



Enhancing Nuclear Safety Regulation in Japan

3 April 2013

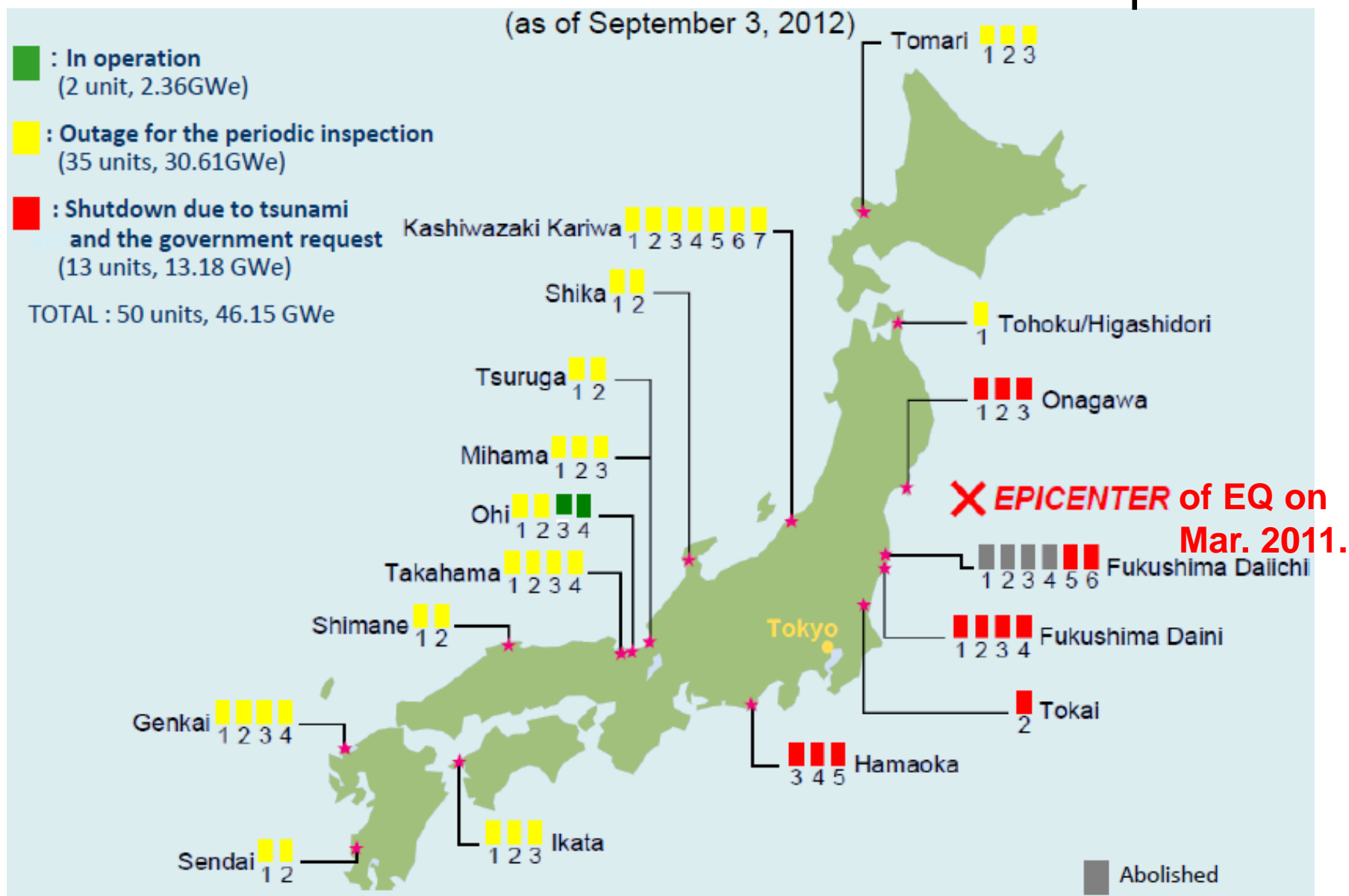
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Authority(NRA)



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- ◆ Current Status of Nuclear Power Plants in Japan
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Current Status of Nuclear Power Plants in Japan





The accident at TEPCO's Fukushima Dai-ichi NPS

TEPCO's Fukushima Dai-ichi NPS Accident

- ◆ The accident rated at INES Level 7 still forcing evacuation.
- ◆ Major causes including at least:
 - Long lasting complete power loss due to the CCF of electrical equipment following tsunami,
 - Insufficient provision against such severe accidents, and
 - Lack of the regulator's competence to properly address above mentioned issues.



The moment when tsunami attacked Fukushima Dai-ichi NPS (Source: TEPCO)



The severely damaged RB of U3 due to the hydrogen explosion (Source: TEPCO)

- ◆ Specified as Disaster-experienced Nuclear Power Plant on 7 Nov. 2012.

Ensuring safety of the decommissioning of reactors.

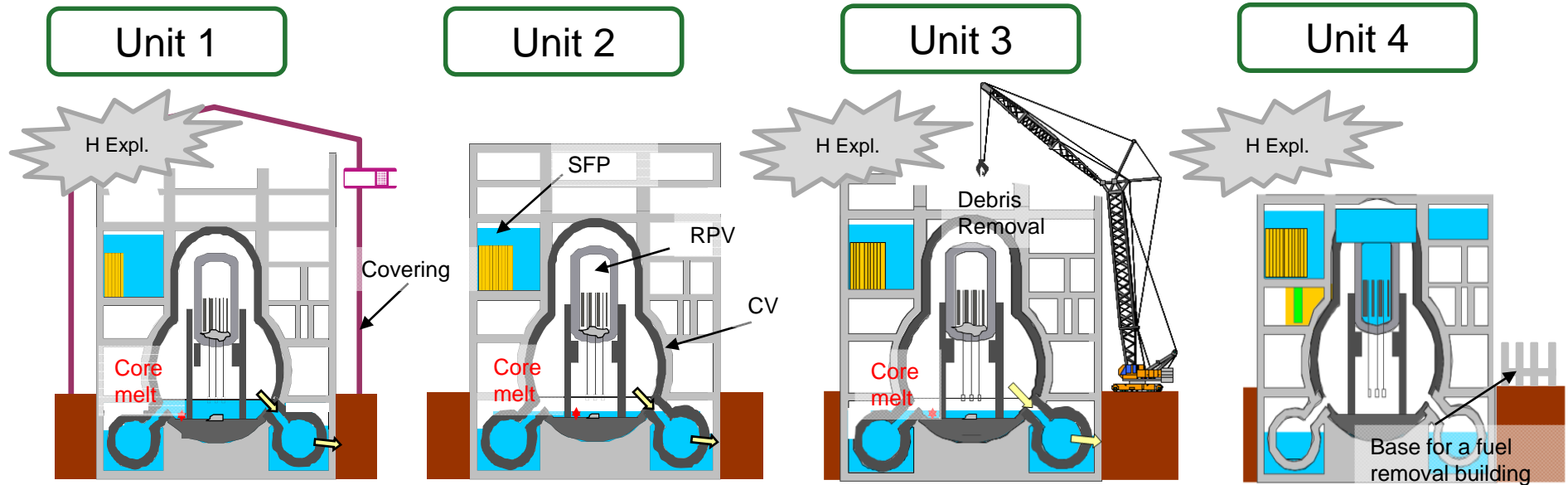
- ◆ Continuing investigation of the accident cause.

Full cooperation for IAEA report.

- ◆ Experts groups on radiation emergency medicine and on health care administration.
To recommend measures to control radiation pollution and reduce long-term anxiety to human health.



