NUCLEAR SAFETY REGULATION AND KINS

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CONTENTS

1. Government and regulation

□ Government

- A body of people that sets and administers *public policy,* and exercises *executive, political and sovereign power* through customs, institutions and laws within a state
  - *Legislators, administrators, and arbitrators* in the administrative bureaucracy who control a state at a given time
  - *Means* by which state policy is enforced, and *mechanism* for determining the policy

□ One of the functions

- Provide public goods and services for well-being of the community as a whole
  - *Provide better than private business* for the community at large

□ Needs for legal & governmental infrastructure

- Ensure control over nuclear material, facilities and any other radioactive material
- Ensure that nuclear energy and its applications are exclusively used for peaceful uses
- Ensure that nuclear facilities, nuclear materials and any other radioactive material are handled and operated safely and securely through a system of regulatory control
- Ensure that compensation mechanisms are in place in case of nuclear damage
- Define responsibilities, obligations and rights of parties
- Ensure confidence building in the use of nuclear power at national and international levels

□ How to meet these needs?

- Adopt a comprehensive nuclear law
- Establish an independent regulatory body
- Implement international obligations of the State

□ What is nuclear law?

- Framework providing a balance between risks and benefits in the use of atomic energy
  - ✓ *de minimis non curat lex*
    - *Rule that the law will not remedy an injury that is minimal*
- Traditionally, encompass 4 main fields
  - Safety, Security, Safeguard and Liability
- Encompass national and international level

□ What is regulation?

- Administrative legislation that constitutes or constraints rights, and allocates responsibilities
  - Distinguished from primary legislation by Parliament or judge-made law
- Actions of conduct, imposing sanctions to the extent permitted by the law
- Costs for some and benefits for others, like any other form of coercive action

✓ A rule of order having the force of law, prescribed by a superior or competent authority, relating to the actions under the authority's control

✓ **Efficient regulations** are those where total benefits **to some people** exceed the total costs **to others**

□ Nature of government regulation

- Economic regulation
  - Rules that limit;
    - Who can enter a business *(entry control, needs licenses)*
    - What price they may *charge (price control like railroads, telephone, etc.)*
- Social regulation
  - Broad category of rules, governing how any business or individual carries out its activities with a view to correcting **"market failure"**

Market fails:

※ *When firms or individuals do not take account of the costs their activities may impose on 3rd parties, or*

※ *When firms fail to supply sufficient information for consumers or workers to make informed choices*

□ Benefit of government regulation

- Improve the position of minorities
- Clean the environment
- Prevent monopoly
- Reinforce free competition
- Prevent corruption
- Strengthen the banking system
- Reduce industrial accidents
- Provide resources for the elderly
- Control communicable diseases, and so on

✓ **Benefits are enormous, but incalculable**

2. Global safety framework

Global safety harmonization

Will nuclear accident occur again?

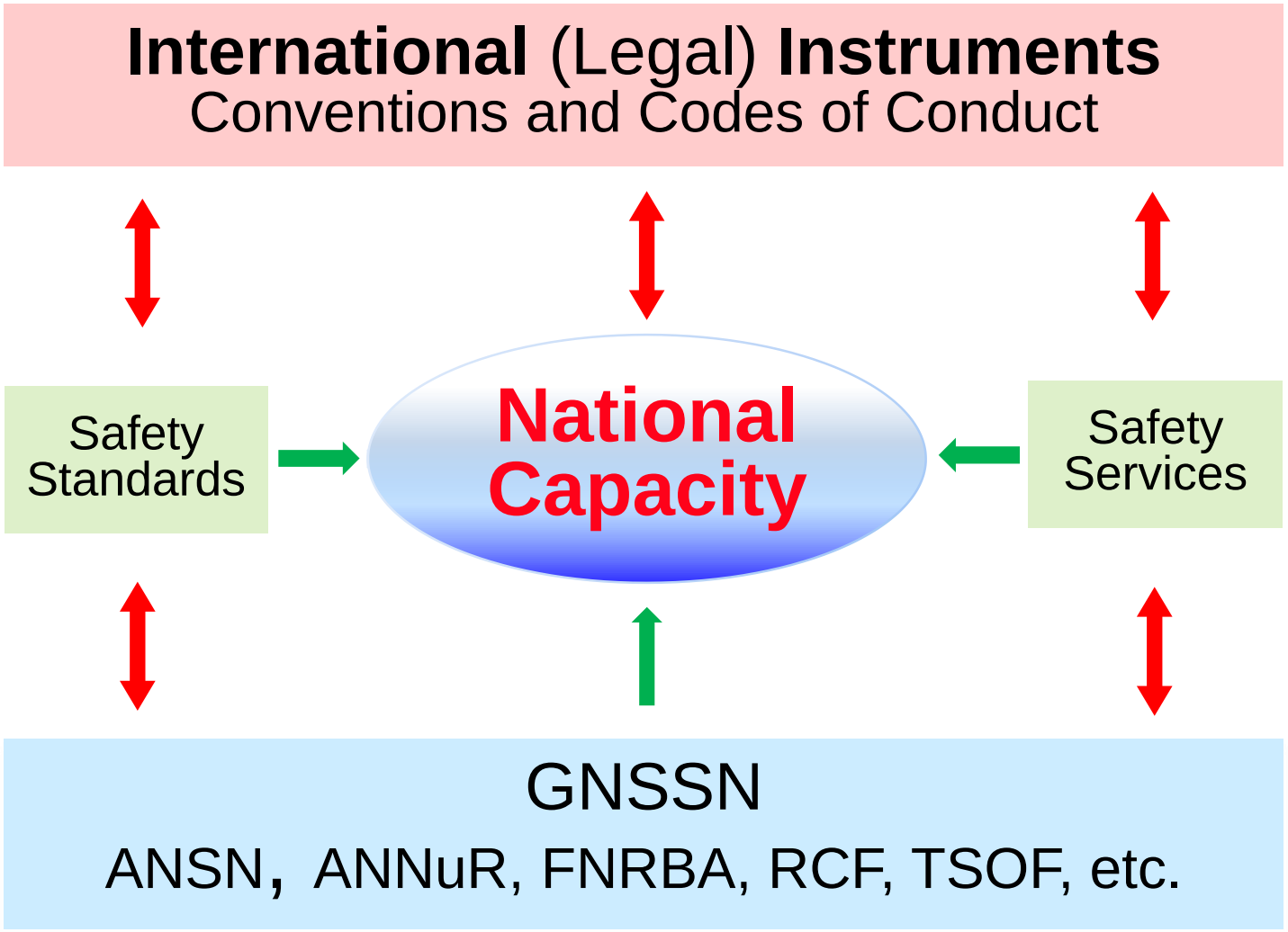
Safety is a **national responsibility**

vs.

Accident is **a global concern**

- Fukushima Daiichi (‘11), Chernobyl (‘86), TMI (‘79)
- **Do not respect** national boundaries

□ Safety framework of the IAEA



※*What is capacity building?*

□ *Institutional and legal framework development*

- *Making legal and regulatory changes to enable organizations, institutions and agencies at all levels and in all sectors to enhance their capacities*

□ *Organizational development*

- *Elaboration of management structure, process and procedures, not only within organizations but also managements of relationships between the different organizations and sectors*

□ *Human resource development*

- *Process of equipping individuals with the understanding, skills and access to information, knowledge and training that enables them to perform effectively*

3. Fundamental safety principles

To protect people and the environment from harmful effects of ionizing radiation

- Achieved without unduly limiting the operation of facilities or the conduct of activities that give rise to radiation risks
- To ensure that facilities are operated and activities conducted so as to achieve the highest standards of safety that can reasonably be achieved, measures have to be taken:
  - To control the radiation exposure of people and the material release to the environment
  - To restrict the likelihood of events that might lead to a loss of control over chain reaction, or sources
  - To mitigate the consequences of such events if they were to occur

□ 10 Safety Principles

① Responsibility for safety

The prime responsibility for safety must rest with the person or organization responsible for facilities and activities that give rise to radiation risks

- The licensee retains the prime responsibility for safety throughout the lifetime of facilities and activities, and this responsibility cannot be delegated

② Role of government

An effective legal and governmental framework for safety, including an independent regulatory body, must be established and sustained

- Governments and regulatory bodies have an important responsibility in establishing standards and establishing the regulatory framework for protecting people and the environment against radiation risks

③ Leadership and management for safety

Effective leadership and management for safety must be sustained in organizations concerned with, and facilities and activities that give rise to, radiation risks

- **Leadership in safety matters** has to be demonstrated at the highest levels in an organization, to achieve safety by means of an effective management system
- This system has to integrate all elements of management so that requirements for safety are established and applied coherently with other requirements, including those for human performance, quality and security, and so that safety is not compromised by other requirements or demands
- The management system also has to ensure the promotion of a safety culture, the regular assessment of safety performance and the application of lessons learned from experience

④ Justification of facilities and activities. Facilities and activities that give rise to radiation risks must yield an overall benefit

⑤ Optimization of protection. Protection must be optimized to provide the highest level of safety that can reasonably be achieved

⑥ Limitation of risks to individuals. Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm

⑦ Protection of present and future generations. People and the environment, present and future, must be protected against radiation risks

⑧ Prevention of accidents. All practical efforts must be made to prevent and mitigate nuclear or radiation accidents

⑨ Emergency preparedness and response. Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents

⑩ Protective actions to reduce existing or unregulated radiation risks. Protective actions to reduce existing or unregulated radiation risks must be justified and optimized

CONTENTS

1. History of nuclear use

1960s	1970s	1980s	1990s	2000s	2010~
Preparation for Nuclear Energy	Introduction of Nuclear Power	Promoting Localization	Technology Self-reliance	Advanced Tech. Development	Export of APR1400
					
Joining IAEA Research Reactor	Construction of Kori #1	Establish Localization Plan	OPR1000, Hanaro Development	APR1400 Development	APR1400 Export
Atomic Energy Act (1958) NEPIO	Turnkey Contract	Component Approach	Technology Self-Reliance	APR-1400 Design Project	APR + Design Project
	Government & KAERI	Government & NSC('81)	Government & KINS('90)		NSSC KINS

□ Development of NPPs

- Turnkey contract (1971 ~ 1978)
  - Kori 1 & 2 (W), Wolsong 1 (AECL)
- Localization (Non-turnkey, 1980 ~ 1986)
  - Kori 3 & 4, Hanbit 1 & 2 (W) , Hanul 1 & 2 (F)
- Self-reliance of NPP technology (1984 ~ 1989)
  - Korean Standard Nuclear Plant (KSNP)
  - ✓ Hanbit 3 & 4, scale-down design of Palo Verde CE System-80 from 1,300 to 1,000 MWe
  - ✓ *Reference design of the KEDO LWR project*

- OPR-1000 (2005)
  - Improvement of the KSNP design
  - Common radiowaste building, integrated reactor head assembly, dedicated auxiliary feed water tank, passive hydrogen recombiner

  ※ OPR: Optimized Power Reactor

- APR-1400, new standard design (1992 ~ 2002)
  - Advanced design features for safety and operational flexibility, and power capacity of 1400 MWe

  ※ APR: Advanced Power Reactor

  ✓ *Reference design of the 4 Barakah NPPs in the UAE*

□ APR and OPR

	APR-1400	OPR-1000
Design life (yrs)	**60**	40
Safety Seismic Earthquake (SSE, g)	**0.3**	0.2
Core damage frequency	**10^{-5}**	10^{-4}
Radiation exposure (mSv/person-yr)	**20**	50

- APR+ standard design (2007 ~ 2014)
  - Further improvement of safety features and increase of power capacity from APR-1400
    - Number of fuel assemblies from 241 to 257
    - Unique computer codes for design, and localized RCP and MMIS
  - Standard Design Approval in August 2014

□ APR+ and APR

	APR+	APR-1400
Capacity (MWe)	**1500**	1400
Number of safety trains	**4**	2
Core damage frequency (1/yr)	**10^{-6}**	10^{-5}
Auxiliary feed water system	**Passive**	Active
Construction process	**Modular**	Conventional

□ Nuclear reactors at a glance

In operation
24 units
1 P. Shutdown
(23GW)

Under
Const.
5 units
(7 GW)

Radioactive Waste
Disposal Facility

HANARO

KJRR

Hanul 6 units
Shin-Hanul
2 units

Wolsong 4 units
Shin-Wolseong
2 units

Kori 4 units
Shin-Kori 4 units

Hanbit
6 units

In operation
Under construction

□ Nuclear facilities subject to KINS regulation

Type	Facilities	Owner
NPPs	• **24 units in operation (23 GWe) and 5 units under construction** **- Permanent shutdown of Kori #1 on 18 June 2017**	KHNP
Fuel cycle facilities	• **Fuel fabrication facilities for NPPs**	KNFC
	• Research facilities for irradiated nuclear materials	KAERI
	• Spent fuel processing facilities for research	
Research & training reactors	• **KJRR (under the CP review)**	
	• **HANARO and related facilities**	
	• TRIGA Mark II, III (decommissioned)	
	• AGN-201 for education	Univ.
Repository facility	• **Low and intermediate level radwaste disposal facility**	KORAD
Facilities using RIs	• **About 8,000 organizations in medical, industrial or academic fields**	

