KOREA INSTITUTE OF NUCLEAR SAFETY



Nuclear Safety Regulation in Korea
- Historical Overview -

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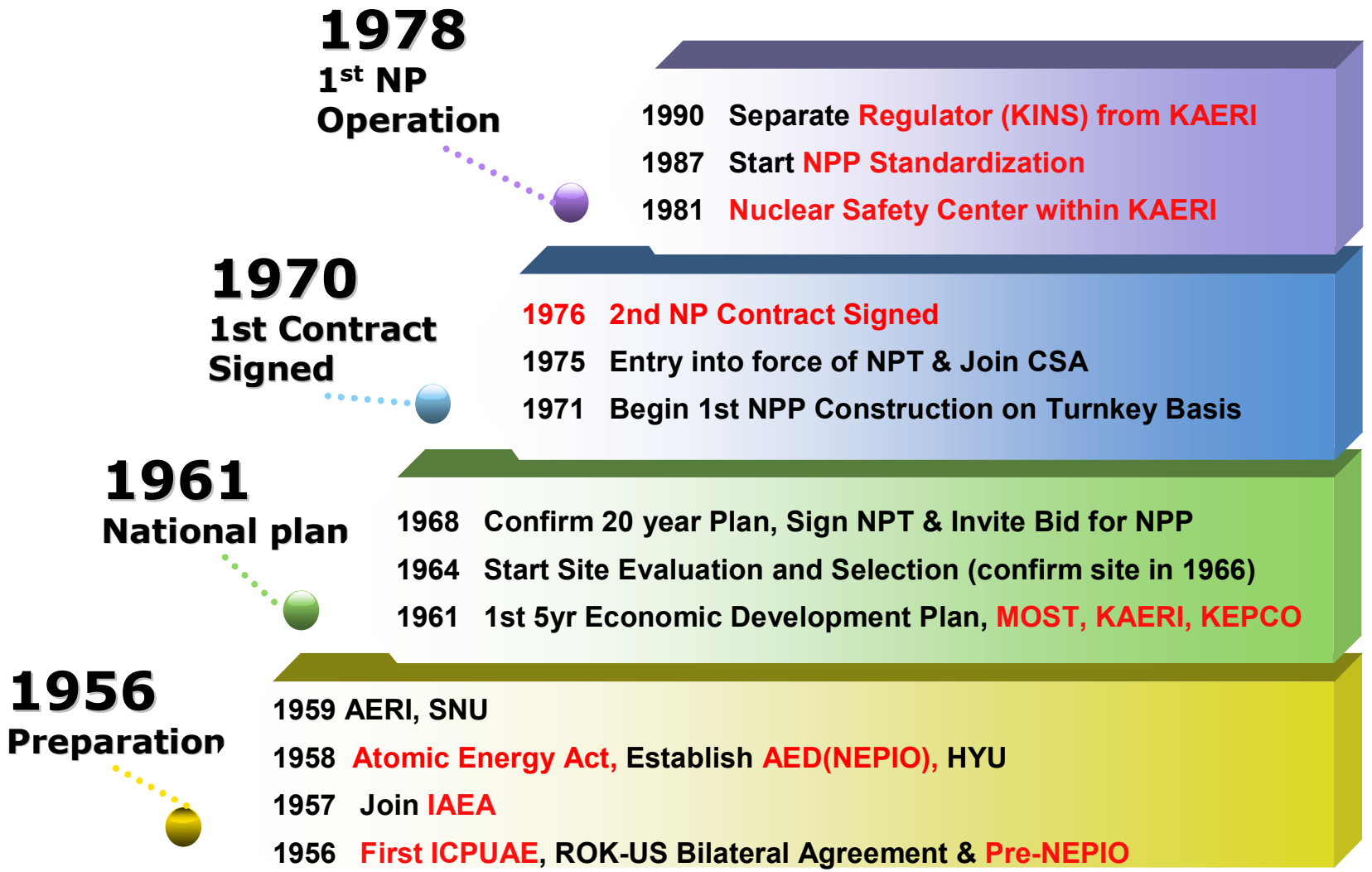
Overview of nuclear program-Initial stage



An Overview of Korean Nuclear Programs

1960s	1970s	1980s	1990s	2000s
Preparation for Nuclear Energy	Introduction of Nuclear Power	Promoting Localization	Technology Self-reliance	Advanced Tech. Development
				
Joining IAEA Research Reactor	Construction of Kori #1	Establish Localization Plan	OPR1000, Hanaro Development	APR1400 Development

NEPIO	Government & KAERI(TSO)	Government & NSC(TSO)	Government & KINS(RSO)

- Universities → Utilities → KINGS
- NTC/KAERI → INTEC
- Regulator → INSS/KINS

First Phase : Role of Government

- Korea in 1950s
  - Korean War : 1950~1953
    - *Left the country totally impoverished*
    - *Industrial and social infrastructure was completely destroyed.*

  - Electricity Supply : from one big hydro plant in North Korea
    - *After the cease-fire in 1953, North Korea blocked it*
    - *Electricity generation capacity of the South Korea*
      - *only 127,000kW about 1/500th of today's capacity*
  - Per Capita Gross National Product (GNP) : $70 (In 1954)
  - At the end of 1950s, Korean economic and industrial situation;
    - *Excessive population density in the small country,*
    - *Lack of energy resources,*
    - *Industrial infrastructure destroyed by the Korean War,*
    - *Large expenditures on defense under the cease-fire state,*
    - *Political instability, little experience in administration and the lack of government driving force, and*
    - *Insufficient domestic private capital*

