

Licensing Experiences on the Standard Design Approval of SMART100



Regional Workshop on Safety Benefits and Challenges in the Development of the Adoption of Small Modular Reactors, 31 Mar – 4 Apr 2025.

Korea Institute of Nuclear Safety (KINS)

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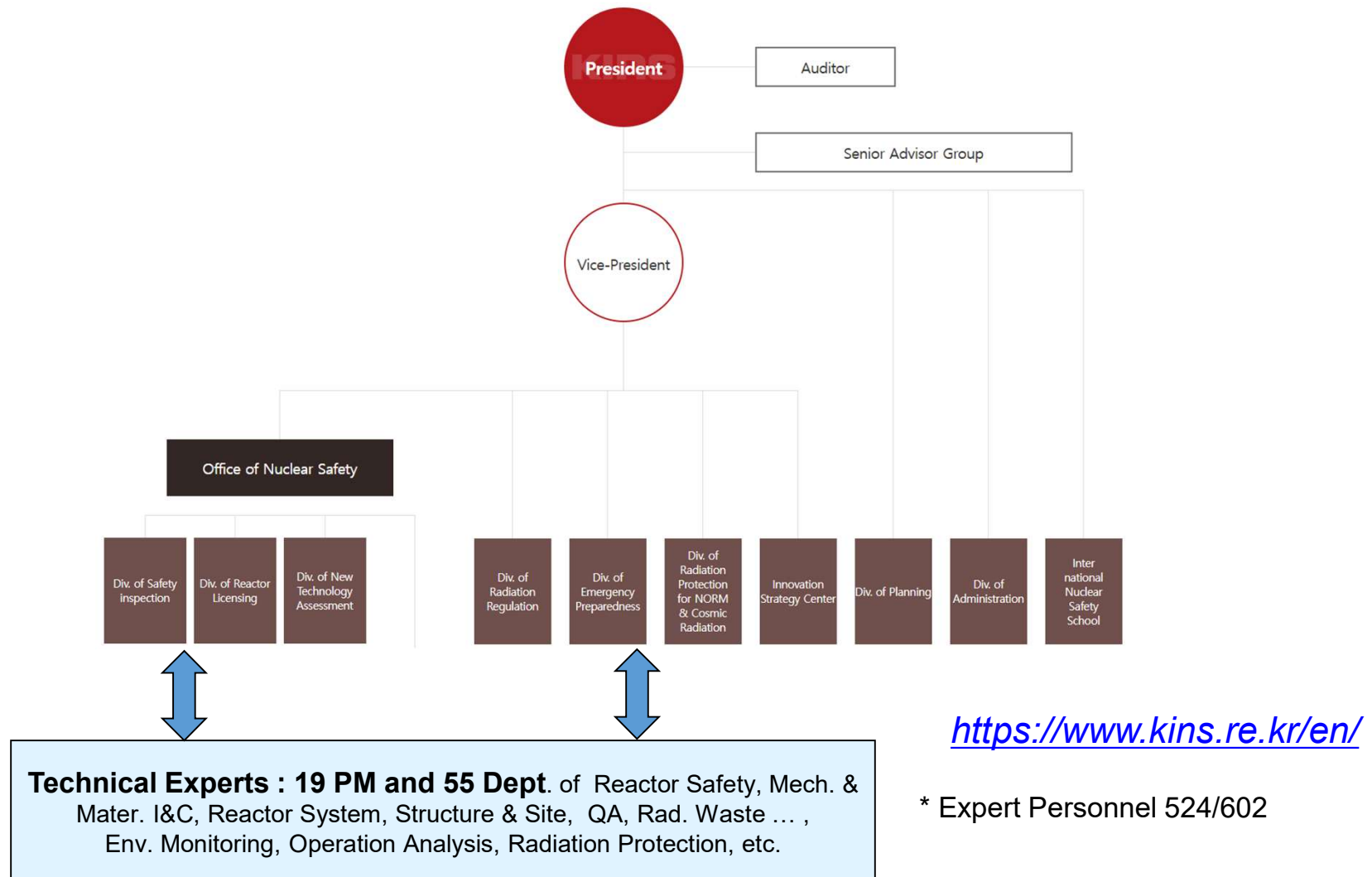


