KINS Perspective on Long Term Regulatory Research

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Introduction

❖ Nuclear regulatory technology

- ➢ Decision making capabilities based on systems engineering and management technology that systematically analyze and integrate relevant technologies and resources

❖ Main role of nuclear regulatory research

- ➢ Expand/upgrade technical bases for regulatory decision making, reflecting the latest development of related technologies

Introduction

❖ Objectives of nuclear regulatory research

- ➢ Develop regulatory requirements and guidelines
- ➢ Develop regulatory technology to resolve safety issues and assure safety
- ➢ Enhance technical capability for making timely regulatory decision
- ➢ Prepare a plan to build an efficient and effective regulatory framework

Overview of KINS research program

❖ Status of nuclear power program in Korea

- ➢ Status of nuclear power plants (as of Dec. 2009)
  - In operation: 20 units
  - Under construction: 6 units
  - Planned by 2022: 6 units
- ➢ Development plan of Gen IV reactors and advanced fuel cycles
  - Based on “Action Plan for Developing Future Nuclear Energy System” approved by the Korea Atomic Energy Commission in Dec. 2008
  - Sodium Fast Reactor (SFR): development phase of conceptual system design
  - Advanced Fuel Cycle (AFC): development phase of engineering scale pyro-processing facility design
  - Very High Temperature Reactor (VHTR): development phase of key technology

Overview of KINS research program

❖ Nuclear R&D project in Korea

- Conducted mid and long term safety research since 1997, revising every 5 (3+2) years
  - Budget for regulatory research: about one tenth of the cost of reactor system design
- Invested 30 billion KRW (27 million USD) in the nuclear safety research each year
  - One third of the budget allocated to KINS' regulatory research, which consists of development of regulatory codes and standard, and resolution of pending safety issues
  - Two thirds of the fund allocated to KAERI's nuclear safety basic research which includes development of computational tools and large-scale safety experiments
- Relation with industries
  - Sharing of experimental database
  - Independent evaluation and analysis capability

Overview of KINS research program

❖ Strategy for KINS regulatory research

- Responding to demand: administer procedures to investigate the needs of various stakeholders in the nuclear sector
- Priority on areas of safety significance: select several specific technologies and bring up specialists for continuous upgrade (Piping and S/G tube integrity, etc.)
- Development of regulatory technology in parallel with design: provide regulatory requirement in the early design phase
- Involvement of regulation department in research activities: promote feedback of the research results in regulatory activities
- Participation in international programs: pursue global harmonization

Overview of KINS research program

❖ Major areas of regulatory research

- ➢ For operating reactors:
  - Improve regulatory analysis methods or tools
  - Resolve new issues arising from operating experience and new technology

* Recently focused on a cultural or ethical aspect as nuclear safety regulation is no more legal or technical matter only

- ➢ For new and advanced reactors:
  - Develop new regulatory tools, codes and guidance
  - Resolve safety issues concerning design

Overview of KINS research program

❖ Distinction between near-term research and mid & long-term research

- ➢ Near-term research, addressing current and urgent issues, which are normally identified from operating experiences (e.g. sump clogging issue, etc.)
- ➢ Mid & long-term research, addressing both current and future needs, which will take a longer time (more than 3 years) to complete (e.g. computational tool development, GEN-IV, rad-waste storage, decommissioning, etc.)

R&D program for existing reactor

❖ Advanced regulation system using risk information

- ➢ Implementation of risk informed and performance-based regulation
- ➢ Risk communication with the public
- ➢ PSA based Vital Area Identification (VAI), etc.

❖ Global issue resolution

- ➢ Safety assessment of passive safety system
- ➢ Severe accident mitigation features
- ➢ Impact of airplane crash, etc.

❖ Safety issues of Pressurized Heavy Water Reactor

- ➢ Uncertainty of void reactivity in LOCA analysis, etc.

R&D program for existing reactor

❖ Material aging due to long term operation

- ➢ Aging management program (AMP)
- ➢ Time limited aging assessment (TLAA)
- ➢ PWSCC issue and cable aging, etc.

❖ Reduction of radiation risk

- ➢ Optimization of radiation protection
- ➢ Verification of radioactive waste safety
- ➢ Establishment of advanced radiological emergency response system, etc.

❖ Seismic safety assessment for reactor site

- ➢ Mapping of quaternary faults near nuclear power plants, etc.