Current State of the Damaged Reactors



	Unit 1	Unit 2	Unit 3	Unit 4
Reactor	20°C (RPV) 21°C (CV)	35°C (RPV) 35°C (CV)	33°C (RPV) 31°C (CV)	No fuel
	Circulated cooling water injection N2 gas injection CV gas control including sampling			
SFP	15°C	16°C	14°C	23°C
	Circulated cooling water injection		Circulated cooling water inj. Desalination	Cooling water circulation Ion exchanger
notes			Debris removal from RB	RB covering work

Immediate issues at the accident site:

#1 Fuel removal

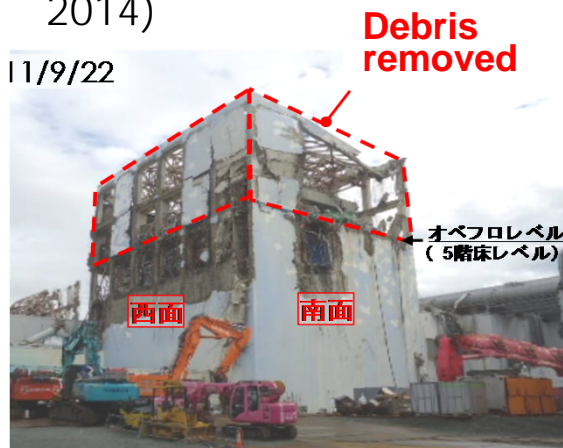
#2 Contaminated water management



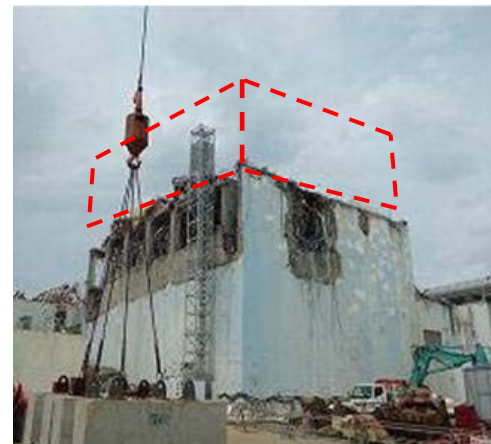
Immediate Issue #1: Fuel Removal

Debris removal from the top of RB of U4 was completed. Covering work is cont'd.

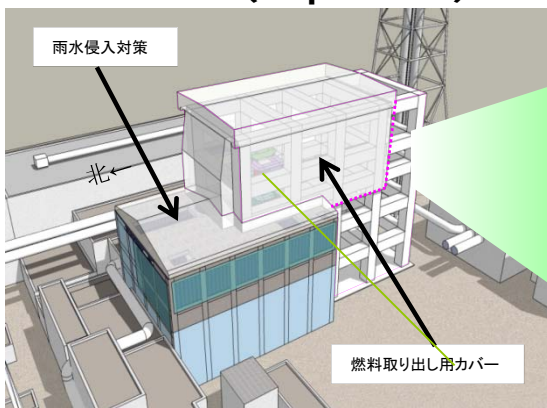
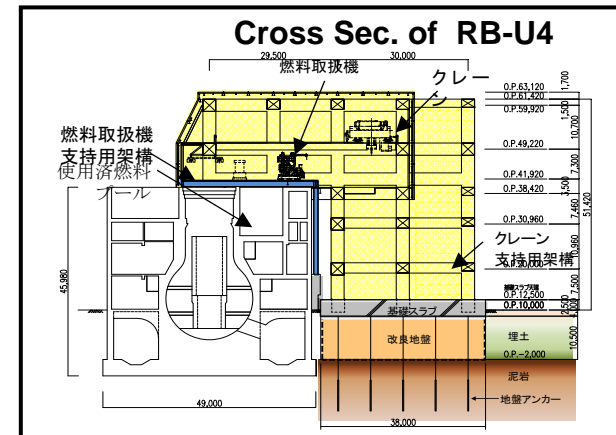
- Aiming early completion of fuel removal from the U4 SFP (planned from Nov. 2013 to the end of 2014). (For U3, the removal work is planned to initiated at the end of 2014)



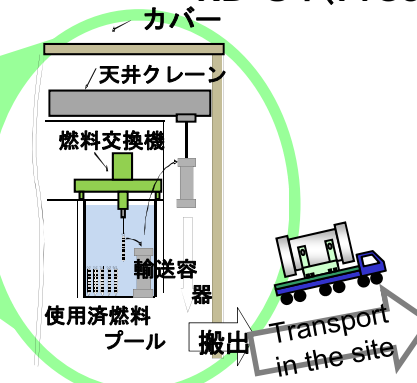
RB-U4 (Sep. 2011)



RB-U4 (Present)

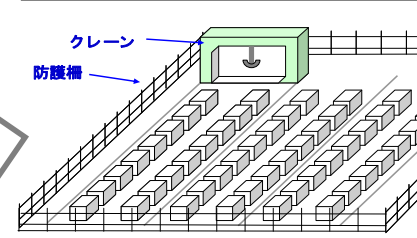


A Planned covering structure for fuel removal work

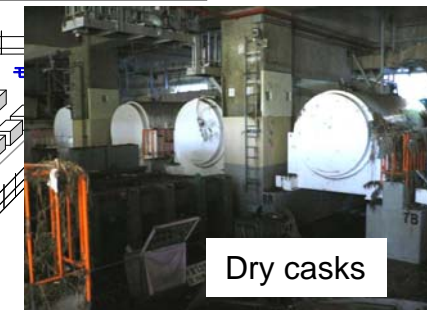


Removal work

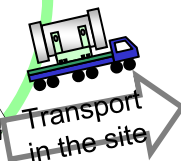
Dry cask storage facility



Air-cooling



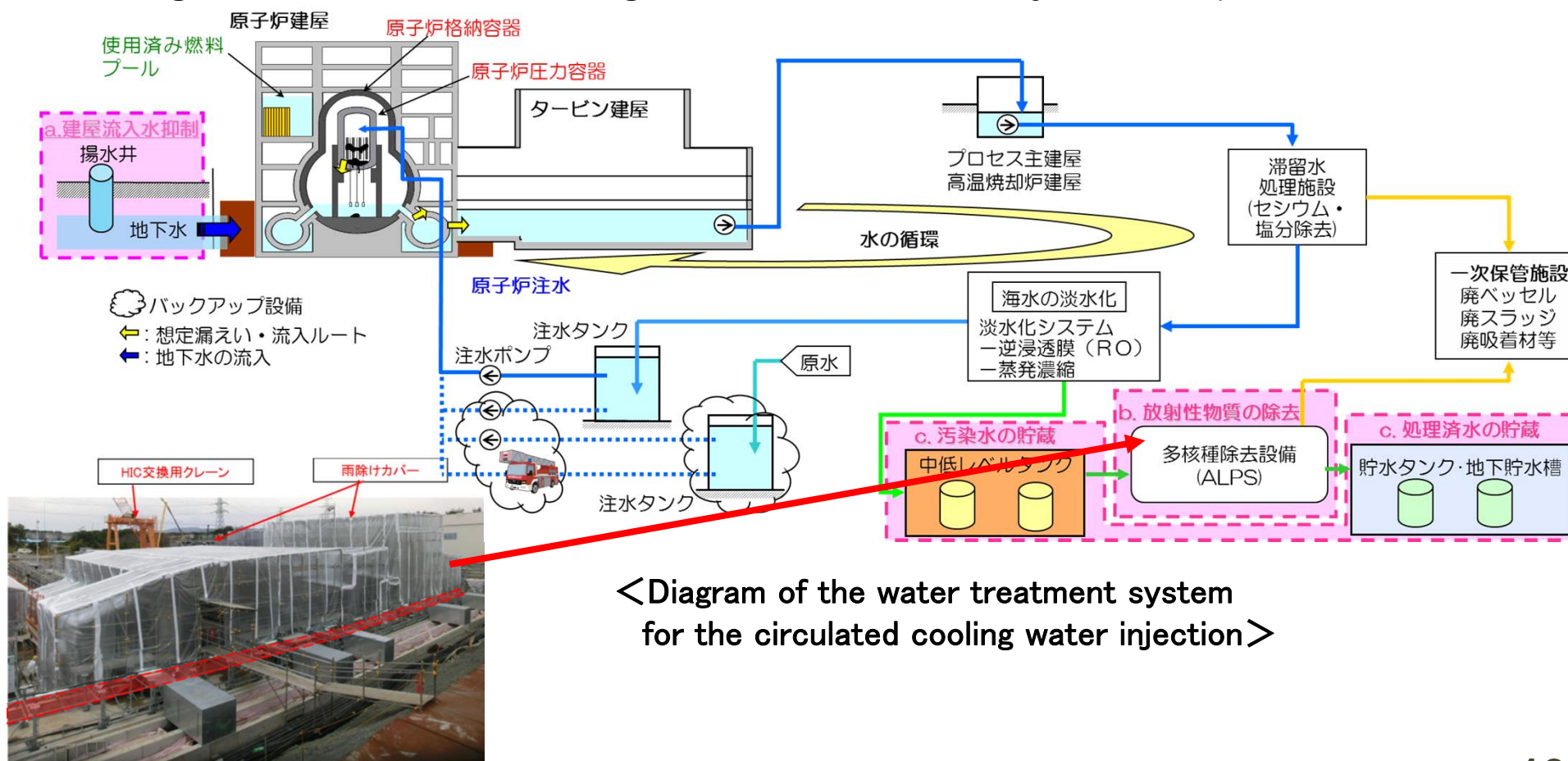
Dry casks



Immediate Issue #2: Contaminated Water Management

(1) Enhancing the function of the water treatment system to deal with multi-nuclides

- The new system can remove 62 nuclides while the present system can mainly remove Cesium, by which radioactivity of treated water can be controlled on a lower level.
- Toward the introduction of the new system, the safety and reliability of the system are being confirmed, and tests using water with radioactivity will be implemented.

