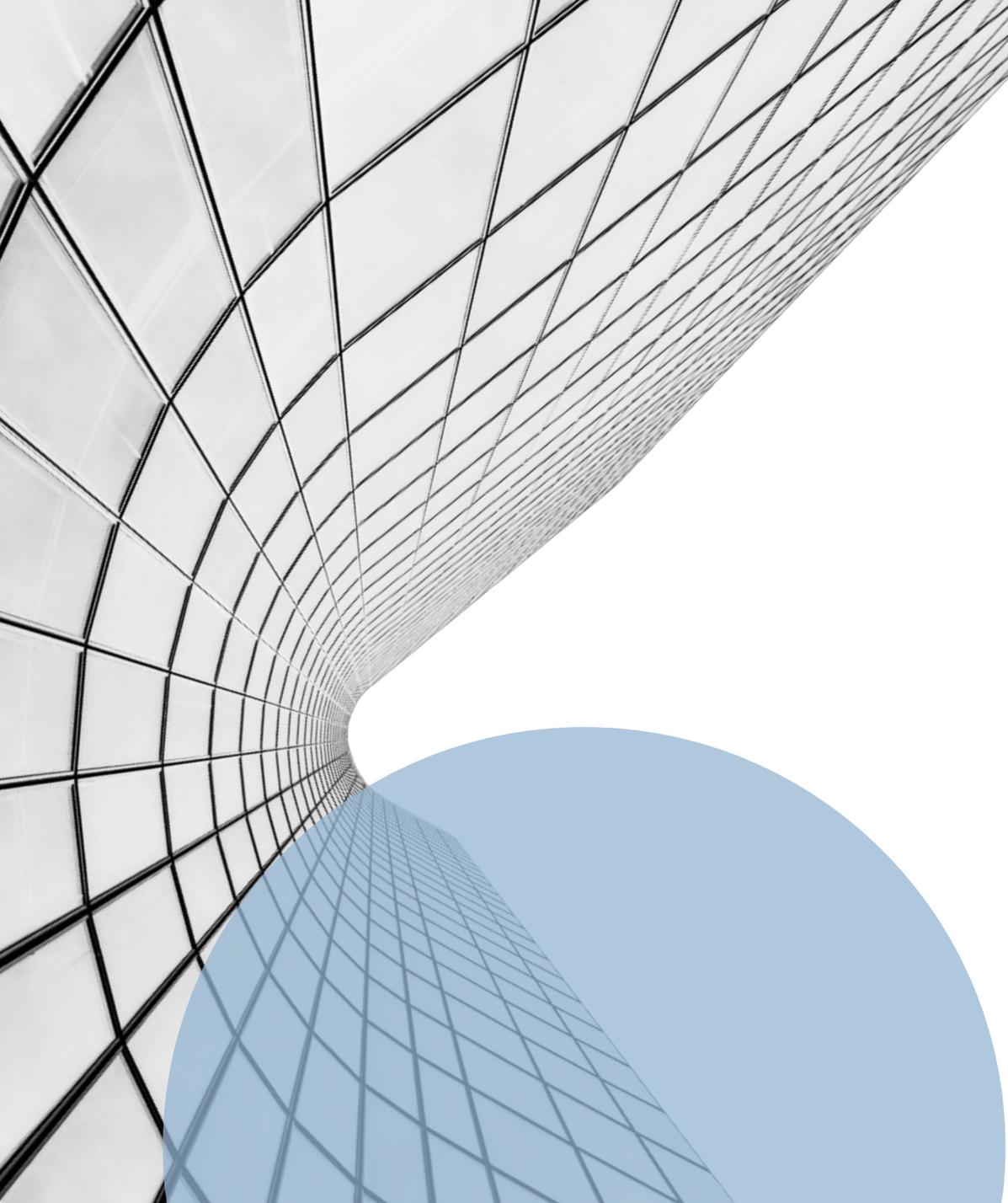


NATIONAL RESPONSE FRAMEWORK AND PROGRESS IN A&P STRATEGY IN REPUBLIC OF KOREA

ASSESSMENT AND PROGNOSIS SYMPOSIUM
INTERNATIONAL RAMP USER'S GROUP MEETING
HOTEL PRESIDENT, IVY HALL
16 APRIL 2024

KYUWON CHOI

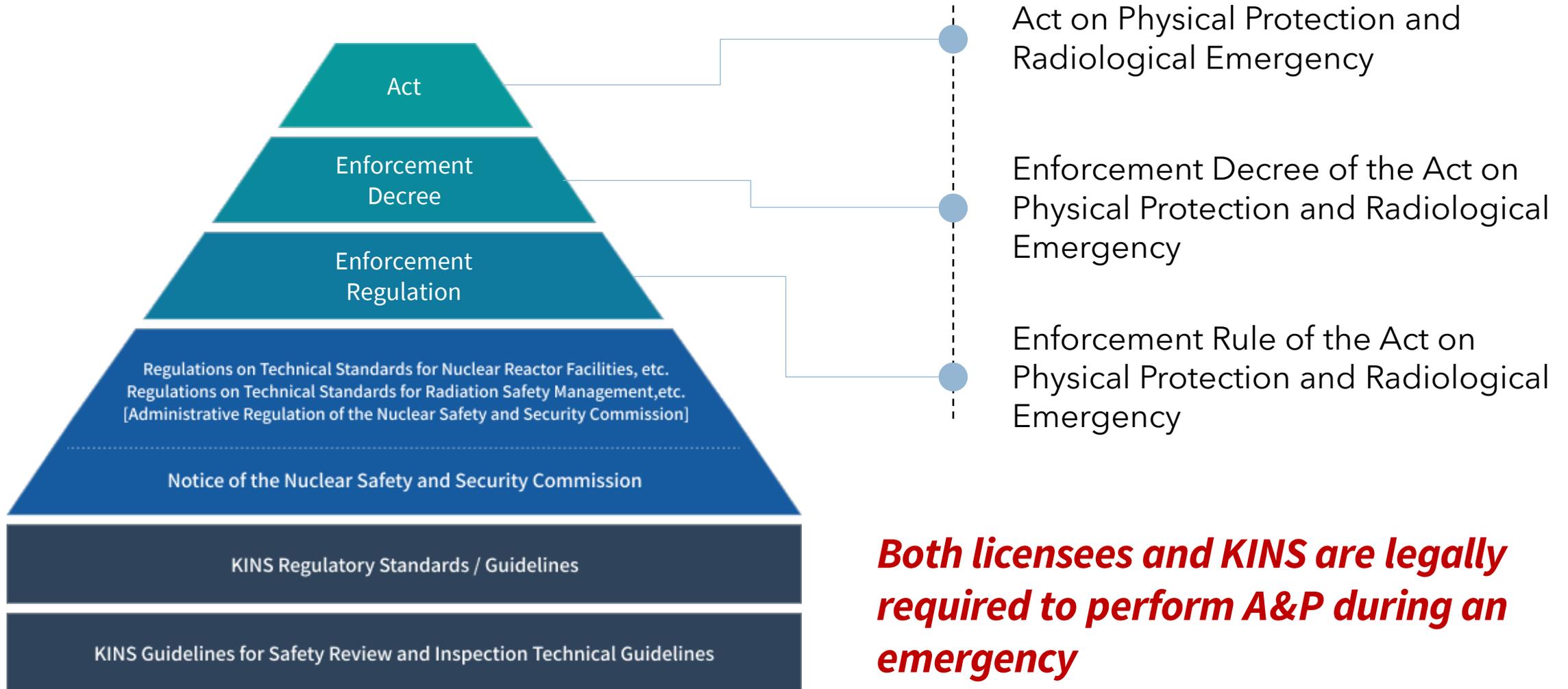
KOREA INSTITUTE OF NUCLEAR SAFETY



NATIONAL RESPONSE FRAMEWORK

DECISION-MAKING PROCESS

LEGAL FRAMEWORK FOR EP&R



Both licensees and KINS are legally required to perform A&P during an emergency

ROLES & RESPONSIBILITIES



Nuclear Safety and Security Commission

Independent administrative authority in charge of nuclear safety and radiation protection for nuclear power. It manages all affairs related to a nuclear or radiological emergency preparedness and response, security of nuclear materials and facilities from attacks and attempts to illicit use of radioactive materials.



Ministry of the Interior and Safety

Takes charge of establishing, supervising and adjusting policies related to safety and disaster management such as emergency countermeasure, civil defence and disaster prevention.



KOREA HYDRO & NUCLEAR POWER CO., LTD

A state-owned Korean electric utility company that operates all nuclear reactors in Korea. Its primary responsibilities are mitigating the consequences of an incident and minimising the radiological hazards to the public.