2. History of safety regulation

1958 — 1980

Initial

- Basic regulatory infrastructure
- 1 step licensing and vendor country requirements
- First 3 NPPs

1989

Transitional

- Nuclear Safety Center for safety expertise
- Regulatory requirements and HRD
- 6 more NPPs

2010

Competency-focused

- Regulatory independence and competence with KINS & NSC
- Global contributions in nuclear safety regulations
- Standard NPPs of OPR-1000 & APR-1400

New chapter ~

- Nuclear Safety Act and NSSC & KINS after Fukushima
- Regulatory paradigm shift towards public confidence
- 30 NPPs and new standard NPP of APR^{+}

□ Initial stage from 1958 through 1980

- Foundations for the peaceful use of nuclear energy and its safety control
  - The Division of Atomic Energy in 1956, and the Atomic Energy Act and the Office of Atomic Energy directly responsible to the President in 1958
- First 3 NPPs of Kori unit 1 & 2 PWR and Wolsong unit 1 PHWR
  - Safety strategy of "the initial NPPs of proven technology" and turnkey projects
  - Vendors were responsible for schedule, inspection, startup and performance of the plants
  - Safety evaluation by Safety Review Committee, in accordance with vendor countries' requirements, and support of the IAEA
- Designated KAERI as expert organization in 1978

✓ TMI unit 2 accident in 1979

□ Transitional stage from 1981 through 1989

- Nuclear Safety Center in 1981
  - Subsidiary organization of KAERI
- Amendment of the Rules & Regulations in 1982
  - Embrace the expanded use of nuclear energy and emphasize safety after the TMI accident
  - Atomic Energy Commission (AEC)
  - Legal hierarchy of the Act-Decrees-Regulations and 2 step licensing process of CP and OL for NPP
  - Entrust of technical regulations to the center
- 6 more NPPs with non-turnkey basis, multipurpose research reactor, and localization of NPP and fuel
- Regulatory competence developments
  - Regulatory requirements & guidelines, regulatory staff, resident inspector, and emergency preparedness plan

✓ *Chernobyl accident in 1986*

□ Competency-focused stage from 1990 through 2010

- Enhancement of regulatory independence
  - Foundation of Korea Institute of Nuclear Safety (KINS) as the regulatory expert organization by the special KINS Act in 1990
  - Nuclear Safety Commission (NSC), separating the functions of AEC in 1996
- Accumulation of ample regulatory experience with the 19 new plants
  - 14 OPR-1000, 2 APR-1400, 3 PHWR plants, including 2 KEDO plants for the DPRK
- Introduction of new regulations
  - Periodic Safety Review (PSR) of a 10 year interval for operating plants in 2000
  - Standard Design Approval (SDA) in 2001
  - Continued operation after design life in 2005

- Commencement of global contributions
  - Orientation for 25 DPRK regulators in 2002
  - IAEA training courses since 2008
  - Support for global safety networks of ANNuR, ANSN and FNRBA together with the IAEA

✓ Attainment of a high level of regulatory competency towards nuclear safety

□ New chapter since 2011

✓ Fukushima Daiichi Accident in March 2011

- Nuclear Safety Act and NSSC (Nuclear Safety & Security Commission)
  - Further independence of administration and activities of nuclear safety regulation
  - 9 commissioners, including 4 members recommended by the National Assembly
- Expansion of the scope of regulatory oversights
  - All the organizations involved
  - Extension of emergency planning zone to 20 ~ 30 km radius from NPP
  - Formation of regional safety councils
- 24 NPPs in operation, 5 under construction and 1 in permanent shutdown, and SDA for APR^{+}

- ✓ Regulatory responses to public concerns
  - Fukushima Daiichi accident in 2011
  - SBO concealment of Kori unit 1 in 2012
  - Falsification of quality verification documents in 2012

- ✓ Regulatory paradigm shift
  - From safety priority towards enhancing public confidence
  - Extension of regulatory oversight scope to all the activities involved
  - Proving regulatory leadership for nuclear safety

CONTENTS

1. Regulatory infrastructure

□ Fundamentals of nuclear regulation

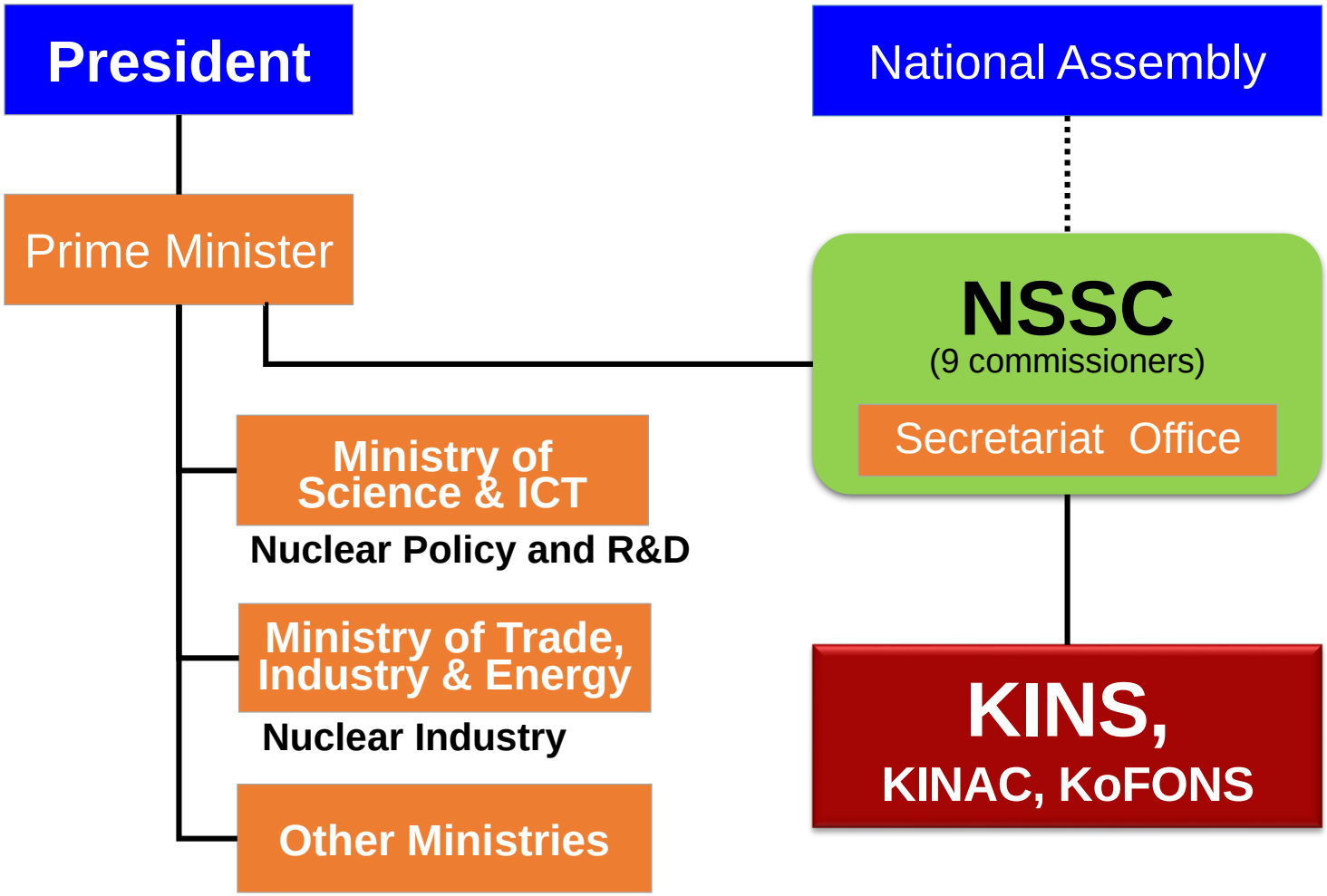
- Protect the public health and safety from radiation hazards
- Preserve the environment from any subsequent harmful effects
- The scope for nuclear facilities covers;
  - Site selection
  - Design
  - Manufacturing
  - Construction
  - Operation
  - Decommissioning

- Core values for nuclear regulation
  - **Excellence**: expertise and experience towards public confidence
  - **Independence**: safety and security in the eyes of the people
  - **Transparency**: no doubt in the process of regulatory decision making
  - **Impartiality**: objective approach in policy and decision making
  - **Reliability**: conformity of principles, and clarity and consistency

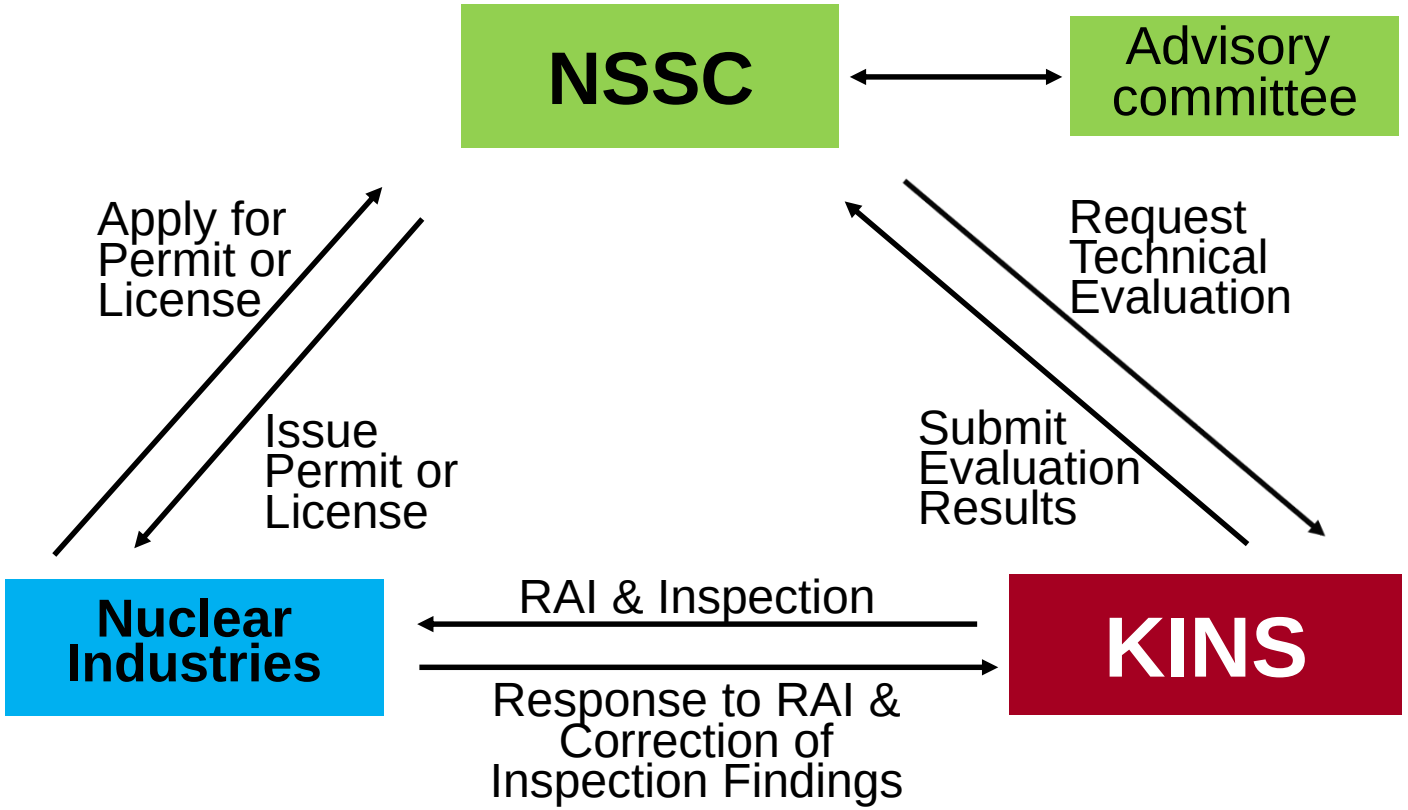
✓ Convention on Nuclear Safety, Article 8.2

"Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those - - - concerned with the promotion or utilization of nuclear energy"

□ Regulatory framework



□ Working mechanism



□ **NSSC** (Nuclear Safety & Security Commission)