- ◆ **Status of nuclear installations of Korea**

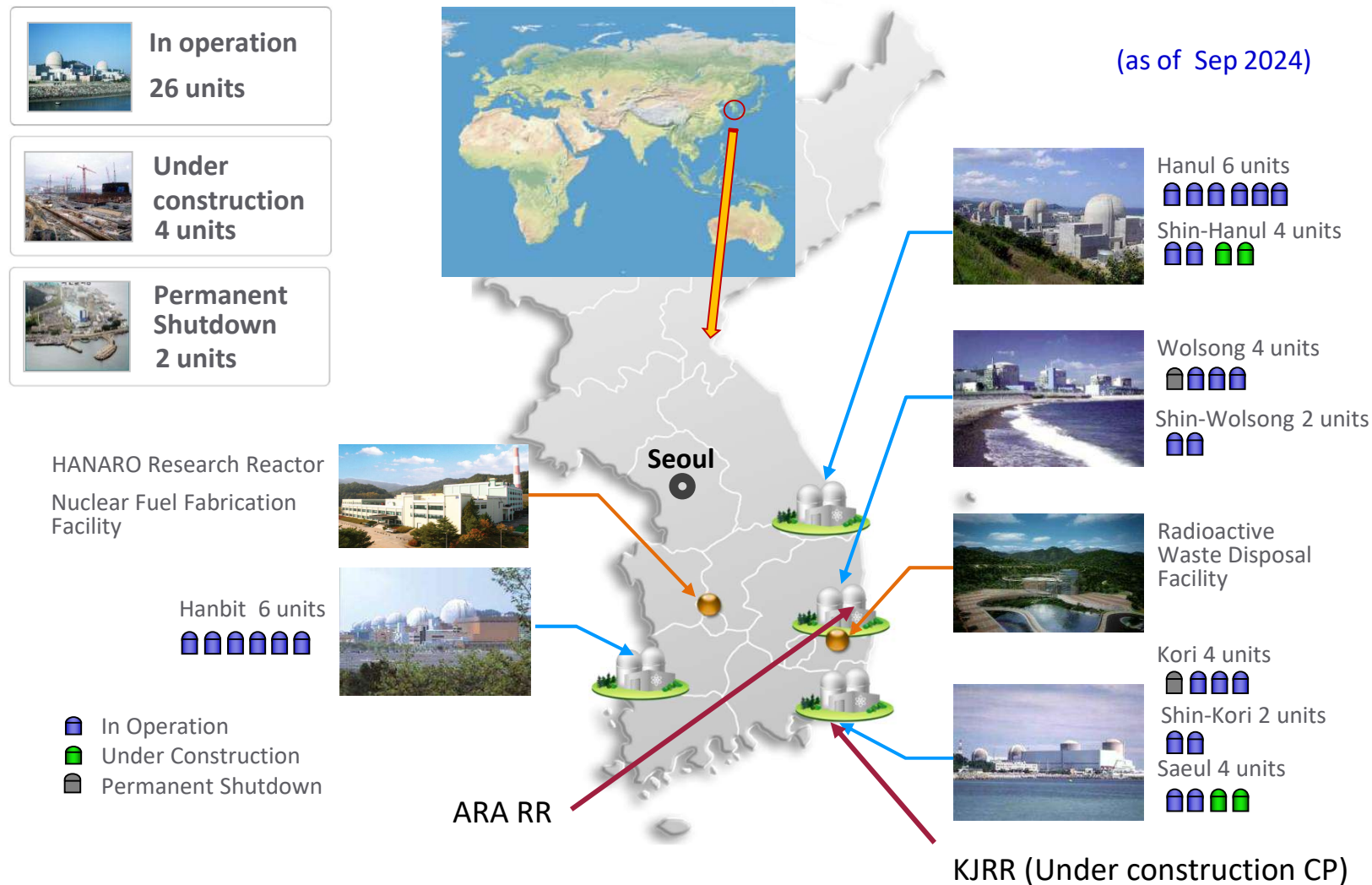
- ◆ **Regulatory Framework of Korea**
 - Legal Framework (incl. Technical standards)
 - Licensing Process

- ◆ **Standard Design Approval for SMART100**
 - SDA Application
 - Review Progress
 - Design Features
 - Review results

• Organization Chart for KINS



Overview of Nuclear Power Program



- ◆ In Korea, the legislative framework for nuclear safety regulations consist of
 - Nuclear Safety Act, the Enforcement Decree and Enforcement Regulation of Act
 - The Technical standards and Notices from the NSSC (Nuclear Safety and Security commission),
 - Regulatory Standards & Guides
- ◆ The regulatory document schemes consist of the regulatory guides.
 - Regulatory Standards provide the safety level to be stipulated in the requirements from the standpoint of safety.
 - Regulatory Guides provide specific methods and technical conditions for executing the regulatory standards.