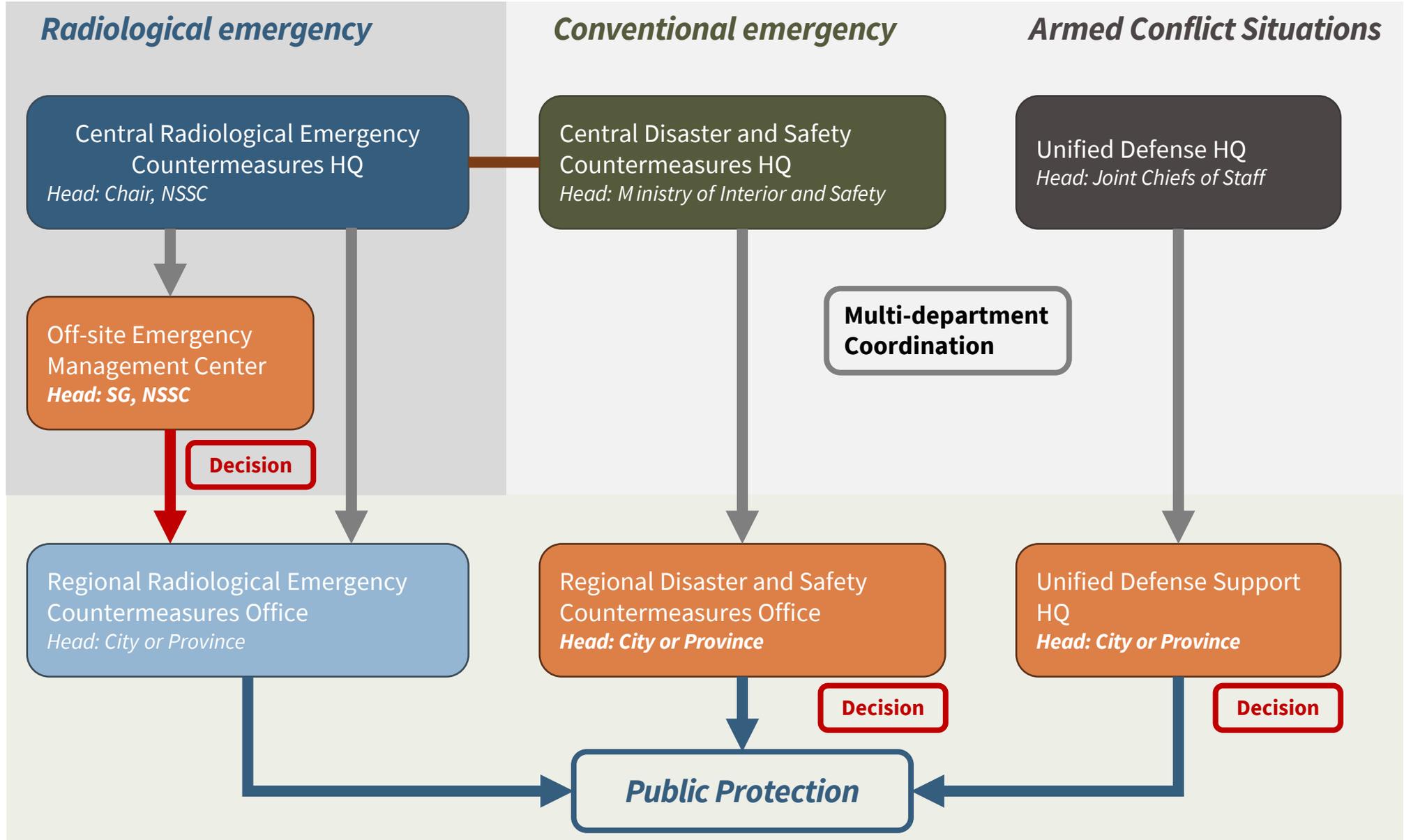
한국원자력안전기술원
KOREA INSTITUTE OF NUCLEAR SAFETY

Source of technical expertise on a nuclear or radiological emergency response. As such, it participates in managing emergencies. It assists the NSSC to protect people and the environment and return facilities to safe conditions.

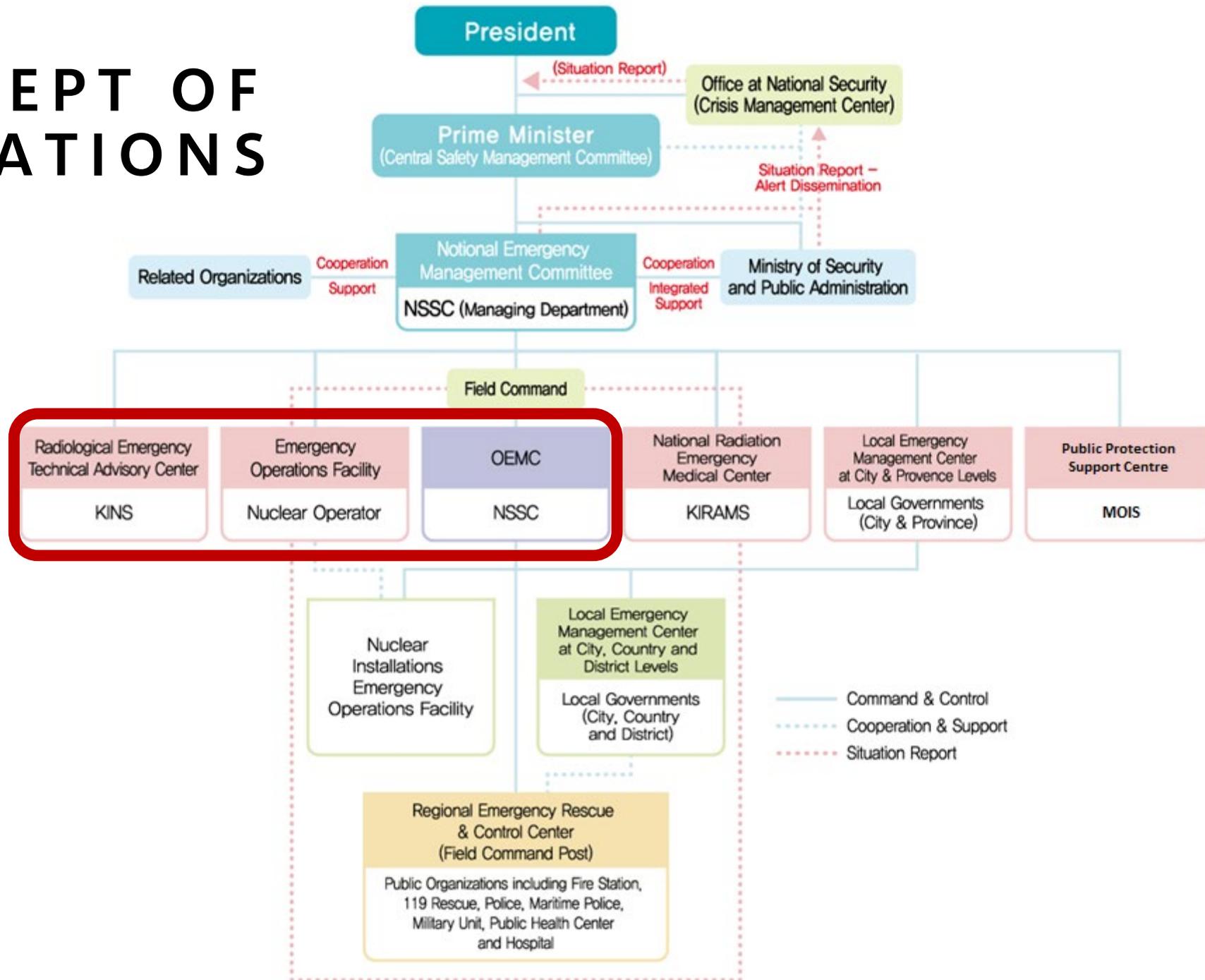
COMMAND AND CONTROL SYSTEM

Government Level

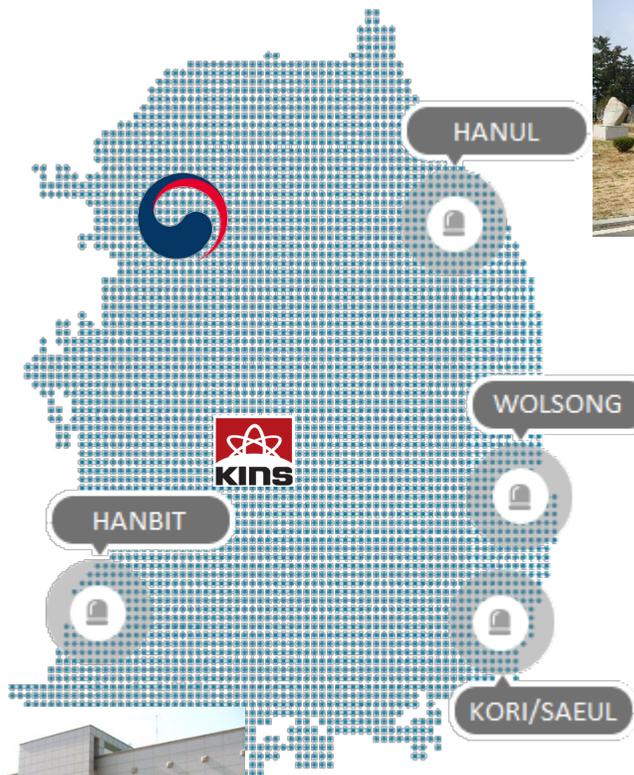
Local Level



CONCEPT OF OPERATIONS



OFF-SITE EMERGENCY MANAGEMENT CENTRE



- Located in the vicinity of NPPs (within 30 km)
- Specifically built for radiological emergency response
- Key emergency response personnel from the NSSC, the MOIS, the KINS, local authorities physically gather at the centre
- The Head of OEMC is appointed by the Secretary General of the NSSC, who will act as the decision-maker consulted by relevant authorities
- Local authorities are dedicated for implementation of protective actions

PAR/PAD PROCESS IN A NUTSHELL...