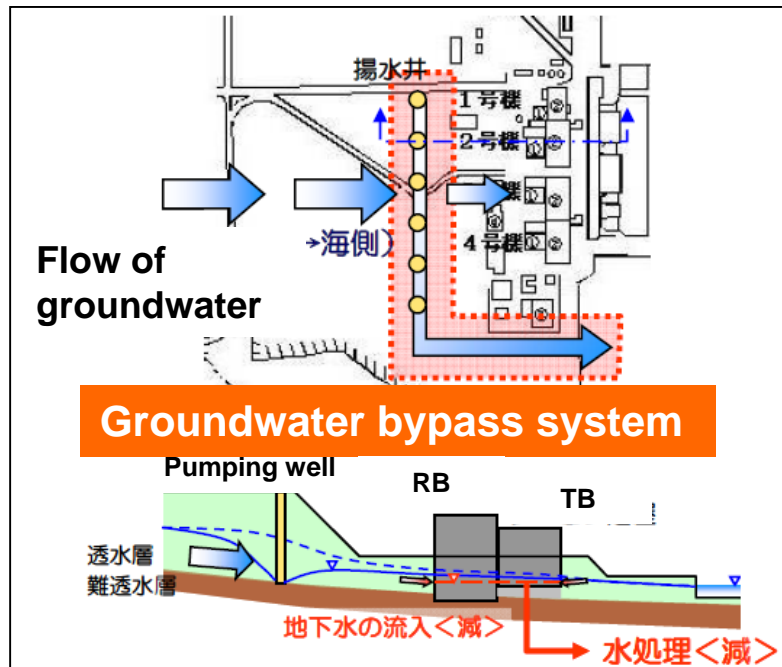


<Diagram of the water treatment system for the circulated cooling water injection>

Immediate Issue #2 (cont'd)

(2) Bypassing of the groundwater flow

- To reduce ground water flow coming into the RB by lowering groundwater level around the RB, facilities for groundwater bypass are being introduced.
- As of the end of Jan. 2013, the construction work of 6 pumping wells has been completed. Now the other facilities including 6 pump wells and piping are being constructed aiming completion at the end of this March.



Recent Incident

- Failures at Power Supply Facilities -

- ◆ At around 6:57 PM JST on March 18, 2013, the power supply facilities (M/Cs: Metal-clad switch gears) in the Main Anti-earthquake Building stopped. The affected facilities by this power supply failure are below:

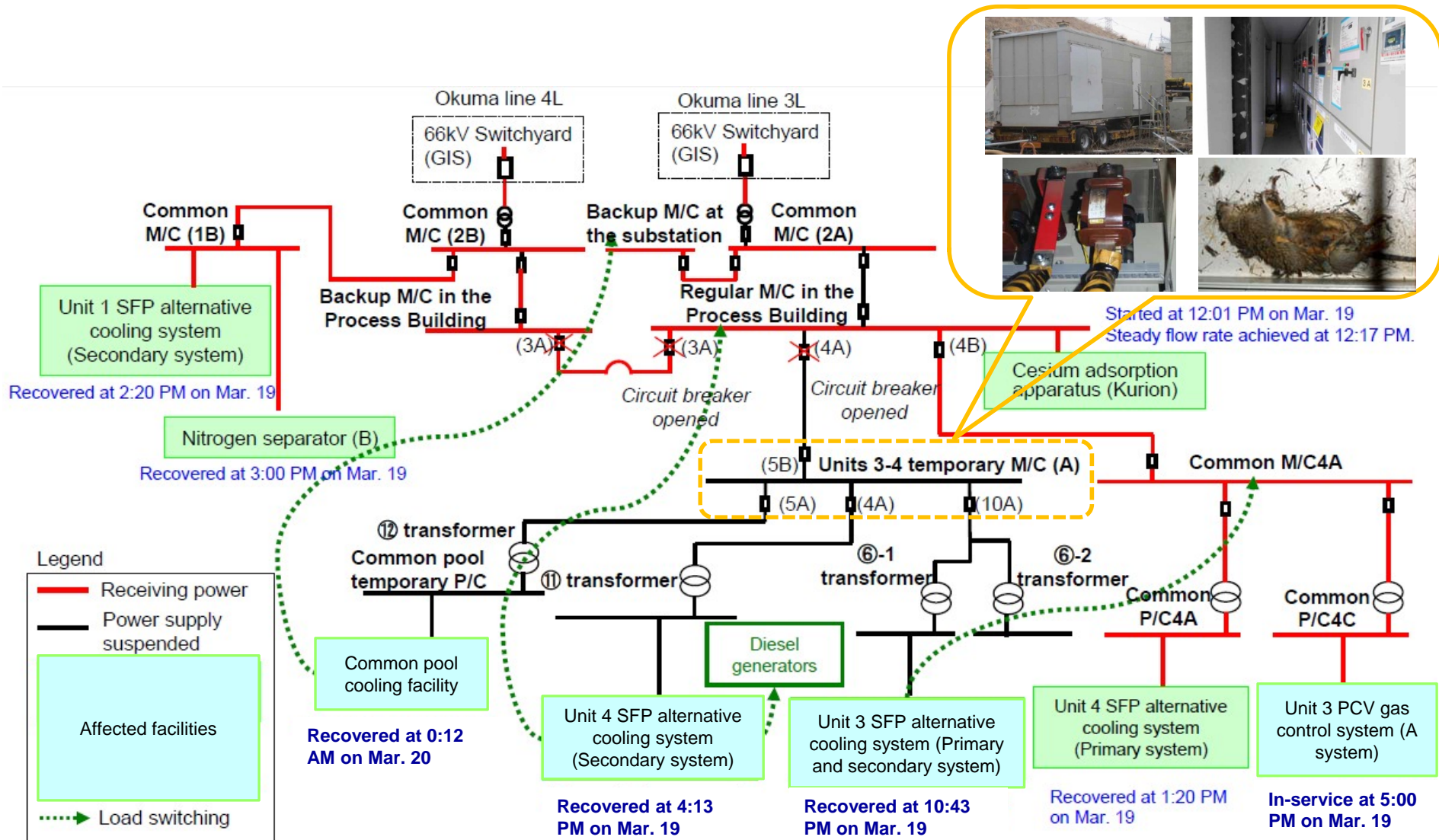
Affected facilities	Power supply
Cesium adsorption apparatus (Kurion)	Regular M/C in the Process Building
Unit 1 spent fuel pool alternative cooling system (Secondary system)	Common M/C 1B
Unit 3 spent fuel pool alternative cooling system (Primary system)	Units 3-4 temporary M/C (A)
Unit 3 spent fuel pool alternative cooling system (Secondary system)	Units 3-4 temporary M/C (A)
Unit 4 spent fuel pool alternative cooling system (Primary system)	Common M/C 4A
Unit 4 spent fuel pool alternative cooling system (Secondary system)	Units 3-4 temporary M/C (A)
Common pool cooling facility	Units 3-4 temporary M/C (A)
Unit 3 PCV gas control system (A system)	Common M/C 4A
Nitrogen separator (B)	Common M/C 1B

- ◆ Reactor cooling systems and U2 SFP cooling were not affected and no unusual radioactive indication had been detected.
- ◆ By 0:12 AM JST on March 20, the affected facilities including the common pool cooling purification system were restarted.
- ◆ The temperature of SFPs before and after the incident is as below.

	U1	U3	U4	Common
Before (16:00 on Apr. 18)	16.0°C	13.7°C	25.0°C	25.2°C
After (Apr. 20)	17.0°C	17.0°C	30.0°C	31.8°C

Recent Incident


- Failures at Power Supply Facilities (Cont'd) -



Recent Incident

- Failures at Power Supply Facilities (Cont'd) -

- ❑ A dead small animal was found on the floor under a switch board with singe. According to TEPCO's investigation report, the animal seems to cause damage of the switch board, which initiated failure of the power supply systems.
- ❑ This incident occurred on the way to the reinforcement of the whole safety facilities of Fukushima Daii-chi NPS, e.g., introducing permanent facilities to replace temporary equipment, establishment of diversity and redundancy.
- ❑ NRA requested TEPCO to accelerate implementation of the safety facility reinforcement plan reflecting the lessons learned from this incident.
- ❑ NRA also requested TEPCO to improve its contingency operation to early restore from such a failure of safety significant functions.