Legal Framework regarding nuclear safety regulation

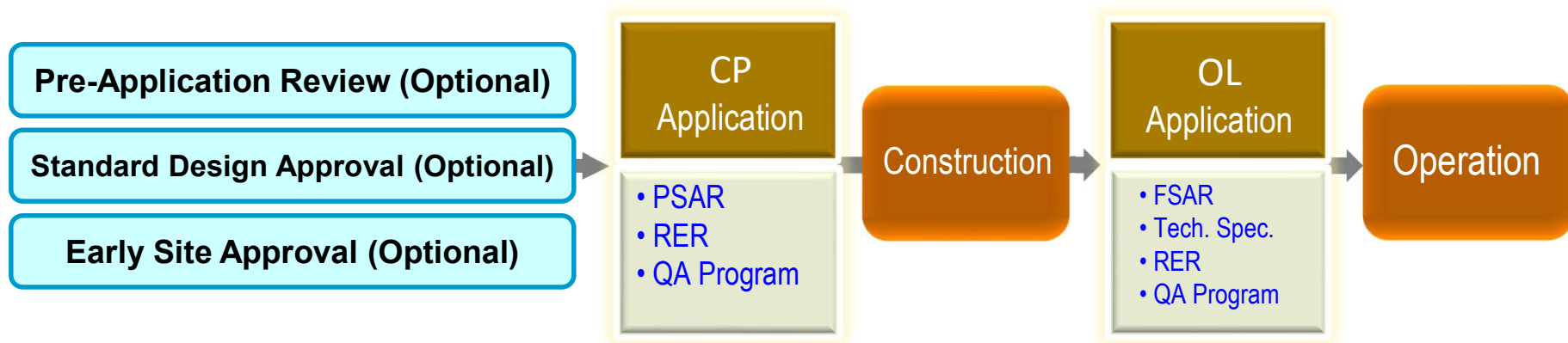
Act	• Nuclear Safety Act, Act on Physical Protection and Radiological Emergency, and Nuclear Liability, etc.	Acts (NSSC)
Enforcement Decree (Presidential Decree)	• Particulars entrusted by the Act • Enforcement Decree of the Nuclear Safety Act and Enforcement Decrees of Other Related Acts	
Enforcement Regulations (Ordinance of the Prime Minister)	• Particulars entrusted by the Act or the Decree and necessary for their enforcement (including detailed procedures and format of documents) • Enforcement Regulations of the Nuclear Safety Act and Enforcement Regulations of Other Related Acts	
Technical Standards (Administrative Regulation)	• Brief technical standards as delegated by the Act and/or Decree • Regulations on technical standards for Nuclear Reactor Facilities, etc., Regulations on Technical Standards for Radiological Safety Management, etc.	
NSSC Notice (Administrative Regulation)	• Details on technical standards, procedures of formats as delegated by the Act, Decree and/or Regulation • Notice on Technical Standards for the Location of Nuclear Installations	
Regulatory Standards	• Further particulars or interpretation of technical standards	Guidelines (KINS)
Regulatory Guidelines	• Acceptable methods, conditions, specifications, etc.	
Guidelines for Safety Review and Inspection	• Standard Review Plan, Inspection Manuals, etc	
Industrial Code and Standards	• KEPIC, ASME, IEEE, ASTM, etc.	