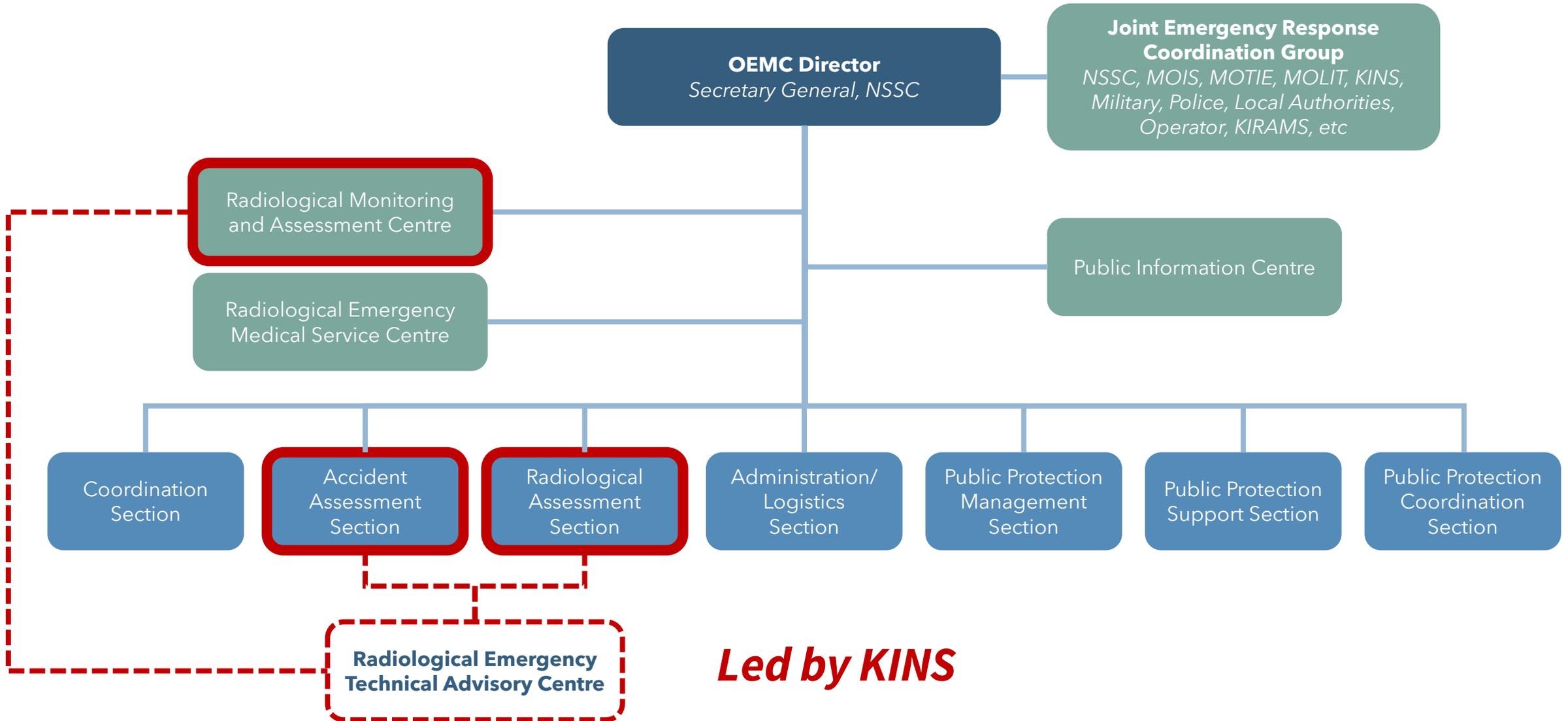
Nuclear Safety and
Security Commission



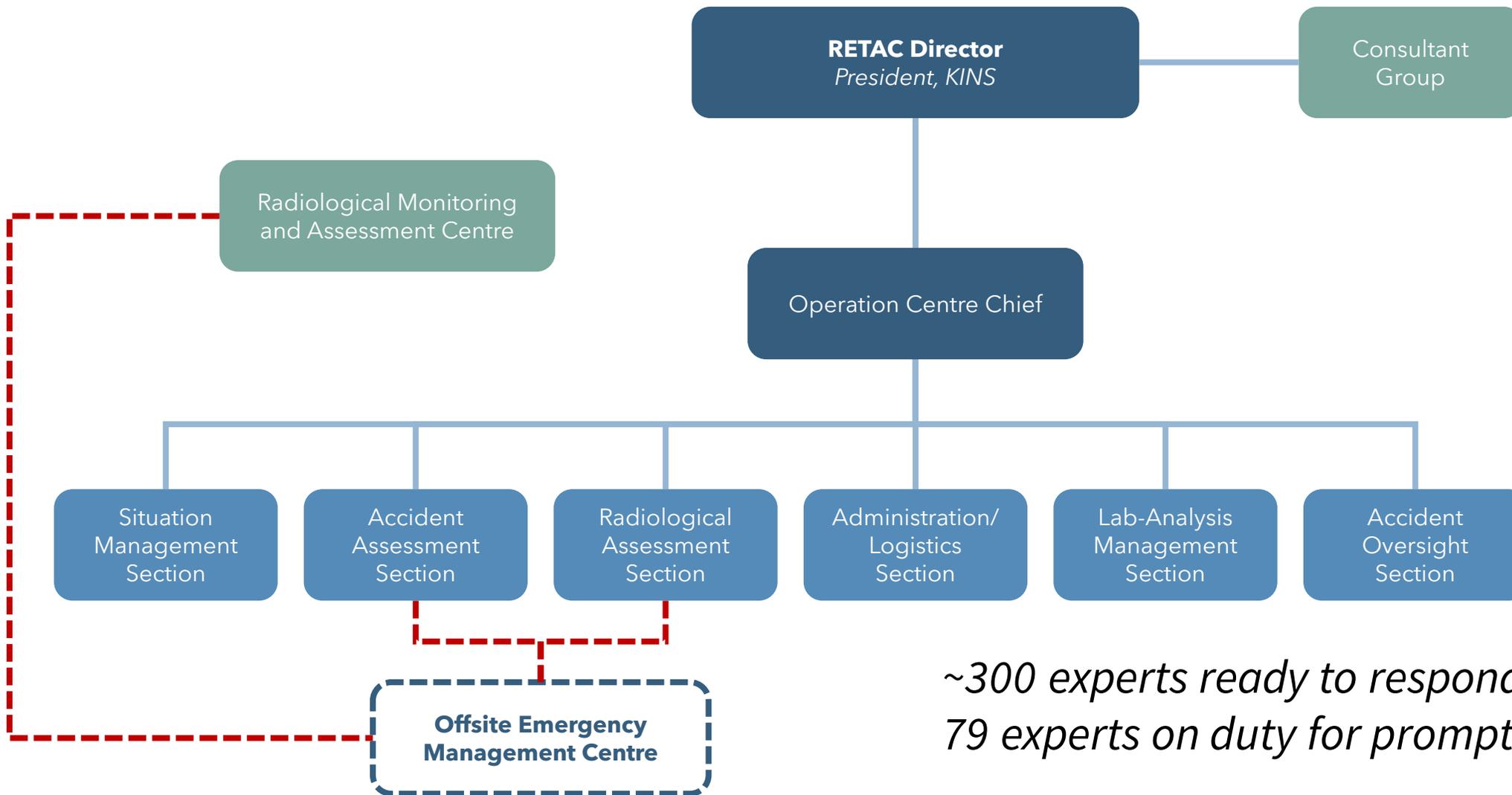
한국원자력안전기술원

KOREA INSTITUTE OF NUCLEAR SAFETY

OFF-SITE EMERGENCY MANAGEMENT CENTRE (OEMC)



RADIOLOGICAL EMERGENCY TECHNICAL ADVISORY CENTRE (RETAC)



*~300 experts ready to respond
79 experts on duty for prompt response*

ENVIRONMENTAL MONITORING RESOURCES



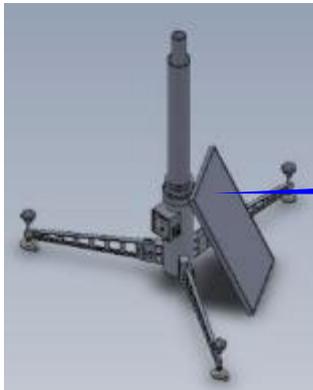
Aerial Monitoring

Marine Monitoring

Vehicle-Based Monitoring

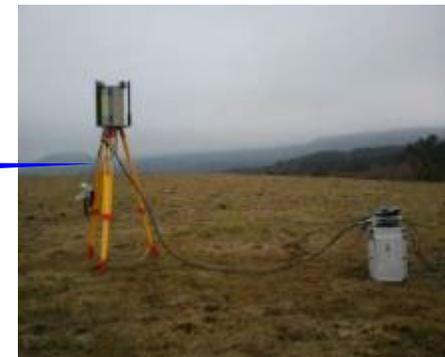


Fixed Monitoring Post (IERNET)



Mobile Monitoring Post

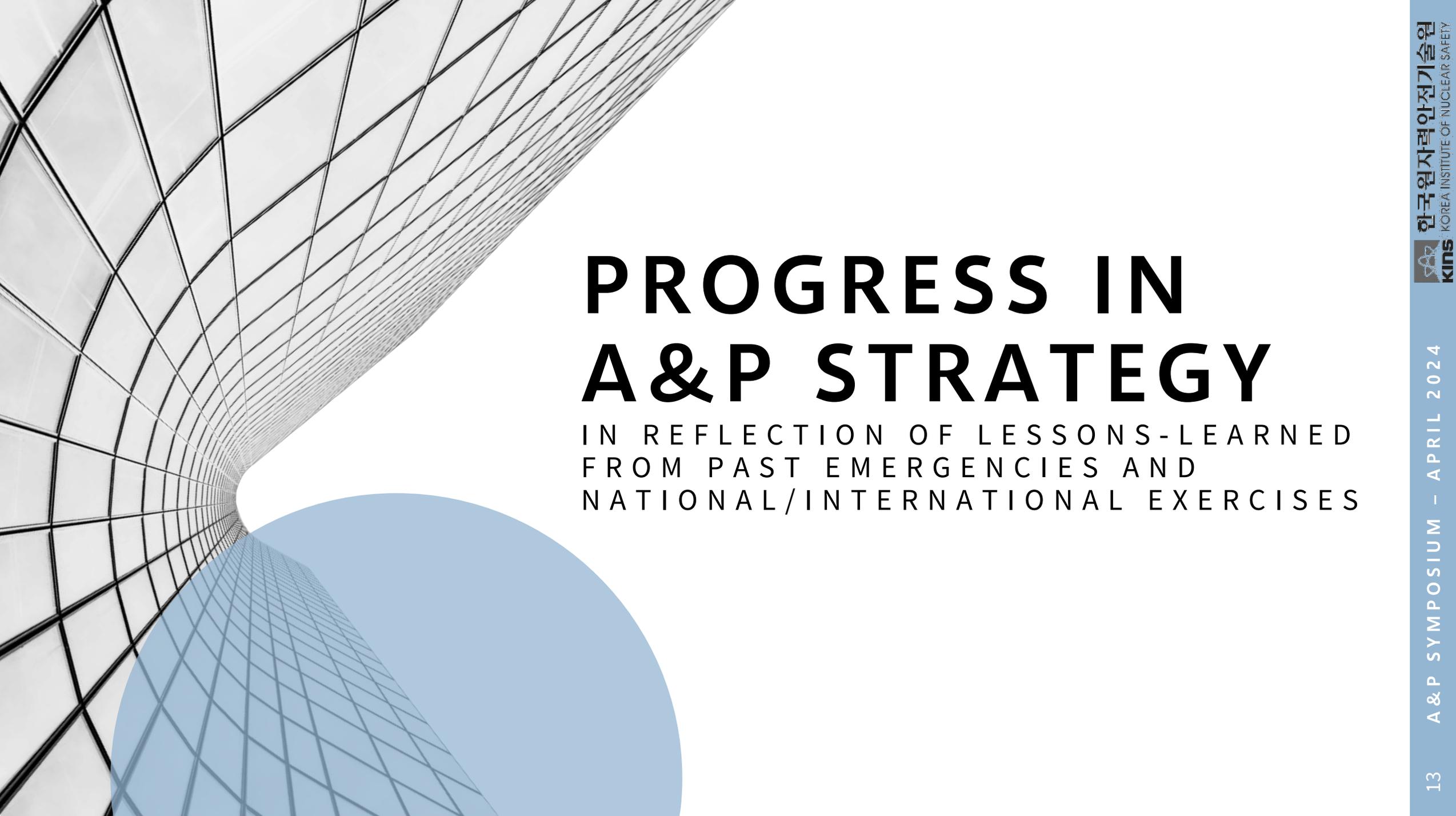
SIREN
System for Identifying Radiation in Environments Nationwide



