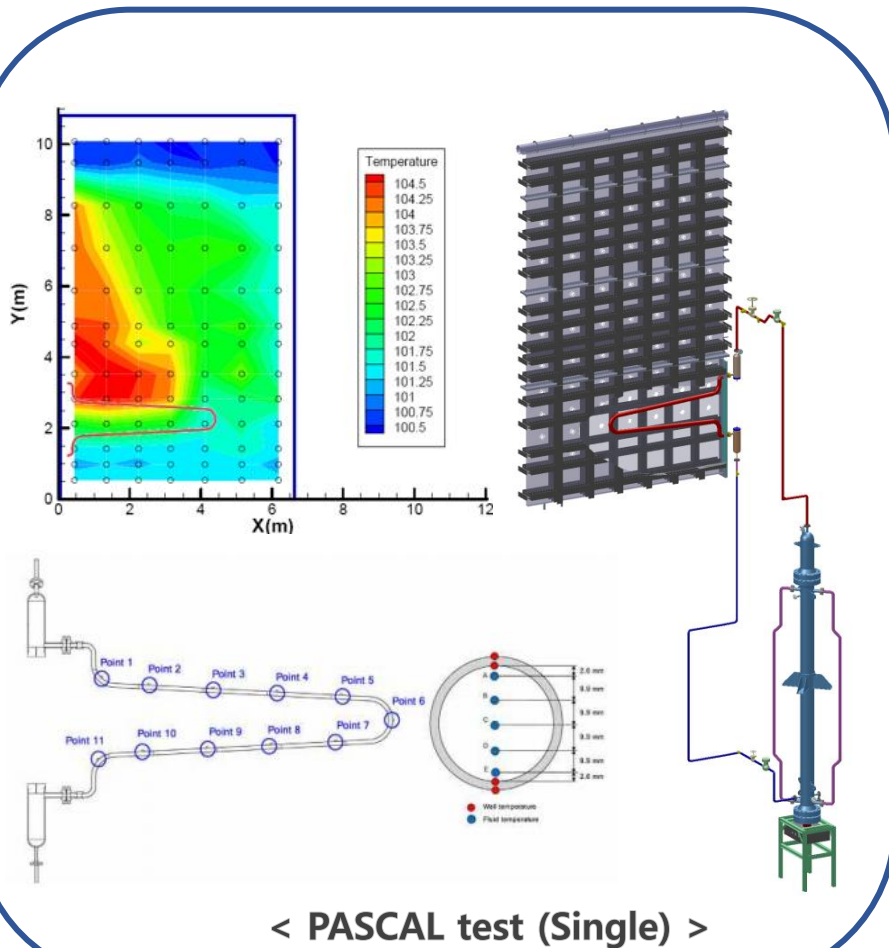
Multi-module

Integrated Control
Room

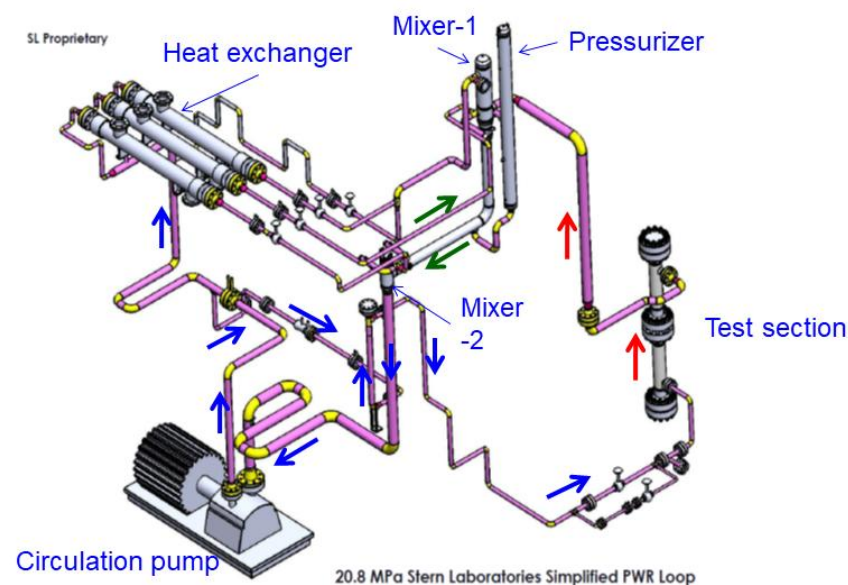
Steel Containment
Vessel

◆ Separate Effect Test (SET) for passive auxiliary feedwater system (PAFS)

