JNES Incorporated Administrative Agency
Japan Nuclear Energy Safety Organization

Current Regulatory Actions Taken in Japan

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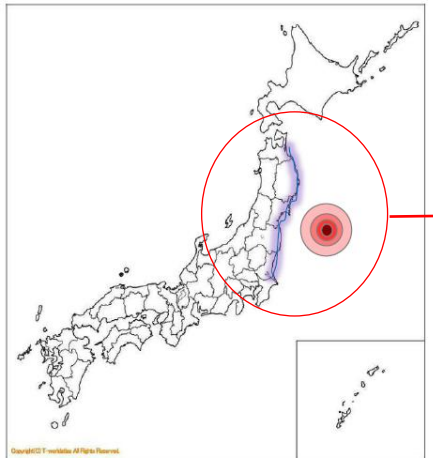
Contents

Current Status: Evacuation

Source: Current Status and Path Toward Reconstruction, **May 2013**, Reconstruction Agency

- More than **300,000 people** are still obliged to live away from home due to tsunami / earthquake and Fukushima accident.



Casualties

- Deceased : over 15,800
- Unaccounted for: over 3,200
- Injured: over 6,000

Evacuees

- Over 321,000 as of December 2012

- Approximately 1/3 of them are from the **Evacuation Order Area**.
  - Approx. **107,000** persons in total

≪Areas with no restrictions on new business or entry≫

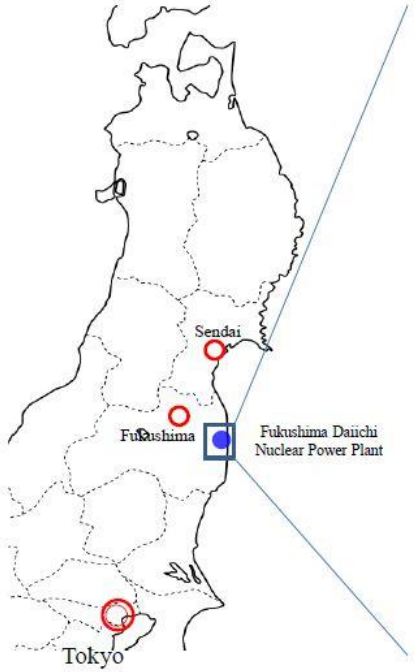
Evacuation order ready to be lifted — Approx. 33,000 persons

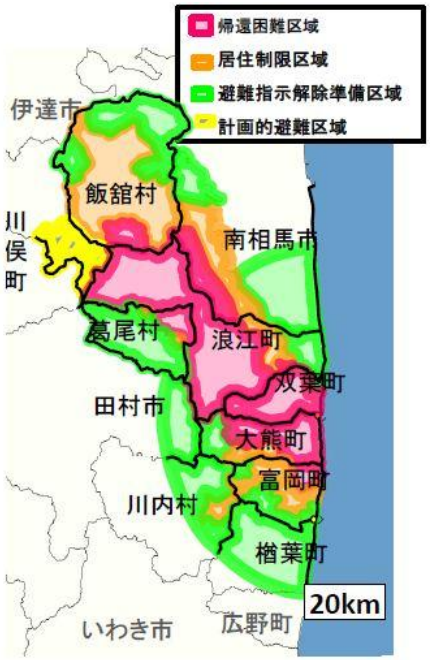
≪Areas with restrictions still in place≫