Establishment of Nuclear Regulation Authority (NRA)



Established in Sep. 2012

Commission



Secretariat

The Secretariat of the NRA
(About 500 staffs)

TSOs

JNES

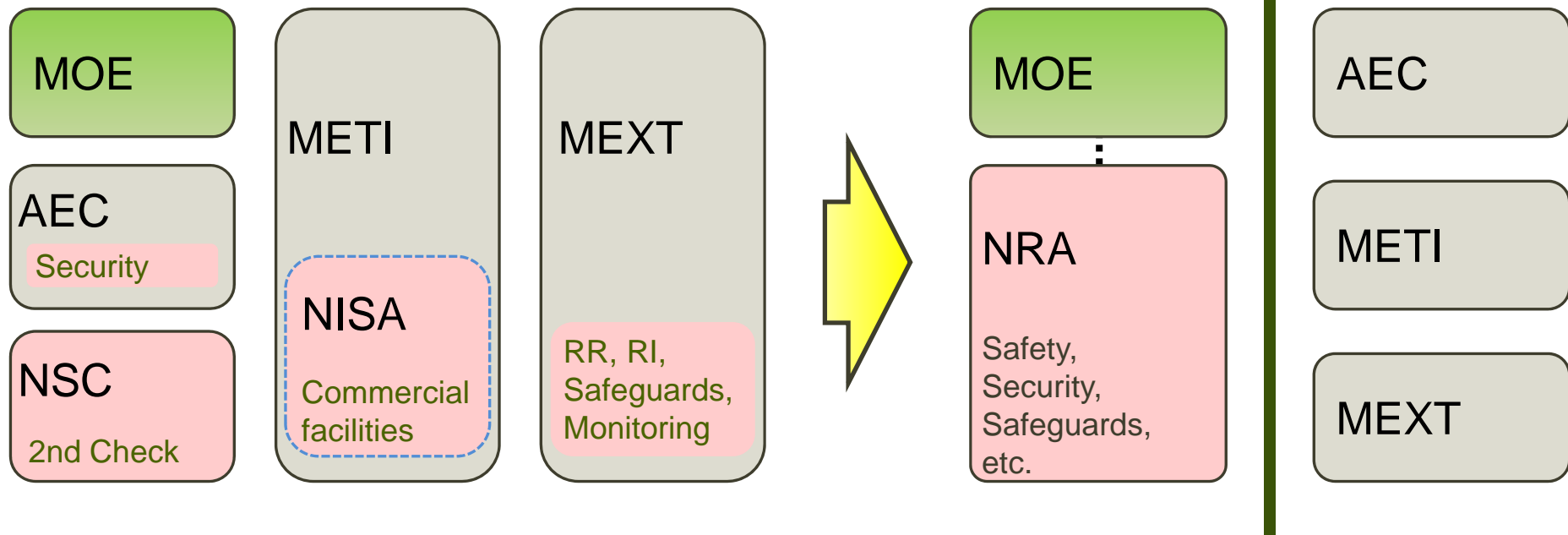
JAEA

NIRS

Independence

&

Integration



- AEC : Atomic Energy Commission
- METI : Ministry of Economy, Trade and Industry
- MEXT : Ministry of Education, Culture, Sports, Science and Technology
- MOE : Ministry of the Environment
- NISA : Nuclear and Industrial Safety Agency (abolished)
- NSC : Nuclear Safety Commission (abolished)

Transparency

- ◆ NRA meetings are open to the public (streamed live on the Internet).
- ◆ Meeting records with licensees are open to the public.
- ◆ Criteria for appointing outside experts
- ◆ Three press conferences are held each week.





New Safety Standards for Nuclear Power Plants

New regulation system to be introduced

- ◆ New regulation on **severe accidents**
Legally-requested measures to prevent and to mitigate severe accidents.
- ◆ Develop new regulatory standards and apply to **existing nuclear facilities (back-fitting)**.
- ◆ **40-years operational limit** for NPPs
Legally defined limit to 40 years.
NRA can permit a less-than-20-years extension.
- ◆ Safety measures against **external event risks**, including earthquakes, tsunamis, tornados, fires and terrorist attacks.
Establishing new standards for Earthquake and Tsunami in particular.

Basic Policy of New Safety Standards

1) Thorough Application of Defense-in-Depth Concept

- Prepare multiple effective measures (multi-layered protective measures) and, for each layer, achieve the objective only in that layer regardless of the measures in the other layers.
- Assume the preceding layer be breached (denial of preceding layer) with no reliance on subsequent layer (denial of subsequent layer).

2) Enhancement of Reliability as the Bases for Safety

- Strengthening of fire protection, and of measures against inundation by tsunami.
- Reinforcement of SSCs important to safety (elimination of shared use of passive components if relied on for a long time).

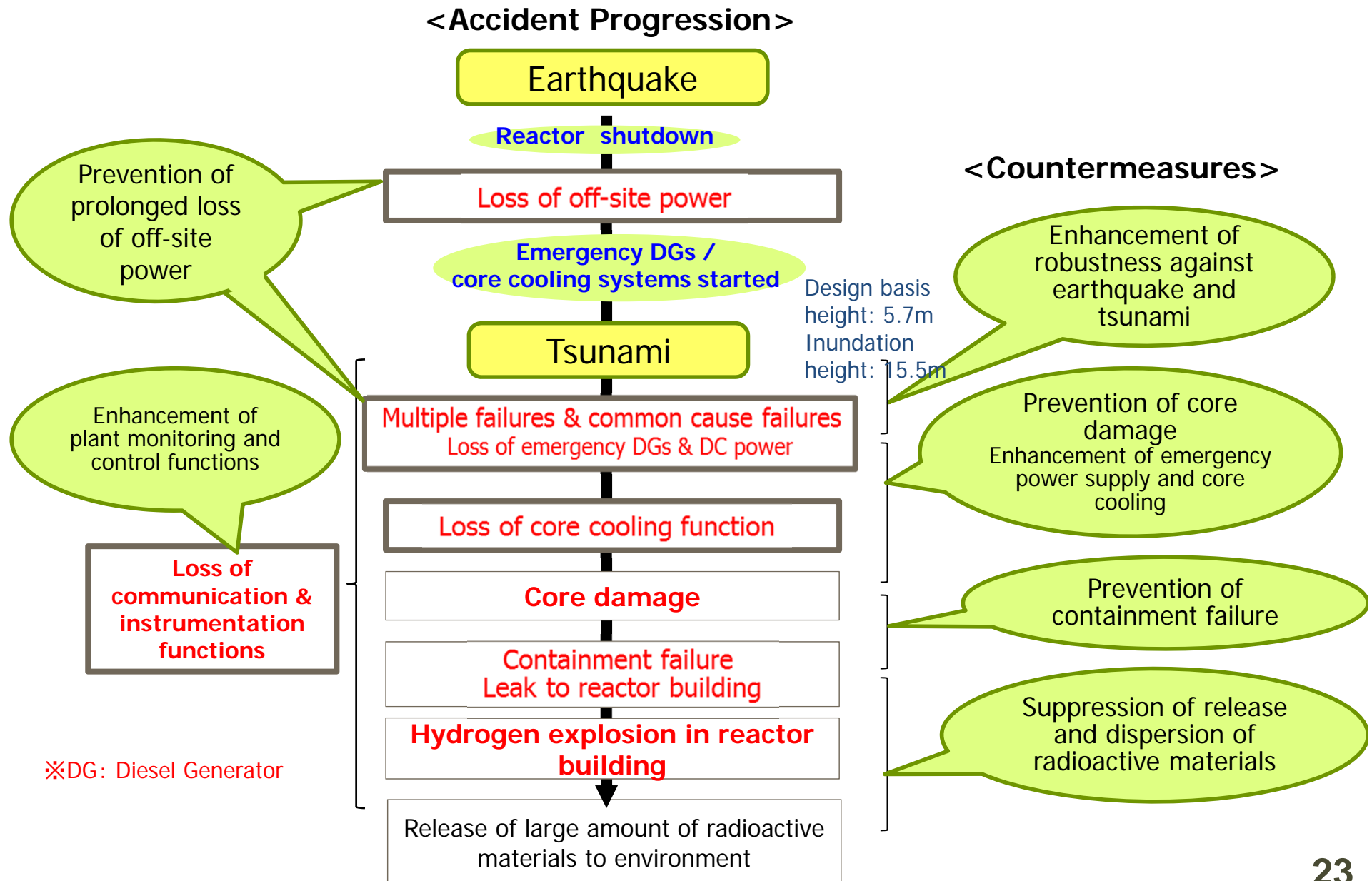
3) More Conservative Postulation Associated with Common Cause Failures due to Natural Hazards and Enhanced Protective Measures

- More stringent approach for assessment of earthquake and tsunami, introduction of measures against tsunami inundation.
- Due consideration of diversity and independence (shift of emphasis from “redundancy centered”).