Licensing Process in KOREA

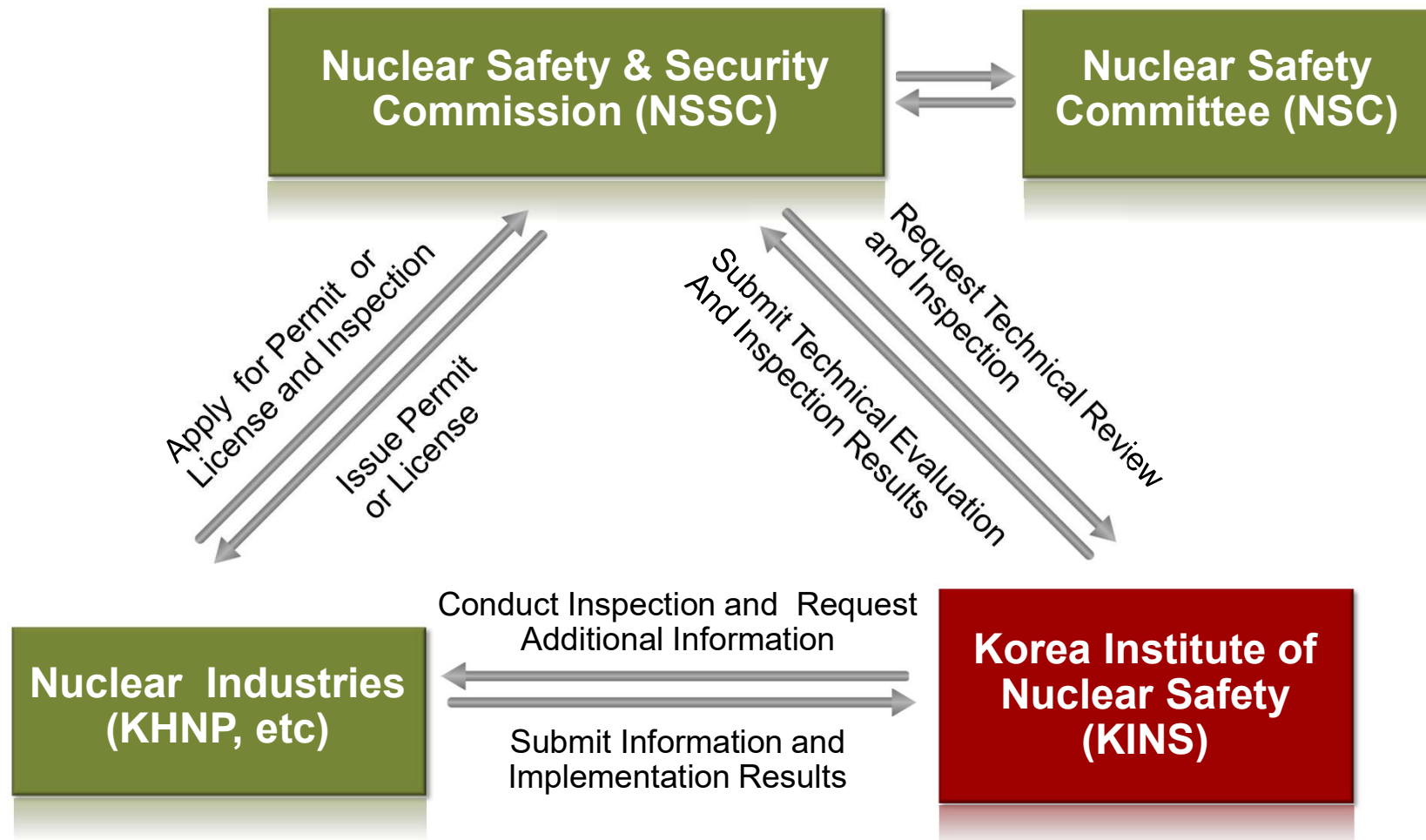
- ◆ **Standard Design Approval (SDA):**

- Approved items in the standard design are exempted from the following licensing review
- Provides accredited reactor safety and environmental statement for construction
- Reduces uncertainty and risk before CP application

- ◆ **2 Step Licensing (C/P to O/L)**



Regulatory Framework



Standard Design Approval(SDA) application

◆ Application of SDA

- Any person who intends to repeatedly construct the nuclear power reactor of the same design and install related facilities may obtain approval for such design from NSSC [Nuclear safety act, article 12(1)]
- APR1400('02.5), SMART('12.7) and APR+('14.8), [SMART100\('24.9.26\)](#)

◆ Application submittals

- Standard Safety Analysis Report,
- Specification of the Standard Design
- Preparation Plan for Emergency Operating Procedures
- Explanatory Statement on the Use of the Nuclear Reactor,
- Explanatory Statement on Technical Capabilities in respect to the Design of the Nuclear Reactor,
[Enforcement rule of Act, article 9(3)]

- **Standard Design Approval(SDA)**
 - To improve safety in future plants and promote more efficient reviews
 - To certify a standard NPP design for the repeated construction; effective for 10 years
- **The standards for Approval (Nuclear Safety Act Article 12(5))**
 - Regulations on Technical Standards for nuclear Reactor Facilities, Etc.(Chapter II Section 1 and Section 2), Notice of NSSC(11), etc.
- **SMART100**
 - NSC issued the SDA approval of SMART on July 4, 2012
 - Changed the design of safety systems from a previous approved SMART

Nuclear Safety Act Article 12(5)

(Approval for Standard Design)

1. The location, structures, equipment and performance of a nuclear power reactor and related facilities shall conform to the technical standards as prescribed by the Regulations of the Commission in such a way that they do not present any impediment to the protection of disasters caused by the radioactive materials, etc. to human bodies, materials and the public;
2. The construction of a nuclear power reactor and related facilities shall conform to the standards as prescribed by the Presidential Decree in order to prevent any harm to public health and the environment caused by the radioactive materials, etc.

SDA Review progress for SMART100

◆ SDA Application for SMART100

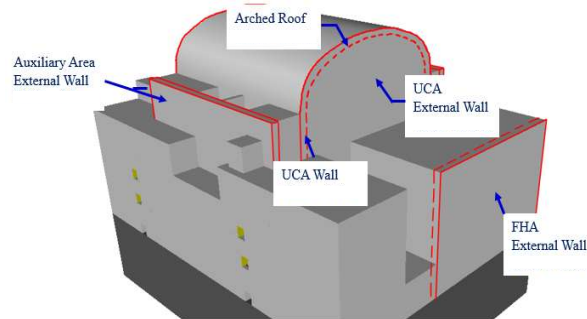
- Korea Hydro and Nuclear Power (KHNP), Korea Atomic Energy Research Institute(KAERI), King Abdullah City for Atomic & Renewable Energy(K.A.CARE) in Dec.30 2019 applied for SMART100 SDA
- Reactor type: Integral PWR (365 MWth)
- Design life: 60 years