- Independent administrative commission
  - Protect people and the environment and contribute to the peace of mankind
  - 9 Commissioners of Chairman (Vice-Minister), Secretary General (Director General) and 7 non-executive members
    - 4 members recommended by the National Assembly
- Advisory committee
  - 15 senior experts from various technical areas, non-standing
  - Ad-hoc subcommittees, as necessary
- Secretariat office
  - 3 bureaus and 13 divisions
  - 4 resident offices at each NPP site
  - 5 off-site emergency management centers near facilities
- Policy making, authorization, administration and enforcement actions for nuclear safety and security

□ **KINS** (Korea Institute of Nuclear Safety)

- Nuclear safety expert organization, having about 600 staff members
  - Safety review and inspection, and development of policies, rules, regulations and guidelines
  - ✓ Established in 1990 by the special KINS Act

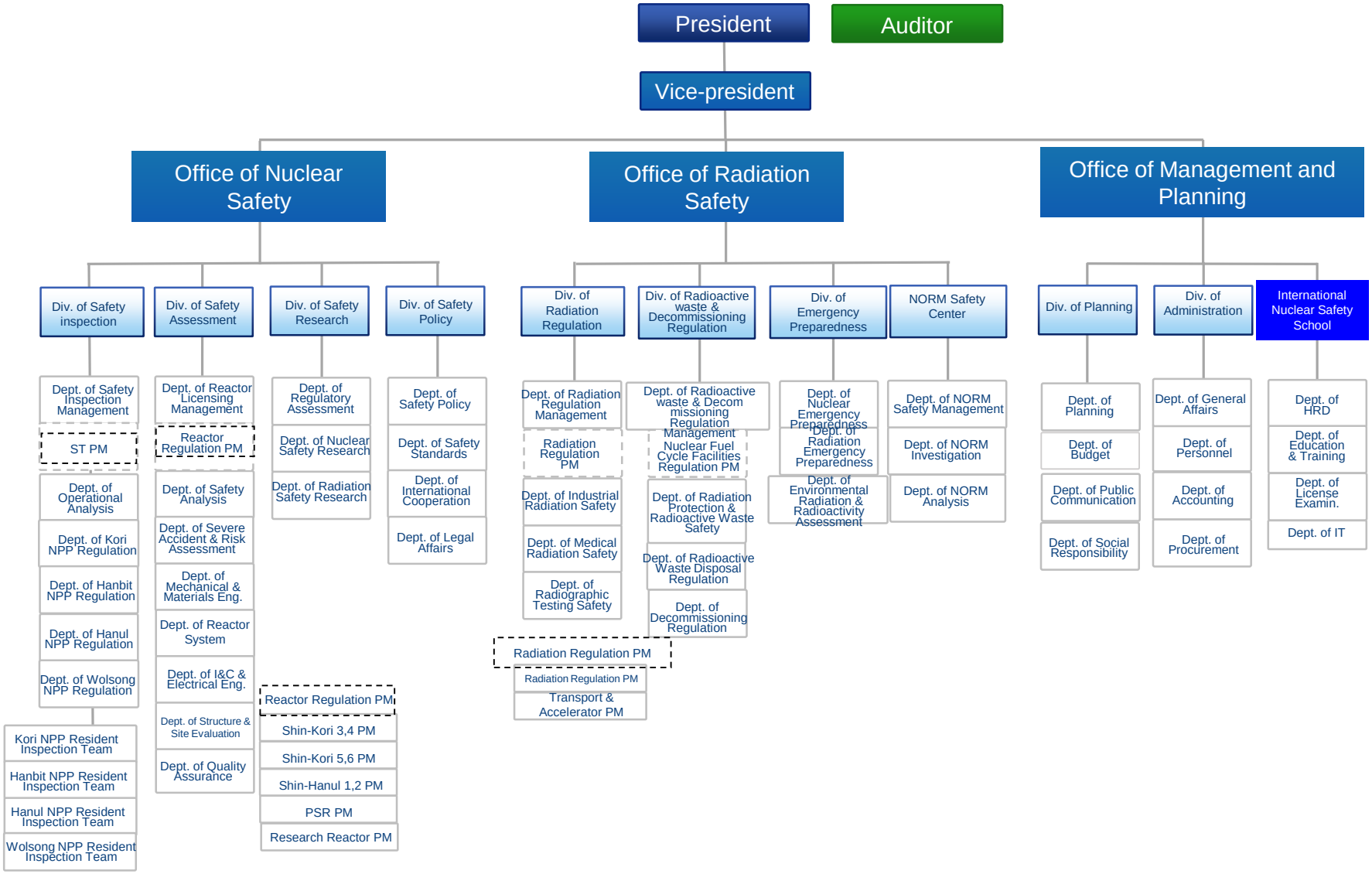
□ KINAC (Korea Institute of Nuclear non-proliferation & Control)

- Safeguards and security expert organization from 2006

□ KoFONS (Korea Foundation of Nuclear Safety)

- Supporting organization in managing government funds for nuclear safety regulations and the relevant R&D projects

• KINS organization



- Overview of nuclear regulation

Safety Policy

Safety Standards

Safety Review

Safety Management

Safety Inspection

Incidents Investigation

Regulatory Research

Human Res. Develop.

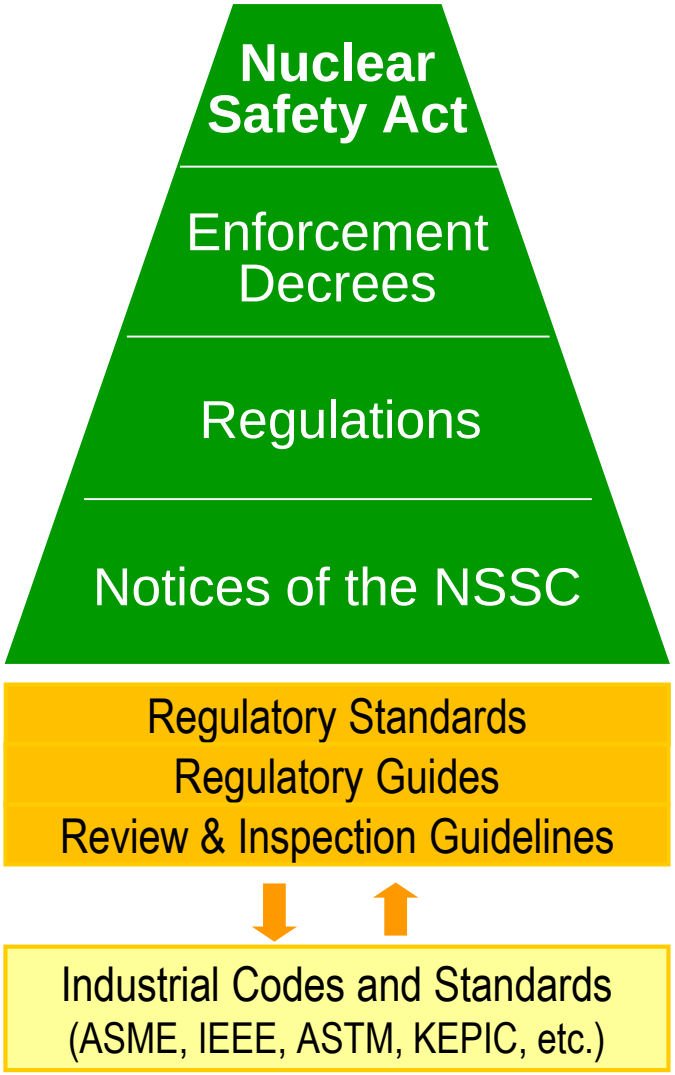
International Co-op.

Infra. Improvement

□ Legal and policy frameworks

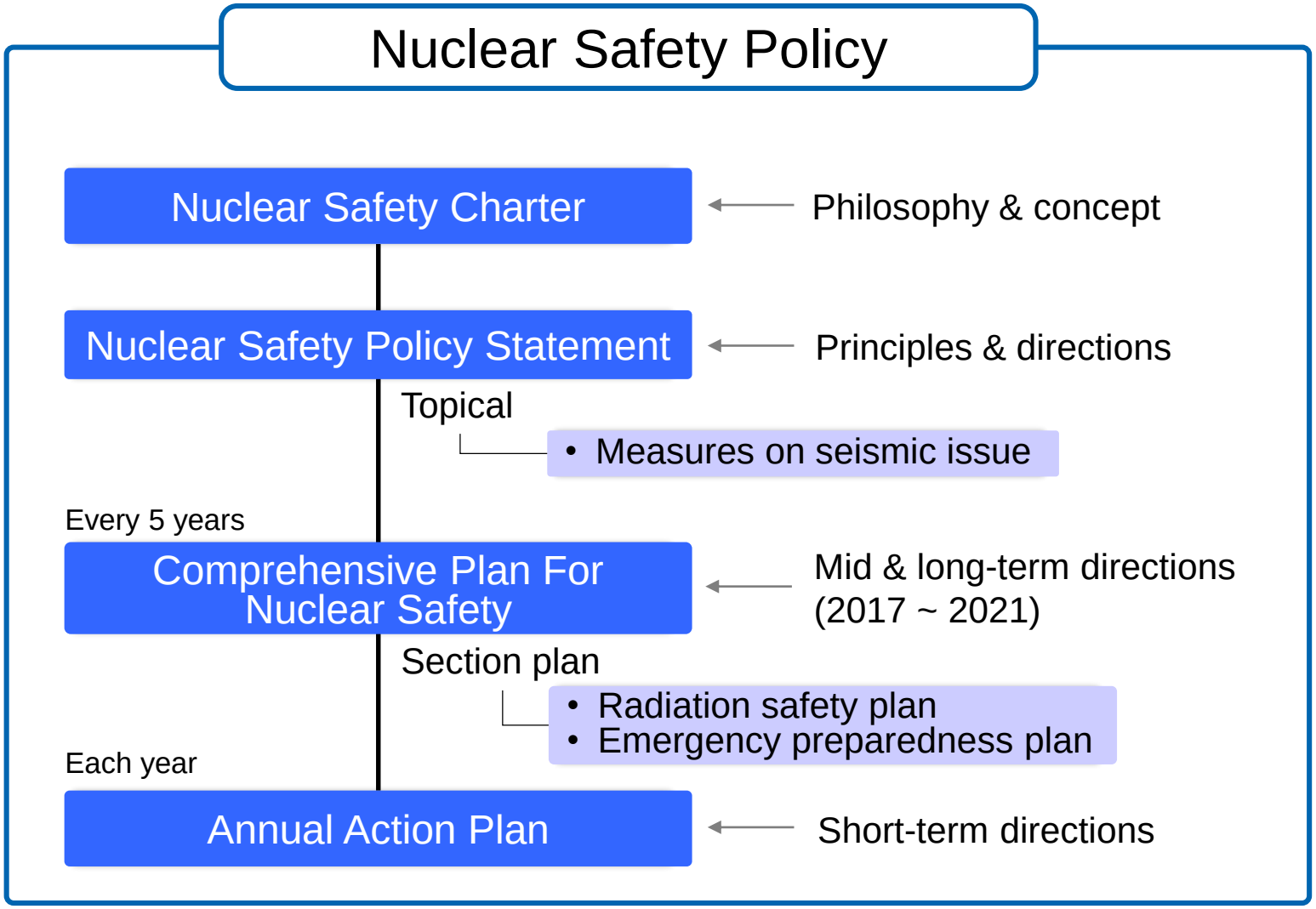
- Nuclear safety act in 2011
  - All provisions for nuclear safety regulation and radiation protection
  - ✓ Separated from the Atomic Energy Act since 1958
  - ✓ Supplemented by the “Act on Physical Protection and Radiological Emergency” in 2003
- Nuclear safety charter in 2001
  - Philosophy and concept for nuclear safety
- Nuclear safety policy statement in 1994
  - Principles and directions, emphasizing safety culture
- Comprehensive plan for nuclear safety
  - New direction of regulations and planning of its related R&D
  - Based on the Act, Art. 3 (Establishment) & 4 (Implementation)

