

International Workshop

KOREA's "SMART" Road to SMR in CANADA

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Korean Nuclear Society

Division of Reactor System Technology

Understanding of Safeguards for SMR

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1 Introduction of IAEA SBD



01 Introduction of IAEA SBD

- The IAEA recommends SRA(State Regulatory Authorities), operators, and designers to incorporate SBD*(Safeguards by Design) for new nuclear facilities.
- With the decision to implement new facilities and carry out designs, it is recommended that safeguards be reflected from the early stages through IAEA's early involvement.

**SDB Definition : Integration of features to support IAEA safeguards into the design process for a new or refurbished nuclear facility.*



01 Advantages of SBD

Introduction of IAEA SBD

- The IAEA discusses the following advantages of SBD:
 - Reduction of operator's burden
 - Minimization of unnecessary design changes
 - Efficiency of verification through the joint-use equipment
 - Flexibility in the installation of additional safeguard equipment
 - Cost reduction benefits

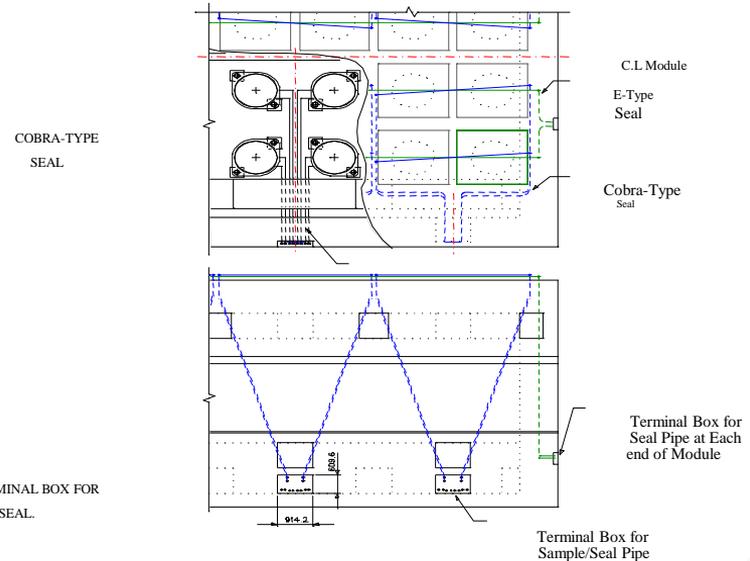
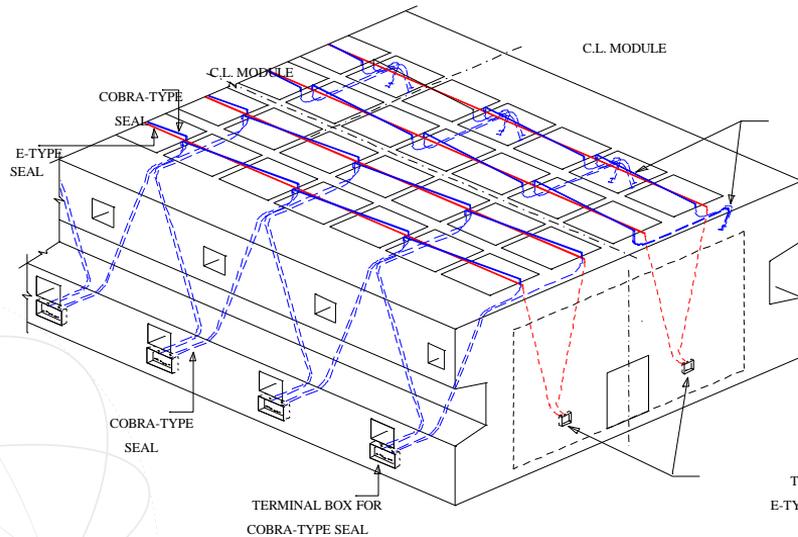