Deliberate Evacuation Area — Approx. 1,000 persons

Residents are not allowed to live in — Approx. 25,000 persons

Long-term evacuation inevitable — Approx. 25,000 persons

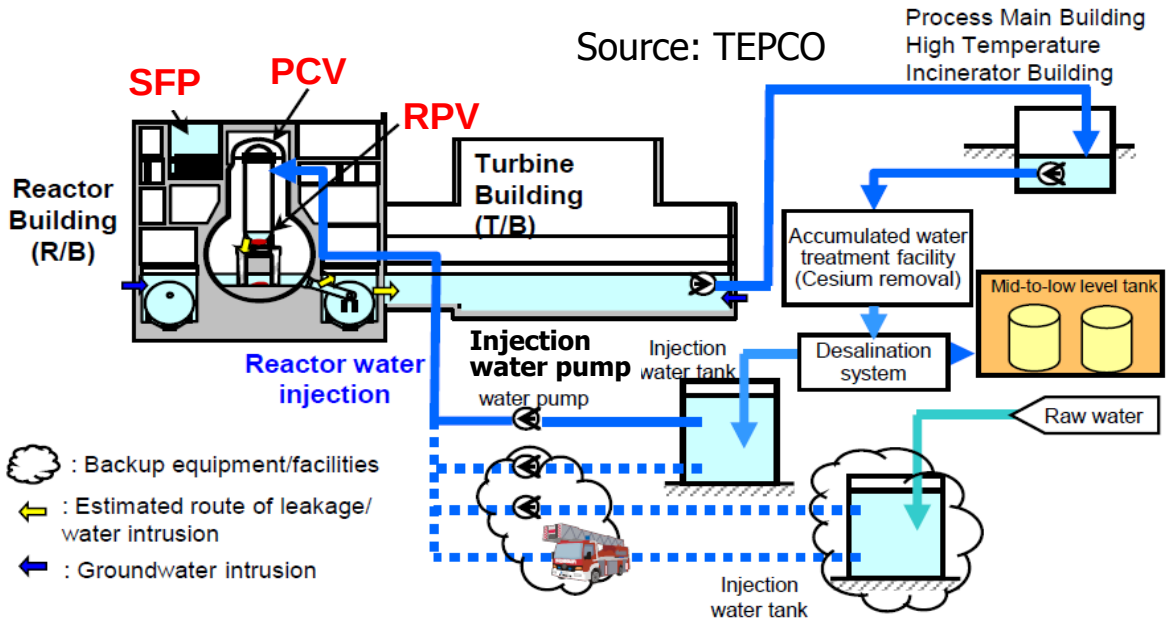


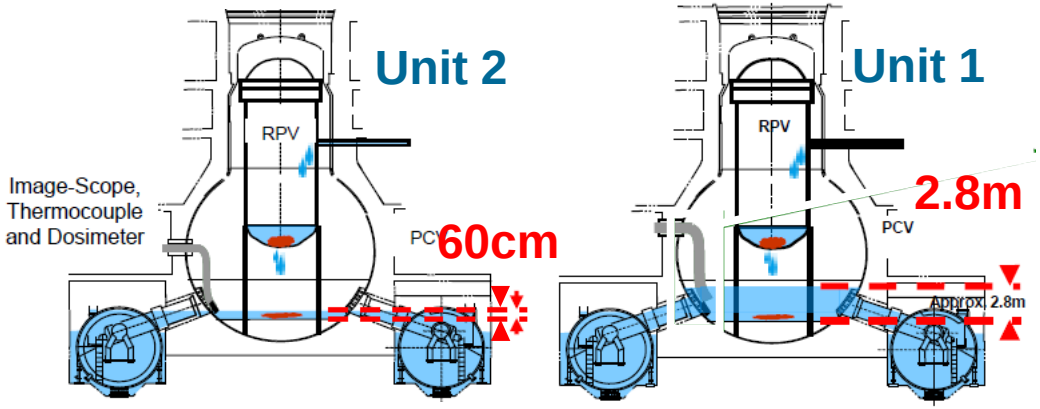


Current Status of Fukushima Dai-ichi

- **Stable debris cooling has been maintained in Units 1 - 3.**
  - RPV bottom temperatures and gaseous phase temperatures inside RPVs are app. 30-50°C (Nov. 6, 2012).
- **Visual inspections** have been done inside PCVs by using cables with image scopes, thermocouples and dosimeters in Units 1 and 2:
  - **In Unit 2**, max. radiation dose was app. 73 Sv/h and water level was app. **60 cm** from the bottom (Jan. 19 and May 26–27, 2012).
  - **In Unit 1**, max. radiation dose was app. 11.1 Sv/h and water level was app. **2.8 m** from the bottom (Oct. 9-13, 2012).

Source: TEPCO





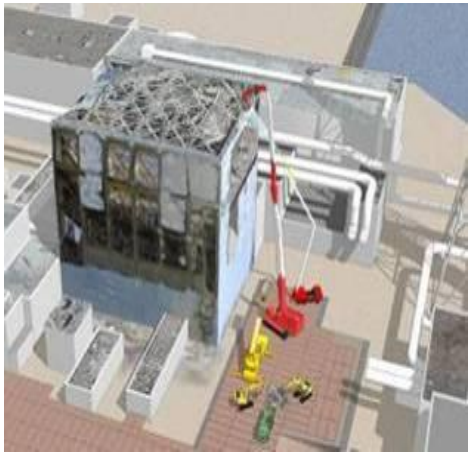
Source: TEPCO

Mid-and-Long-Term Roadmap towards Decommissioning

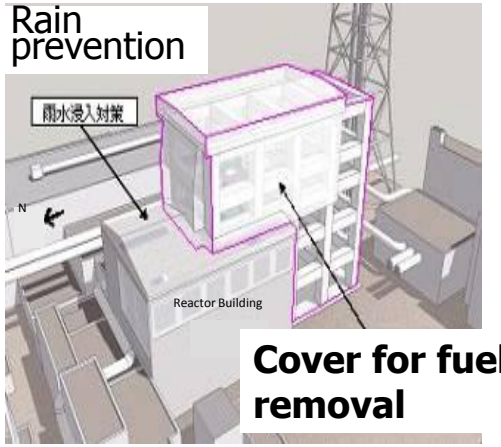
- On **December 21, 2011**, the government and TEPCO jointly set forth **the roadmap**:
  - **Phase 1**: **start removal of fuel from SFPs within 2 years**
    - ✓ Fuel removal from **Unit 4 SFP** will start **till the end of this year**
  - **Phase 2**: **start removal of fuel debris within 10 years**
    - ✓ **Complete the debris removal in 20-25 years**
  - **Phase 3**: **end decommissioning in 30 – 40 years**
- **Two fresh fuel assemblies** were removed from Unit 4 SFP for testing on **18-19 July 2012**.