◆ Kew Review progress

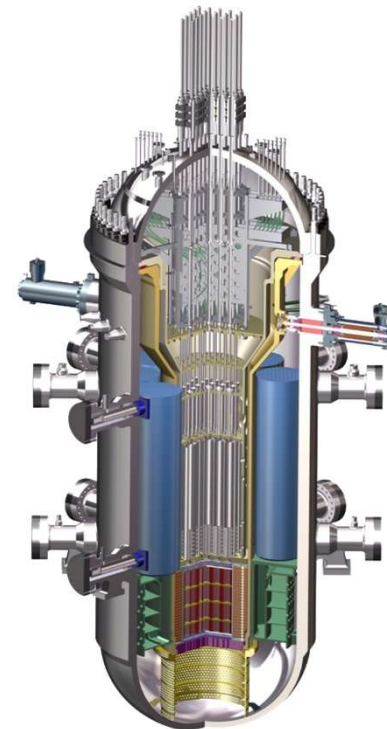
- until April 2024 : SDA review(2621 RAIs)
- April ~ May 2024: to be reported to Nuclear Safety Special Committee
- July ~ Sep 2024: to be reported to NSC for deliberation

Design features for SMART100

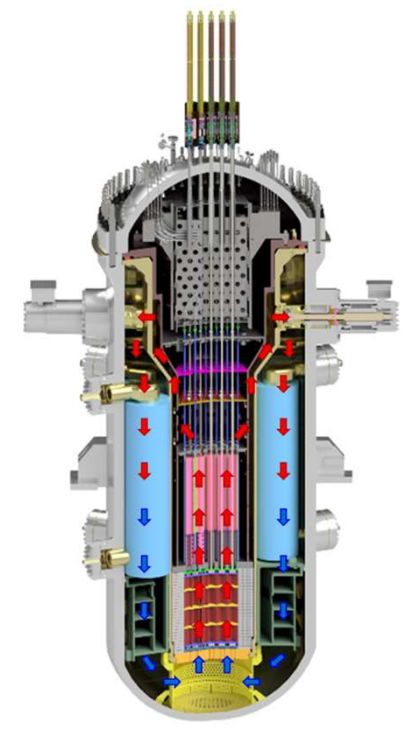
Classification	SMART	SMART100
power	330 MWt(100 MWe)	365 MWt(110 MWe)
Refueling Cycle	36 M	30M
Safety system	Active + passive	passive
Emergency Power	EDG	Battery
Driving force for Safety functions	AC	DC
Coping time	30min	72h
Core Damage Frequency (Internal Events · Full Power)	$< 1.0 \times 10^{-6}/\text{RY}$	$< 1.0 \times 10^{-7}/\text{RY}$
Containment type	Dome/cylindrical	Arch/cube