2 Examples of SBD in the ROK



02 MACSTOR/KN-400 Examples of SBD in the ROK

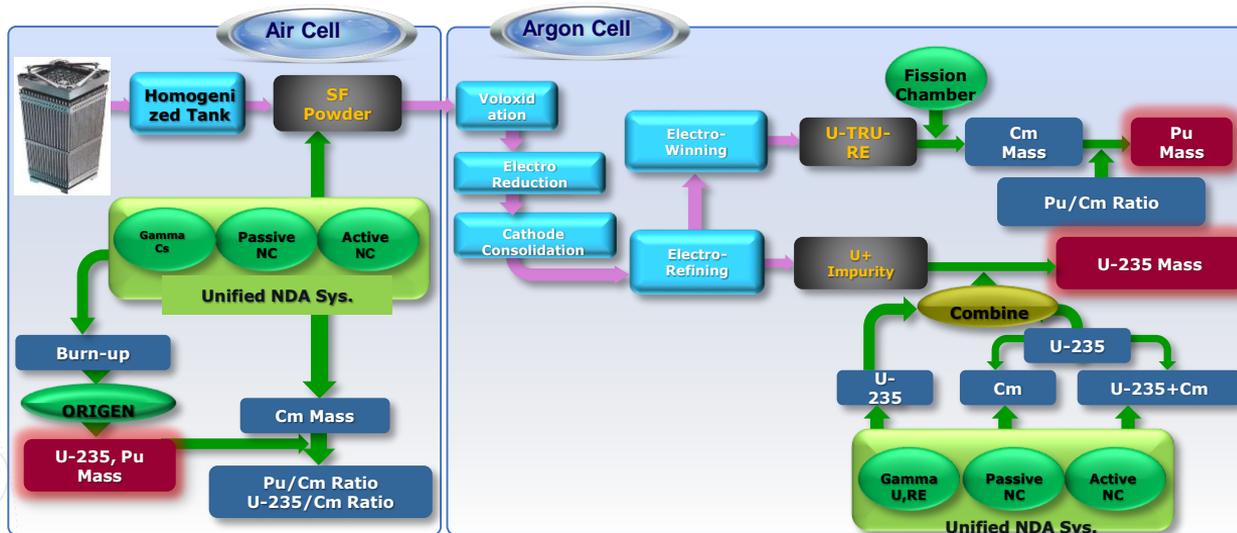
- MACSTOR/KN-400: In 2004, construction plans were notified to the IAEA, leading to a construction delay of about 2 years due to the derivation of a verification method for the Inner Silo.



02 Pyro-processing Facilities

Examples of SBD in the ROK

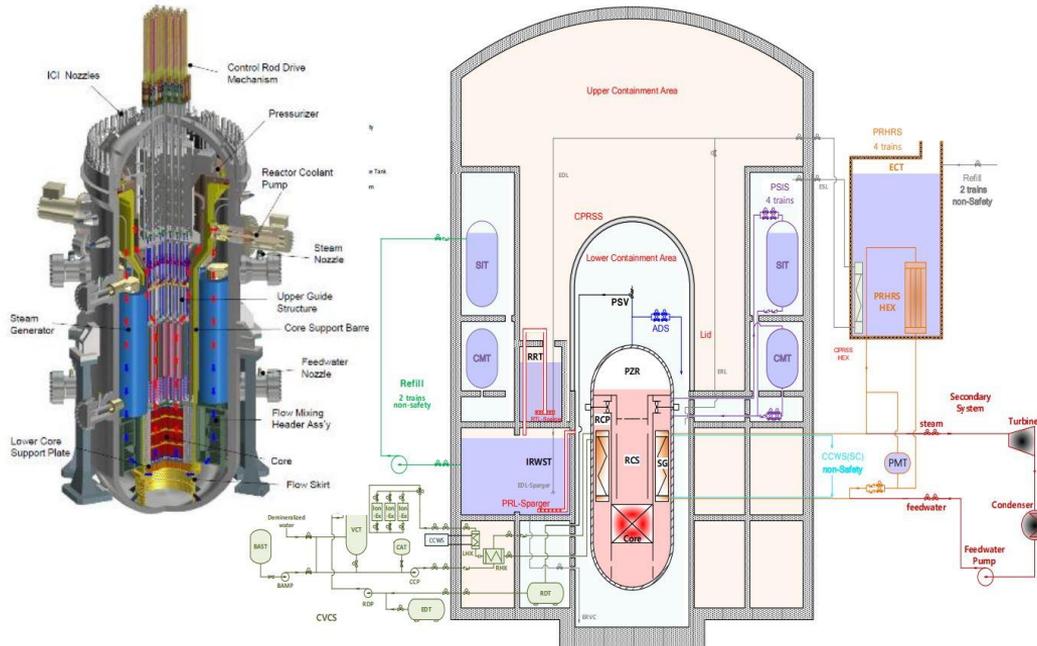
- Pyro-processing Facility MSSP: Initiated in 2008, various verification methods were agreed upon during the construction of domestic Pyro-related facilities



02 SMART100 Examples of SBD in the ROK

SMART100

- SMART100 MSSP: Initiated in 2019, KAERI is developing model DIQ and draft STR for SMR based on the developing SMART100.