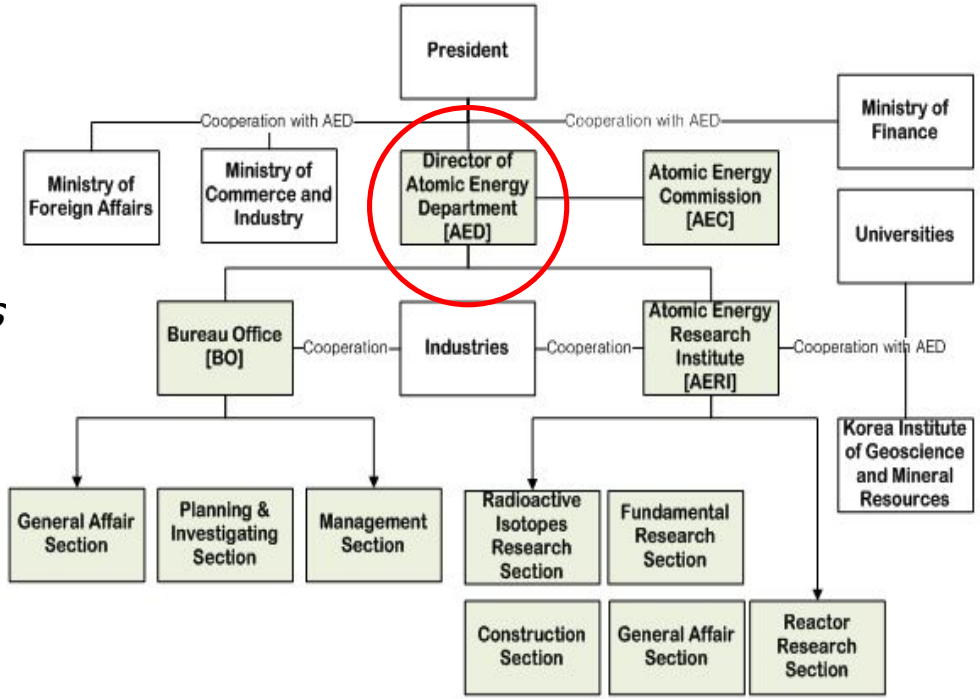
First Phase : Role of Government - NEPIO

❑ Pre-NEPIO in Korea (AES in 1956)

- ❖ Organizing an informal study group
  - *Voluntary group of young scientists and engineers without any funding for the services*
  - *Self-studies on the nuclear technology and the Atomic Energy Act of other countries*
- ❖ Establishment of Atomic Energy Section (AES) under ministry of education
  - *Played a central role in the initial nuclear power programme for 2 years*
    - *Establishing the Atomic Energy Department (AED)*
    - *Establishing AERI*
    - *Selection of the research reactor to be introduced*
    - *Securing funds for building national infrastructures with the Ministry of Finance*
    - *Sending nuclear technology trainees abroad for human resources development*
  - *Developed the Atomic Energy Act (Approved by the National Assembly in 1958)*

First Phase : Role of Government - NEPIO

- NEPIO in Korea (AED)
  - Establishment of AED (in 1959)
    - *Responsible for the nuclear energy programme including administration, regulation and research*
    - *Members : attracted from various areas including government, politics, universities, research institutes*
  - Special features and privileges;
    - *Directly under the President*
    - *Dealt with use, development, production and management of nuclear energy and other related technology*
    - *BO : administration*
    - *Research institute : responsible for scientific and technical research*



First Phase : Role of Government - NEPIO

❑ Establishment of KEPCO

- ❖ The military power group took over the government on May 16, 1961
  - *Established the owner/operator organization as the state-owned electric power company, the Korea Electric Power Company (KEPCO)*

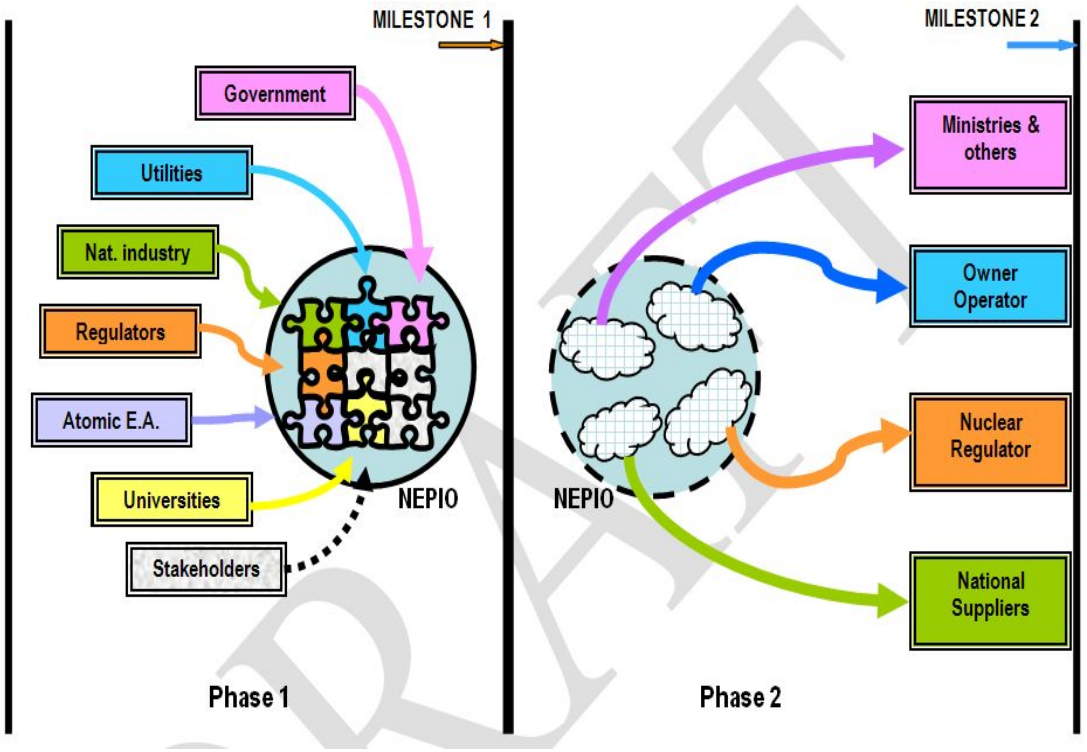
❑ Transferring Responsibility (AED → KEPCO)

- ❖ Initially KEPCO did not have the responsibility for preparing the NPP introduction as the owner/operator.
  - *It was still AED's responsibility and*
  - *KEPCO was assisting the AED*
- ❖ In 1968, the responsibilities for preparing the NPP introduction : AED → KEPCO
- ❖ Change of AED Function
  - *AED concentrated on policy making, safety regulation and licensing*
- ❖ In 1967, the AED → Office of Atomic Energy (OAE) under the Ministry of Science and Technology (MOST), instead of being directly responsible to the President.
  - *With this change, the role of owner/operator was transferred to KEPCO*
  - *The functions of the AED (OAE) were steadily moved to R&D and safety regulation parts of the overall programme infrastructure.*