Containment and Aux. Building



SMART



SMART100

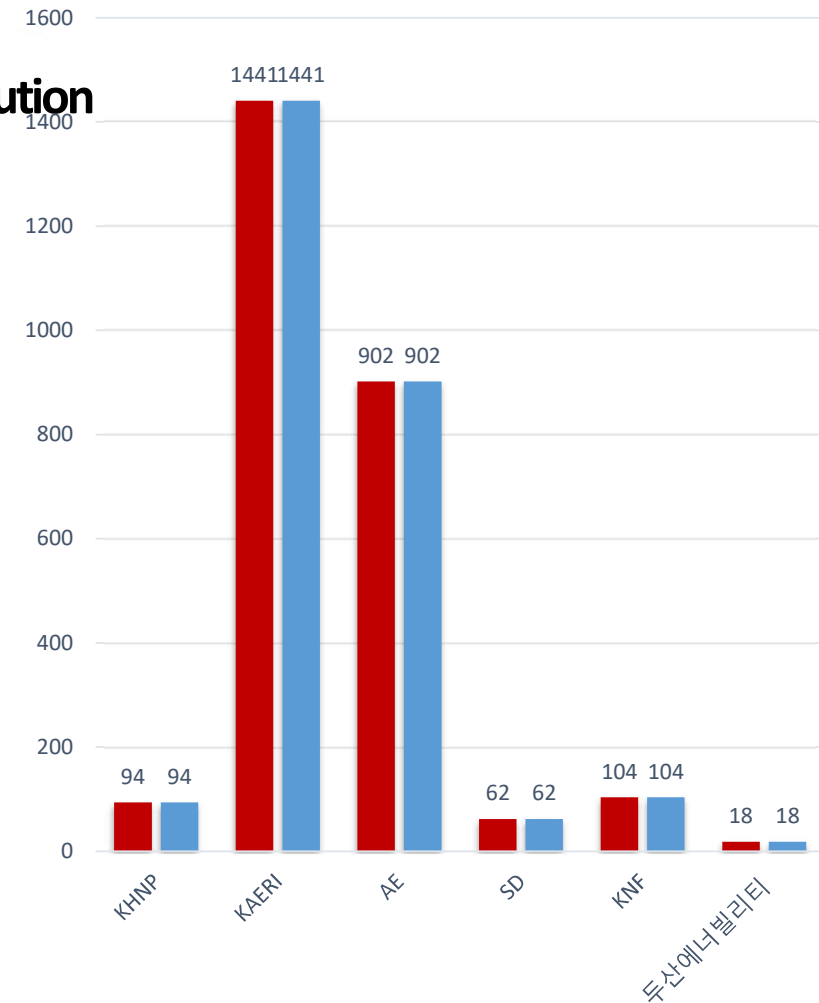
SDA Review progress for SMART100

- **Key Review Progress**
 - **2019.12.30:** Application for standard design approval submitted to the Nuclear Safety and Security Commission (NSSC)
 - **2021.08.13:** Report on the result of document adequacy review and review plan at the 145th NSC meeting
 - **2021.08.17:** Notification of the document adequacy review result and review plan to the applicant; commencement of the standard design approval review
 - **2021.08.17 – 2024.04.02 (32 months):** 12 rounds of review with a total of 2,621 review inquiries
- **Reports to the Nuclear Safety Special Committee**
 - **2023.05.12:** Overview report on standard design approval at the 95th meeting of the Nuclear Safety Special Committee
 - **2023.06.02, 07.07:** Reports on SMART100 design characteristics at the 96th and 97th meetings of the Nuclear Safety Special Committee
 - **2023.11.03:** Report on the status of SMART100 review at the 98th meeting of the Nuclear Safety Special Committee
 - **2024.04.19, 05.17:** Reports on the results of SMART100 standard design approval review at the 103rd and 104th meetings of the Nuclear Safety Special Committee
- **Operation of the Working Review Committee**
 - **2023.12.01 – 2024.03.15:** Operation of the Passive Safety System Working Review Committee (3 sessions total)
Note: Discussion on additional review of the passive safety system at the 98th special committee meeting
 - **2024.05.02 – 2024.05.27:** Operation of Power System Working Review Committee (2 sessions total)
Note: Discussion on additional review of the power system at the 103rd special committee meeting
- **Nuclear Safety Committee**
 - **2024.07.11:** Report on SMART100 standard design approval review at the 197th NSC meeting
 - **2024.09.26:** Deliberation and resolution on SMART100 standard design approval (proposal) at the 201st NSC meeting

SDA Review for SMART100

- Status of Inquiries and Responses by Institution

Organization	RAIs
KHNP	94
KAERI	1441
AE	902
SD	62
KNF	104
Doosan Enerbility	18
Total	2621



한국원자력안전기술원
KOREA INSTITUTE OF NUCLEAR SAFETY

- 인허가 정보 공유 시스템**
Licensing Information Sharing System(LISS)

진자결과 인허가신청 심사관리 세부일정/계획 통계 자료실 모니터링

④ 인허가 결과답변

No.	KMS연계ID	KMS연계순번	프로젝트명	공리공문번호	공리번호	공리처리번호	상세ID
136	20X0052100001	4	SDA	202002100250C3	000NSR114741S1193200187 DR-SSAP-3-6-1-I-02-1	114741	
137	20X0052100001	5	SDA	202002100250C3	000NSR114741S1193200190 DR-SSAP-3-6-2-I-01-1	114741	
138	20X0052100001	6	SDA				
139	20X0052100001	7	SDA				
140	20X0052100001	8	SDA				
141	20X0052100001	9	SDA				
142	20X0052100001	10	SDA				
143	20X0052100001	11	SDA				
144	20X0052100001	12	SDA				

[조회] [초기화] [엑셀]

클릭하면 해당 공문내용을 볼 수 있습니다.
[http://cmsweb.sshn.go.kr/comm_id=2020052100001&com_seq=12 - 독립전송시스템 도입 - Internet Explorer](#)

공리번호 : 모든 시스템별 교육 담당처(소)를 소스(SDA)로 선택하십시오
 URL: SSAP-5.2.3-I-01-1.htm [C:\Users\MUSER\AppData\Local\Microsoft\Windows\WinCache\WebCache\WTOUIF...]

서취적합성검토 보완요구서

①관리번호, DR-SSAP-5.2.3-I-01-1	②제행일자, 2020.2.28
③정보대상, SMART(X) (SSAR)	④작성 장·월, 5.23,
⑤면포자, 기계·정보기술실업팀	⑥작성 일자, 2020.3.30
⑦첨대역, 차수, 1, 일지, 2020.4.24	⑧담당일자, 2020.5.8
⑨첨대역, 차수, 1, 일지, 2020.4.24	⑩분류, 기술내용보완
⑪첨대역, 인사혁신처 스텔라시스템에 대한 검토 적합성 검토	