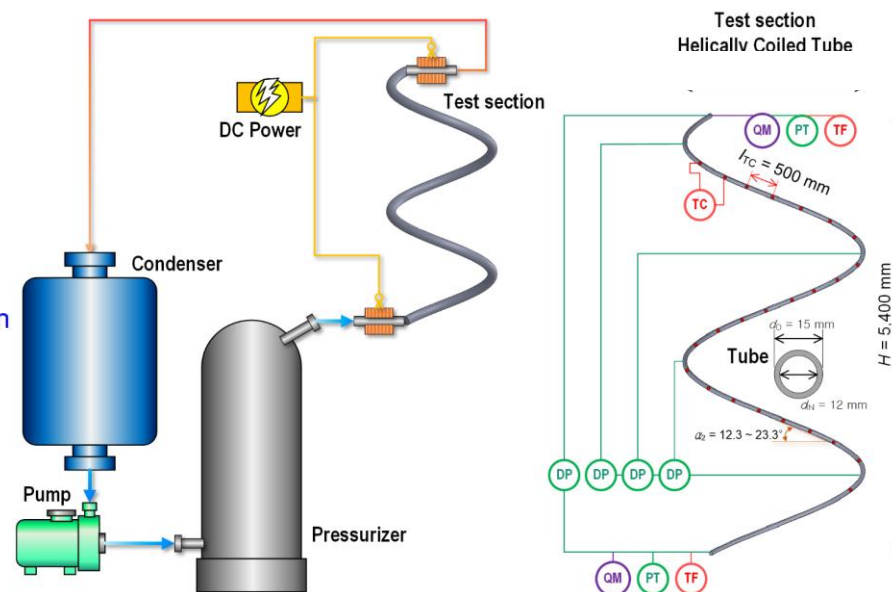
- Single tube condensation test, Bundle tube test, and APR+ PAFS Integral effect test had been carried out
- Development of condensation model for PAFS is completed



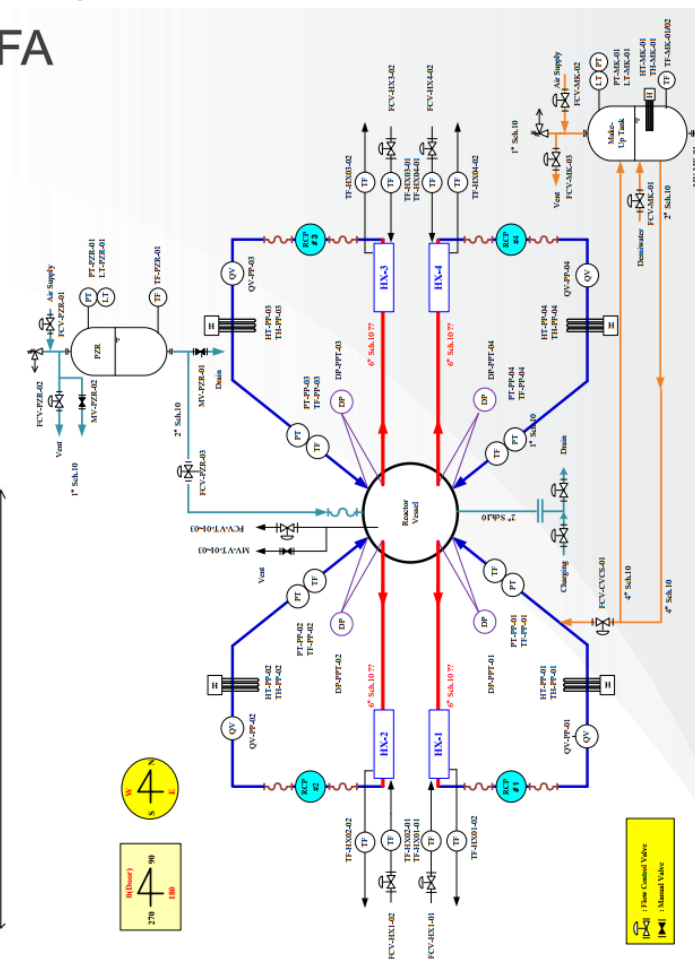
- Prototype of **helical coil steam generator tube test** : Pressure drop, HTC's, Density wave oscillation
- Core inlet **flow distribution Test** : Quantification of core inlet flowrate for each FA
- Critical Heat Flux (**CHF**) test for i-SMR fuels
 - ✓ CHF correlation update and expanding flow velocity range