First Phase : Role of Government - NEPIO

❑ Disappearing of NEPIO

- After KEPCO became the owner/operator,
  - *the NEPIO handed over many of their functions to KEPCO.*
- OAE became a smaller section in MOST in 1973
  - *with separation of the research institutes*
  - *They shifted their functions to permanent organizations for the national nuclear power programme.*
- The NEPIO was steadily transferring authorities
  - *to various specialized institutes and*
  - *disappearing.*



First Phase : Role of Government - Legislation

❑ Introduction

- ❖ The enactment of the AEA should precede the development effort for a nuclear power programme.
- ❖ The AEA must encompass a wide range of issues
  - *From management responsibilities to regulatory frameworks.*

❑ Initial drafting of AEA in Korea

- ❖ With the birth of the AES,
  - *On July 2, 1956, the draft of Atomic Energy Art was submitted to the National Assembly.*
- ❖ The Act officially became effective on March 11, 1958.
  - *The provisions for the regulation of the NPP were enacted in 1969.*
    - ***No legislation on NP regulation until 1969***

First Phase : Role of Government – Regulatory Framework

❑ Introduction

- ❖ For the success of a long-term NP programme, an independent and competent regulatory body is essential.

❑ Shortage of Human Resources

- ❖ Not feasible to launch a separate regulatory body
- ❖ Until 1968, development section, in the AED, carried out regulations only for radiation protection and research activities.

❑ Preparation of Legislation for Regulatory Framework

- ❖ As the first NPP construction effort became tangible,
  - *the government was compelled to establish the regulatory organization responsible for the licensing of the construction permit for the first NPP.*
- ❖ On 24 January 1969, provisions for safety regulation were enacted.

First Phase : Role of Government – Human Resource Development

Introduction

- With the limited human resources, it was difficult to launch domestic education systems on nuclear engineering.
  - *up-to-date education and training could not be provided within Korea and*
  - *began supporting overseas training of young researchers.*
- In the early phase, with two major efforts
  - *sending trainees abroad and inviting experts for lectures, reviews and research.*

Overseas Training

- The young talented group had been trained in the USA and Europe.
  - *From 1956 to 1958, most human resources development was made through oversea training, funded by the government despite the extreme lack of foreign currency.*
- From 1955 to 1964, Korea sent 237 persons abroad, but only 150 persons returned to Korea.
  - *To solve the problem, in 1961, the government imposed return obligations on all government scholarship students.*

Contribution of International Cooperation in Early Stage

❑ Human Resource Development

- The First President Rhee recognized the importance of nuclear energy after the meeting with Mr. Cisler (Former president of the Detroit Power Company)
  - *Mr. Cisler recommended the training of young scientists and engineers in overseas*
- More than 300 students sent out to overseas under full government support
  - U.S., U.K., France and West Germany
- They became the main human capital for nuclear development and safety

Contribution of International Cooperation in Early Stage

Activities (1957-1969)	**Total**
International conference and symposium (both attending and hosting)	47 times
Inviting foreign technical experts	61 times (81 persons: 1 day ~18 mos.)
Sending internal human resources	310 persons under poor financial condition
Participation in international scientific projects	16 times (with IAEA)
Safety and proliferation resistance system	Bi-lateral, IAEA-INFCI and NPT

Contribution of International Cooperation in Early Stage

❑ Nuclear Power Plant Construction

- ❖ As part of the first Long-term Plan for Electricity Supply, the generating capacity of the first nuclear power plant, Kori Unit-1, had been determined in 1967;
  - Total installed Capacity in Korea < 2,000MWe
  - Initial plan was 150,000 kW
    - Considering Korea's total electricity production at the time, the reasonable capacity of the nuclear power plant was 150,000 kW.
  - Consultation with IAEA Expert, Mr. Krynn
    - "Determine the generation capacity based on the electricity demand forecast of 10 year future, not present"
  - Finally, determined to be 587,000 kW

Second Phase : Role of Government – Industry Involvement

❑ Turnkey Contract Approach

- ❖ where main contractors were responsible for design, construction and commissioning of the whole project and in charge of the project management.

❑ Contract

- ❖ KEPCO contracted WEICO (PWR) for the first NPP, Kori 1, in 1970.
  - ※ WEICO : Westinghouse Electric International Company
  - ● *Like the first NPP, the second NPP in Korea, Kori 2, was also ordered from WEICO in 1974.*
- ❖ First CANDU plant, Wolsong 1, was ordered from the AECL, Canada in 1975.

❑ Domestic Industries Involvement

- ❖ Domestic industries and technicians participated in civil engineering, construction and nondestructive testing.
- ❖ Local industries tried to establish quality control database and experience by participating in the construction of the second and third NPP.

Second Phase : Role of Government - Localization

- Localization Policy *(Non-Turnkey contracts approach)*
  - Domestic companies : sub-contractors , Foreign companies : main-contractors
  - Contracts were separately awarded for major components
    - *Thus enabling more domestic industries to participate as subcontractors*
    - *Classified components by localization feasibility, importance, and target schedule.*
- Supply of Components
  - KEPCO was obligated to utilize the developed components
    - *through agreement with the suppliers of the NPP*
  - Kori 3&4 : contracted to a foreign supplier with terms for domestic component supply
- Localization Results
  - Increasing components supply from local suppliers
  - Quality management for local suppliers was put into place
    - *to improve the quality of both nuclear and non-nuclear products.*

Second Phase : Role of Government - HRD

❑ University Programmes

- ❖ Expanded beyond theoretical education into engineering courses
  - *Design process of an NPP, nuclear fuel cycle, nuclear power economy, reactor safety analysis and heat transport*

❑ Overseas Training

- ❖ Government continued funding scholarships, but at a reduced budget.

❑ KAERI NTC

- ❖ Nuclear Training Center was established in KAERI.

❑ KEPCO Training Center

- ❖ KEPCO contracted with WEICO for training
- ❖ Additional staff was trained at existing thermal plants and research organizations.
- ❖ KEPCO opened training center at the Kori 1 site.