R&D program for future nuclear system

❖ Major milestones

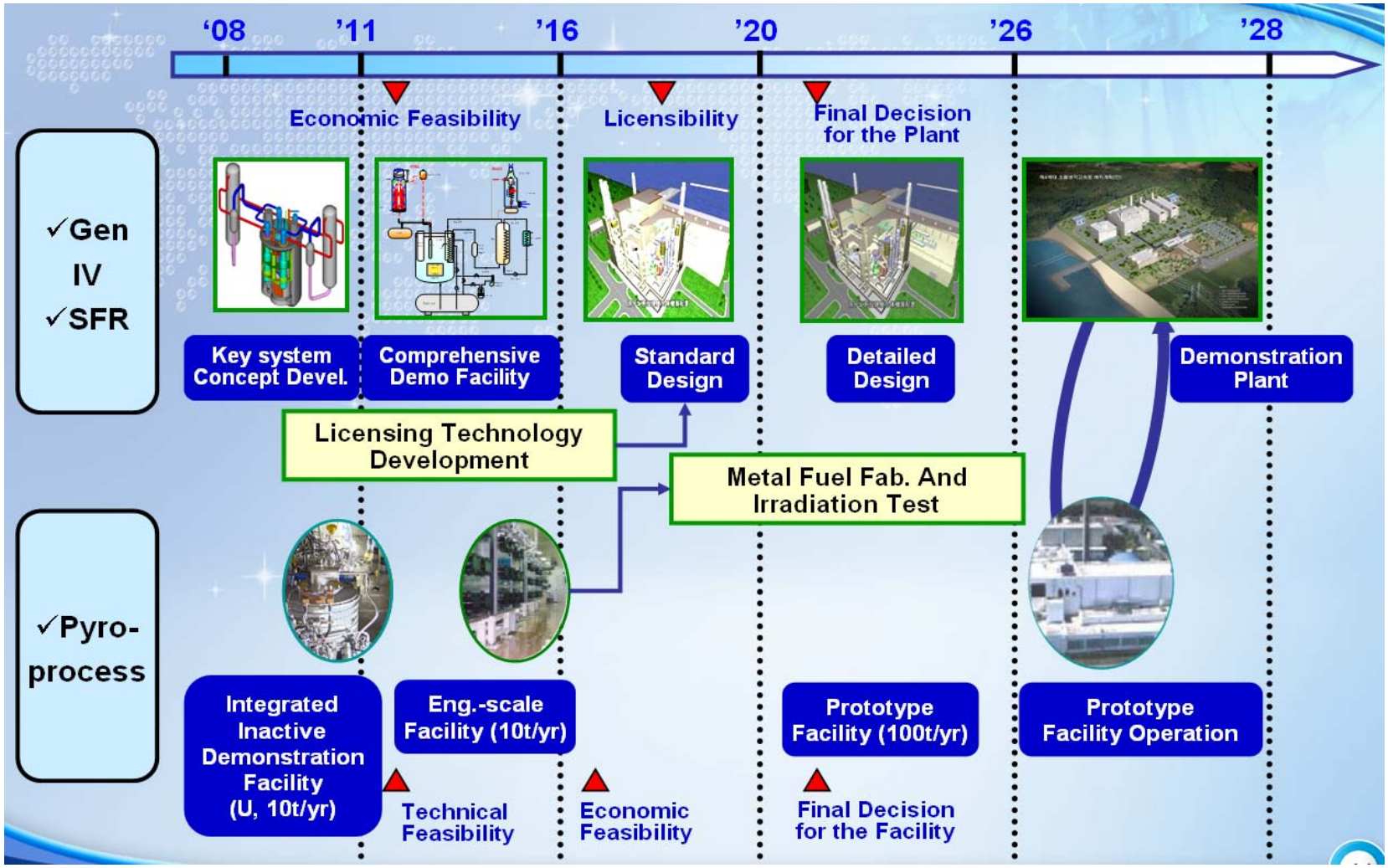
- ➢ Sodium Fast Reactor (SFR)
  - Licensing application of a prototype SFR: 2017
- ➢ Advanced Fuel Cycle (AFC)
  - Licensing application of an engineering scale pyro-processing facility: 2013
- ➢ Very High Temperature Reactor (VHTR)
  - Licensing application of a prototype VHTR: 2017