< CHF test >



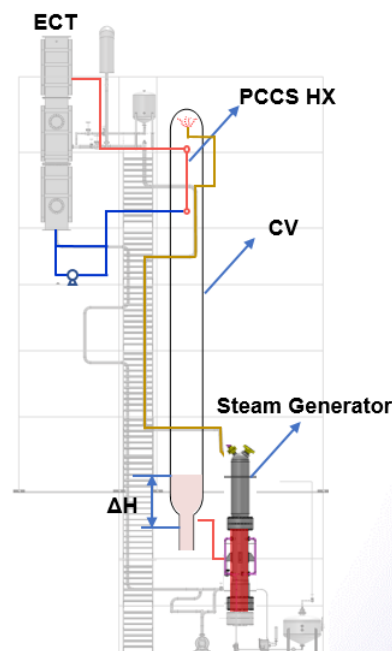
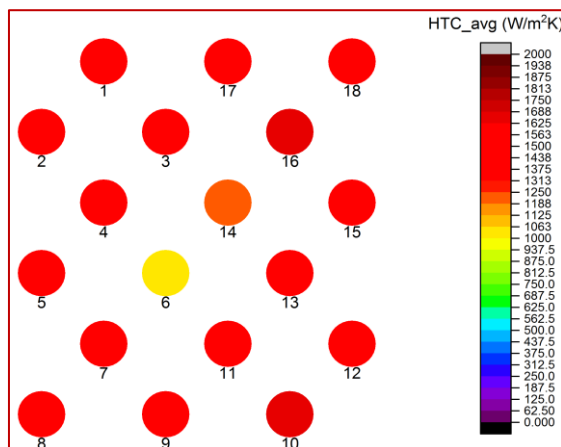
< Helical coil SG test >



< Core flow distribution test >

◆ Separate Effect Test (SET) plan for passive containment cooling and emergency core cooling

- **PCCS condensation test** : Obtaining condensation HTC of PCCS HXs for single tube and bundle tubes
 - As-is : Low P(<0.5MPa), High N.C. gas fraction ($0.1 < W_a < 0.7$)
 - To-be : High P(<5MPa), Low N.C. gas fraction ($0 < W_a < 0.1$)
- **PECCS natural circulation test**
 - Measuring the natural circulation flow rate of ERV coupled with PCCS condensation
 - Preserving the pressure drop of natural circulation and ERV K-factor for prototype



< PCCS performance test for i-POWER >

< Manufacturability Validation >

< i-SMR SET facility >

◆ Integral Effect Test (SET) Plan

➤ Objectives

- ✓ to confirm performance of new passive safety systems
- ✓ to validate the safety analysis code and related models.