Second Phase : Role of Government - Regulation

❑ Establishment of NSC (in 1981 : predecessor of **today's KINS**)

- as part of KAERI
- Many experienced researchers of the KAERI joined the NSC

❑ Regulatory Activities

- 6 NPPs were constructed by employing localization policy.
  - *Kori unit 3&4, Yonggwang units 1&2, Ulchin units 1&2*
- Two step licensing system(CP and OL) was incorporated into the law
- Licensing difficulties encountered *from different Origin of Countries*
  - USA, Canada, France

Third Phase : Role of Government - Localization

- As part of technological self-reliance program,
  - major efforts have been concentrated on maximizing technological development and improvement of domestic industries
- Component contract approach
  - Plant owner took the major responsibility and risk associated with the project implementation
  - The top priority for selecting suppliers was the condition of transferring higher nuclear technology
- Starting from Yonggwang units 3&4 contracts in 1987,
  - KEPCO assumed the overall management and responsibility for construction projects.
  - Prime contractors : domestic companies
  - Foreign companies : subcontractors

Third Phase : Role of Government - Regulation

- Establishment of KINS
  - KINS was founded in 1990 to ensure the independence of Regulation
- Regulatory Activities
  - Licensing for Yonggwang 3&4 (CE design)
  - Licensing for Wolsong 2, 3 & 4
    - *Heavy water reactor designed by AECL*
  - Licensing for Ulchin 3&4 (first standardized units of OPW-1000), Yonggwang 5&6 (OPR-1000)
  - Safety review for LWR project of the Korean Peninsula Energy Development Organization (KEDO)
    - *Construction of two LWRs in North Korea*
      – Suspended from Dec. 1, 2003
- Localization of Industry Code – Industry Initiative
  - Korea Electric Power Industry Code (KEPIC) was developed based on major international codes such as ASME, IEEE, etc.

In 2000s : Role of Government - Advanced Technology Development

❑ APR–1400 Project (1992 – 2002)

- ❖ The Project has been carried out as part of national energy development program:
  - *To take economic advantage of larger output per unit,*
  - *To consider the difficulties in obtaining new NPP sites*
- ❖ Improved design features
  - *Direct reactor vessel injection of emergency core cooling water,*
  - *Digitalized instrumentation and control system,*
  - *Workstation based control room and*
  - *In-containment refueling water storage tank, etc.*

❑ Continued Safety Enhancement for OPR-1000

- ❖ Design improvement and enhancement in safety features and operating performance has continued since YGN 3&4 and UCN 3&4 :
  - *To reflect changes in industrial codes and standards i.e., ASME, IEEE*
  - *To incorporate the feedback of operating experience and technical development in the industry*

In 2000s : Role of Government - Regulation

❑ Licensing and Regulation for APR-1400

- ❖ Standard Design Approval (SDA) System was introduced
  - *Issued for APR-1400 in 2002.*
- ❖ Construction Permit was issued for APR-1400 (Shin-Kori units 3&4) in 2003

❑ International Cooperation for New Entrants

- ❖ Establishment of International Nuclear Safety School in 2008
  - *A number of co-host training programs with IAEA*
  - *Nuclear Safety Master Degree Program from 2009*
  - *Nuclear Infrastructure Support Group*

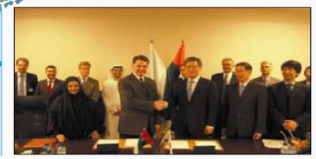
Knowledge Sharing-International Cooperation

Asian Nuclear Safety Network
(ANSN, 13 countries)

Strengthen of
Intl. Cooperation

Arab Network of Nuclear Regulators
(ANNuR, 22 countries)

Regulatory Cooperation
with Jordan



Regulatory
Cooperation with
UAE

Education and
Training for
New Entrants

Forum of Nuclear
Regulatory Bodies in Africa
(FNRBA, 28 countries)

Ibero-American Network
(FORO, 8 countries,planning)