3 Safeguards Requirements for New Facility



03 Under the Safeguards Agreements

Safeguards Requirement for New Facility

- When constructing new facilities, DI(Design Information) must be notified to the IAEA under the CSA(Comprehensive Safeguards Agreement)

Subject	Date or time limit
Provision of preliminary design information for new facilities	<u>As soon as the decision to construct or to authorize construction has been taken, whichever is earlier</u>
Provision of further information on designs of new facilities	As design is developed Information to be provided early in the project definition, preliminary design, construction and commissioning phases
Provision of completed Agency Design Information Questionnaires for new facilities, based on preliminary construction plans	As early as possible, and in any event not later than 180 days prior to the start of construction
Provision of completed Agency Design Information Questionnaires for new facilities, based on “as-built” design	As early as possible, and in any event not later than 180 days before the first receipt of nuclear material at the facility

- General plans for the succeeding ten-year period relevant to the development of the nuclear fuel cycle when approved under the AP(Additional Protocol)

03 Under the Nuclear Safety Act

Safeguards Requirement for New Facility

- Preparation of documents for New Facility required by the Safeguards Agreement, following the Nuclear Safety Act and the Notice of NSSC

preliminary design information	Initial design information about the early business plan, preliminary design, construction, and start date of operation	Within one month after the decision on the construction plan or construction permit
further information on designs	Design information at a more detailed stage than the initial design information	Within one month after a change in the initial design information or the finalization of a more detailed construction plan than the initial design information
Initial DIQ(Design Information Questionnaire)	A general DIQ based on the construction plan, formatted according to the standards set by the IAEA	Up to seven months before the start of construction
Final DIQ(Design Information Questionnaire)	A detailed DIQ based on the constructed design, formatted according to the standards set by the IAEA	Up to seven months before the initial receipt of nuclear material

03 Under the AP Safeguards Requirement for New Facility

- Under the Safeguards Agreements and National Law, there is no obligation to submit specific design information for SBD for New Facility at the construction permit stage



- There is a need to consider mandating the provision of sufficient design information at the construction planning or permitting stage for New Facilities that require SBD



4 Safeguards Consideration for SMR



04 SMART100 Safeguards Consideration for SMR

- Annual PIV verification plan due to long operation cycles.
- Closed Core PIV
- Seal Verification for Reactor
- Consideration of applying C/S similar to LWRs
- Applying the Remote Monitoring, if possible



04^{i-SMR} Safeguards Consideration for SMR

- Annual PIV verification plan due to long operation cycles.
 - Closed Core PIV
 - Seal Verification for Reactor
- Development of multiple scenarios for internal material movement due to multi-unit operation
- Application of diverse C/S for multiple units
 - Selecting efficient Seal & Camera Position considering the Design Information
- Applying the Remote Monitoring, if possible

04 HTGR(High Temperature Gas-cooled Reactor) Safeguards Consideration for SMR

- Challenges with Item verification for Pebble Bed fuel
 - Need to establish a monitoring system to maintain the CoK(Continuity of Knowledge)
 - Monitoring system similar to existing CANDUs.
- SF is stored in the casks : need to apply C/S that meet 'Difficult to Access'
- Application of Tags identified by specific mixtures of rare earths
- Considering the characteristics of SMR, need to apply a monitoring system that minimizes design changes

04 MSR(Molten Salt Reactor) Safeguards Consideration for SMR

- High Temperature, Tritium, High radiation, inert atmospheres, toxic material, Continually changing material
 - Traditional safeguards tech. may not be applicable
 - Item counting & visual verification may not be possible
 - Inaccessibility for inspector
- Establishment of a verification plan for liquid fuel(Bulk Form)
 - Need to Material Balance Evaluation with DA sampling, **but are DA assay technologies adequately developed?**
 - Considering NRTA(Near Real Time Accountancy) System, **however the size of the facility should be taken into account**

5 Conclusion



05 Conclusion

- Need to Consideration of various types of SMRs' safeguards approaches in advance
- Review of domestic obligations necessary for the promotion of SBD
- Need for R&D to develop new technological for SMRs safeguards requirements

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THANK YOU



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