SOURCE: TEPCO

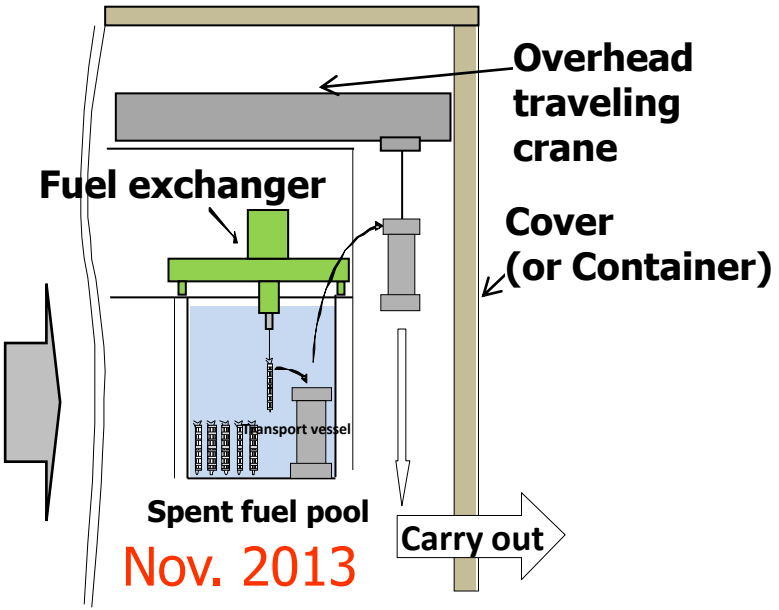
Start by Nov. 2013, complete by Dec. 2014



Debris removal from the upper part of the Reactor Building



Cover installation for fuel removal Mid 2013



Nov. 2013

Current Status of NPPs and Safety Regulation in Japan

- Currently, only **2 units** (Ohi Units 3 and 4) are in operation while the other 48 units are in shutdown.
  - Since **May 2012**, all the units had been in shutdown.
  - After the stress test, the two units restarted in **July 2012**.
- The National **Diet's** Fukushima Nuclear Accident Independent Investigation Commission reported to the Diet in July 2012.
- The **Nuclear Regulation Authority (NRA)** was established on **September 19, 2012**.
  - NRA has developed the draft **regulatory requirements** that consists of 3 volumes:
    - ✓ **Design Basis,**
    - ✓ **Beyond-Design Basis** incl. **aircraft crash**, and
    - ✓ **Earthquake and tsunami.**

  - Fukushima lessons learned,
  - International standards,
  - Approaches in other countries:
    - **FLEX** concept in US,
    - **Hardened safety core, bunkered system**, etc. in EU

  - The new requirements shall be established **by July 2013** and will be applied to all the existing NPPs (**backfitting**)

The National Diet's Fukushima Nuclear Accident Independent Investigation Commission

Reported to the Diet on July 5, 2012

Message from Chairman

- … this was a disaster "**Made in Japan**." Its fundamental causes are to be found in the **ingrained conventions** of **Japanese culture**: our **reflexive obedience**; our **reluctance to question authority**; our **devotion to 'sticking with the program'**; our **groupism**; and our **insularity**.

Organizational issues …

- … The Commission found that actual relationship **lacked independence and transparency**, and was far from being a "safety culture." In fact, it was a typical example of "**regulatory capture**," in which the oversight of the industry by regulators effectively ceases.

Conclusions

- … **The lack of expertise** resulted in "**regulatory capture**," and the postponement of the implementation of relevant regulations. They **avoided their direct responsibilities** by letting operators apply regulations on a **voluntary** basis.

http://warp.da.ndl.go.jp/info:ndljp/pid/3856371/naiic.go.jp/en/report/

Amendments to the Nuclear Regulation Act
promulgated on June 27, 2012

- New regulation on **severe accidents**
  - Legally require to take measures to prevent and mitigate the consequence of severe accidents
- Regulation based on the **state-of-the-art** knowledge
  - Require compliance with NRA's **regulatory requirements** and apply to existing nuclear facilities (**backfitting**)
  - Introduce new systems, e.g. design certification of SCCs.
- Continuous improvement
  - Require licensees to conduct "**Safety assessment for safety enhancement**" periodically and to make the results open to the public
- Introduce legal "**limit of operation**" **of 40 years** for NPPs
  - NRA can permit **less-than-20-years extension** just **once**
- Special regulation to **disaster-experienced NPPs**
  - Fukushima Daiichi Units 1 to 6