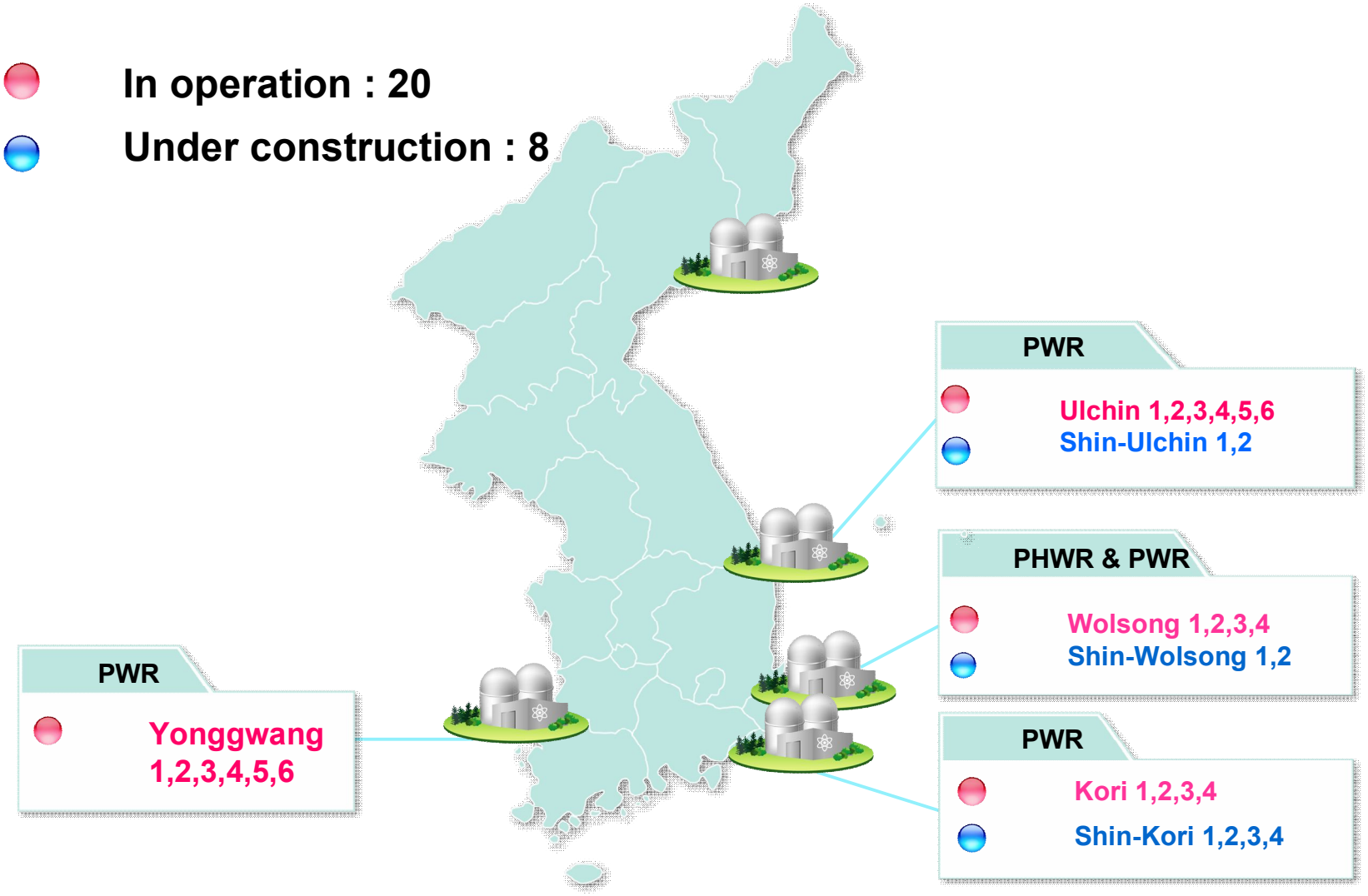
II. Nuclear Safety Regulation in Korea

1. Status of Nuclear Power
2. Regulatory Framework
3. Licensing Process
4. Safety Inspection

Status of Nuclear Power Plants

In operation : 20

Under construction : 8



Regulatory Framework

MEST