In Situ Gamma Spectroscopy

MISSION/ROLE OF KINS DURING AN EMERGENCY

- **Performing independent A&P** of the incident and potential offsite consequences and **issuing PARs**
- **Oversighting licensee's A&P**, to include monitoring, evaluation of protective action recommendations, advice, and assistance
- **Leading technical sections at OEMC**
- **Operating RMAC** and conducts national monitoring programme
- **Being a technical focal point** for domestic/international communication



PROGRESS IN A&P STRATEGY

IN REFLECTION OF LESSONS-LEARNED
FROM PAST EMERGENCIES AND
NATIONAL/INTERNATIONAL EXERCISES

A&P IS PERFORMED AGAINST:



KEY BARRIERS

- Fuel clad
- Reactor coolant system
- Containment



SAFETY SYSTEMS

- Core cooling systems
- Containment systems
- Fission product removal/control systems



HAZARDOUS EVENTS

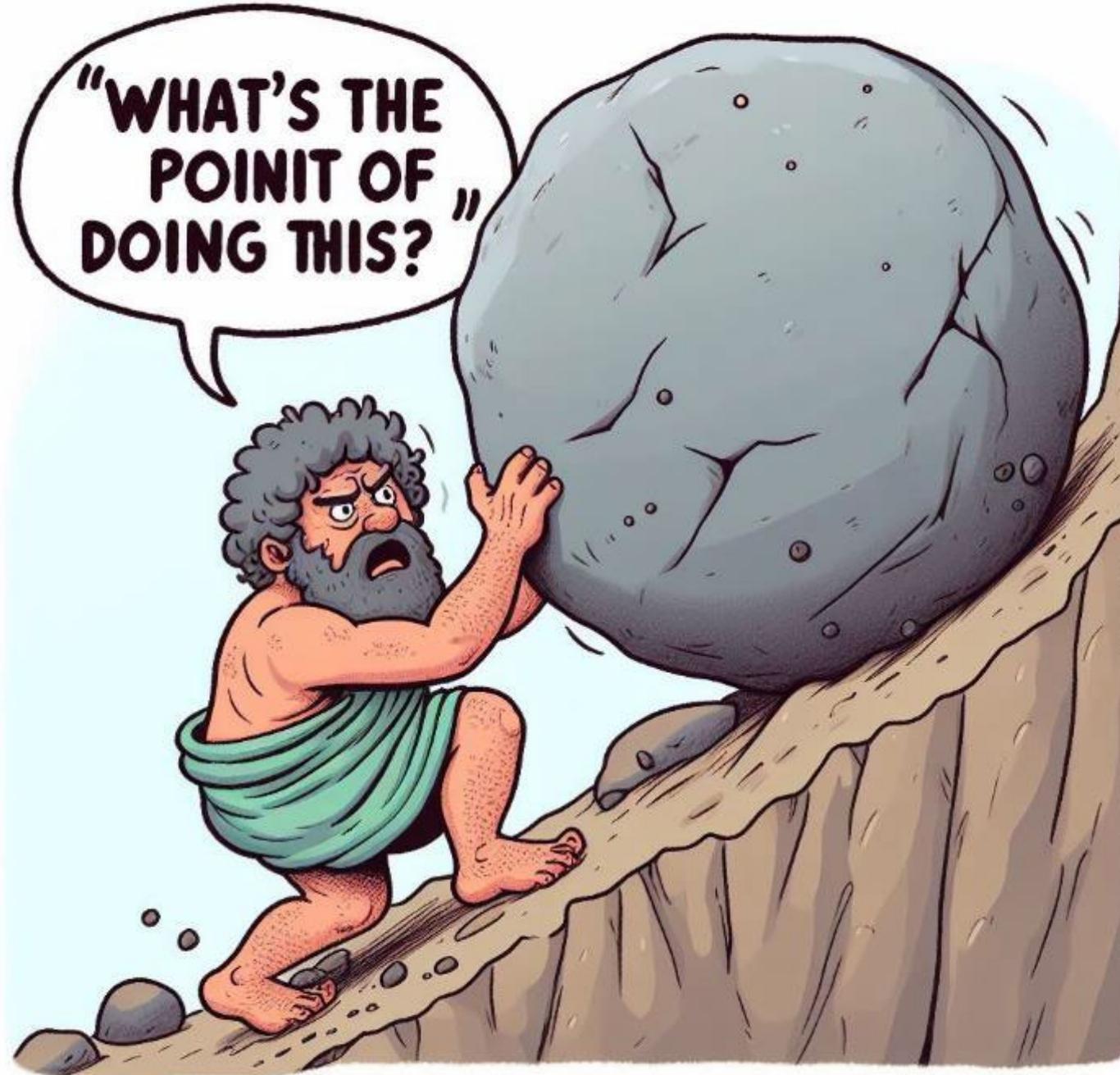
- Seismic events
- Flooding events
- High winds
- Fire/explosion
- Malicious act

A & P IS



KEY BARRIERS

- Fuel clad
- Reactor coolant
- Containment



HAZARDOUS

- Events
- Progression of events
- Human errors
- System failure
- Loss of act

OBJECTIVES OF A&P IN KOREA

- **To provide a clear transition point** from Operating Procedures to Emergency Operating Procedures (**EOPs**) or Severe Accident Management Guidelines (**SAMGs**)
- **To classify an emergency**

Licensee ONLY

- **To assist the decision-maker** in determining where to implement public protective actions

Licensee & KINS

- **To provide timely insights** about ongoing situation to relevant authorities and the public including international communities
- **To figure out further assistances needed** in federal or international level
- **To prioritise limited resources**

Licensee & KINS

A & P CHALLENGES REGARDING:

UNCERTAINTY

- **To assist the decision-maker** in determining where to implement public protective actions

TIME CONSTRAINT

- **To provide timely insights** about ongoing situation to relevant authorities and the public including international communities