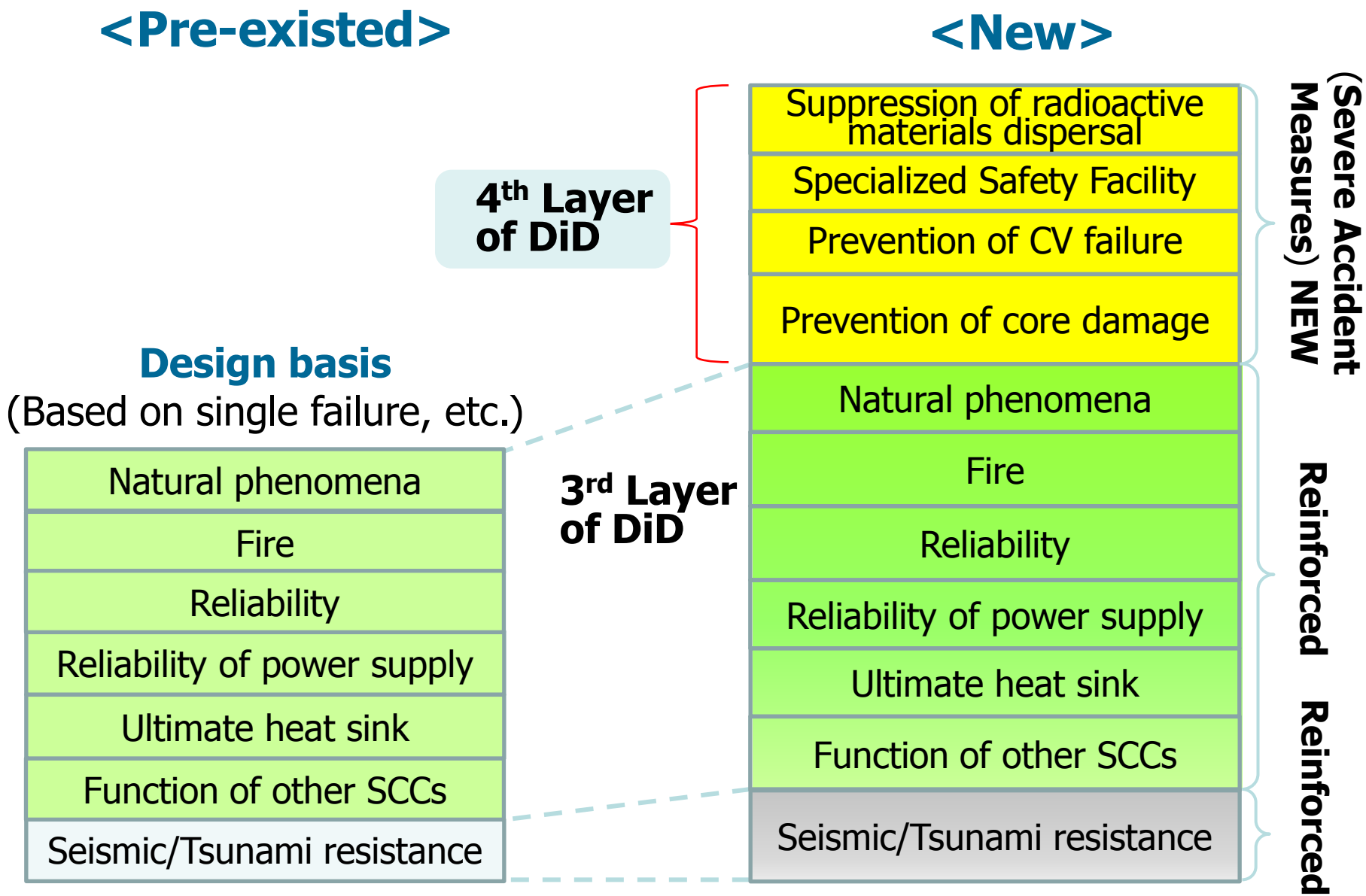
Basic Policy of Regulatory Requirements Proposed by NRA

- Place emphasis on **Defense-in-Depth** (DiD)
  - Prepare multi-layered protective measures and, for each layer, achieve the objective only in that layer regardless of the measures in the other layers.
- Eliminate **common cause failures**
  - Strengthen **fire protection** and measures against **tsunami inundation**.
  - Enhanced reliability of SSCs important to safety (eliminate shared use of passive components, if relied on for a long time).
- Assess and enhance protective measures against **extreme natural hazards**
  - Introduce accurate approaches in assessment of earthquake and tsunami and measures against tsunami inundation.
  - Make much account of "**diversity**" and "**independence**", shift from "**redundancy centered**".
- Define "**functional**" **requirements**
  - **Provide flexibility** in choosing **acceptable measures**.

Characteristics of Measures against Severe Accidents and Terrorism

- Prepare multi-layered protection for
  - Prevention of **core damage**,
  - Maintaining **containment integrity**,
  - **Suppression of radioactive materials dispersion**.
- Use **mobile equipment** as a base, as in U.S., and enhance reliability with **permanent systems/equipment**.
- Enhance protective measures in **spent fuel pool**.
  - Water level measurement, alternative water supply, **spray cooling**, etc.
- Improve **command communication** and **instrumentation**.
  - Reinforced seismic-resistance of **on-site emergency response center**,
  - Improved reliability/durability of **communication system**,
  - **Enhanced instrumentation** including in spent fuel pool.
- Introduce "**Specialized Safety Facility**" against intentional **aircraft crash**, etc.