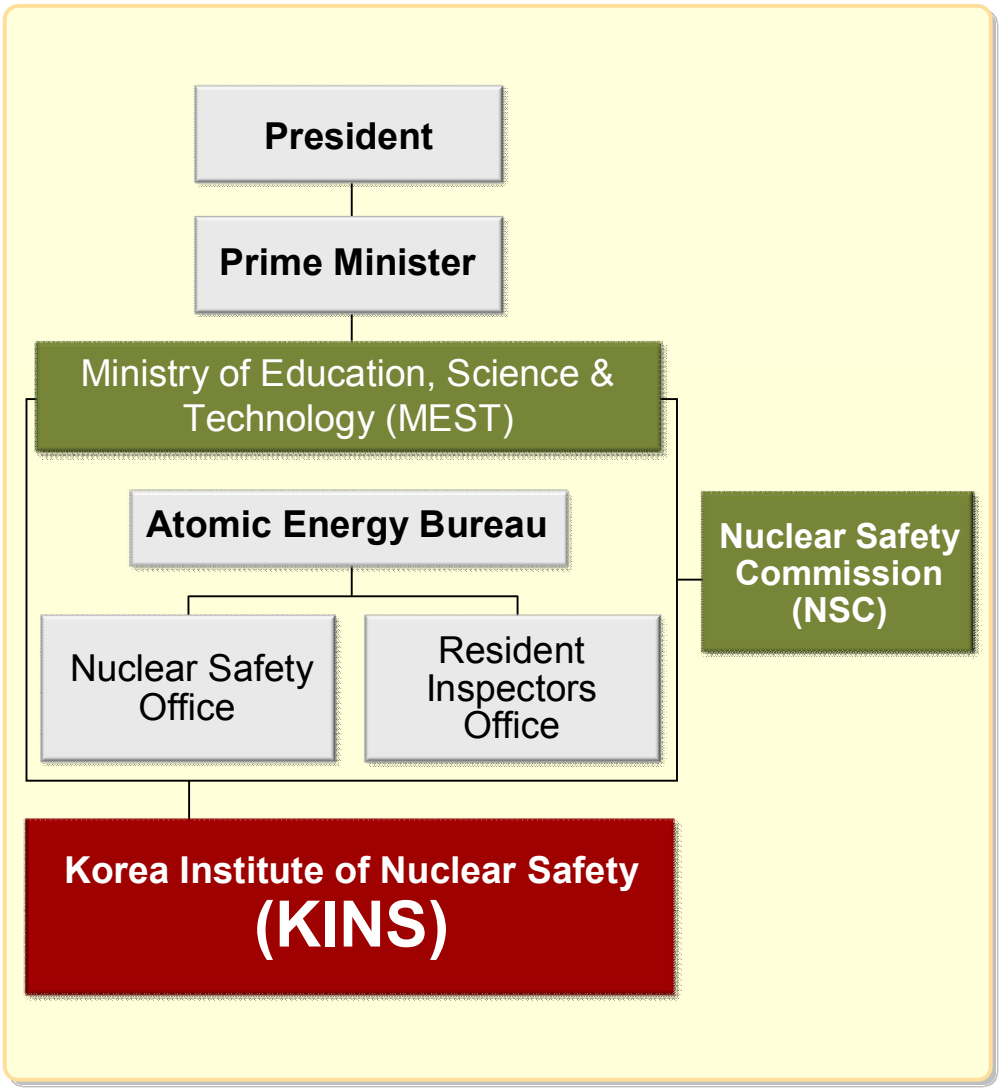
- Regulatory enforcement authority

NSC

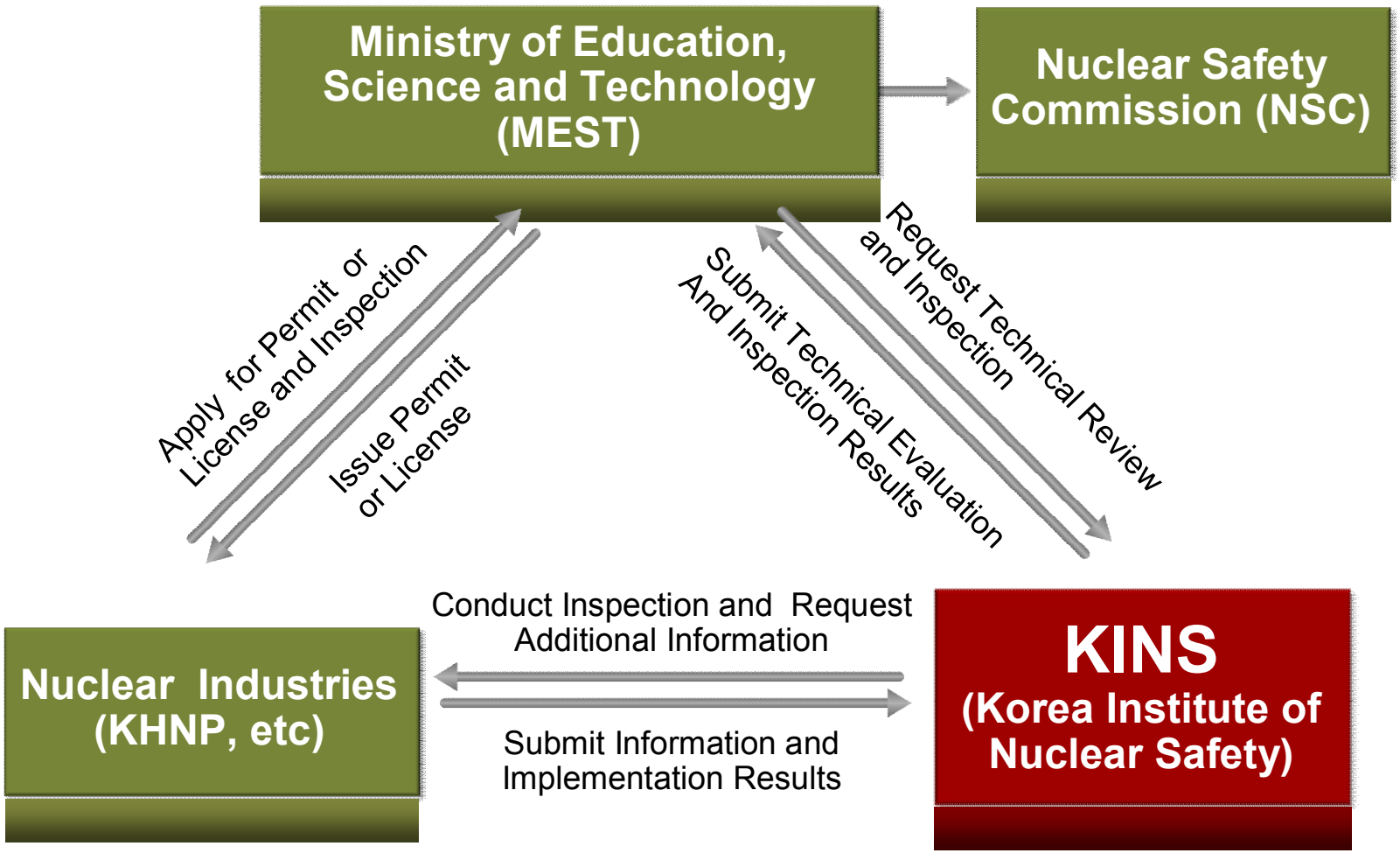
- 9 members and supported by 5 sub-committees
- Decision-making on major nuclear issues

KINS

- Regulatory agency having expertise
- Entirely dedicated to nuclear safety regulation