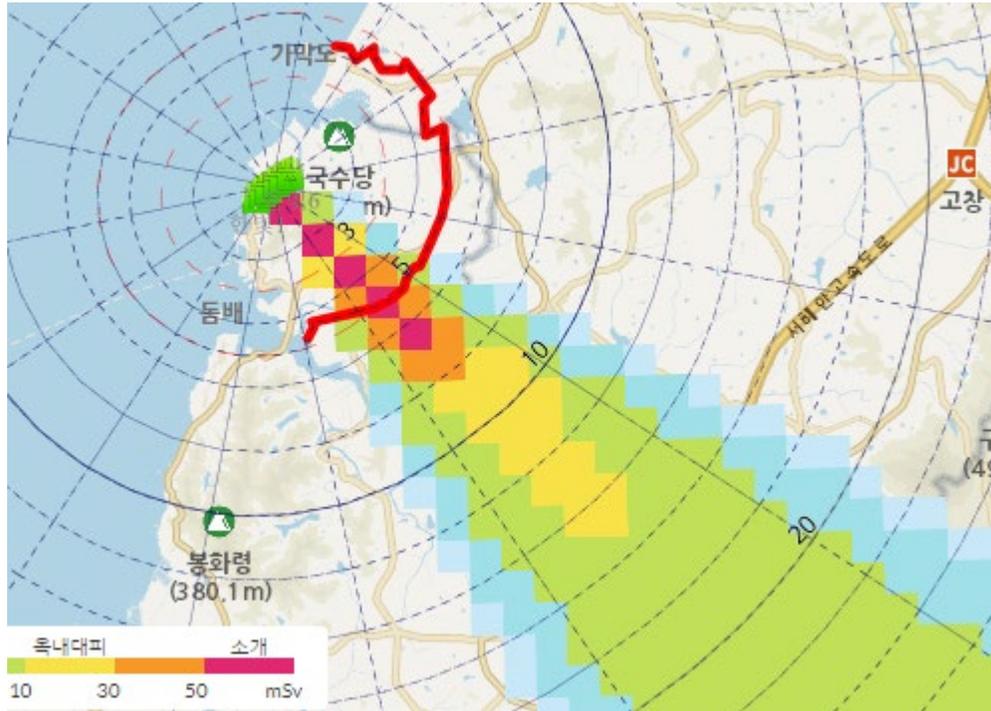
UNCERTAINTY

THAT YOU SHOULD NEVER BE OPTIMISTIC ABOUT

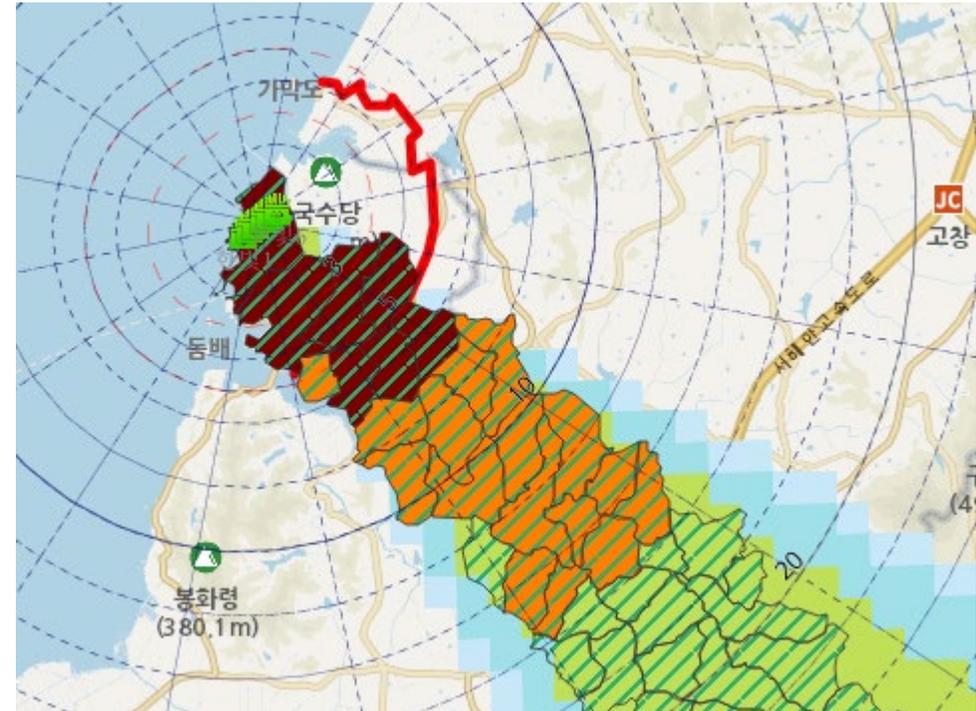


WHAT INFORMATION CAN ASSIST DECISION MAKER?

Potential offsite impact



Relevant administrative area



To provide these map products, followings need to be assessed:

- ① Accident Source Term
- ② Dispersion/Deposition
- ③ Public Dose

WHAT IS ACCIDENT SOURCE TERM?

“Magnitude of the radionuclides released from the fuel to the environment”

Accident Source term =

radionuclides released from the fuel

× leakage fraction to the environment

× release duration

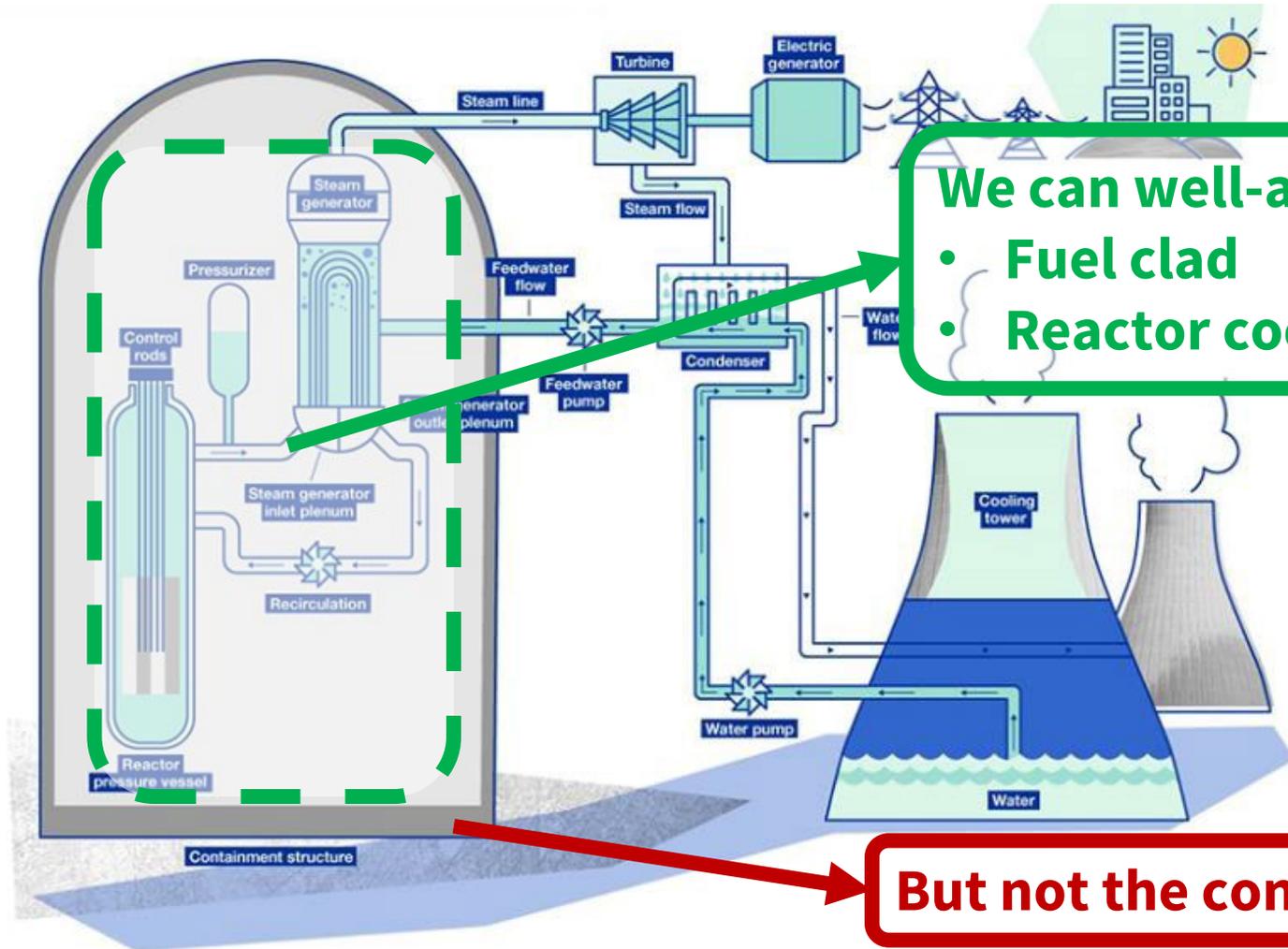


Fuel clad & RCS



Containment

WHY IS IT SO UNCERTAIN DURING BDBAs?



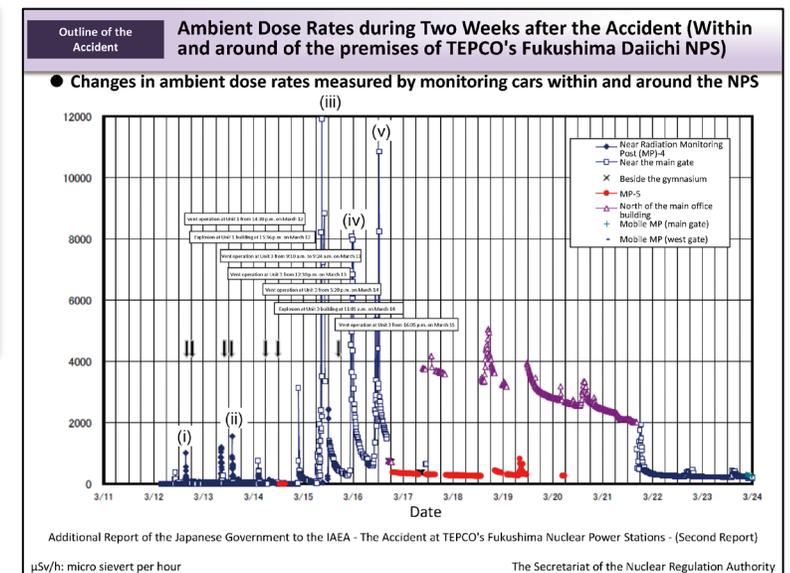
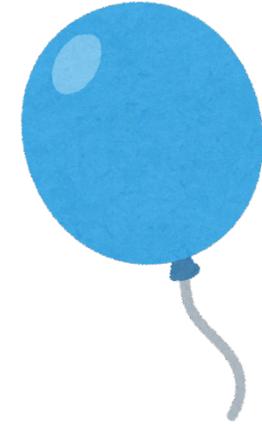
We can well-assess behaviour/status of:

- Fuel clad
- Reactor coolant system

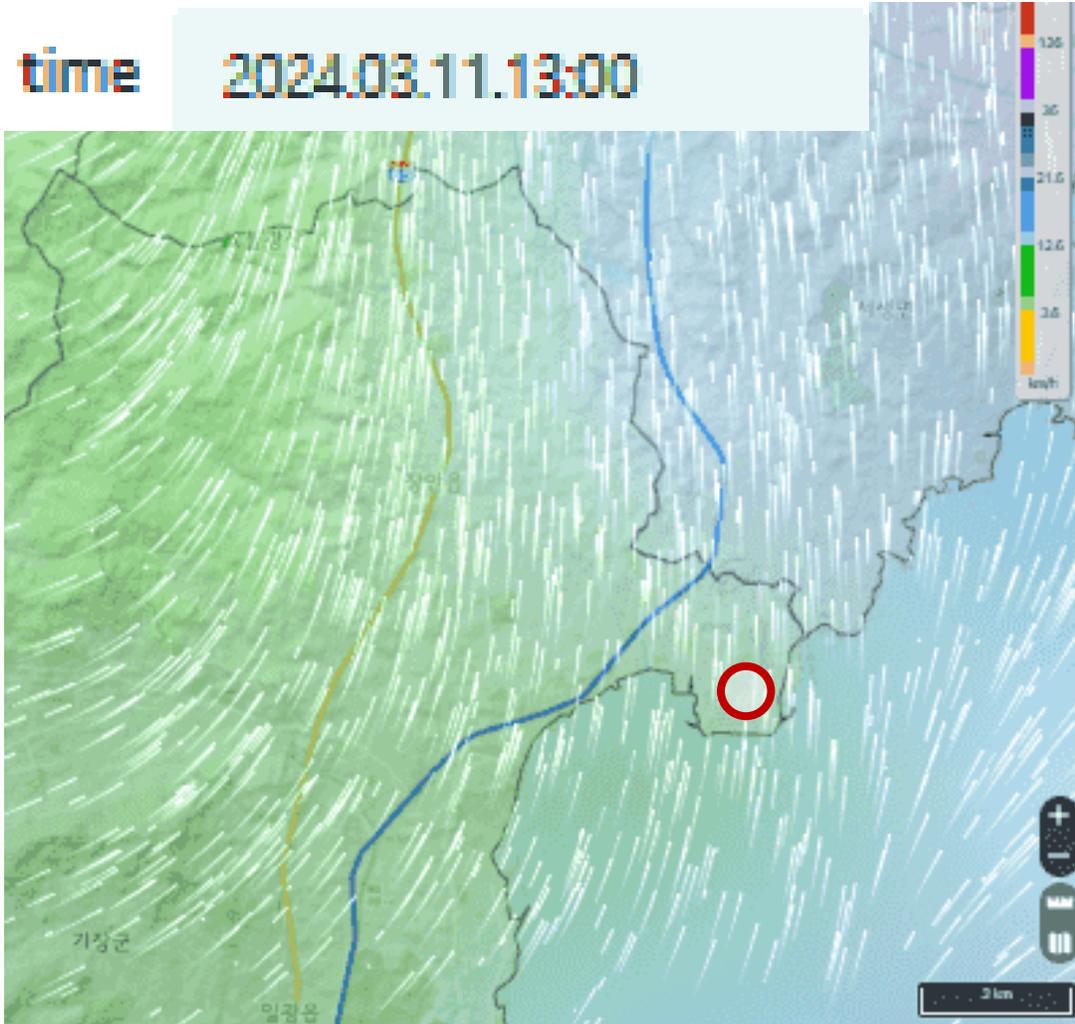
But not the containment behaviour

CONUNDRUMS OF CONTAINMENT BEHAVIOUR DURING BDBAs

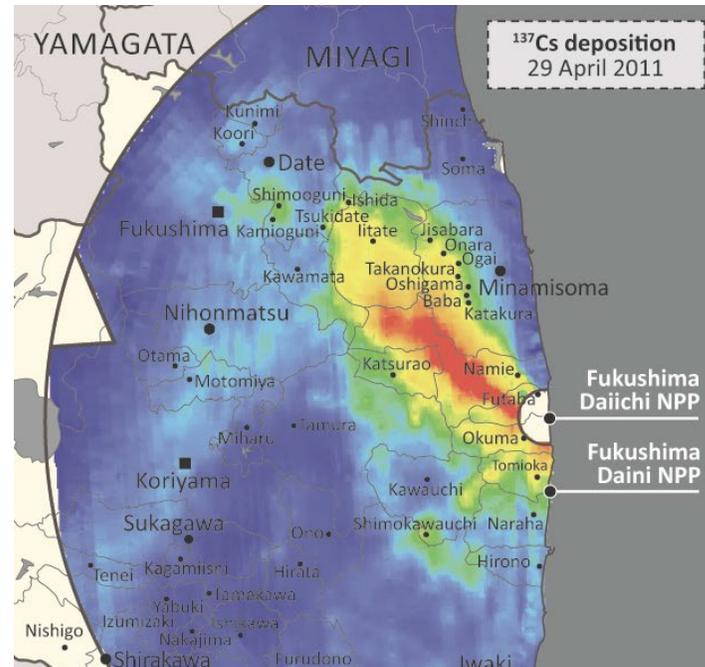
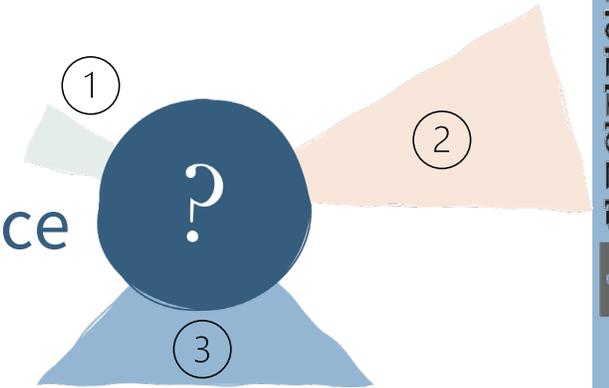
- *When will the containment **fail** or **be bypassed**?*
- *How **severe** will the potential release be?*
- *How **long** will the potential release last?*



ALSO, WIND DOES SHIFT



... and major downwind/distance changes



The actual dispersion/deposition pattern will be a lot more complex

QUESTIONS WE NEVER EXERCISE

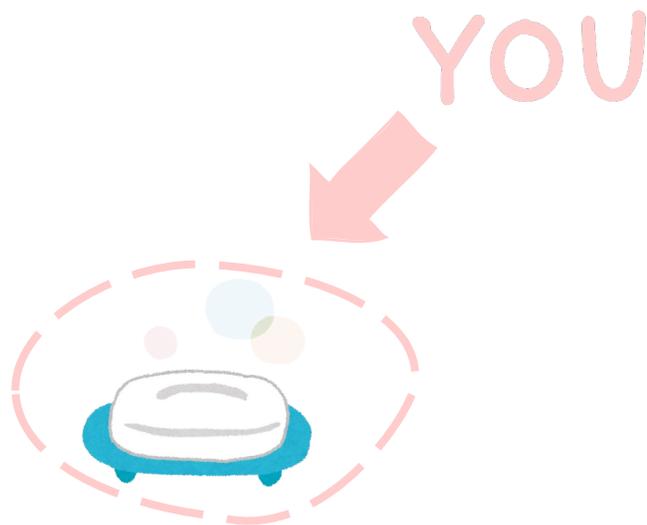
Is this all we need to do?

Is there any other possibility?

Is it the worst possible scenario?

...Are you sure?

*During an emergency,
you are neither water nor oil,
BUT A BAR OF SOAP.*



A&P shall be performed
TO CONVINC,
NOT TO CONFUSE.

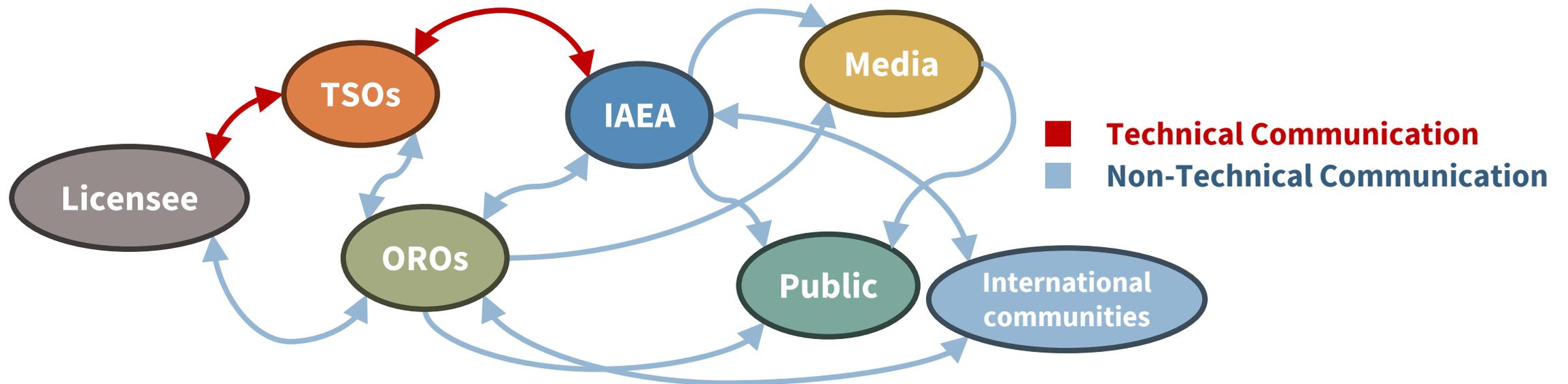
TIME CONSTRAINTS

INDUCED BY NON-EMERGENCY MATTERS



DIFFICULTIES IN “TIMELY” COMMUNICATION

- *Data processing and delivery*
- *Accident assessment and prognosis by licensee and TSOs*
- ***Validation, comparison, and discussion***
- ***Reporting, explanation, and Q&As***



***SIMPLE & CLEAR COMMUNICATION
FRAMEWORK*** *needs to be established
for the entire period of an emergency*

A&P STRATEGY

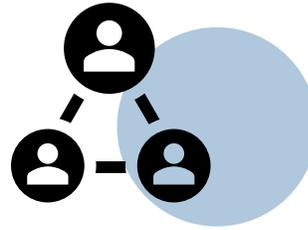


HOW WE RESPOND



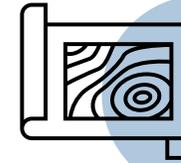
EMERGENCY CLASSIFICATION

- **Key communication tool** between all relevant organizations
- **A primary measure for recommending & initiating the predetermined protective actions** within the EPZs



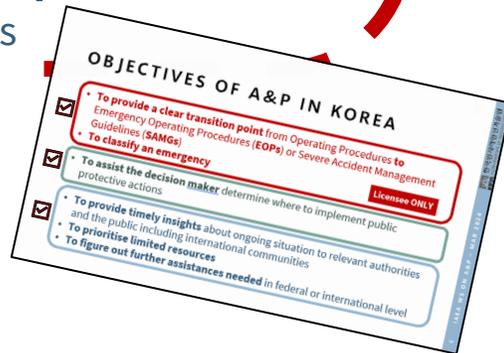
ASSESSMENT BY USING MODELS

- **Primary communication tool** between technical organizations
- **A secondary measure for adjusting and optimising initial protective actions** decided per EALs