- Legal framework



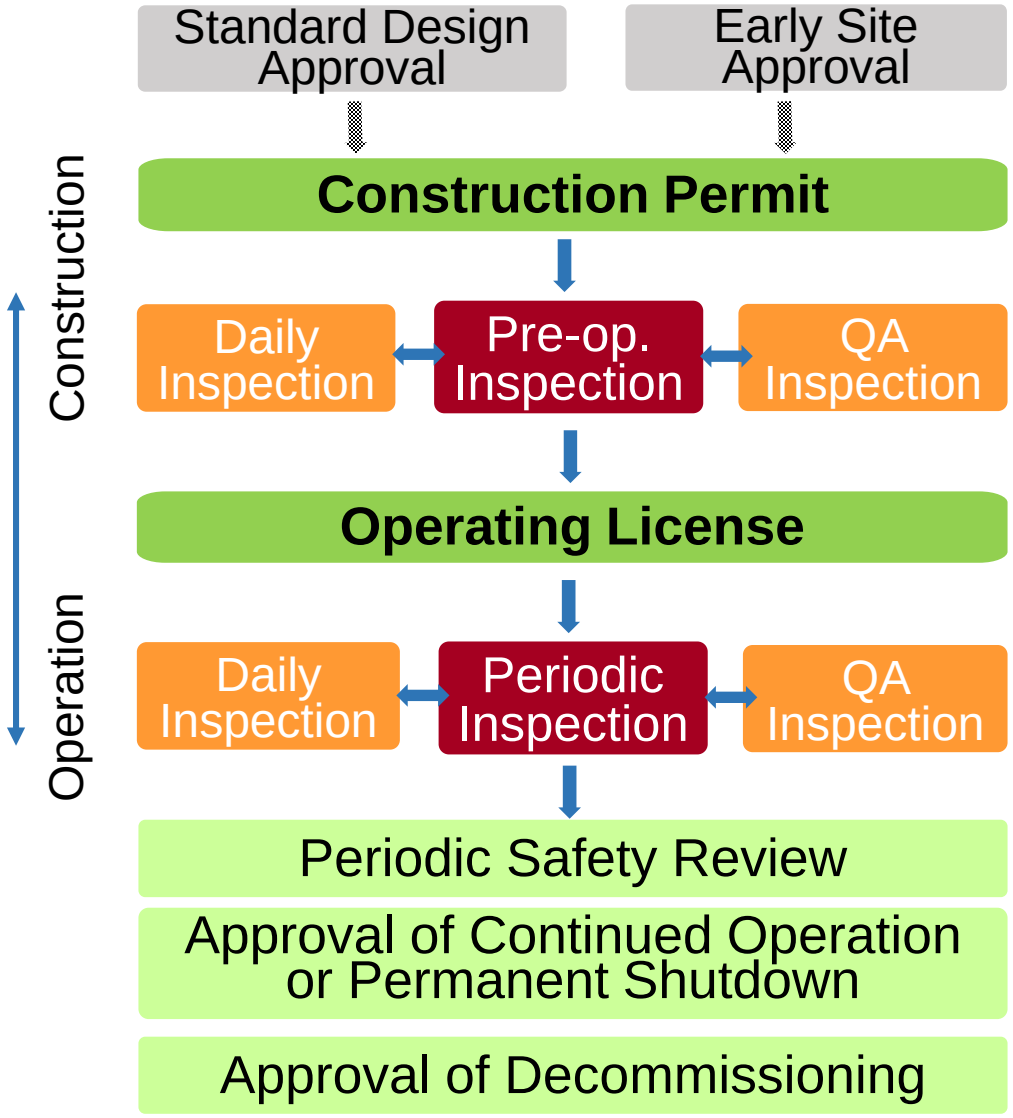
- Bases and fundamental matters regarding safety regulations
- Particulars entrusted by the Act and necessary for the enforcement of the Act
- Technical standards and particulars entrusted by the Act and the Decree
- Details on technical standards, procedures or formats as designated by the Act and relevant regulations
- Interpretation, detailed criteria, acceptable methods, conditions, and specifications of the technical standards
- Staff guidance for regulations

- Policy framework



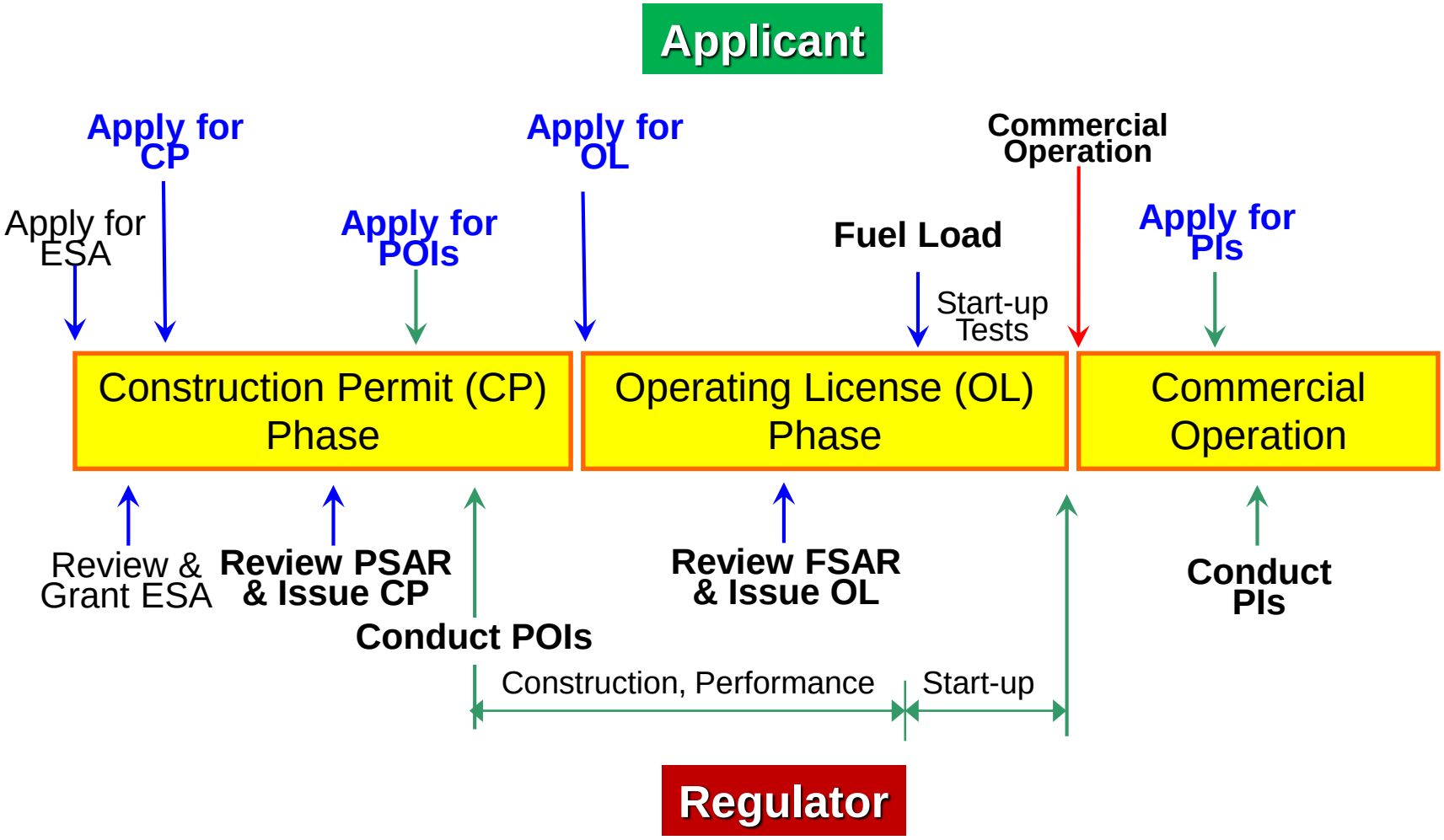
- 2nd Comprehensive Plan for Nuclear Safety
  - Policy directions
    - Impartial safety management for accident prevention
    - Transparent regulatory framework towards public confidence
    - Preparation for future regulatory capabilities
  - 7 strategic goals
    - Safety management plan and programme extended to the severe accidents of NPPs
    - Transparency with the pro-active release of information and communication
    - Safety management system for the back-end fuel cycle of nuclear industry
    - Practicality of disaster preparation, including earthquakes, and radiological emergency response
    - Reinforcement of the system for nuclear security and non-proliferation
    - Preemptive actions in responding to the environmental changes in radiation use
    - Expansion of regulatory infrastructure with R&D, human resources development, and international cooperation

2. Licensing process



- SAR for standard design and preparation plan of EOP
- Site survey report with geologic survey results
- PSAR, QAP for construction, ER
- Confirm the construction, considering project milestone
- FSAR, QAP for operation, Radiological emergency plan
- Confirm the plant as licensed and/or commissioned
- Re-evaluate each NPP safety in a 10 year interval
- Extend operating period after the design life

- Process for permit and license



□ Safety review

- Construction Permit (CP)
  - To ensure the adequacy of plant location and design, and construction approaches in accordance with the rules & regulations, prior to the commencement of construction
  - Major application documents
    - Preliminary Safety Analysis Report (PSAR),
    - Quality assurance program for design and construction
    - Environmental Report (ER)

✓ Early Site Approval (ESA)
- To allow the applicant to perform a limited civil engineering work of site preparation and power block excavation, before CP
- Site Survey Report
- Detailed Geological Survey Report

- Operating License (OL)
  - To confirm the final adequacy of plant design and operational approaches
  - Perform safety review in the same manner as that for CP
    - With some additional reviews of the operating capability and accident response ability of the applicant
  - Major application documents
    - Final Safety Analysis Report (FSAR)
    - QAP for operation
    - Technical Specifications for Operation
    - Radiological Emergency Plan

✓ Nuclear fuel loading and commissioning tests upon the issuance of OL

- Standard Design Approval (SDA) for NPP
  - Prior authorization of a standard NPP design for the repeated construction; *effective for 10 years*
    - Safety analysis report on the standard design
    - Preparation plan of emergency operating procedures
  - Issued for the designs of APR-1400 and APR^{+}, and SMART NPP in 2001, 2014 and 2012, respectively

- Amendment of Permit or License, or SDA
  - Modification of the contents of approved documents after permit, license or approval
  - Supplementary documents to verify the adequacy

- Periodic Safety Review (PSR)
  - Comprehensive re-evaluation for the safety of each operating NPP or research reactor in a 10 year interval after the OL
  - Physical conditions, safety analysis, equipment verification, aged deterioration, safety performance, experience feedback, operating procedures

- Continued operation
  - Extension of operating period after the design life of NPP
  - Applied, as necessary, 2 to 5 years before the end of the life for additional 10 years of operation
  - Periodic safety evaluation report, aging evaluation report of major equipment, radiological environmental report

□ Safety inspection

<table>
<tr><th>Category</th><th colspan="2">Construction</th><th>Operation</th><th>Type</th></tr>
<tr><td rowspan="3">Planned</td><td colspan="3">Quality Assurance (QA) Inspection</td><td rowspan="3">Regular and announced</td></tr>
<tr><td colspan="2">Pre-operational Inspection</td><td>Periodic Inspection</td></tr>
<tr><td colspan="3">Resident Inspection</td></tr>
<tr><td rowspan="2">Reactive</td><td colspan="3">Special Inspection</td><td rowspan="2">Irregular and unannounced</td></tr>
</table>

- QA inspection
  - Confirm the quality achievement of organization involved in the design, manufacturing, construction, and operation of facilities
  - 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

- Pre-operational inspection
  - 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's milestones

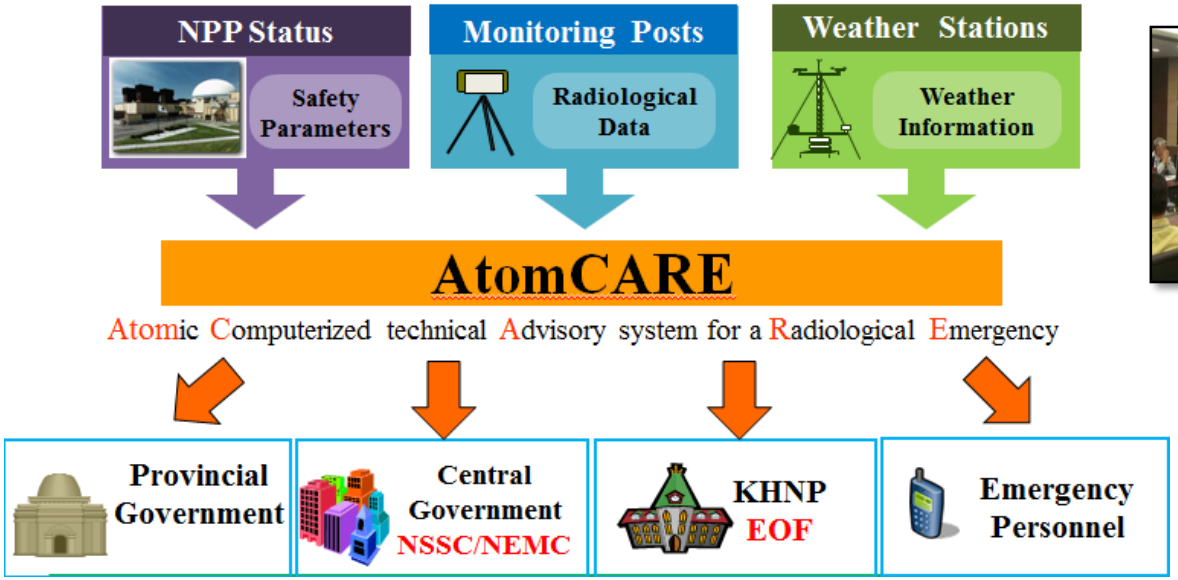
- Periodic inspection
  - Ensure the performance of reactor facility for re-criticality after plant overhaul
  - Performed during the NPP outage period
  - For research reactor, conducted every 24 months in accordance with the standard inspection items and re-started with the approval of regulatory body