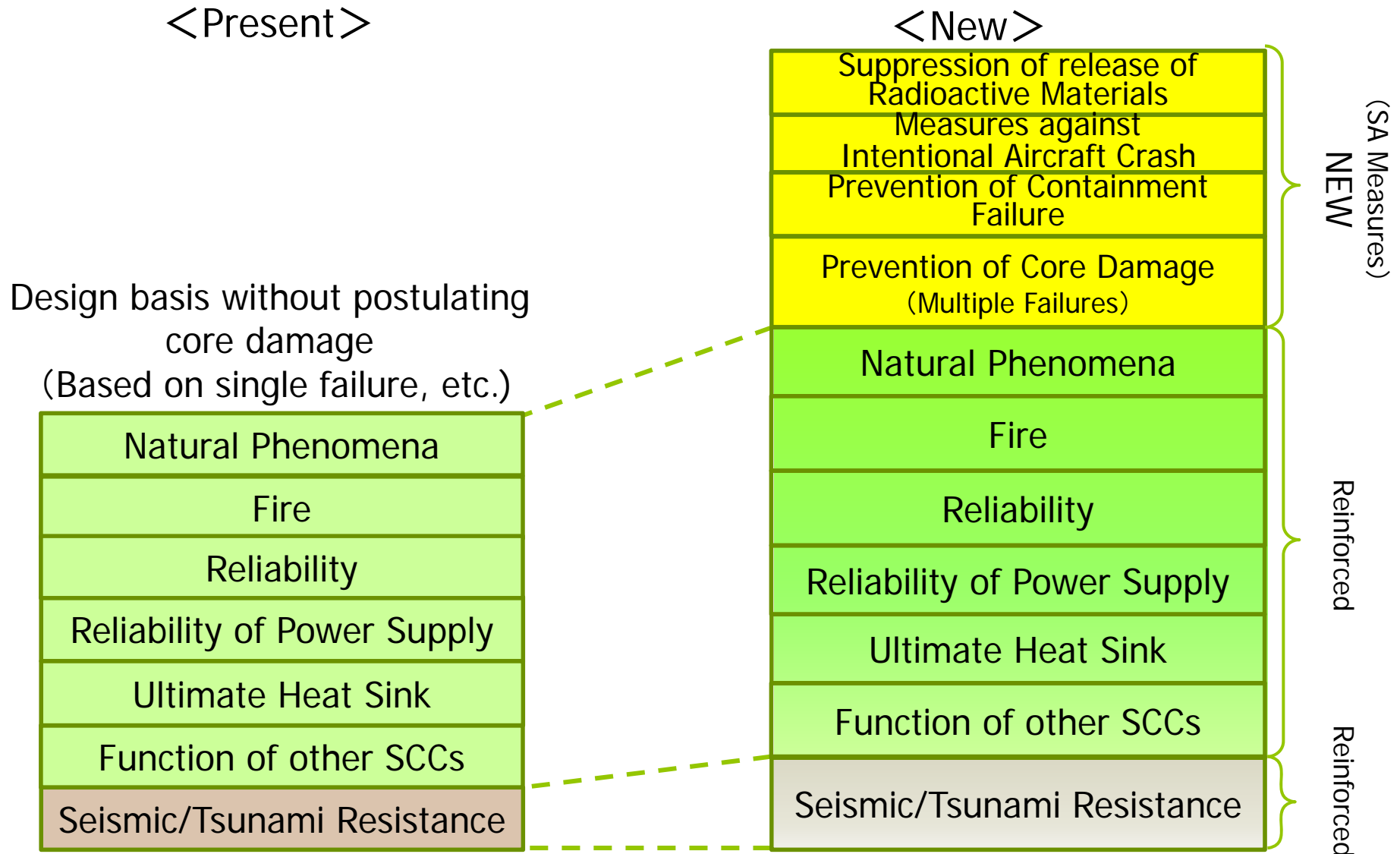
Basic Policy on Measures against SAs and Terrorism

- 1) Preparation of multi-layered protective measures for “prevention of core damage”, “maintaining containment integrity”, “controlled release by venting”, and “suppression of release / dispersion of radioactive materials”
- 2) Use of mobile equipment as a base similar to U.S. etc. and further enhancement of reliability by combined use with permanently installed systems / equipment (Continuous improvement)
- 3) Enhancement of protective measures for SFP
(Water level measurement, Alternative water supply, Spray)
- 4) Reinforced seismic-resistance of on-site emergency response center, improved reliability / durability of communication system, enhanced instrumentation including SFP (enhancement of command communication and instrumentation)
- 5) Introduction of “Specialized Safety Facility” against intentional aircraft crash

Progression of the Fukushima Accident and Countermeasures



Structure of New Safety Standards



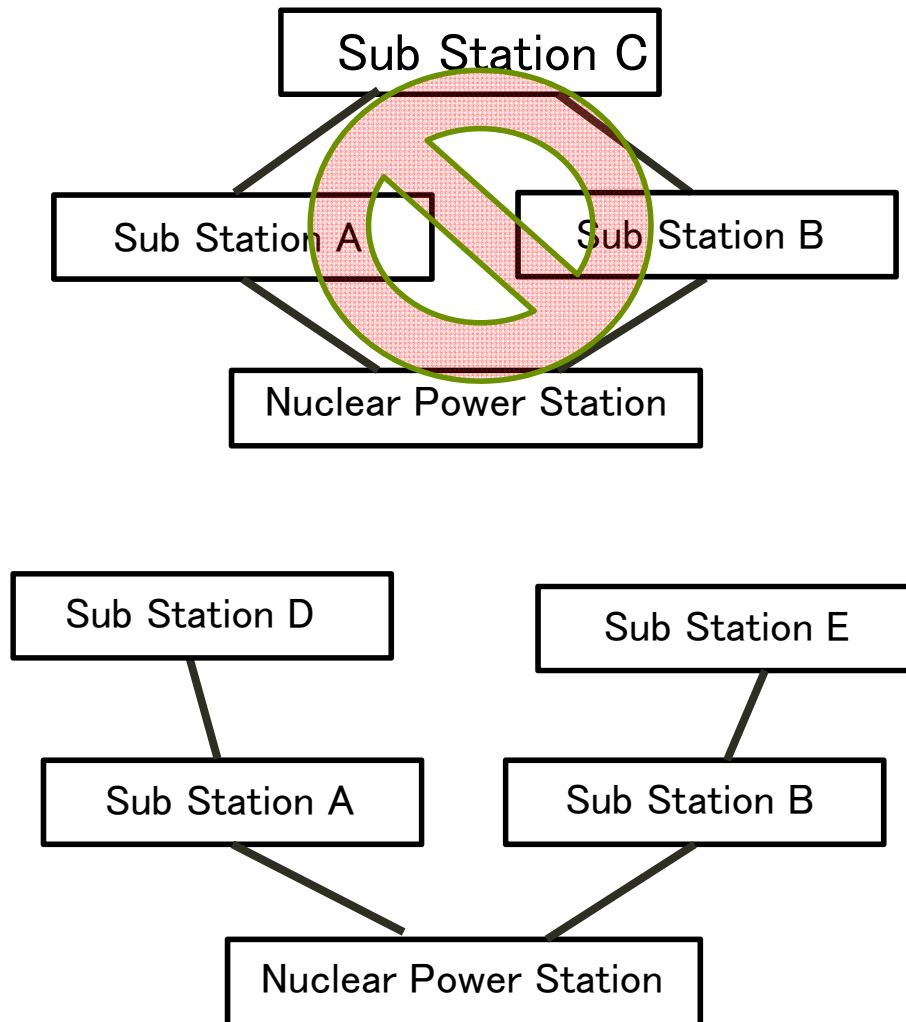
1-1. Strengthening of Design Basis

Revision of "Design basis without postulating core damage "

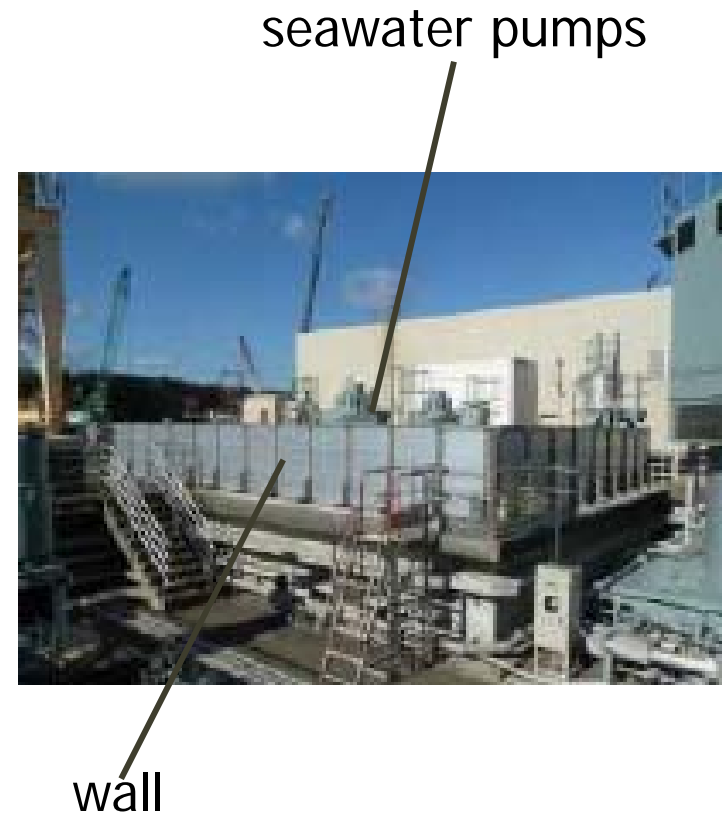
- 1) Addition of natural phenomena to be considered such as tornado and forest fire
- 2) Reinforced fire protection measures
- 3) Enhanced reliability of SSCs important to safety
(Redundancy of piping if relied on for a long time)
- 4) Reinforcement of off-site power supply (connection to different substations through multiple lines)
- 5) Protection of systems for Ultimate Heat Sink
(Protection of seawater pumps, etc.)