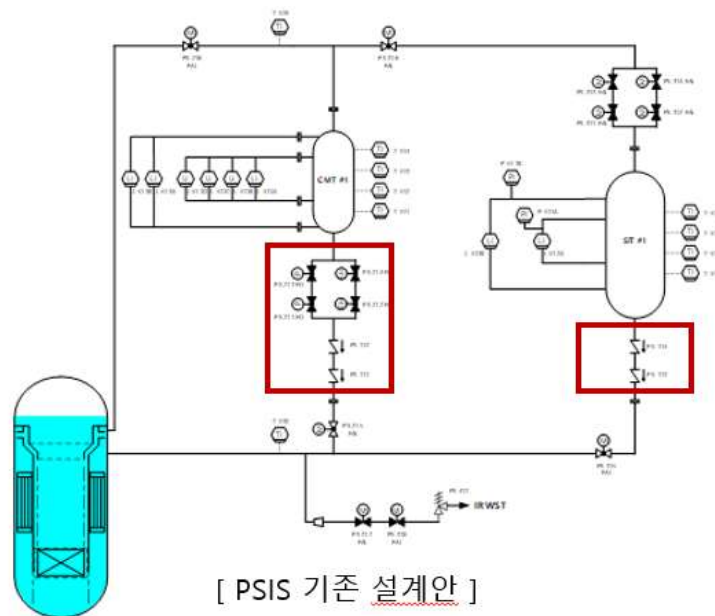
<다 보충요구사항>
 허가자료실 중의 기술기록에 관한 권고 제12조의 근거하여 원시데이터인원에게

질의 연계정보																											
연계 기본정보																											
신청명		SMART100 표준설계인가 신청에 따른 안전성 심사 의뢰 (본심사)																									
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공문번호						공문발송일자																					
연계내용																											
담당부서 *		계획평가실				담당자 *		송영주																			
담당자연락처 *		042-868-0877				담당자이메일 *		k975sc@koms.re.kr																			
연계 대상 순 1 건																											
장점번호		절의제목		관리번호		차수		절의자		상태																	
17		RTNSS 적용기준 및 각종 선정 보고서 확인		SSAR-17.2-II-01-I		2 1		송영주		PM 승인																	
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- **Passive Safety System Definition and Characteristics**
 - **Safety related terms for advanced nuclear plants(IAEA-TECDOC-626)**
 - provides precise definitions of commonly used safety terms in reactor design, especially clarifying the distinction between passive and active safety system
 - "Either a system which is composed entirely of passive components and structures or a system which uses active components in a very limited way to initiate subsequent passive operation."
 - **operating without reliance on external power sources, signals, or mechanical actions**
 - **Utilizing natural physical principles such as gravity, natural circulation, or stored energy to perform its safety function.**
 - **categorizing passive systems into different levels based on the degree of passivity, from completely self-sufficient (Category A) to those requiring an initial external trigger but operating passively afterward (Category D).**

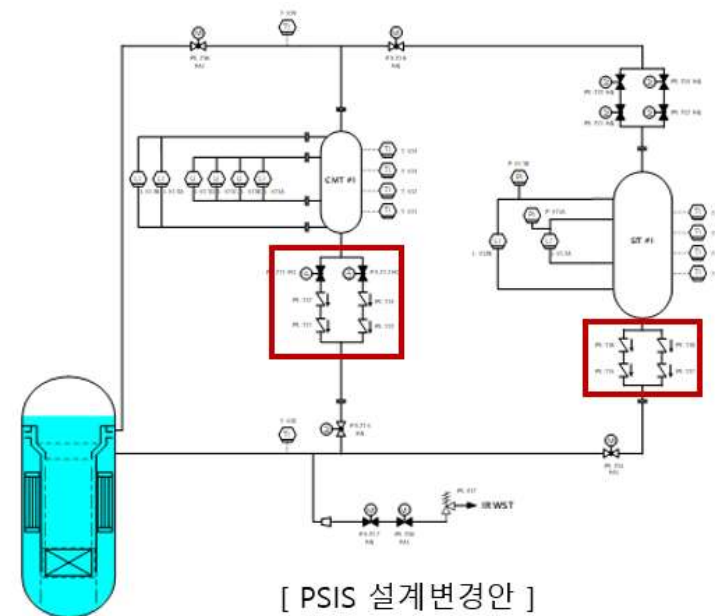
Review Items during the Review Process

- Configure the check valve arrangement in parallel by applying the single failure criterion to the check valve
 - The check valves applied to passive safety systems have high safety significance but require the single failure criterion because their driving force is relatively smaller compared to the check valves used in commercial pressurized water reactors.



[PSIS 기존 설계안]

[Before]