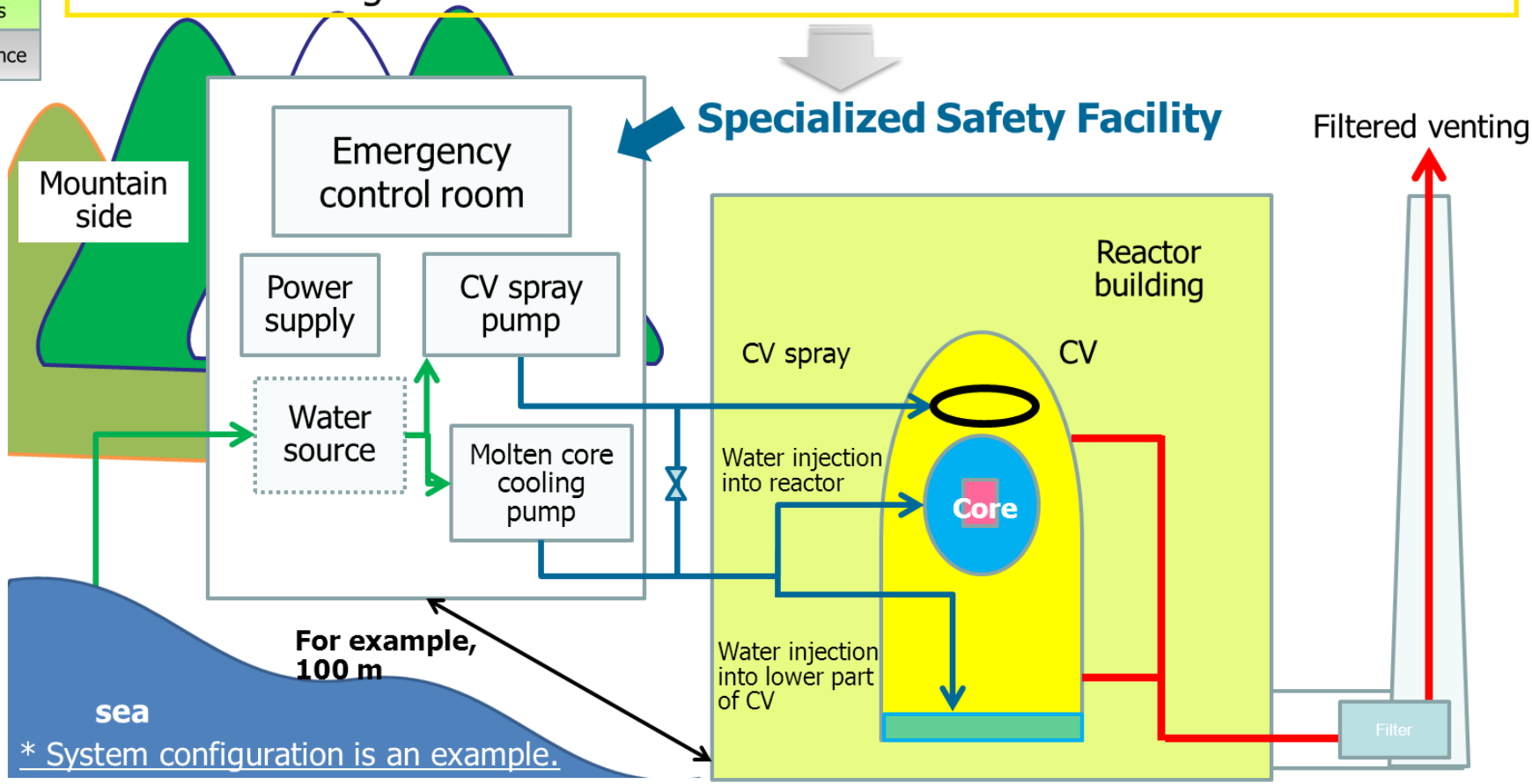
Structure of Proposed Requirements



Suppression of radioactive materials dispersal
Specialized Safety Facility
Prevention of CV failure
Prevention of core damage
Natural phenomena
Fire
Reliability
Reliability of power supply
Ultimate heat sink
Function of other SCCs
Seismic/Tsunami resistance

Measures against Intentional Aircraft Crash, etc.

Require "Specialized Safety Facility" to mitigate release of radioactive materials after core damage due to intentional aircraft crash



For BWR, one filtered venting for prevention of containment failure (p.19) and another filtered venting of Specialized Safety Facility are acceptable solution.