1-2. Example of Strengthening of Design Basis

- 4) Reinforcement of off-site power supply (connection to different substations through multiple lines)



- 5) Protection of systems for Ultimate Heat Sink (Protection of seawater pumps, etc.)



2-1. SA Measures (Prevention of Core Damage)

New Requirements for Measures to Prevent Core Damage in case of assuming beyond Design Basis Accidents

Measures against the followings:

- 1) ATWS
- 2) Loss of reactor cooling function (at high pressure)
- 3) Loss of reactor depressurization function
- 4) Loss of reactor cooling function (at low pressure)
- 5) Loss of UHS System
- 6) Loss of support function (makeup water, power supply)

2-2. Example of Prevention of Core Damage

5) Loss of UHS System

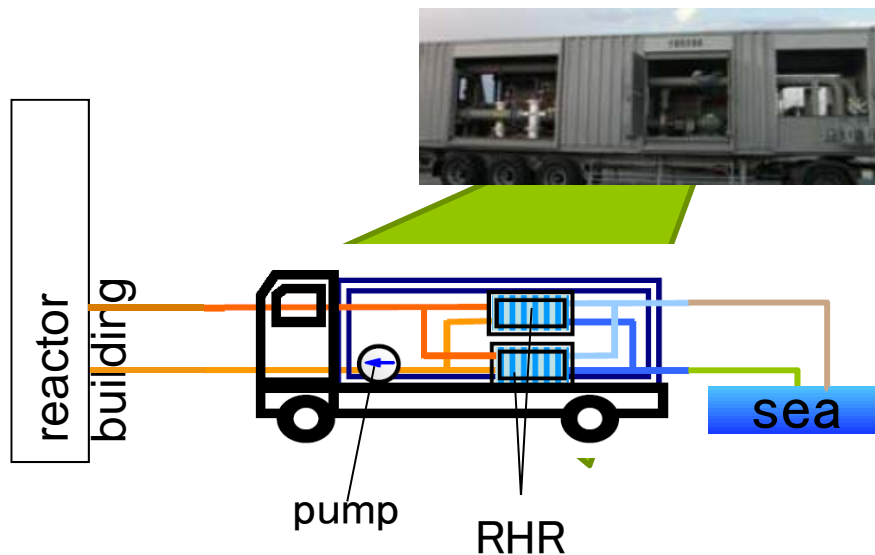
Alternative UHS System

PWR

- ✓ Through main steam relief valves to the atmosphere
- ✓ Sea water injection to RHR-S

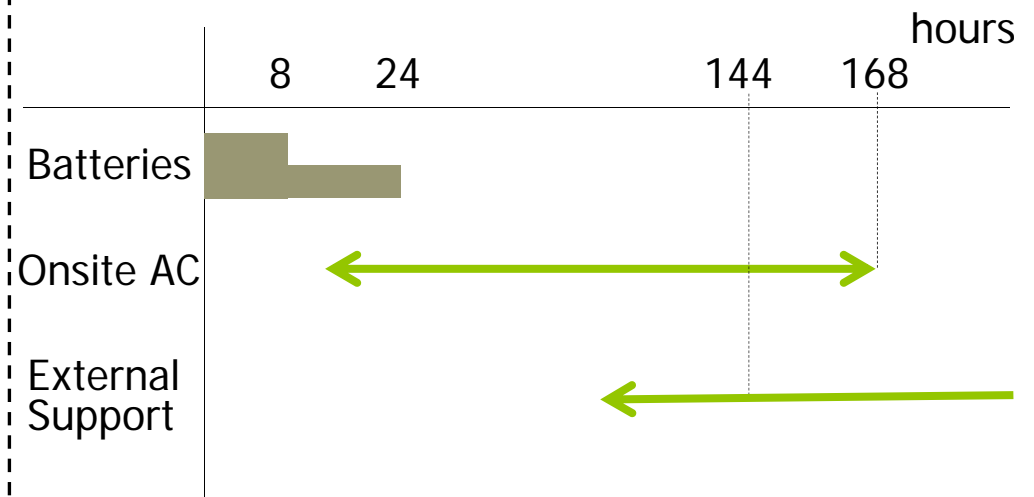
BWR

- ✓ Filtered venting system
- ✓ Mobile RHR



6) Loss of support function(SBO)

- Batteries(8hours without load shedding + 16hours with load shedding)
- Alternative onsite AC power for 7days
- External Support by the 6th day



Alternative onsite AC power (Power Vehicle)

2-3. SA Measures (Prevention of Containment Failure)

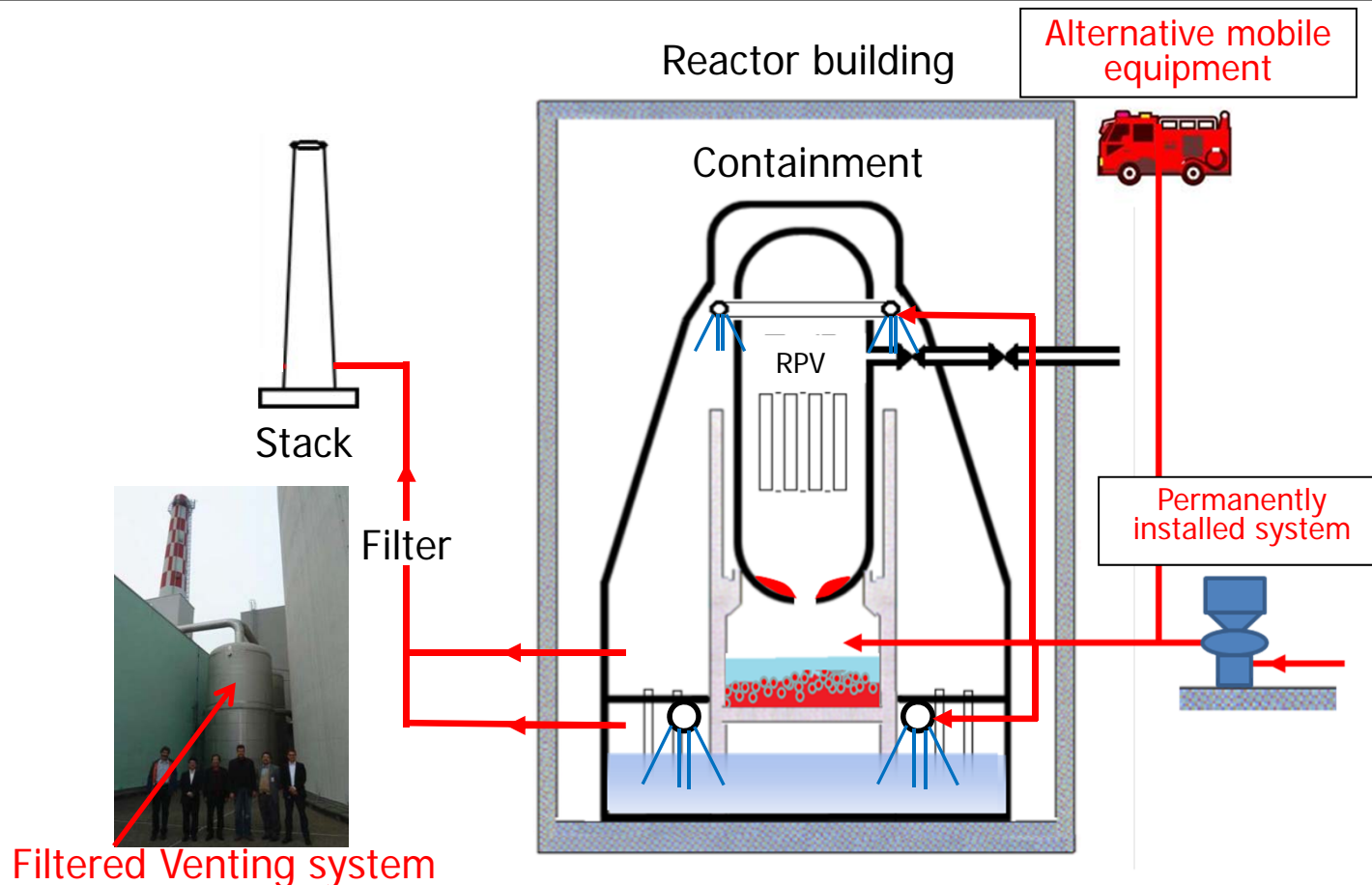
New Requirements for Measures to Prevent Containment Failure in case of postulating Core Damage