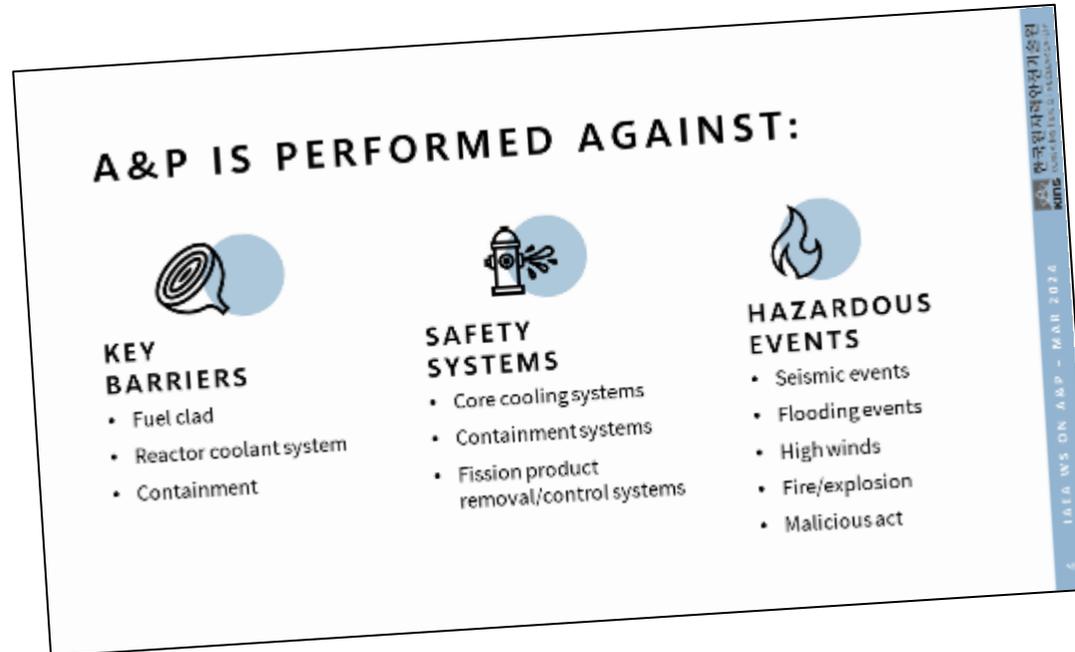
ENVIRONMENTAL MONITORING

- Basis for adjusting initial protective actions and transitioning from urgent responses to early responses



Giving a way for field monitoring

Emergency is classified by **EALs** which are developed considering:



And its severity increases:

FE

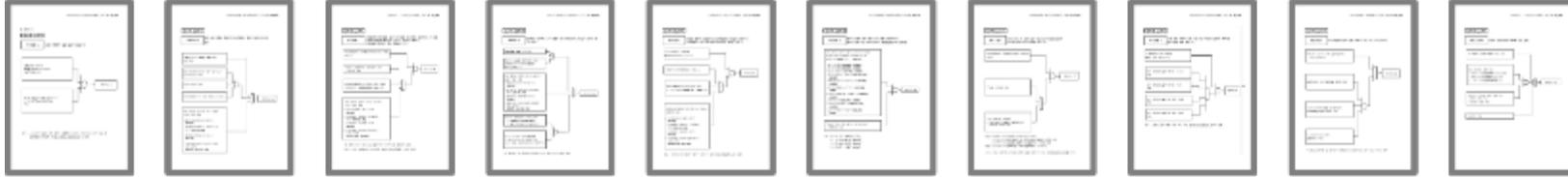
SAE

GE

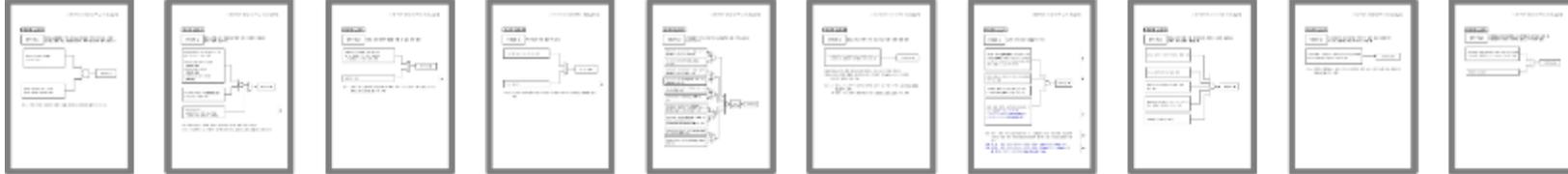
*Lost of key barrier(s)/ Failure of safety system(s)
/ Radiological significance of potential release*

Example Set of EALs

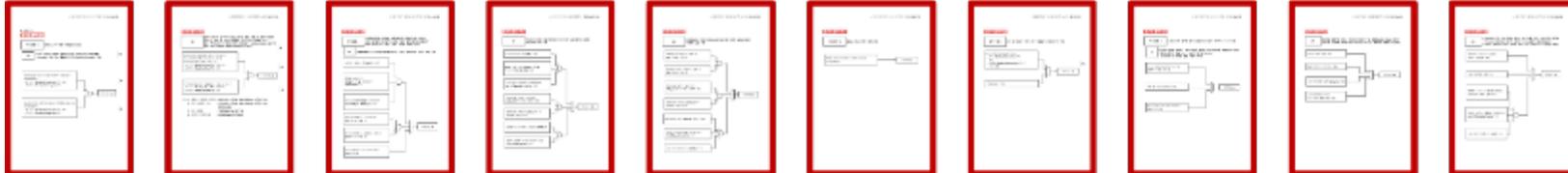
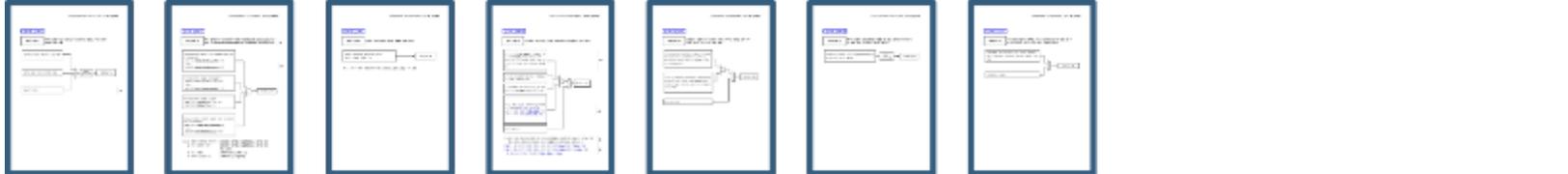
FE



SAE



GE



EMERGENCY CLASSIFICATION AND ITS APPLICATION (1/2)



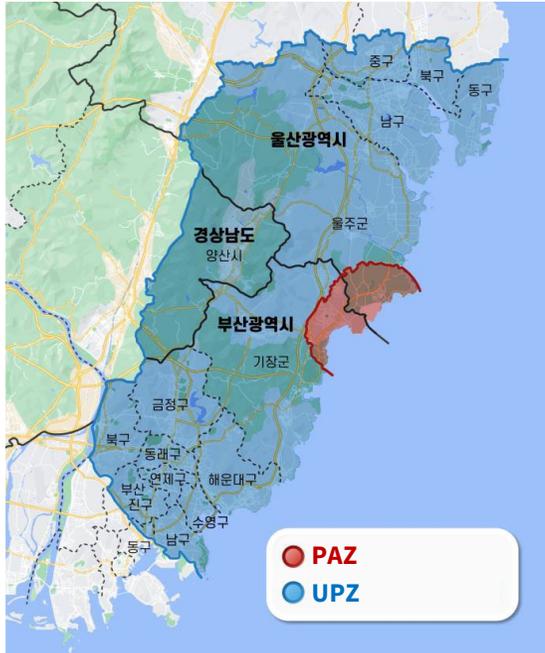
Why (precautionary) **urgent protective actions** are based on emergency classification

- High risk of major release for core damage accidents
- Ease of detection of core conditions
- Difficulty in projecting containment failure/bypass
- To avoid/minimize severe deterministic effects near a facility
- Urgent protective actions shall be implemented before containment failure (a major release begins)

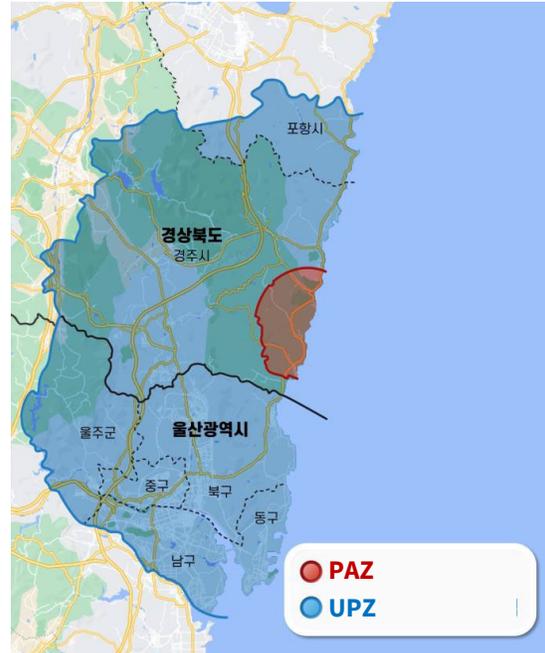
EMERGENCY CLASSIFICATION AND ITS APPLICATION (2/2)

Emergency Class	Key actions to be taken for off-site emergency responses	
	Licensee	Off-site Response Organisations
Facility Emergency	<ul style="list-style-type: none"> • Notification to OROs • Providing information to OROs • Operation of emergency response facilities 	<ul style="list-style-type: none"> • Preparatory activation for emergency response organisations • Notification to other relevant organisations • Public communication
Site Area Emergency		<ul style="list-style-type: none"> • Full activation of emergency response organisations
General Emergency	<ul style="list-style-type: none"> • Protective action recommendations to OROs • Supporting off-site response activities 	<ul style="list-style-type: none"> • Implementing predetermined protective actions and other response actions

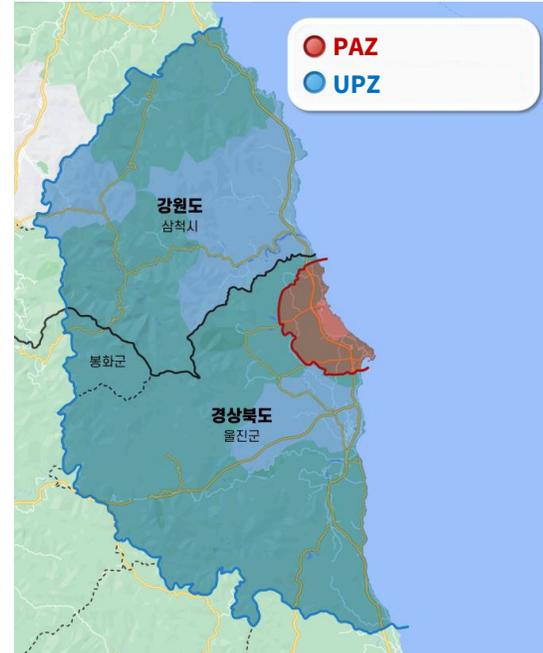
EMERGENCY PLANNING ZONES



KORI/SAEUL
7 Reactors
+ 2 under construction



WOLSONG
5 Reactors



HANUL
8 Reactors



HANBIT
6 Reactors

Population in the PAZ

Few thousands to few tens of thousands

Population in the UPZ

Few tens of thousands to few millions

LIST OF TOOLS (1/2)