- Resident inspection
  - Monitor daily construction and operation status, and identify and respond to any activities adverse to safety
  - Operate, both NSSC and KINS, resident inspection office at each NPP site

- Special inspection
  - Initiated in response to any unexpected, unplanned or unusual situations or events, as necessary

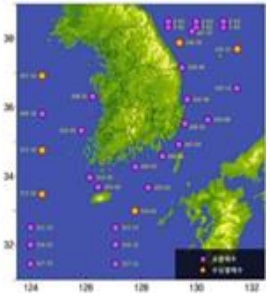
3. Safety management

- Radiological emergency preparedness and drill



- Unified Radiological Emergency Drill
  - Annually organized by NSSC
- Joint Emergency Preparedness Drill in TRM framework
  - TRM: Top Regulators Meeting of Korea-China-Japan

- Radiation monitoring
  - Air 128, sea 21 and airport & harbor 73 posts



- RADiation Source LOcation Tracking

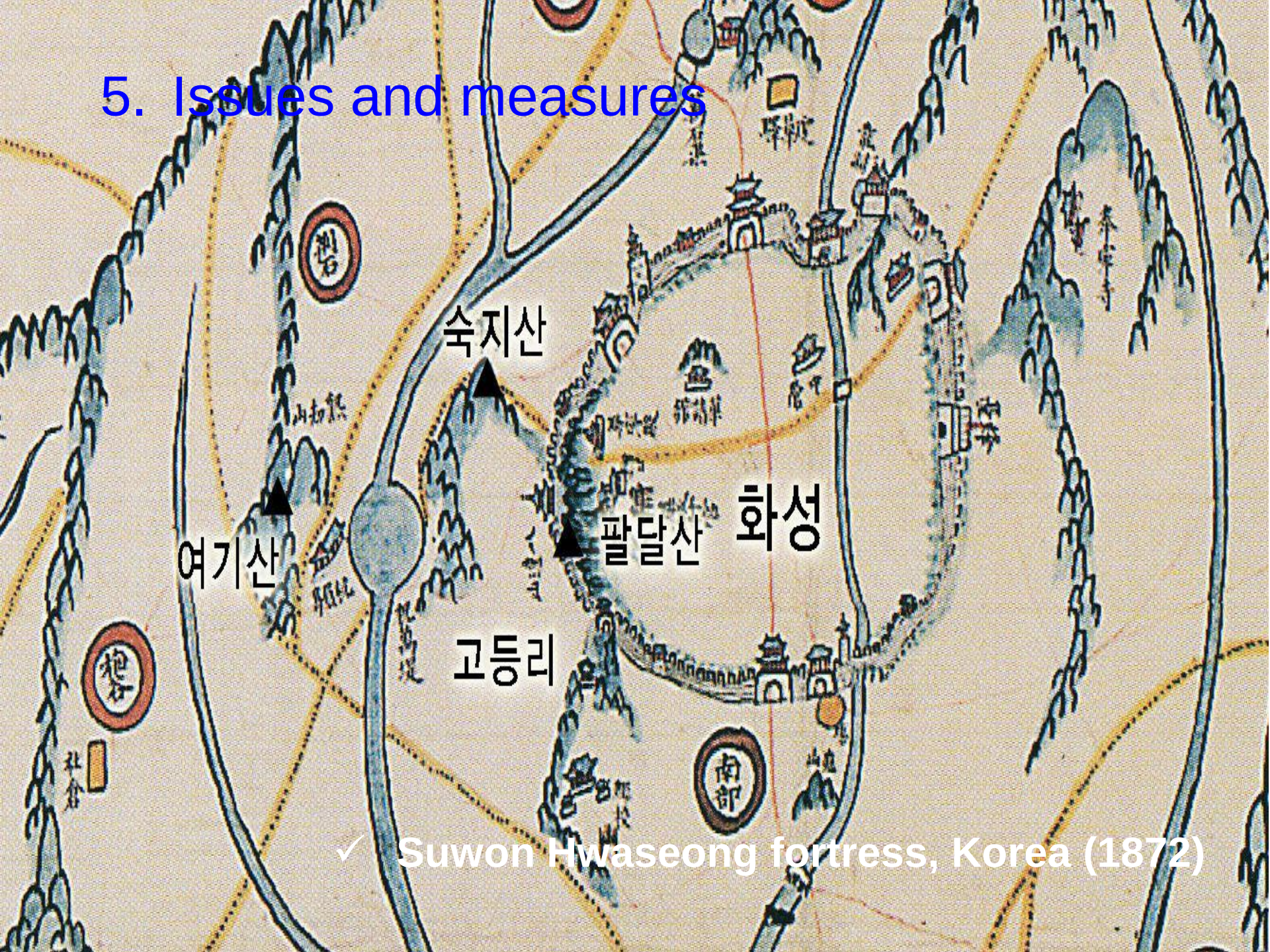
4. Regulatory research

Category	Research Issues
NPP accidents by extreme hazard	Extreme natural hazards, fire protection, severe accidents mitigation features, accident management strategies
Long-term operating NPPs	Aging of inaccessible component & reactor vessel internals, evaluation of dynamic effects and failure probability of NPP components
Radiation and radioactive waste	Verification of radiation protection and environment, therapeutic and industrial use of radiation, potential risk ass. for existing exposure
Licensing of future reactors	Sodium fast reactor, very high temperature gas cooled reactor, engineering scale pyro-process facility
Safety systems	Emergency core cooling system, thermal-hydraulic safety, fluidic device

Objective

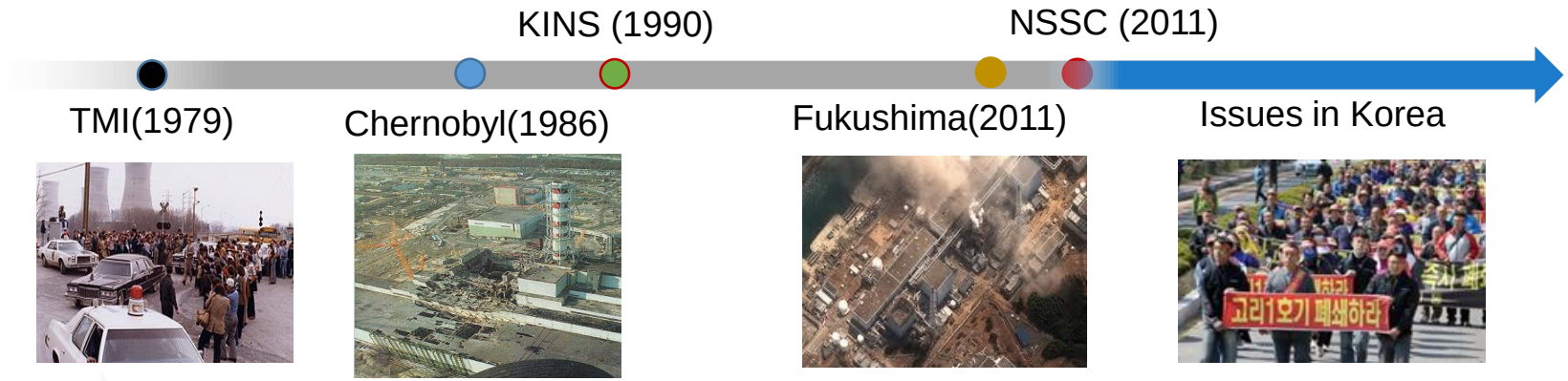
- Establish safety standards for outstanding safety issues
- Improve regulatory framework and licensing technology
- Develop evaluation methodology of state-of-the-art technology

5. Issues and measures



✓ Suwon Hwaseong fortress, Korea (1872)

- Defense in Depth (DiD)



The DiD concept remains valid, but implementation needs to be strengthened

Technical	Human & Organizational	Institutional
Lessons learned from Fukushima	**Fukushima lessons + Issues in Korea**	**Fukushima lessons + Issues in Korea**
Reevaluate external event	Safety culture, Quality assurance	Independence, Peer reviews, 3C

- Technical aspect
  - ✓ Post-Fukushima action items
  - – Special inspections
    - Identified 50 action items by the Special Safety Assessment Team in 2011 and completed in 2015
  - – Stress tests for operating NPPs
    - The 2 oldest NPPs of Kori 1 and Wolsong 1 since 2013
    - Covered earthquake, tsunami, loss of safety functions (SBO, LUHS), severe accidents, emergency response, human factors
    - Evaluated the coping capability of NPPs; human errors in decision-making under extreme situation; operating capability of organization, manpower and available means
    - Improved the preparations for multi-unit accident; communication system; radiation protection of workers and facilities; performance of mobile emergency equipment; earthquake-induced fire protection measures
  - ✓ All other NPPs from 2016 in order of the plant age

- Human and organizational aspect

  ✓ Safety culture and quality assurance

  – Cultural issues in nuclear industry (2012 ~ 2013)
    - Cover-up of station blackout during the overhaul outage period at Kori 1
    - Falsified quality documents

  – Expansion of regulatory oversight scope to cover human and organizational issues
    - Vendor inspection
    - Reporting of non-compliance
    - Notification of contract
    - Equipment & material tracking system for all safety-related items
    - Regulatory oversight of licensee's safety culture

- Institutional aspect
  - Enhancement of regulatory independence
    - Nuclear Safety Act and Nuclear Safety and Security Commission (NSSC) in 2011
  - Additional safety related laws
    - Act on Safety Control of Radiation around Living Environment in 2012
    - Amendment of Nuclear Safety Act for Accident Management Program in 2015
  - Better 3Cs of Communication, Cooperation and Collaboration
    - Nuclear safety policy coordination committee between ministries
    - Regional office at each NPP site for oversight and communication
    - Regional safety council to discuss with local residents

- Openness and transparency
  - IAEA IRRS and follow-up missions in 2011 & 2014, respectively
  - Public participation in stress test and special inspections
  - Nuclear safety ombudsman for anonymous reporting
  - Disclosure of nuclear safety information to public in accordance with the Public Information Act from 2016

□ Severe accident rulemaking

- Severe Accident Policy in 2001
  - Safety goal, probabilistic safety assessment, severe accident management program, measures for severe accident and mitigation
  - ✓ Implementation with the administrative orders
- Amendment of Nuclear Safety Act to cope with severe accidents in 2015
  - Accident management program for the OL application of new NPPs and within 3 years for the existing NPPs
  - Cover all accident levels including severe accident and the management measures

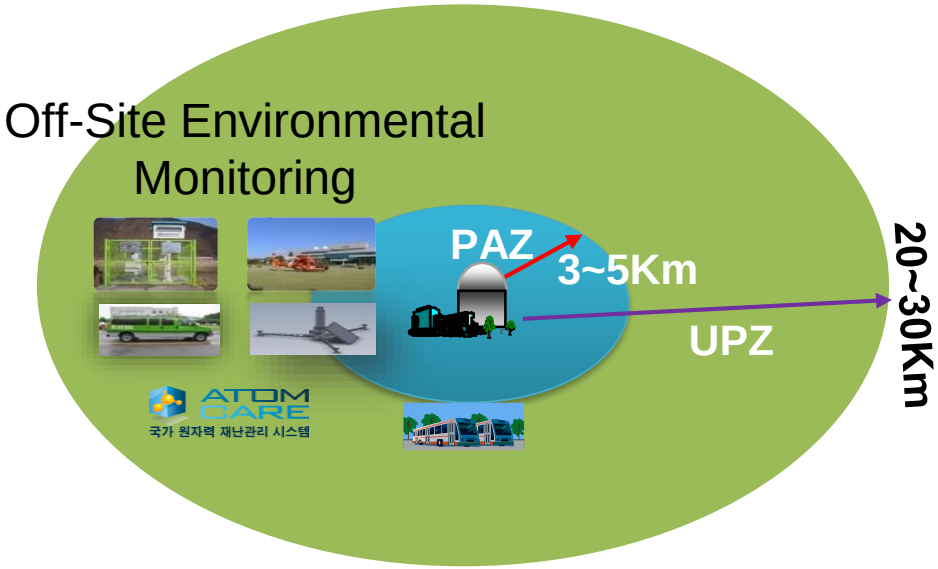
※ *Accident management: a set of actions to prevent the escalation of accidents, to mitigate the consequence of accidents and to recover a NPP from accident conditions*

✓ Issues in severe accident rulemaking

- Extreme natural and man-made hazards, safety goal and acceptance criteria, multi-units site

□ Emergency preparedness

- New and extended radiological Emergency Planning Zone (EPZ) from May 2015



– EPZ is reorganized, dividing into PAZ and UPZ, and extended by the revised "Physical Protection and Radiological Emergency Act"
  - PAZ: Precautionary Action Zone
  - UPZ: Urgent Protective action Planning Zone