- 1) Cooling and depressurization of CV, reduction of release of radioactive materials (e.g., CV spray)
- 2) Heat removal from CV and depressurization of CV (e.g., Filtered venting)
- 3) Cooling of molten core at the bottom of CV (e.g., water injection)
- 4) Prevention of hydrogen explosion inside CV (e.g., igniter)

- 5) Prevention of hydrogen explosion at reactor building etc.
- 6) Cooling of SFP

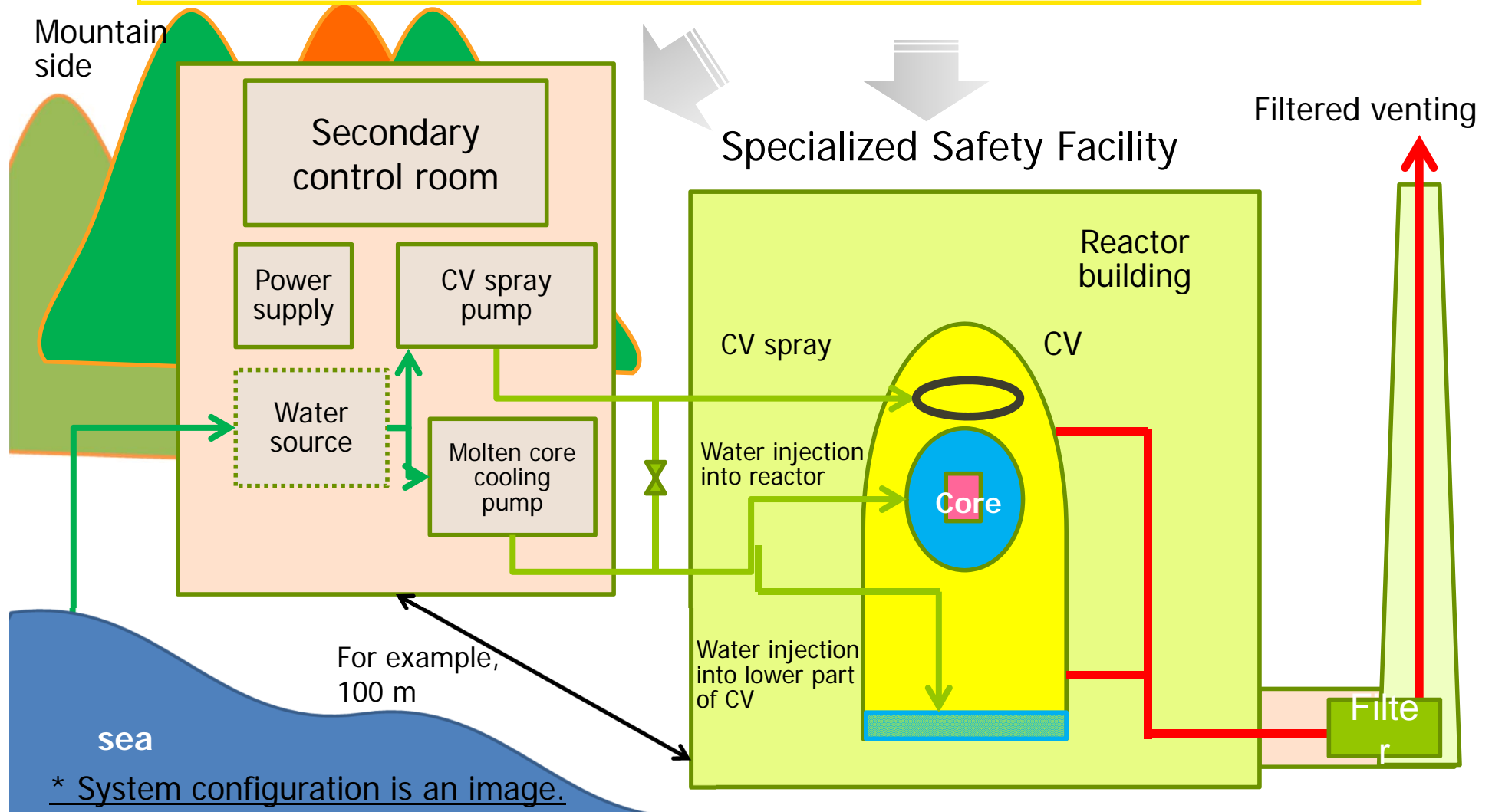
2-4. Example of Prevention of Containment Failure (BWR)

- 1) CV spray to cool and depressurize CV, and reduce release of radioactive materials.
- 2) Filtered venting to reduce the pressure and temperature inside CV in addition to reducing radioactive materials while exhausting.
- 3) Water injection system into lower part of CV to prevent CV failure due to molten core (mobile pumps, hoses etc.)



2-5. Measures against Intentional Aircraft Crash, etc.

Require a facility (Specialized Safety Facility) in case of core damage due to intentional aircraft crash



For BWR, one filtered venting for prevention of containment failure and another filtered venting of Specialized Safety Facility are required.

2-6. Measures for suppression of release / dispersion of radioactive materials

Assuming CV failure, require outdoor water spraying equipment, etc.
(Suppression of dispersion of radioactive materials by water spraying to reactor building)



Water-spraying training with a large scale
bubble water cannon system
(Osaka and Wakayama wide area
cooperative disaster prevention
committee)

(Pictures cited)

Fire fighting white paper, 2011 edition, http://www.fdma.go.jp/html/hakusho/h23/h23/html/2-1-3b-3_2.html

3-1. Enhanced Measures for Earthquake / Tsunami

Stringent Evaluation Method on Earthquake and Tsunami; Particularly Enhanced Tsunami Measures

More stringent Standards on
Tsunami



Define "Design Basis tsunami" that exceeds the largest in the historical records and require to take protective measures such as breakwater wall based on the design basis tsunami

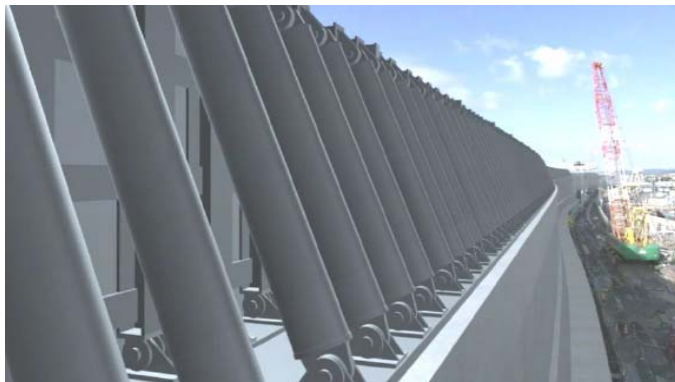
Enlarged Application of
Higher Seismic Resistance



SSCs for tsunami protective measures are classified as Class S equivalent to RPV etc. of seismic design importance classification

<Example of tsunami measures (multiple protective measures) >

○ Breakwater Wall
(prevent inundation to site)



○ Tsunami Gate
(prevent water penetration into the building)



More stringent criteria for active faults



Active faults with activities later than the Late Pleistocene (later than 120,000-130,000 years ago) be considered for seismic design

Activities in the Middle Pleistocene (later than 400,000 years ago) be further investigated if needed

More precise methods to define design basis seismic ground motion



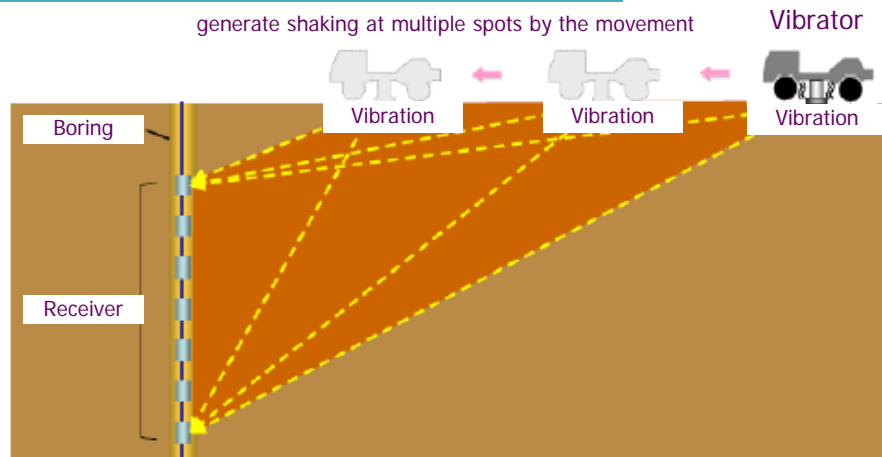
3D observation of underground structure of the site

Clarification of requirements for "displacement and deformation" in addition to the seismic ground motion



Class S buildings should not be constructed on the exposure of active faults

Example of geophysical exploration




The underground structure is explored by generating a vibration by vibrator and analyzing the signals received in a borehole.