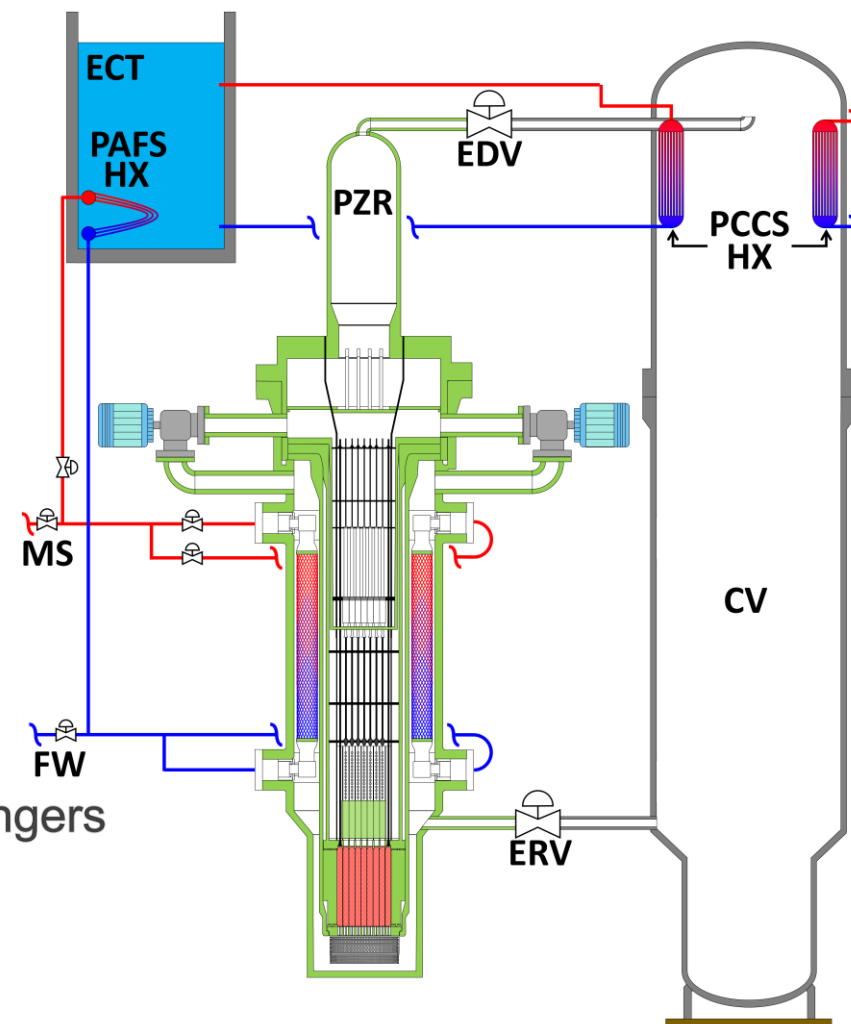
➤ Simulation Accidents : (Phase 1) Major DBA, (Phase 2) BDBA

➤ Facility design

- ✓ Scaling ratio : $H=1/2$, $A=1/49$, $V=1/98$
- ✓ Integral type SG + separated RCPs and CV

➤ Important Phenomena

- ✓ RV and CV wall boiling and recirculation flow in LOCA
- ✓ thermal stratification and natural Convection in ECT
- ✓ Superheated steam condensation in PAFS and PCCS heat exchangers
- ✓ Overall safety performance



< i-SMR IET facility >

◆ Pre-Licensing Review Process

- 13 technical reports were submitted to NSSC (KINS)
 - ✓ New design features and new evaluation methodologies

i-SMR design specific characteristics

Boron-free operation
Steel CV
Fully Passive Safety System
non-safety grade electrical power
FPGA Platform
Multi modules



TeR (Design)