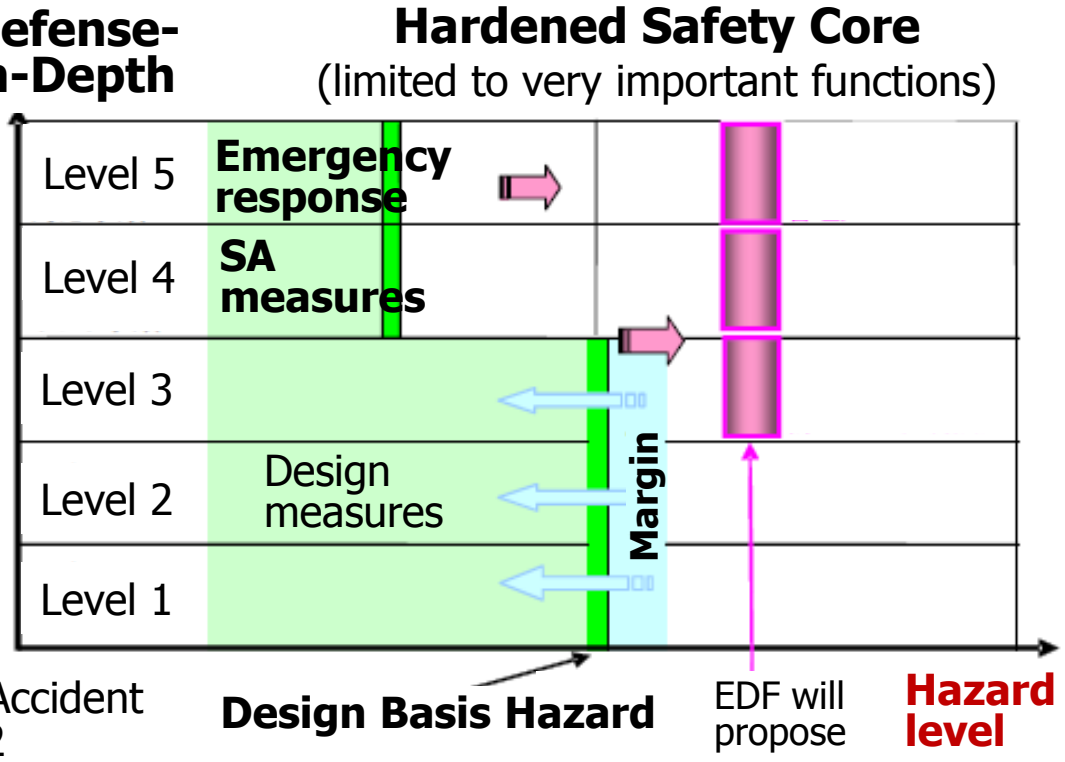
French Approach:
Hardened Safety Core

- **ASN** asked the licensees to propose a "**hardened safety core**" of **hardware** and **organizational measures** for each facility.
  - **Enhanced Robustness** of a **minimum set of hardware and software** indispensable to maintain safety

Source: Nuclear Safety Authority (ASN) opinion nº 2012-AV-0139, 3 January 2012

DiD for external hazard

- "**Hardened safety core**" is a proposal for enhancement of **plant robustness** against external hazards.
- **Two-dimensional expression** of defense-in-depth



Source: Report on Severe Accident Measures, NISA, Aug. 2012

Suppression of radioactive materials dispersal
Specialized Safety Facility
Prevention of CV failure
Prevention of core damage
Natural phenomena
Fire
Reliability
Reliability of power supply
Ultimate heat sink
Function of other SCCs
Seismic/Tsunami resistance

Measures to Suppress Releases of Radioactive Materials

- Measures against large release of radioactive material in case of:
  - Core damage and CV failure
  - Significant damage of fuels in SFP
- Example:
  - **Outdoor water spraying system** to reactor building/SFP against release of radioactive materials

Water-spraying by a large capacity water cannon system

(Pictures cited)
Upper: Fire fighting white paper, 2005 edition, http://www.fdma.go.jp/html/hakusho/h17/h17/html/17705k10.html
Lower: Fire fighting white paper, 2011 edition, http://www.fdma.go.jp/html/hakusho/h23/h23/html/2-1-3b-3_2.html

Prevention of Core Damage

- It is required to take measures to **prevent core damage** postulating **event sequences** such as (example of BWR):

1) Loss of high and low pressure coolant **injection functions**
2) Loss of high pressure coolant **injection function**, and loss of **RPV depressurization function**
3) Loss of **ultimate heat sinks** (LUHS)
4) Loss of **support function** (station blackout (SBO), etc.)
5) **ATWS**
6) Loss of coolant **injection function** during **LOCA**
7) Containment bypass (**Interface system LOCA**)