Tools	Use
Nuclear Emergency Information System (NEIS)	Provides a direct real-time data transfer from licensee plant computers to RETAC
Source Term Estimation System (STES) - RASCAL 4.3.4 South Korea version	Estimates accident source term to assess potential offsite consequences
Accident Dose Assessment and Monitoring (ADAMO)	Assesses offsite consequence based off of source term and monitoring data
Integrated Environmental Radiation Monitoring Network (IERNet)	Aggregates and visualise radiation monitoring data collected from fixed monitoring system
Emergency Response Information eXchange (ERIX)	Enables emergency response organisations to communicate and exchange key information during an emergency
Public protection Geological Information System (PGIS)	Displays protective action recommendations onto the interactive map incorporated with key information such as population, shelter locations, etc

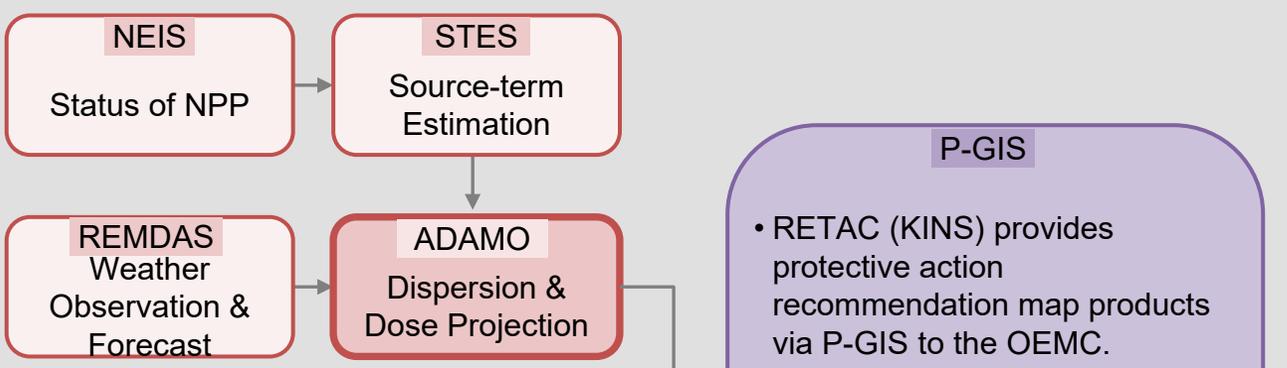
LIST OF TOOLS (2/2)

Tools	Use
Unified System for Information Exchange in Incidents and Emergencies (USIE)	Notification and sharing of information to the IAEA and other relevant countries
International Radiation Monitoring Information System (IRMIS) by the IAEA	Sharing of environmental monitoring data to the IAEA and other relevant countries during an emergency
Reactor Assessment Tool (RAT)	Assessment & prognosis of NPPs per the IAEA methodology
Response Technical Tool (RTT)	Detailed assess and prognosis

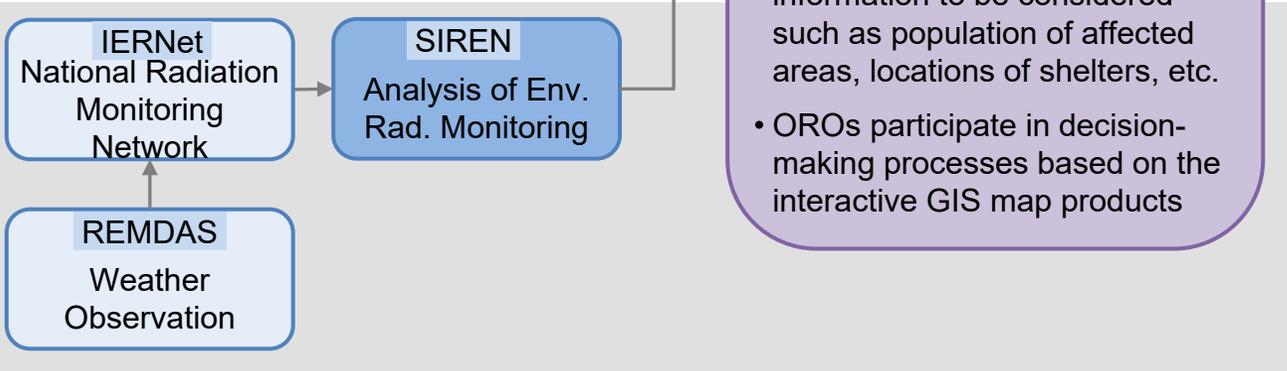
PREDICTIVE MODELLING INTEGRATED WITH OFFSITE MONITORING



Predictive Modelling

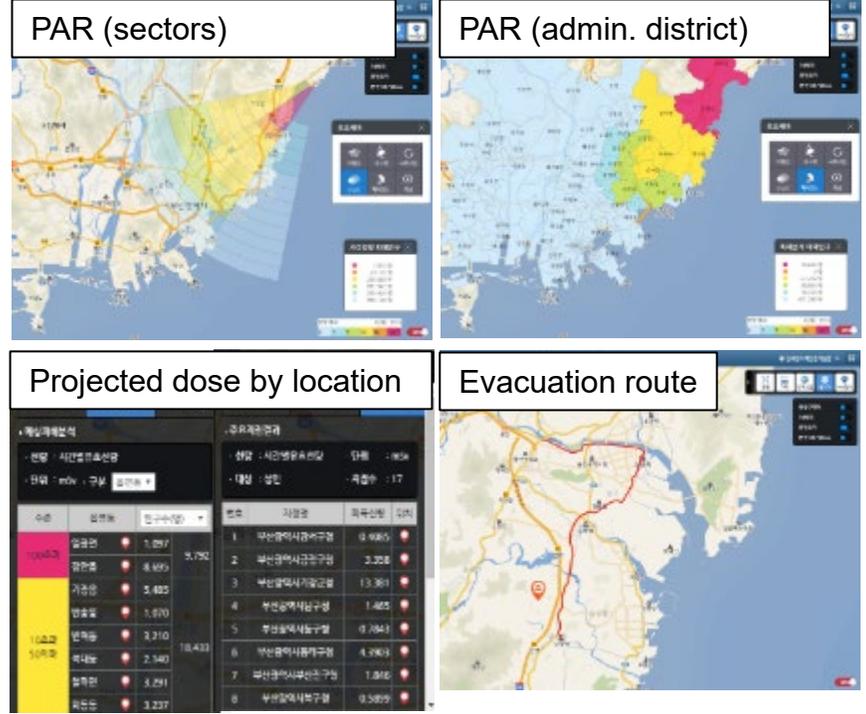


Offsite Monitoring

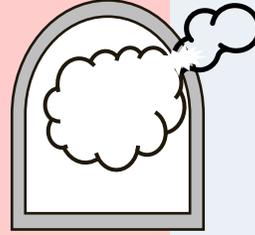
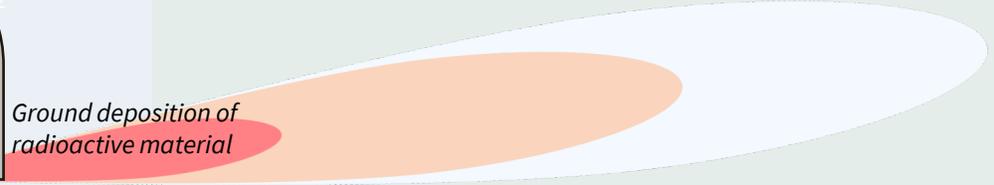


P-GIS

- RETAC (KINS) provides protective action recommendation map products via P-GIS to the OEMC.
- P-GIS contains other key information to be considered such as population of affected areas, locations of shelters, etc.
- OROs participate in decision-making processes based on the interactive GIS map products



RESPONSE FRAMEWORK

	Hours		Days	Weeks - Months	
Event	Declaration of emergency class 	Beginning of major releases 	End of major releases 		
Basis	Emergency Action Levels (EALs)	Observables	Operational Intervention Levels (OILs) aided by predictive modelling		OILs & radiological assessment
Priority	Avoid or minimize severe deterministic effects		Reduce the risk of stochastic effects		Reduce the risk of stochastic effects (with further optimization)
Responses	Precautionary urgent protective actions		Urgent protective actions and other response actions		Early protective actions and other response actions
PAZ	<ul style="list-style-type: none"> Evacuation to the beyond the UPZ and taking an ITB agent Or sheltering and taking an ITB agent if safe evacuation is not possible Access restriction to the PAZ 		<ul style="list-style-type: none"> Registration and monitoring of evacuees Medical follow-up 		<ul style="list-style-type: none"> Lifting the initial urgent protective actions implemented Relocation Restriction on consumption and trade of non-essential food, milk and drinking water as well as of commodities Registration Medical follow-up
UPZ	<ul style="list-style-type: none"> Shelter-in-place (remain indoors) 	<ul style="list-style-type: none"> Sheltering and taking an ITB agent 	<ul style="list-style-type: none"> Evacuation of hot-spots Registration and monitoring of evacuees Medical follow-up 		
EPD	<ul style="list-style-type: none"> Reducing inadvertent ingestion 				
ICPD	<ul style="list-style-type: none"> Protecting food chain and water supply as well as commodities Restriction on consumption and trade of non-essential food, milk and drinking water as well as of commodities 				

THANK YOU

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kyuwon.choi@kins.re.kr

<https://www.kins.re.kr/en/index>