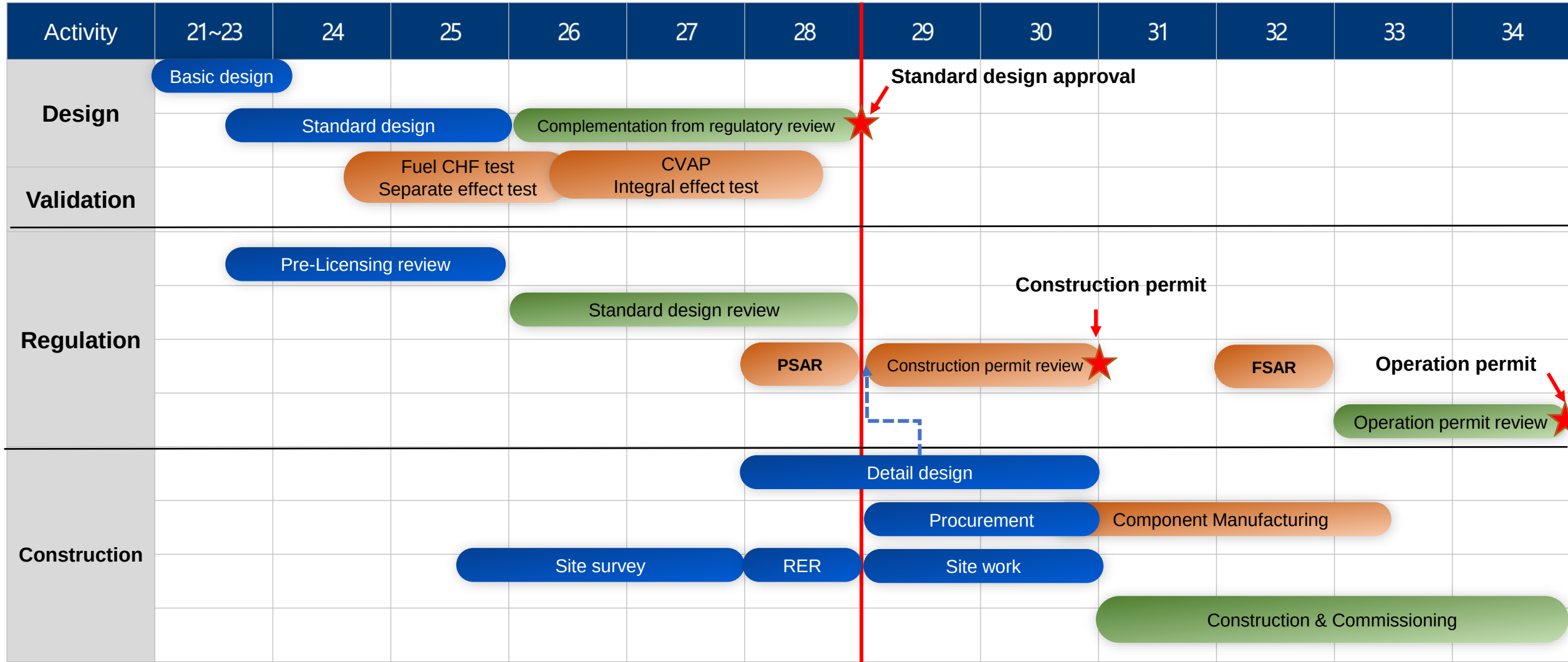
2nd Reactivity Control System
Steel CV
Fully Passive Safety System
Non-safety grade electrical power
HMIS Protection System Platform
Staffing and HFE for Integrated Control Room
Multi-module and shared design



TeR (Evaluation Methodology)

Nuclear design code and methodology
Combustible gas control
Radiological Source Term Methodology
Methodology for LOCA and Non-LOCA
Methodology of Beyond DBAs
Methodology of EPZ

◆ Deployment Roadmap for FOAK construction of i-SMR





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PART IV

Closing Remarks

IV

Closing Remarks

1

SMART is the world's first SMR obtained the standard design approval, and SMART100 with passive safety system has recently obtained the standard design

2

SMART, which has a multi-purpose utilization function, is conducting various feasibility studies and dialogues to deploy it in global markets.

3

i-SMR, which has adopted innovative technology beyond that of SMART, is actively undergoing the standard design process. SSAR will be submitted in Dec. of 2025.

4

The FOAK construction plan for i-SMR has been confirmed in national plan, and activities for equipment qualification and construction design to realize the construction plan will be carried out from next year.



IAEA

International Atomic Energy Agency

Atoms for Peace and Development

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Thank you for your attention