Examples of Measures for Prevention of Core Damage

3) Loss of Ultimate Heat Sinks

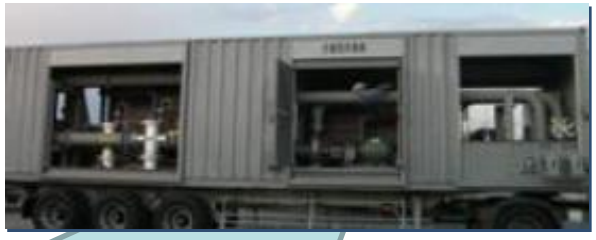
- Alternate UHS

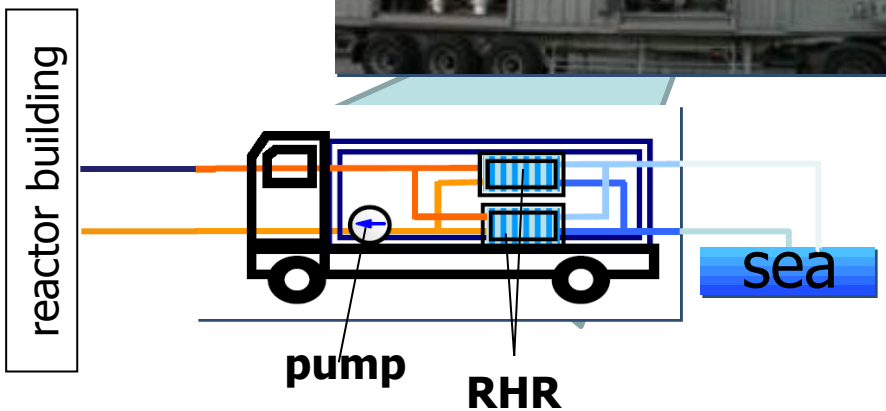
PWR

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

BWR

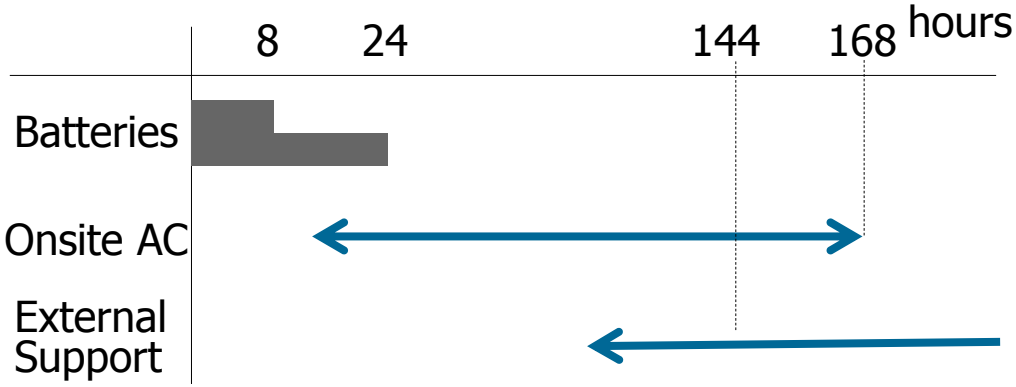
- ✓ **Filtered venting system**
- ✓ **Mobile RHR**



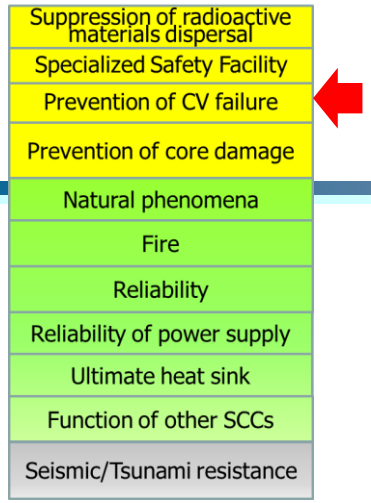


4) Loss of support function (SBO)

- Batteries: **24 hours** (**8 hours** without load shedding + **16 hours** with load shedding)
- **3rd station battery system**
- Alternate on-site AC power for **7 days**
- External Support **by the 6th day**



Alternate on-site AC power (Power vehicle)