OEMC


LEMC

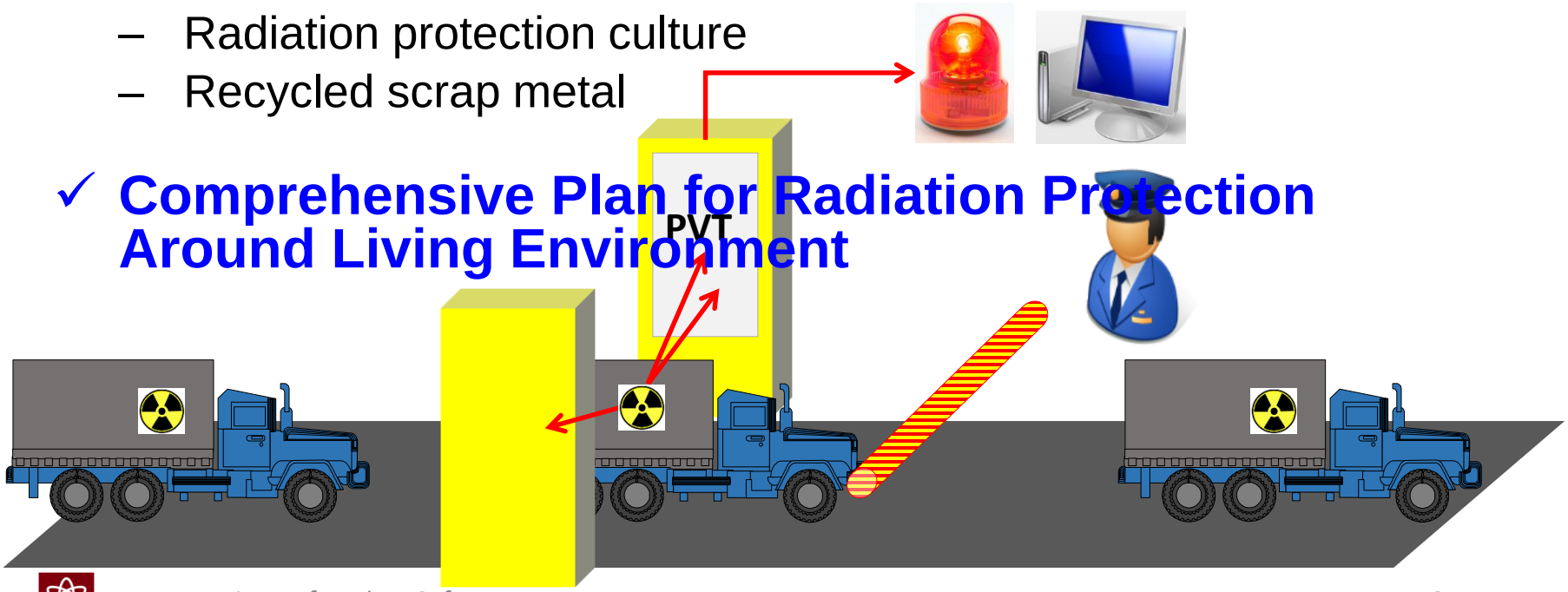

Evacuation Center

EPZ	Before	Now
Area	7 metropolitan 8 local	8 metropolitan 21 local
Population	105,874	2,091,541

□ Radiation around living environment

- Increasing public concerns on radiation risk
  - Naturally occurring radioactive materials
  - Increasing trend of Medical Exposures
  - Cosmic rays: management of cockpit resources
  - I-131 after thyroid therapy
  - Protection of NDT workers
  - Low dose effect
  - Radiation protection culture
  - Recycled scrap metal

✓ **Comprehensive Plan for Radiation Protection Around Living Environment**



□ Decommissioning of NPP

① Application of the OL change for permanent shutdown

② Public hearing regarding the draft of decommissioning plan

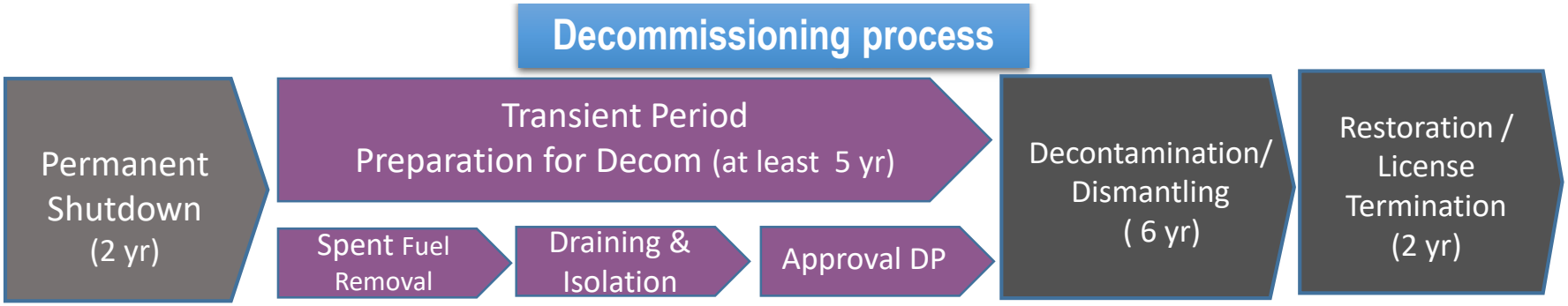
③ Application of decommissioning approval

- Decommissioning Plan, QAP, public hearing results

④ Reporting of the decommissioning and regulatory inspection

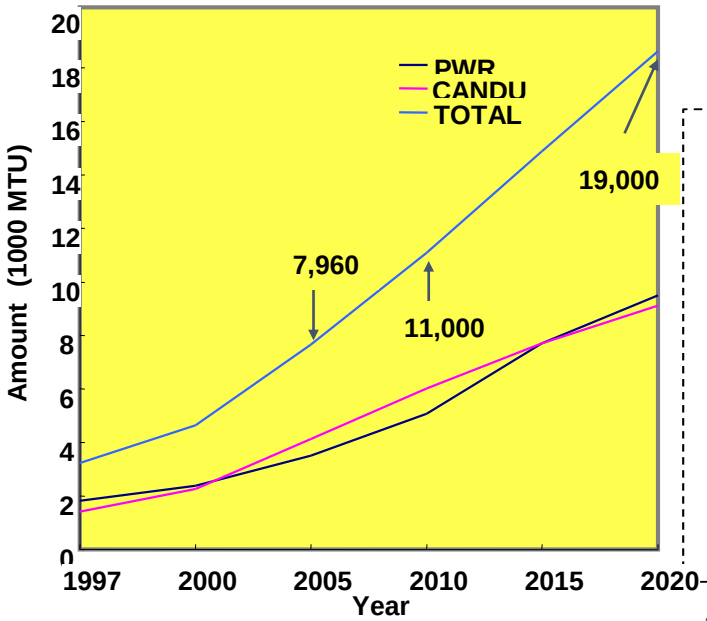
- Status of decom., radiation safety, and waste management

⑤ Termination of the OL



□ Spent nuclear fuel management

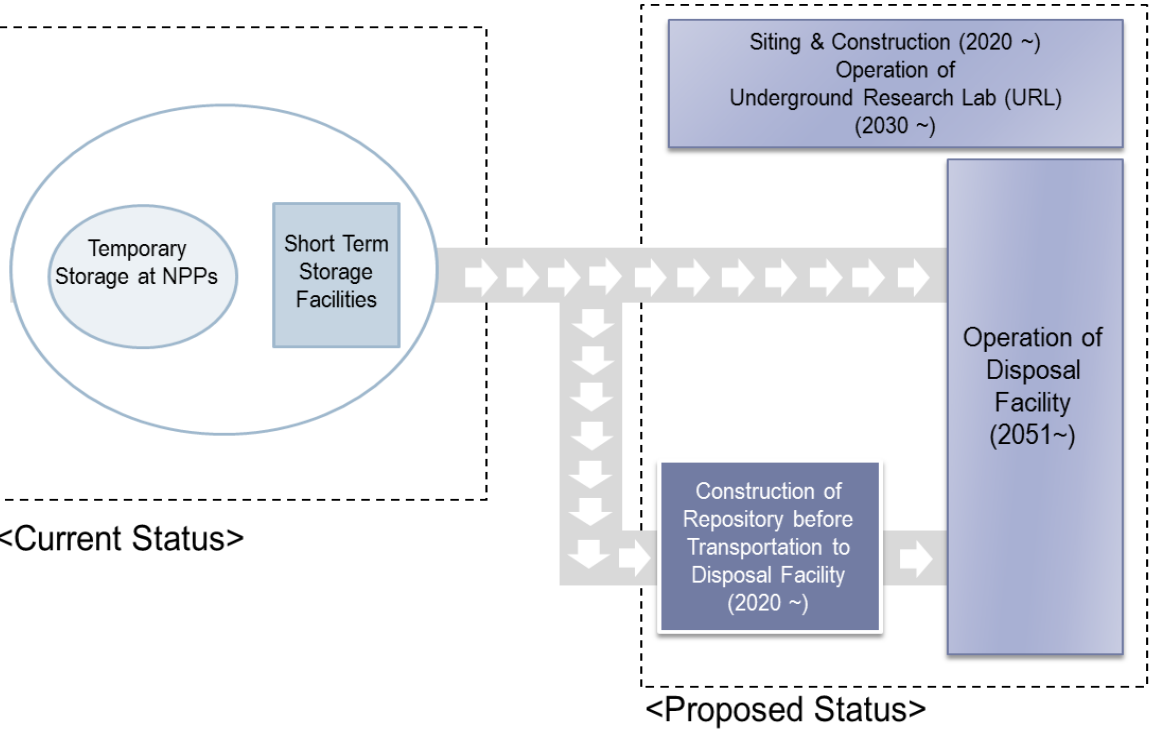
- Regulatory framework for HLW geological disposal
- Safety regulation for the interim storage of spent fuel
- Regulation of VLLW clearance



Spent Nuclear Fuel

Recommendation of PECOS*

* Public Engagement Commission on Spent Nuclear Fuel Management



<Current Status>

<Proposed Status>

□ Gyeongju earthquake

- 5.8 magnitude earthquake on 12 September 2016
  - Strongest one ever instrumentally recorded in Korean Peninsula and more than 500 aftershocks
  - Wolsong NPPs, 28 km away from the epicenter
- Safety evaluation of the NPPs
  - 0.098g of maximum peak ground acceleration at the NPP site: 0.1g of OBE (Operation Based Earthquake)
  - Manual shutdown of the 4 NPPs in accordance with the seismic response manual: resumed operations in Dec. 2016
    - No safety issues identified by the 37 inspectors for 81 days
- Post-earthquake safety measures
  - Improvement of earthquake response system
  - Re-evaluation of seismic performance for nuclear facilities
  - Extended research of the geological & seismological aspects in the area
  - Reinforcement of emergency response facilities

CONTENTS

1. KINS and its INSS for HRD

□ Vision and strategies

PUBLIC CONFIDENCE with safety its top priority

Innovation of safety regulatory infrastructure	Greater transparency in regulations
Strengthening of professional competency	Advancement of management system

□ International Nuclear Safety School (INSS)

World-best Organization for E & T on Nuclear Safety

- Foster leadership
- Build-up expertise
- Support CB of newcomers
- Communicate with the public

- Center for building the regulatory competencies of KINS
- International partner for regulatory capacity building toward global safety harmonization
- History

1990s	In-house training and the 1st international program
2002	Orientation of the 25 DPRK staff
2008	International Nuclear Safety School ✓ Government commitment to share Korea's 30 years of experience in nuclear safety (51st IAEA GC, 2007) ✓ Practical arrangement with the IAEA in 2008, which includes the IAEA training courses in Asia and Pacific region
2009	International Nuclear Safety Master's Degree Program
2014	Full-scope NPP simulator for staff training
2018	"KINS-K.A.CARE HCB Program" for the Kingdom of Saudi Arabia

□ HRD towards competency

- Public concerns about nuclear safety and regulatory effectiveness
  - Fukushima Daiichi accidents in March 2011
  - SBO concealment of Kori #1 and forged certificates in 2012
- Generation shift on a large scale
  - 170 retirees and 500 recruits from 2010 to 2020, assuming a total of 700 staff in 2020, and about 300 recruits up to now
- Vision 2020, “PUBLIC CONFIDENCE with safety its top priority”