Nuclear Emergency Response Guidelines

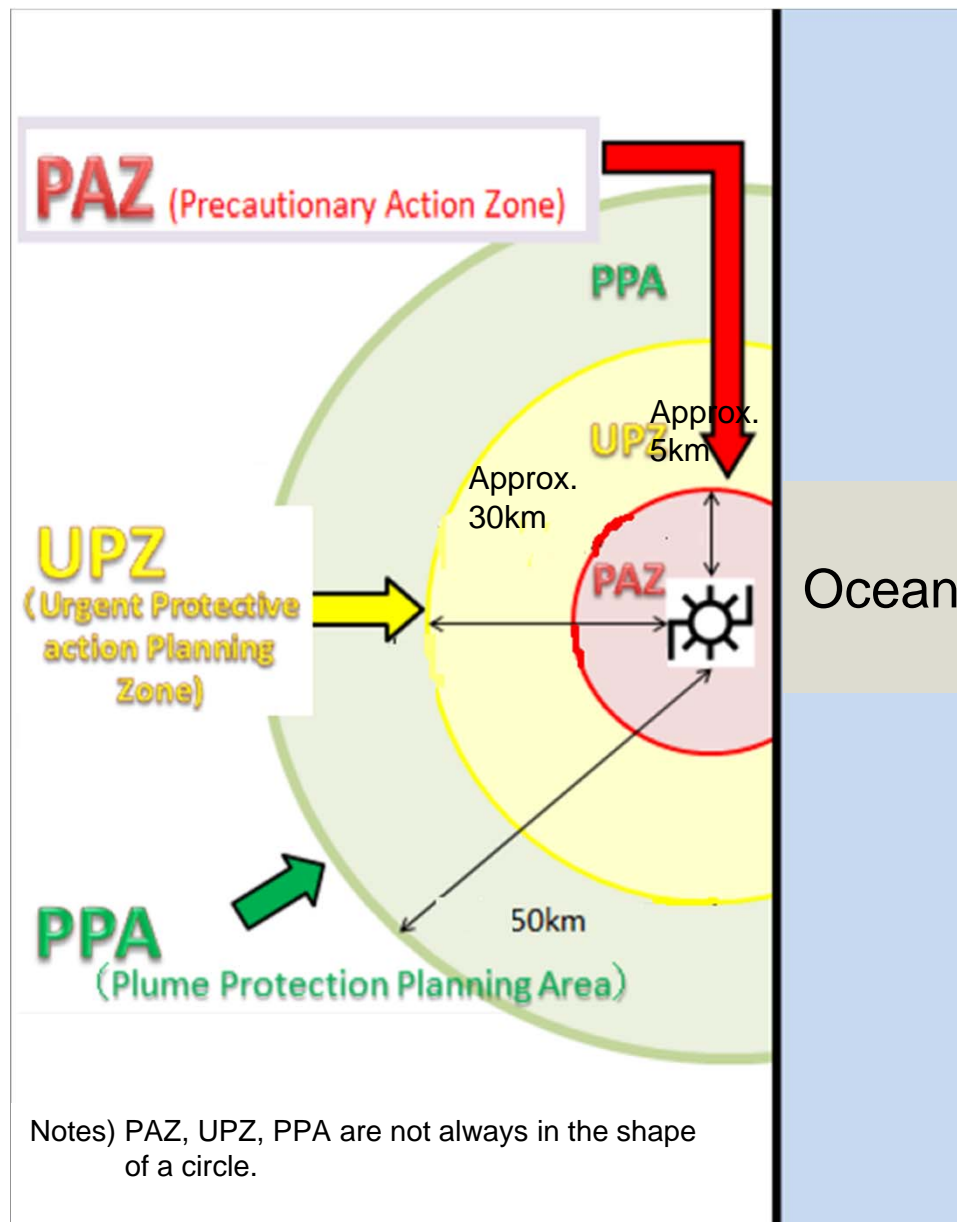
Emergency preparedness and response in off-site areas

- ◆ Nuclear Emergency Preparedness Guidelines were developed (Oct. 31).
Expanded evacuation preparing zone.
The area within about 5km radius from the site is designated as PAZ and that within about 30km radius as UPZ.
- ◆ Study on EAL and OIL underway by experts' group.



Reflecting the Nuclear Emergency Response Guidelines on the Regional Disaster Prevention Plan being revised by local governments.

Illustration of Zones regarding Disaster Response Measures



PAZ: Precautionary Action Zone

(a zone approximately 5 km away from the plant)

An area where precautionary measures will be taken such as immediate evacuation prior to the release of radioactive materials to the environment based on emergency classification in order to avoid severe deterministic effects in the light of accidents that develop rapidly.

UPZ: Urgent Protective action planning Zone

(a zone approximately 30 km away from the plant)

In accordance with the international standards and other standards, to reduce the stochastic effects to residents within the zone as much as possible, arrangements need to be in place to evacuate, stay indoors, provide stable iodine in line with the levels based on the result of environmental monitoring, e.g., the Operational Intervention Level (OIL), the Emergency Action Level (EAL).

(may consider in future)

PPA: Plume Protection planning Area

An area where protection measures will be implemented such as staying indoors for residents to reduce the exposure to plumes containing radioactive materials (a cloud of air containing radioactive materials in the form of gas or particles).

Determination of the zones for which arrangements should be made for protective actions

- The area where immediate evacuation will be carried out before the release of radioactive material just after the declaration of General Emergency judged by EAL.



Setting of PAZ (approx. 5 km)

- The area where protective measures such as evacuation or sheltering will be conducted based on the environmental measurements and criteria of OIL.



Setting of UPZ (approx. 30 km)

Reduction of stochastic effects in accordance with the international standards

Based on lessons learned in the accident, OILs are suggested as below in Japan.

- OIL1: 500 $\mu\text{Sv/h}$ Evacuation or sheltering indoors (within hours)
- OIL2: 20 $\mu\text{Sv/h}$ Temporary relocation (within 1 week)
- (OIL3): 0.5 $\mu\text{Sv/h}$ Contamination screening of food and drink
- OIL4: 40,000 cpm Decontamination of the body (prompt action)
- OIL5: (Not applied) Screening level for assessment of food and drink using OIL6
- OIL6: (According to nuclide analysis) Restriction of food and drink intake

Japan's situations in defining OILs

- GM survey meters commonly used in Japan have larger diameter than that of IAEA.
- The criterion (OIL2) used for early protective actions of temporary relocation is defined to reflect the lessons learned from the Fukushima accident.
- In Japan, as radionuclides in environmental samples can be measured easily, screening levels for further assessment i.e., OIL5 was not defined.



Other Major Issues

Field Surveys of Fracture Zones

- Started additional field surveys at three NPP sites (Oi, Tsuruga and Higashidori)
- NRA organized experts' team to conduct field surveys.



International collaborations in the field of Nuclear Safety Regulation

- China, Korea and Japan TRM (Nov.2012)
- Fukushima Ministerial Conference (Dec. 2012)
- ANSN, GNSSN
- INRA
- Bilateral information sharing
- Bilateral technical cooperation
- IAEA activities incl. 2014 report on Fukushima accident.



Expectation for GNSSN

What roles GNSSN should play?

- Regional framework like ANSN is a strong vehicle to maintain high regional safety level and good public acceptance in a harmonized and effective way.
- Especially, lessons learned from Fukushima accident are updated continuously, so “**anti-obsolescent**” information sharing is crucial.
- GNSSN should seek, promote and disseminate better practices or strategies of regional cooperation, and give good motivation to each forums in order to prevent obsolescence.
- Also, GNSSN can play a effective conveyer of feedbacks between regional forums and IAEA activities.



Thank you for your attention !