❖ Establishment of licensing infrastructure

- ➢ Long-term regulatory technology development project
  - Launched from 2010

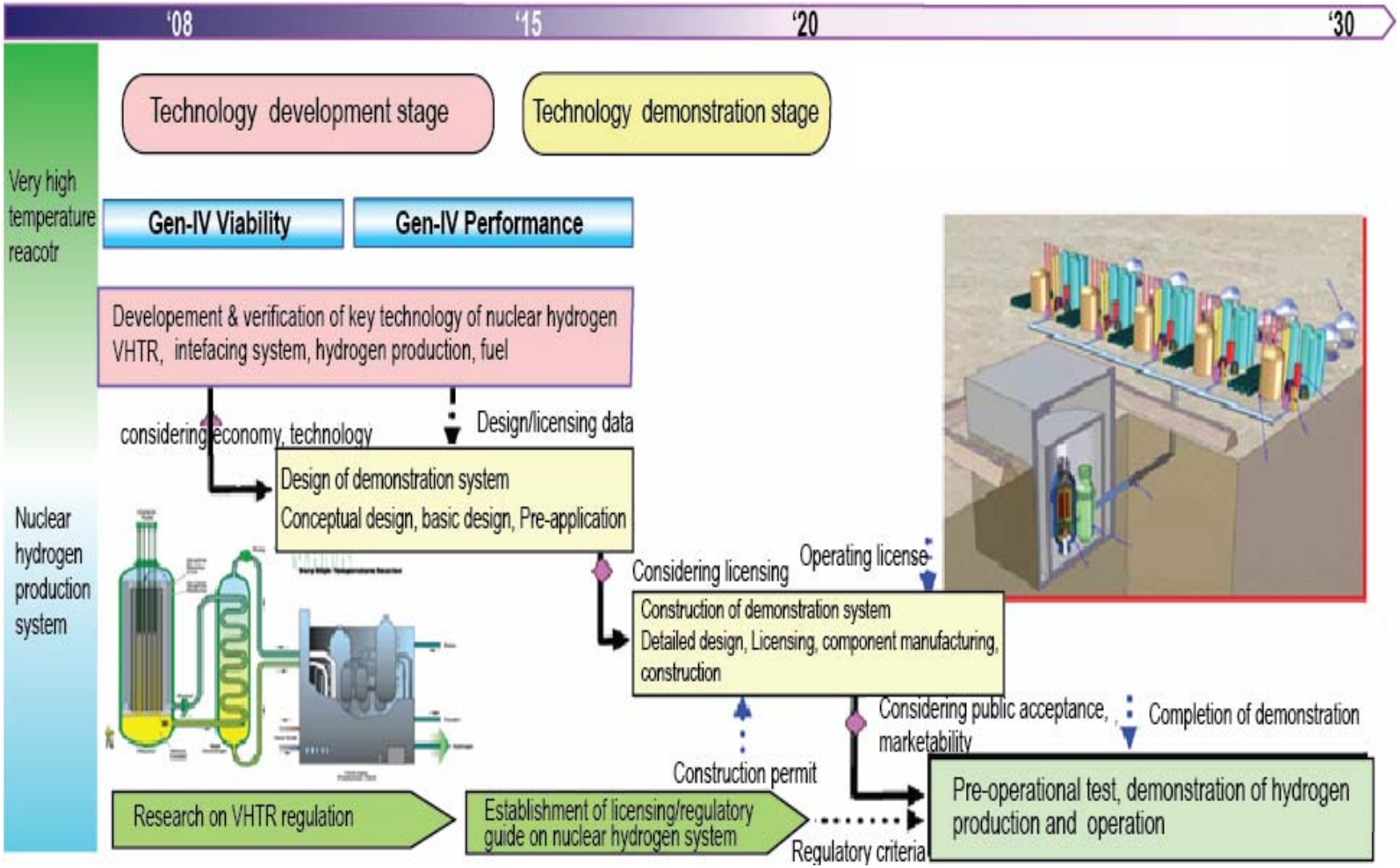
R&D program for future nuclear system

❖ Development action plan (SFR & Pyro-processing)



R&D program for future nuclear system

❖ Development action plan (VHTR)



R&D program for future nuclear system

❖ Research items

- Establishment of a regulatory framework for prototype and multi-purpose reactor systems
- Development of design-specific safety requirements and guides for SFR, AFC, and VHTR
- Identification and resolution of licensing issues for SFR, AFC, and VHTR
- Development of analytical models, tools, and data needed to evaluate design safety of SFR, AFC, and VHTR
- Confirmatory tests and computational tool validation

R&D program for future nuclear system

❖ Research strategy

- Establish regulatory framework to facilitate optimized and efficient regulation on prototype and multi-purpose reactor systems
- Set up safety requirements and guides using deterministic approach with defense-in-depth concept and complemented by risk-informed approach
- Harmonize regulatory positions with foreign regulatory bodies on licensing issues for SFR and VHTR
- Conduct international cooperative research in areas of confirmatory tests and computational tool validation

R&D program for future nuclear system

❖ Expected regulatory issues

- ➢ Licensing policy issues
  - Implementation of defense-in-depth
  - Event classification and acceptance criteria
  - Containment (or confinement) system performance requirements
  - Application of high-temperature industrial codes and standards
  - Relaxation of emergency planning requirements
  - Extent of utilization of risk information
- ➢ Licensing technical issues
  - Safety and performance of fuel
  - Primary coolant flow stability
  - Source term calculation
  - Material integrity and degradation evaluation

R&D program for future nuclear system

❖ Expected regulatory issues

- ➢ Licensing technical issues (cont'd)
  - High temperature component structural integrity analysis
  - Demonstration of safety and performance of passive safety systems
  - Validation and verification of design computer codes
  - In-service inspections and tests for SSCs important to safety
  - Assurance of high reliability of non-safety grade backup systems for passive safety systems
  - Transport and release of fission products
  - Reactivity insertion by core voiding (SFR) and by steam/water ingression (VHTR)
  - Provisions against flow blockage at fuel assembly (SFR)
  - Provisions against graphite dust (VHTR)
  - Impacts of air ingression (VHTR), etc.

Conclusion

- KINS continues to conduct self-upgrading program to enhance decision making capabilities and knowledge management
- KINS is making its efforts to expand knowledge base needed for the proper regulatory decision making
- Especially, in conducting advanced reactor research, KINS will strengthen its efforts to develop the regulatory infrastructure through international cooperative research program