✓ **Institutional competency for regulations**

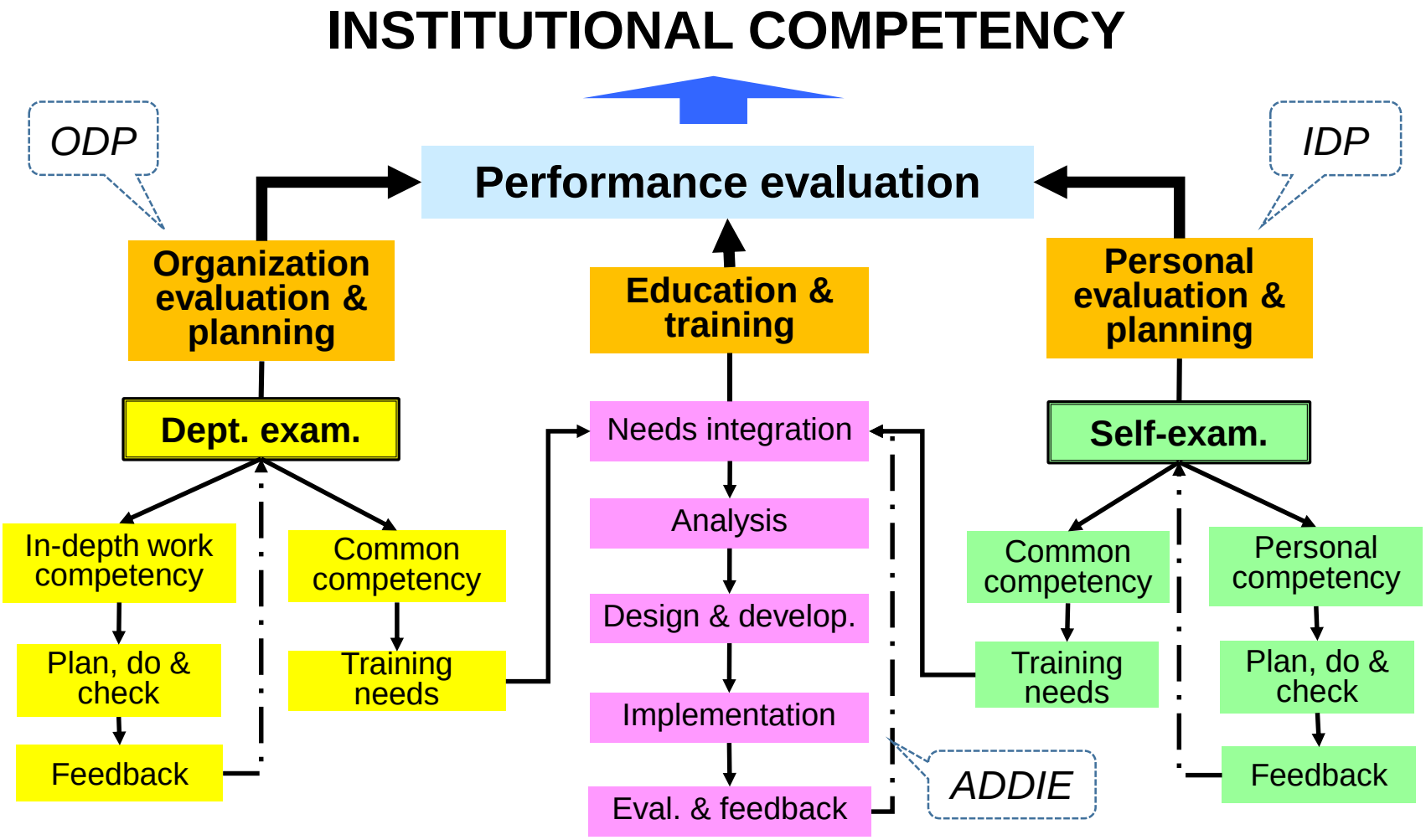
- Respond to the public concern
- Cope with generation shift and achieve KINS vision

❖ Thus, learning

- Theory of workplace learning
  - All about doing some great learning in a workplace instead of a classroom
  - Learn about work and also through work, using opportunities of work experience or work placement

Cave painting in the Old Stone Age, Altamira, Spain
Listed as World Heritage by the UNESCO
"After Altamira, all is decadence," by Picasso

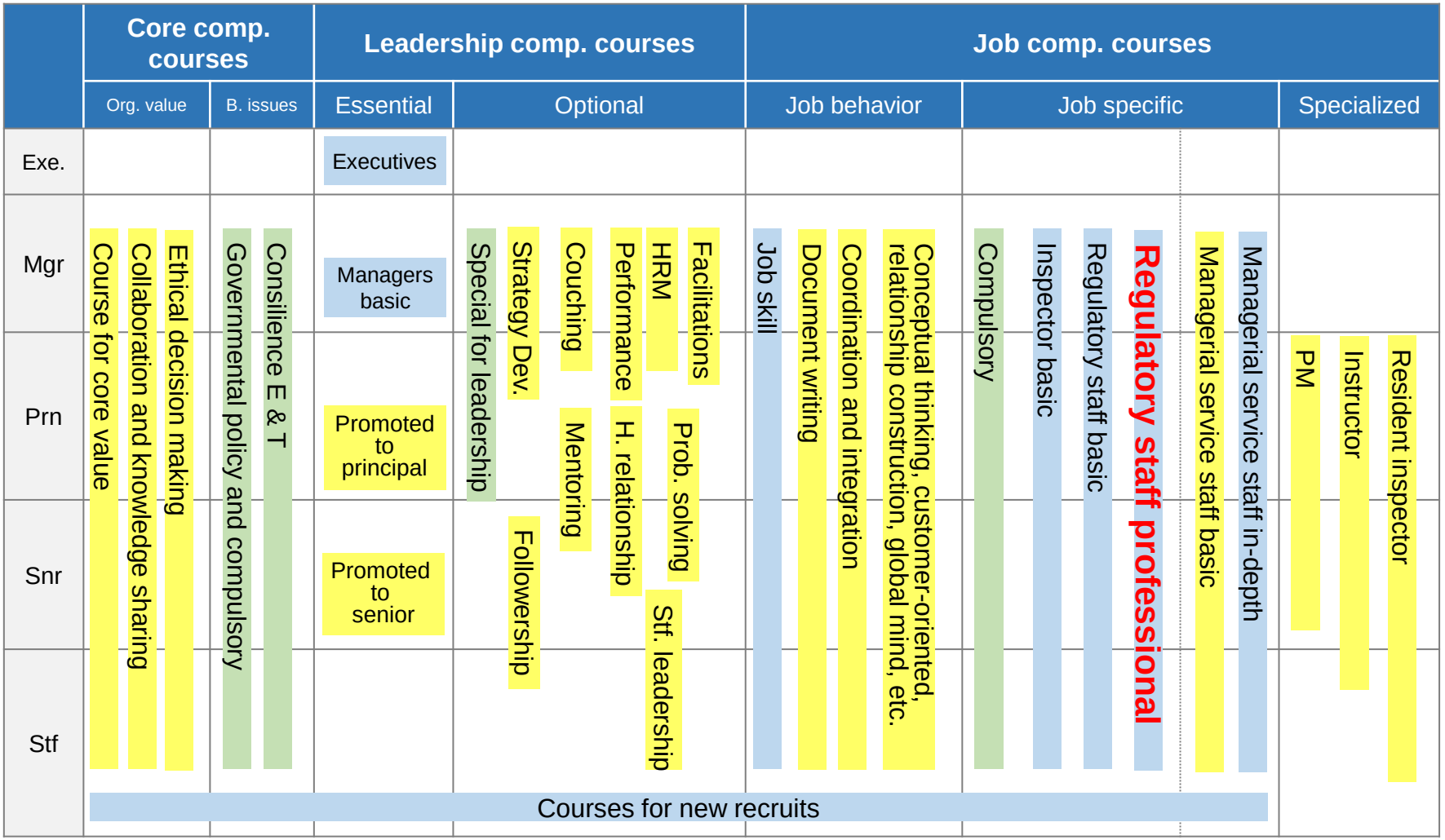
□ Process to strengthen job competency



2. E & T programs

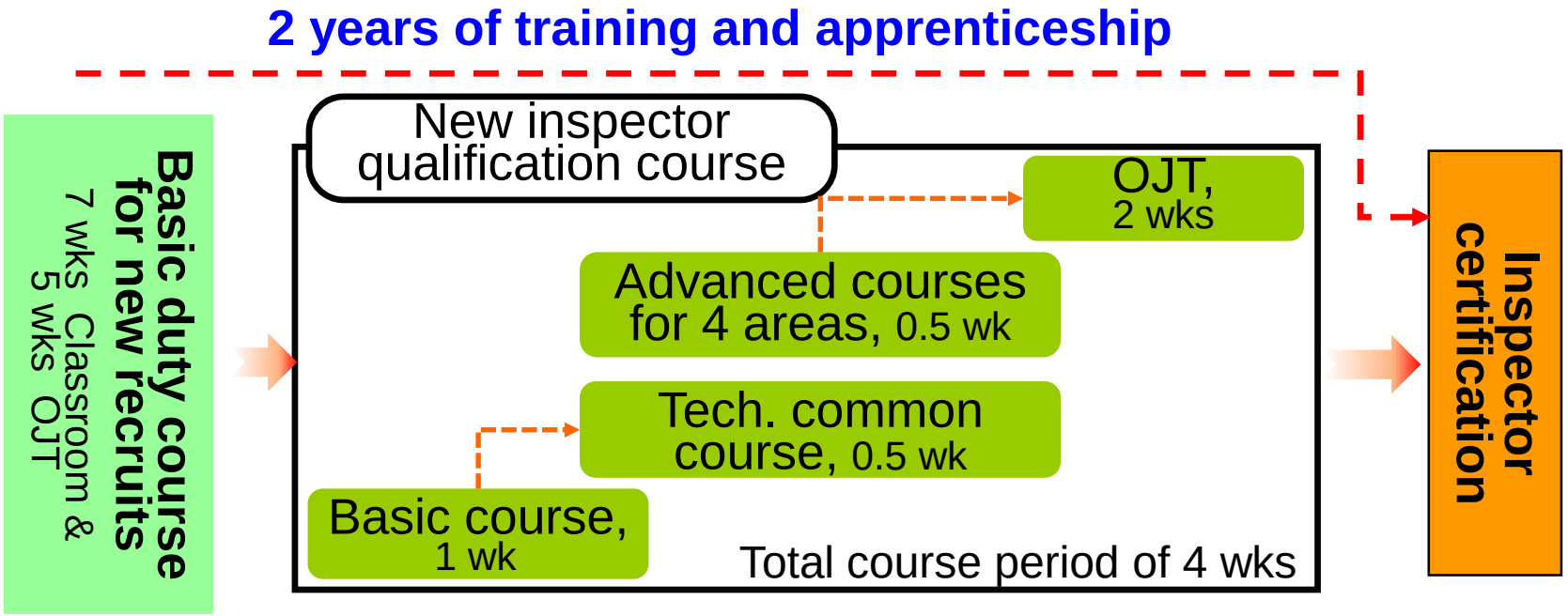
□ In-house program

- E&T diagram



- Examples of E&T courses
  - Regulatory inspectors training program
    - 5 inspection areas of Reactor safety, Radiation safety, Radiological emergency preparedness, Quality assurance
    - Certificate after a 2 year apprenticeship, with 4 week training
    - Renew every 3 years, checking the activities and E & T taken

  ✓ Qualification process



□ International program

- Courses for regional networks with the IAEA
  - Basic professional training, nuclear safety regulation, siting evaluation, regulatory control, safety review and assessment, radiological and nuclear emergencies
    - About 90 member countries of ANSN, ASEAN, ANNuR and FNRBA
- Courses of the bilateral cooperation
  - NPP licensing, inspection of radioactive sources & radiation facilities, QA or pre-operational inspection for NPP under construction
    - Saudi Arabia/K.A.CARE, UAE/FANR, Egypt/NRRA, Jordan/JNRC, Czech/KNA, Vietnam/VARANS