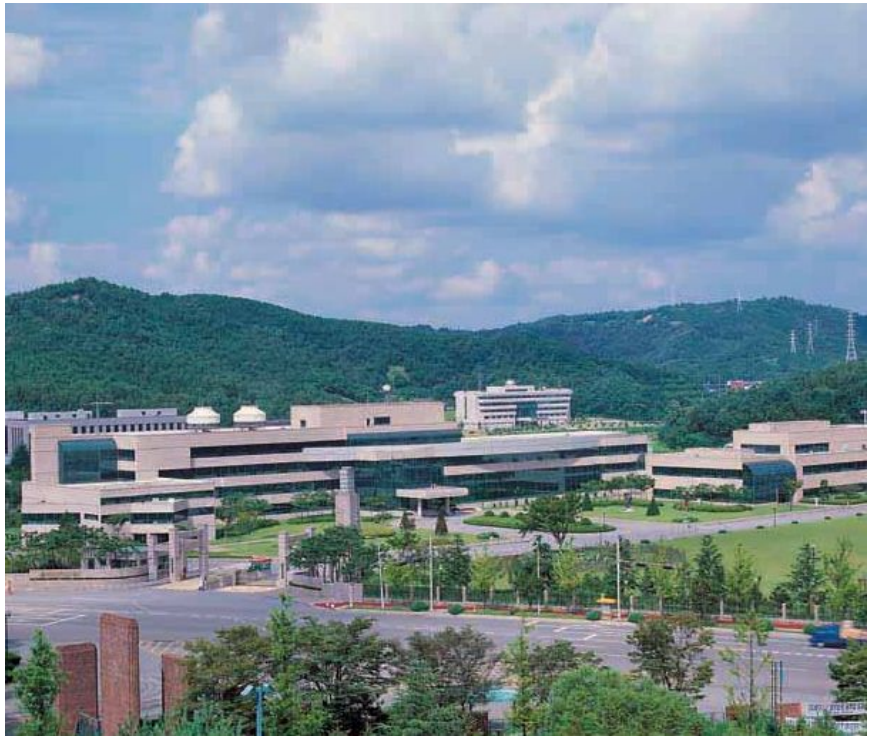
Working Mechanism



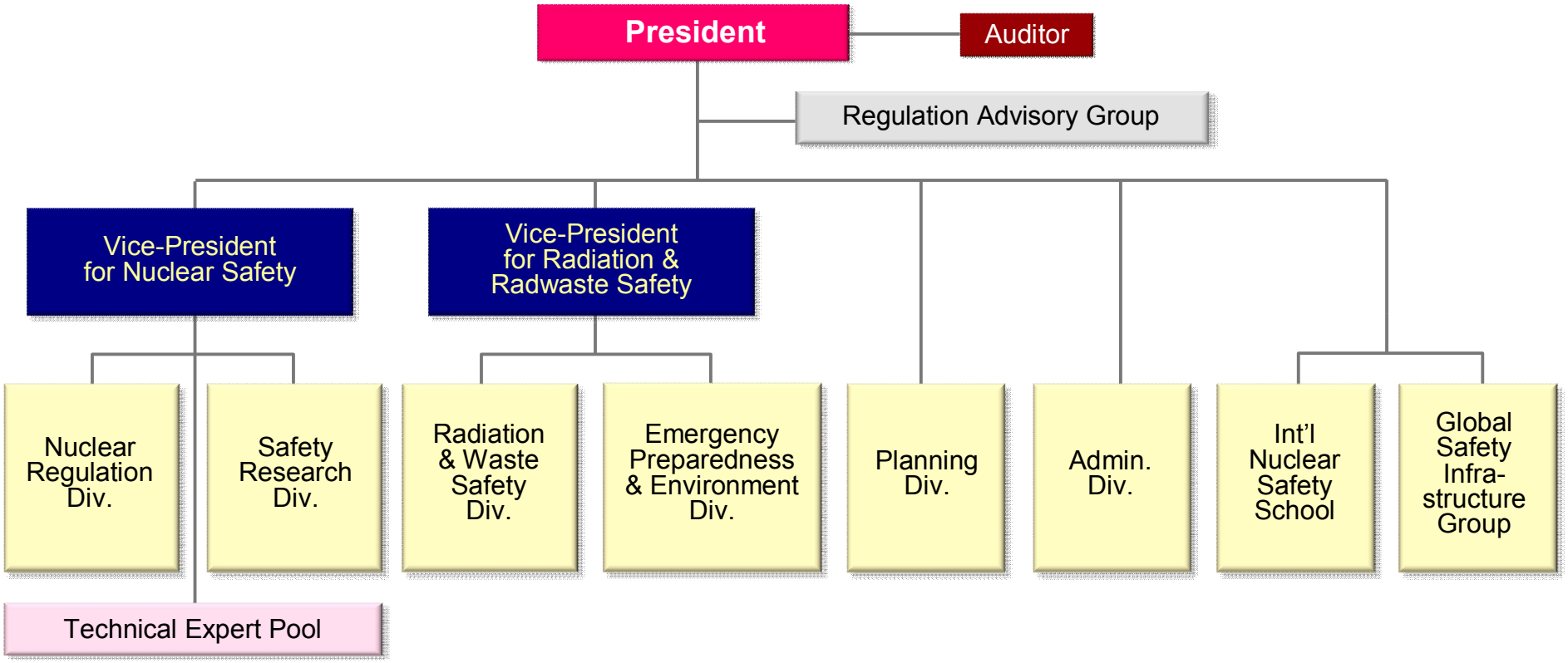
About KINS

- Nuclear Safety Center in 1981
  - A technical expert organization to conduct safety review and inspection (within Korea Atomic Energy Research Institute)

- Korea Institute of Nuclear Safety (KINS) on Feb. 14, 1990
  - Based on the special KINS Act (Law No. 4195)
  - An independent organization entrusted by the Ministry of Education, Science and Technology (MEST)



About KINS


President
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Vice-President for Nuclear Safety
Vice-President for Radiation & Radwaste Safety
Nuclear Regulation Div.
Safety Research Div.
Radiation & Waste Safety Div.
Emergency Preparedness & Environment Div.
Planning Div.
Admin. Div.
Int'l Nuclear Safety School
Global Safety Infra-structure Group
Technical Expert Pool

About KINS

❑Mission

- ❖ To protect the public and preserve the environment from potential radiation hazards

❑ Functions

- ❖ Safety review and inspection for nuclear facilities
- ❖ Regulation of radioisotopes (RIs) users
- ❖ Monitoring and evaluation of environmental radiation
- ❖ Research and development of safety standards
- ❖ Policy development, International Cooperation, Education & Training, Public Relation
- ❖ Emergency Prepardness, etc

Licensing Process in Korea

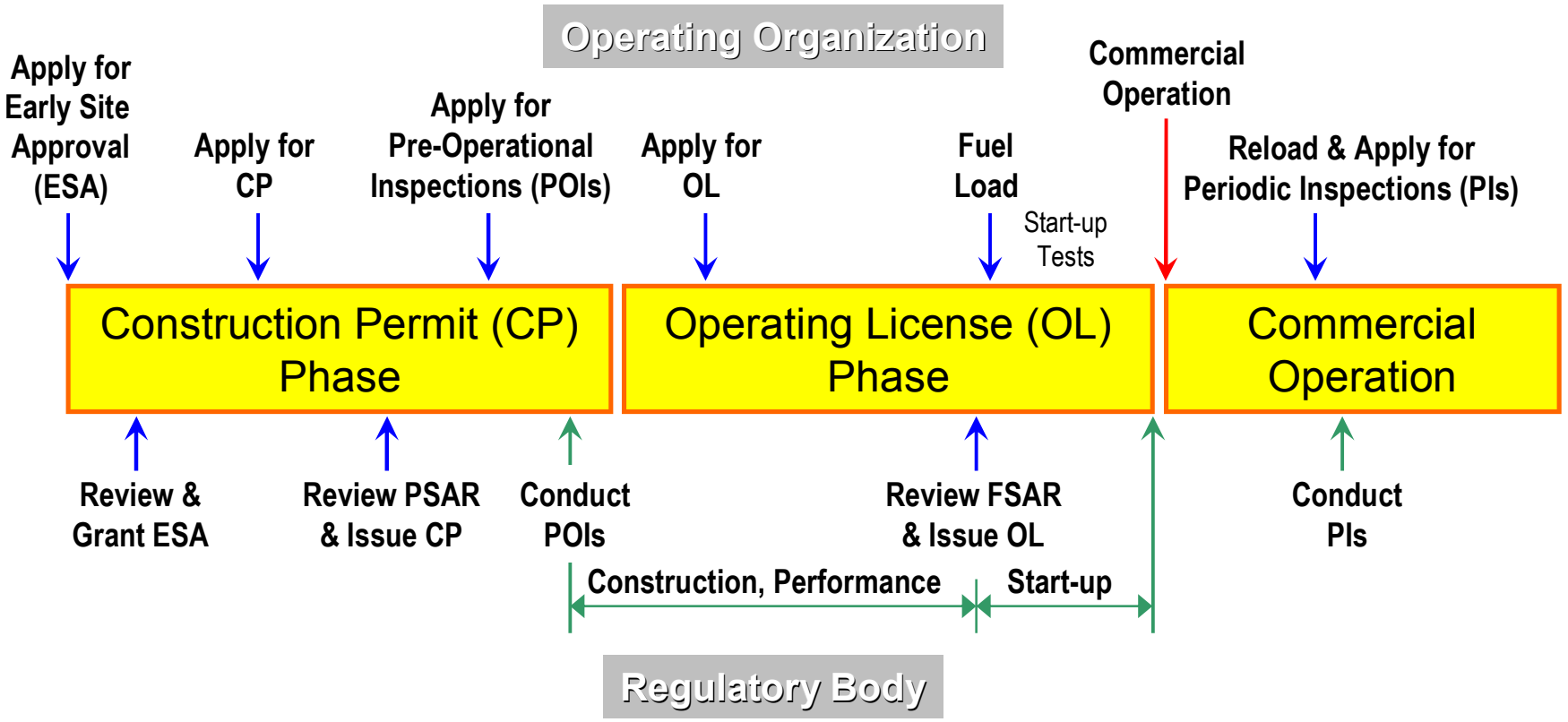
❑2-step Licensing

- ❖ Construction Permit (CP)
  - ● *Early Site Approval (ESA)*
- ❖ Operating License (OL)