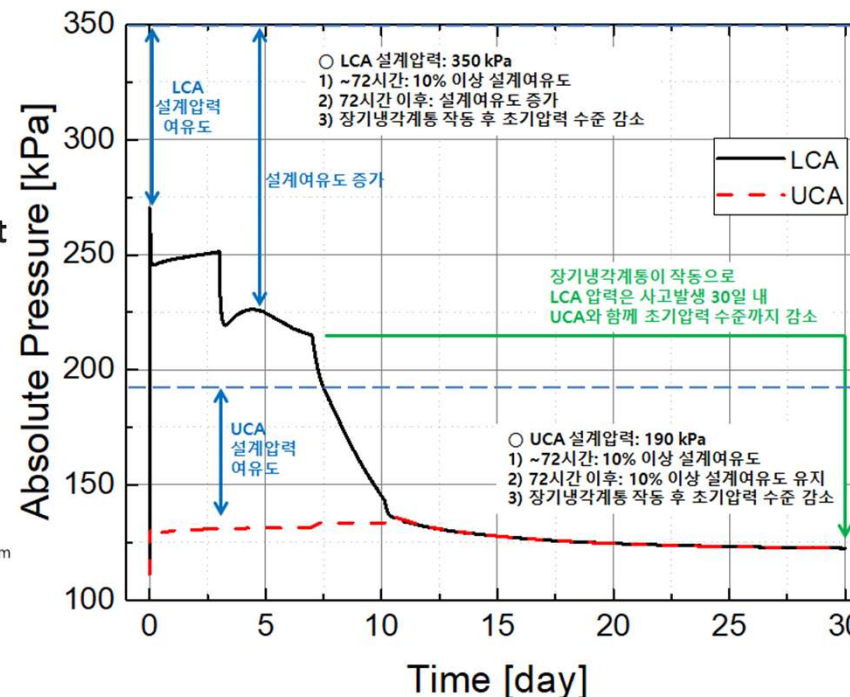


[PSIS 설계변경안]

[after]

Review Items during the Review Process

- Containment Pressure and Radioactivity Suppression System
 - It performs the containment area heat removal function to suppress the pressure and temperature within the containment building to within design limits during design basis accidents (e.g., LOCA, MSLB)
- Addition of the long-term cooling system
 - After 72 hours, when the non-safety systems for shutdown cooling operation of the reactor coolant system are restored and the system becomes available, the long-term cooling system is added to reduce the containment pressure to the initial pressure level.



CPRSS : Containment Pressure and Radioactivity Suppression System
 CDL : CPRSS Discharge Line
 CHX : CPRSS Heat Exchanger
 CRL : CPRSS Return Line
 CSL : CPRSS Steam Line
 IRWST : In-containment Refueling Water Storage Tank
 LCA : Lower Containment Area
 PRL : Pressure Relief Line
 RRT : Radioactive Material Removal Tank
 UCA : Upper Containment Area

Review Items during the Review Process

- Variables that indicate fuel damage or directly monitor its impact are selected, and related equipment is required to be provided.
 - Accordingly, variables related to reactor cooling and containment cooling have been selected, and dedicated power supply equipment and display screens have been added to enhance the design.

Dedicated display screen for severe accidents



[Before]



[after]

Review Items during the Review Process

- **Overview**

- Article 24 of the Reactor Regulations requires “two physically independent off-site power systems.”
- SMART100 is designed with passive safety systems where only the DC power system (batteries) is classified as a safety system, while the AC power system is designed as a non-safety system.

- **Applicant's Design Details**

- SMART100 is designed to reach and maintain safe shutdown through natural circulation in a loss of off-site power, without AC power.
- It is designed to supply power through safety-grade batteries to reach and maintain safe shutdown without operator action or AC power supply.
- The off-site power circuit is configured with two lines, but they are not independently designed (constructed in the same tunnel).

- **Safety-Class DC Power System**

- The safety-class DC power system supplies power to the main loads required to reach safe shutdown for 72 hours during DBA.
- It is composed of 4 physically independent systems with sufficient capacity, performance, and testability to perform safety functions during a single failure.
- The safety-class batteries are designed with 24-hour and 72-hour duty cycles optimized according to their functions.

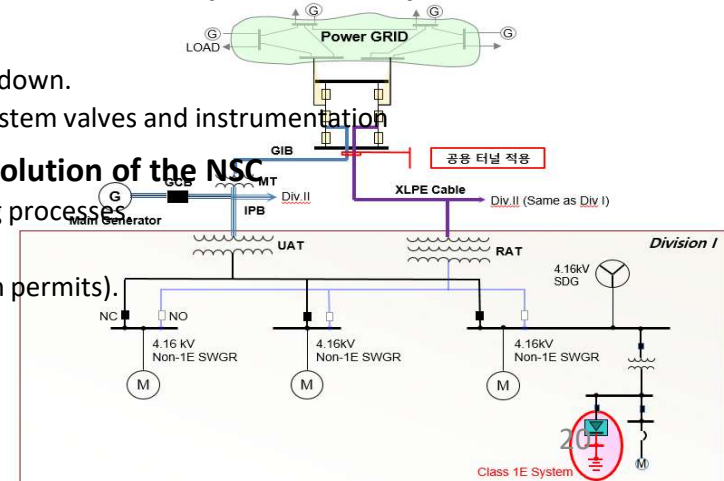
- **Due to the characteristics of the design, a single offsite power circuit does not compromise safety**

(core cooling and containment integrity)

- AC power is not required for the operation of pumps needed for safe shutdown.
- Safety-class batteries are used to power the operation of passive safety system valves and instrumentation

- **Follow-up administrative measures for the SDA according to the resolution of the NSC**

- It was decided to focus on reviewing the power systems in future licensing processes
- KINS plans to focus on reviewing the application of technical standards and design suitability during future licensing reviews (such as construction permits).



감사합니다