✓ About 200 foreign trainees, annually

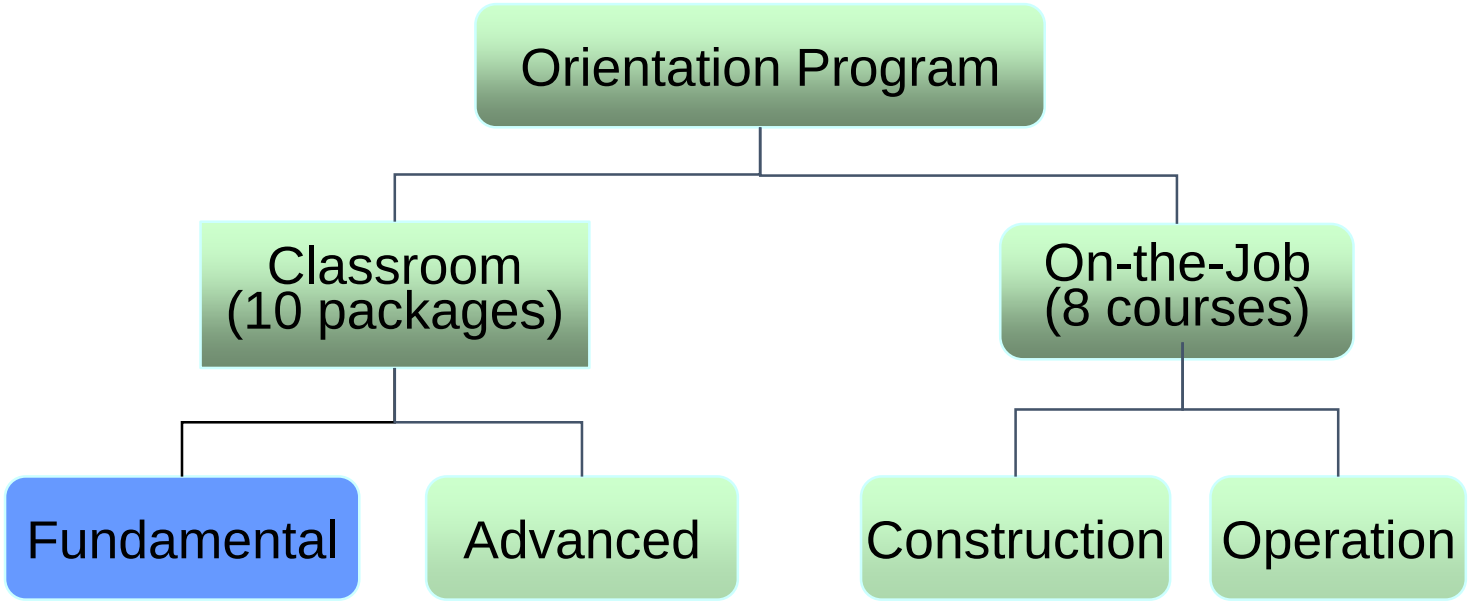
✓ International nuclear & radiation safety MS degree program

- Educate international young generation, aiming at strengthening global nuclear safety
- 3 semesters program
  - Operated jointly with Korea Advanced Institute of Science & Technology (KAIST), a research-focused university
  - Offer a full scholarship to 10 ~ 15 students per batch
- Started in 2009 and 10th batch from August 2018
  - KAIST is responsible for basic theory and fundamental research
  - KINS delivers curricular on safety regulation and conveys regulatory practices through OJT

✓ A total of 100 graduates up to now, and currently 20 students from Arab, Asia and Africa regions

✓ Orientation for the DPRK regulatory staff

- Implemented in July 2002 for the 25 DPRK regulatory staff at KINS
  - Developed, in 1999, the orientation program referencing the SAT methodology and analyzing KINS jobs and tasks
  - Orientation texts by KINS experts
- Program structure



✓ Human Capacity Building (HCB) programme for K.A.CARE

- Launched in January 2018 for the 19 KACARE staff
- Capacity building for nuclear safety regulation, sharing the practical as well as theoretical knowledges

✓KINS-K.A.CARE Framework Arrangement in Oct. 2017

- Programme overview

	Level 1	Level 2	Level 3
Course	**Basic** 3 months	**Intermediate** 5 months	**Advanced** 8 months
Object.	Fundamentals of safety regulation & technologies	In-depth technical knowledges for safety assessment	Practice of safety reviews & inspections
Scope	safety regulation, NPP design & operation, Safety assessment, Rad. safety	Siting, Mechanical engineering, I&C, Safety assessment, QA	Simulated type OJO & field exercises for reviews & inspections

□ National license and qualification management

- Management of licenses and qualifications
  - 7 Licenses for reactor operation, nuclear fuel material handling, and radioisotope handling
  - 3 Qualifications for professional engineer of radiation management and nuclear power

- Refresher training for ROs and SROs
  - Update the safety related knowledge and experience, and renew the attitude of mind for safety culture
  - 5 day training at a 3 year term

  ✓ About 3,400 RO or SRO licensees, in total and gradual increase of the new holders with the new NPPs

□ Community partner program

- Courses for safety management personnel and university students
  - Share safety knowledge and experience
  - Fire-fighter, radiological warfare soldier, civil radiation monitoring group

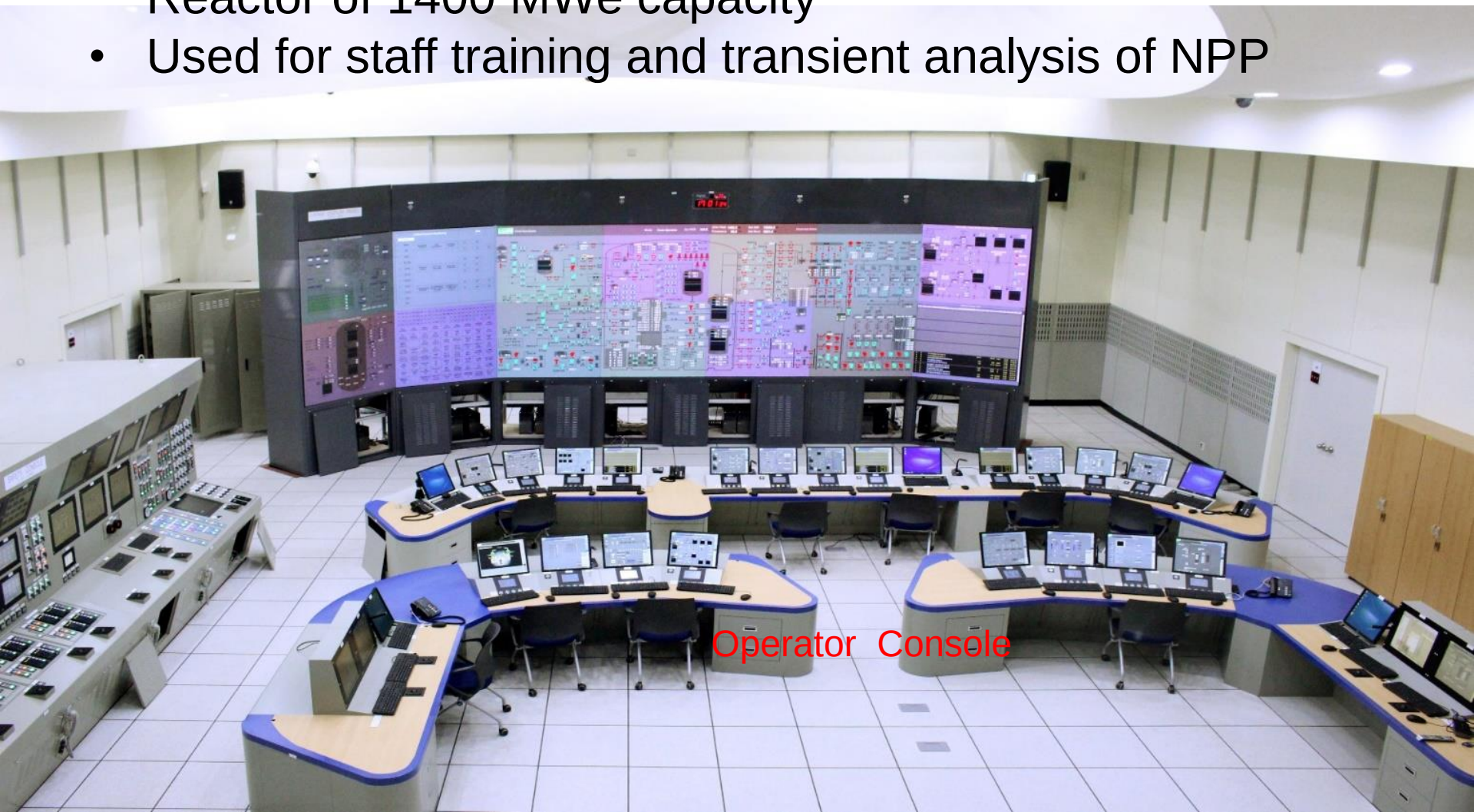
- Safety experience courses
  - Provide the public with the opportunity of understanding nuclear safety regulation
  - Children, parents, teachers, opinion leaders from various social communities

✓ 2,000 participants in 2017, 65,000 in total since 2005

3. Facilities

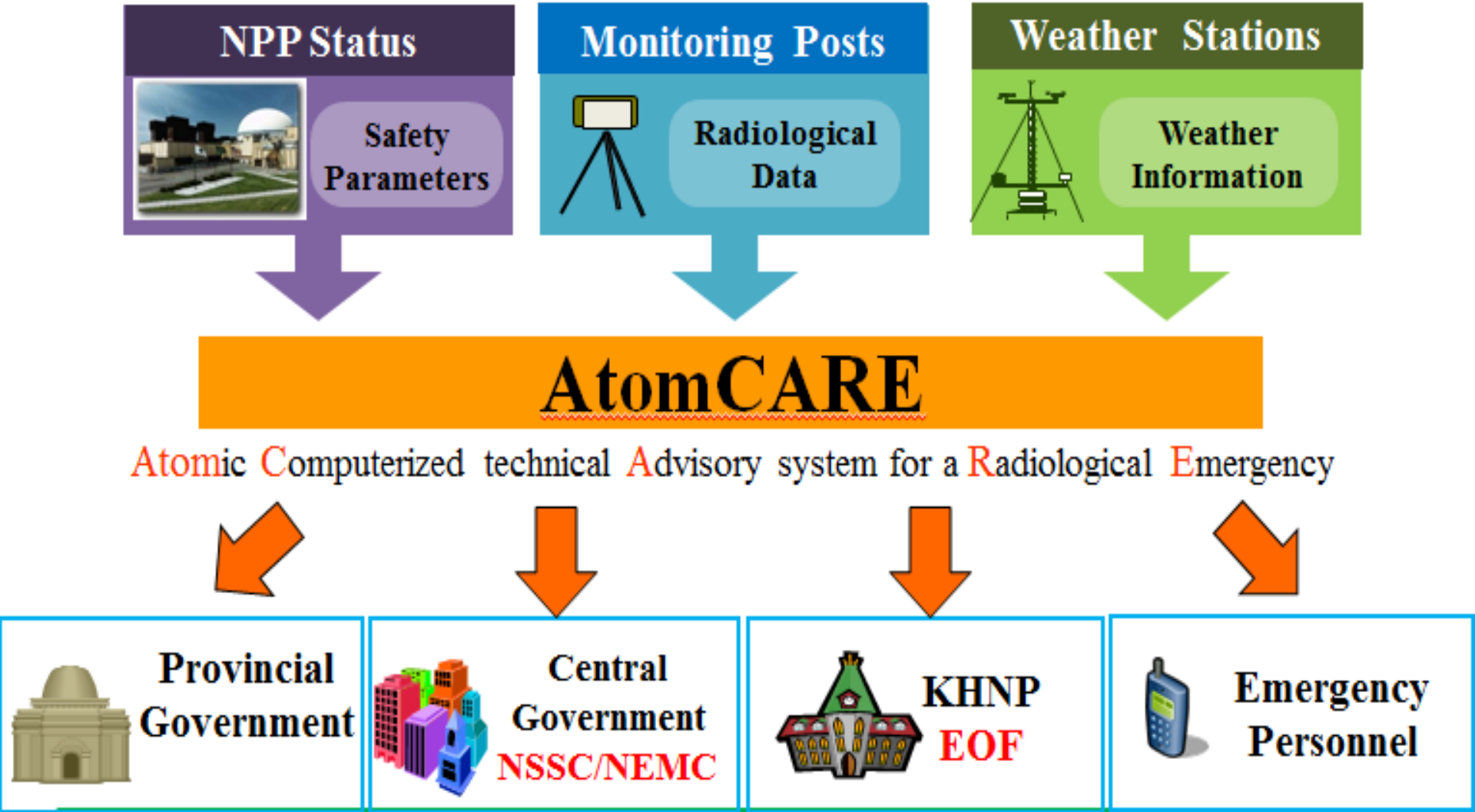
□ Full scope simulator of NPP

- Reference plant: APR-1400, Korea's Advanced Power Reactor of 1400 MWe capacity
- Used for staff training and transient analysis of NPP



□ AtomCARE for emergency preparedness

- Calculate and display the radioactive flume and dose level in a postulated accident on a 3-D map



CONTENTS

For a robust safety infrastructure

✓ Effective investment for safety

- Social & institutional infrastructure, HRD, R&D, improvement of facilities, organizational management

✓ Awareness about safety

- Adding value to and being mindful of safety

For an effective capacity building

- ✓ Work opportunity and experience, the crucial elements of workplace learning
  - Utilize nuclear related program as the chance for building capacity

- ✓ Global safety harmonization with KINS
  - Increase the INSS activities of international cooperation
  - Share practical safety knowledge and experience

감사합니다!

Thank You

한국원자력안전기술원
KOREA INSTITUTE OF NUCLEAR SAFETY