❑Safety Review for Operating Reactor

- ❖ Periodic Safety Review (PSR)
- ❖ Continued operation beyond design life
- ❖ Standard Design Approval
- ❖ Approval of Topical Report (TR)

Licensing Process and Operation



Construction Permit (CP)

❑ Purpose

- ❖ to ensure that the technical standards for the location, structure, facility, and performance of NPP are met

❑ Documents submitted for CP

- ❖ Radiation Environmental Report
- ❖ Preliminary Safety Analysis Report (PSAR)
- ❖ Quality Assurance Plan for construction
- ❖ Description on the technical capability for nuclear plant installation

❑ Time Period for CP Review

- ❖ 15 months for the reactors that have similar type and size in design to the previously licensed ones,
- ❖ Otherwise, 24 months

Review for Operating License (OL)

- Purpose
  - to confirm that the final design of nuclear reactor described in the final safety analysis report meet the applicable standards
  - to ensure that the completed nuclear reactor can be operated as expected throughout the design life

- Documents submitted for OL
  - Final Safety Analysis Report (FSAR)
  - Technical Specifications for Operation
  - Quality Assurance Program for operation
  - Radiation Environmental Report
  - Radiation Emergency Plan
  - Description on the technical capability for the reactor operation
  - Description on nuclear fuel loading plan
  - Description of the technical background and verification method to be for the Emergency Operating Procedure

Safety Inspections

❑Types of Safety Inspection

- ❖ Pre-Operation Inspection
- ❖ Quality Assurance inspection
- ❖ Periodic inspection
- ❖ Resident inspection
- ❖ Special inspection

❑ Pre-Operation Inspection

- To confirm the adequacy of materials, components, systems and structures, as well as construction related activities, processes, procedures and personnel competence
- Performed in compliance with safety assessment results and Safety Analysis Reports, and in reference to the project milestones
- POIs are performed when
  - *When the construction on the important structure of reactor facility has started and when any strength test for each main process may be available*
  - *When any performance test for each system may be available*
  - *When cold hydro test and hot functional test may be available*
  - *When nuclear fuel loading and commissioning test may be available*
- Correction by Inspection Results

- Quality Assurance inspection
  - To confirm the quality achievement of organizations involved in the design, manufacturing, construction, and operation of facilities
  - To verify the effectiveness of QA Program (QAP) and the appropriateness of applicant's QA activities
  - Performed in reference to the QAP approved by the regulatory body, in a programmatic manner, annually planned for each organization
- Periodic inspection
  - To ensure that the performance of reactor facility is maintained in the state of the pre-operational inspection, for re-criticality after plant overhaul
  - Performed during the plant outage period
- Resident inspection
  - To monitor daily construction and operation status, and identify and respond to any activities adverse to nuclear safety
  - Operate, both the MEST and KINS, resident inspection office at each plant site
- Special inspection
  - Initiated in response to unexpected, unplanned or unusual situation or event, as necessary

III. Concluding Remarks

Concluding Remarks

❑ Korean NP Programme

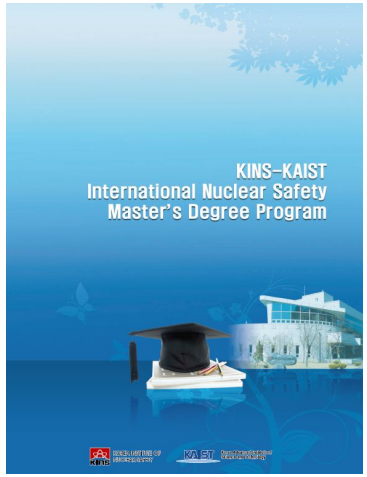
- ❖ Competent NEPIO(AED) played key roles for planning and implementations of successful NP programme
- ❖ Consistent Nuclear Policy has been in place whatever the government changed
- ❖ Human Resources development & international collaborations have been key for establishment of comprehensive nuclear infrastructure

❑ Sharing & Cooperation

- ❖ For taking a shortcut to develop nuclear energy & regulatory system,
  - *Cooperation between experienced countries and newcomers is particularly meaningful.*
- ❖ Korea is willing to share nuclear technologies and regulatory experiences learned and accumulated during the past five decades with newcomers.

Concluding Remarks

- Korea's Support for Regulatory Capacity Building has been and will be demonstrated through:
  - Education and Training of International Nuclear Safety School (INSS)
  - Technical support of Korea Institute of Nuclear Safety (KINS)
- E&T Program in INSS (http://inss.kins.re.kr)
  - Co-host Training Courses with the IAEA
    - *Basic Professional Training Course*
    - *Regulatory Control Training Course*
    - *Trainer Training Course (TBD, Under discussion)*
  - Tailored Professional Training Courses
  - Individual OJT Course
  - Special OJT course for NPP construction
  - International Nuclear Safety Master's Degree Program
    - *Operated jointly with Korea's Higher Education Institute, KAIST*
    - *Full Scholarship awarded for 1.5 years*
    - *Every year, program starts on Sept. 1 with the application deadline of May 31*



Nuclear Safety Challenges

■ Organized by KOREA INSTITUTE OF NUCLEAR SAFETY

■ Sponsored by MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

■ In cooperation with the IAEA International Atomic Energy Agency

❑ How to address the Safety Challenges in a Flat, Mixed and Open World

- ❖ International cooperation between new entrants and NPP countries in the Flattening world
- ❖ Harmonized safety approaches for the Mixed Reactors Generation
- ❖ Transparency and Objectivity in Open Society to the Information

Thank you very much

KINS