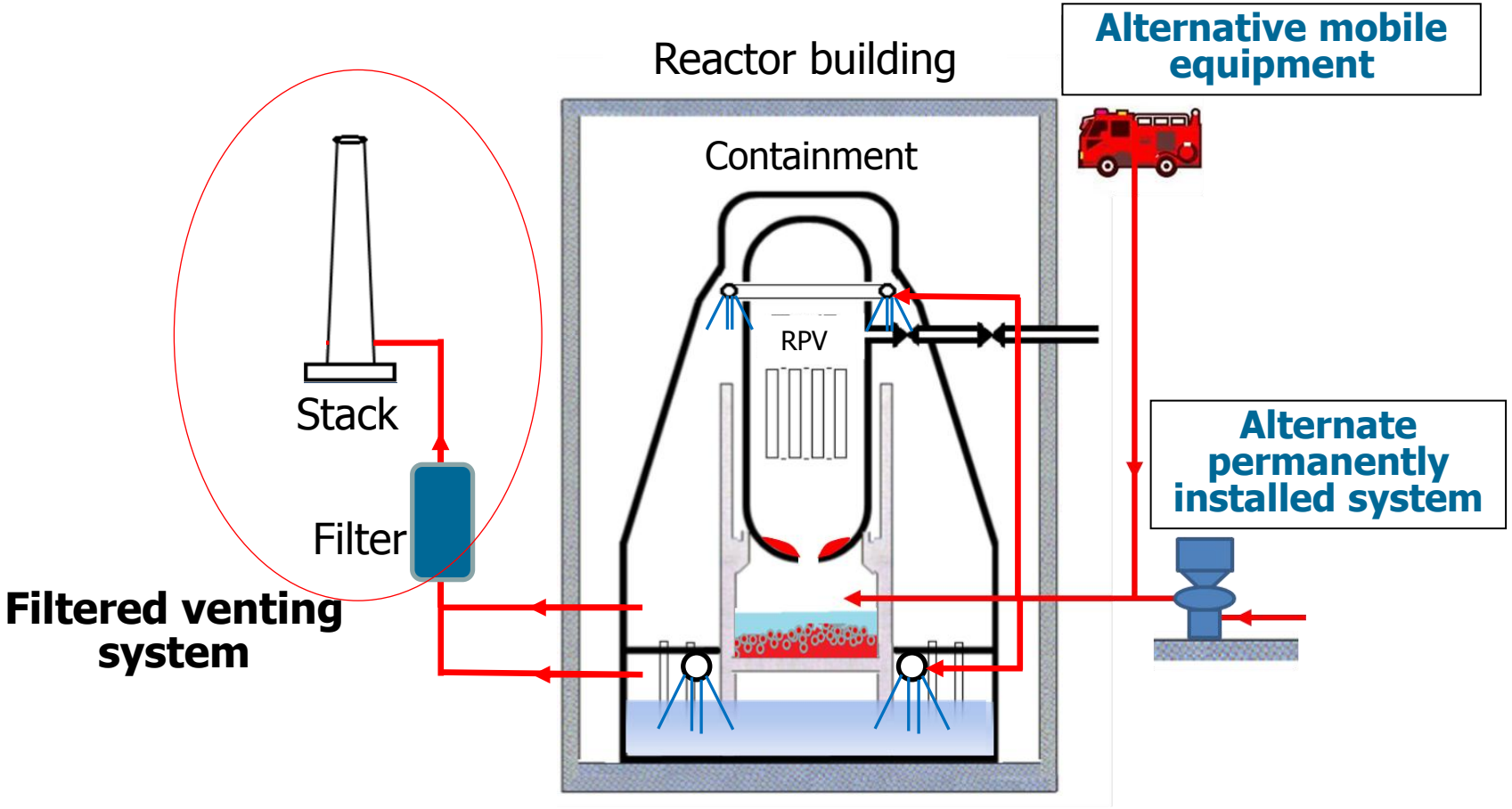
Prevention of Containment (CV) Failure

- It is required to take measures to **prevent containment failure** against **severe accident phenomena** ("**CV failure modes**"):

1) **Over pressure** and **over temperature**
2) **High pressure melt ejection / Direct Containment Heating (DCH)**
3) **Fuel-Coolant Interaction (FCI)** inside CV
4) **Hydrogen explosion** inside CV
5) **Shell attack** (BWR)
6) **Molten-Core-Concrete Interaction (MCCI)**

Examples of Measures for 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.
3) **Water injection** system into **lower part of CV** to prevent CV failure due to **MCCI** (Molten core Concrete Interaction), etc. (mobile pumps, hoses etc.)



Severe Accident Measures (Others)

- It is required to take measures to prevent reactor building damage, fuel damage in spent fuel pool, etc.

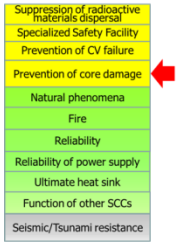
1) Prevention of **hydrogen explosion** at **reactor building**, etc.
2) Maintaining cooling of **spent fuel pools**
3) Prevention of fuel damages **during shutdown**
4) Installation of **Emergency Response Center** (On site)

Plant Specific PRA for "Effectiveness evaluation" of Severe Accident Measures

- It is required to conduct **plant specific PRA** for both **internal events** and **external events** to identify, if any,
  - Risk significant **"Event sequences"** and **"CV failure modes"**

  in addition to **those defined by NRA** and to take measures.

"Event sequences" and "CV failure modes" defined by NRA



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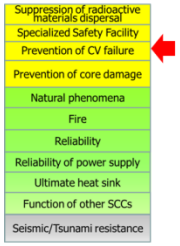

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Enhanced Measures against Tsunami

More stringent standards on tsunami

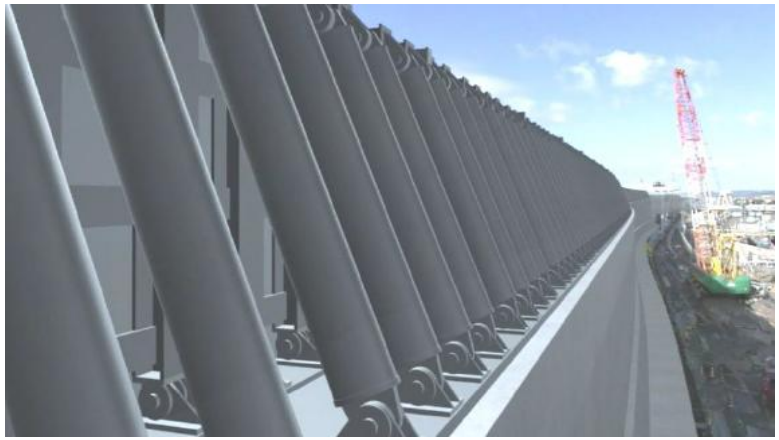
Define "Design Basis tsunami" that exceeds the largest in the historical records and require to take protective measures such as breakwater wall based on the design basis tsunami

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)

Enhanced Measures against Earthquake

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

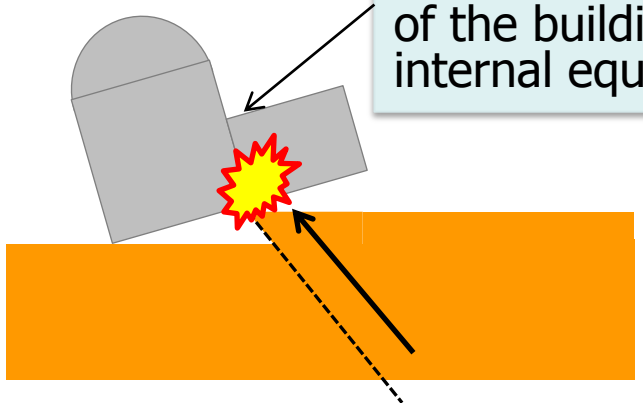
More precise methods to define design basis seismic ground motion

3D observation of underground structure of the site

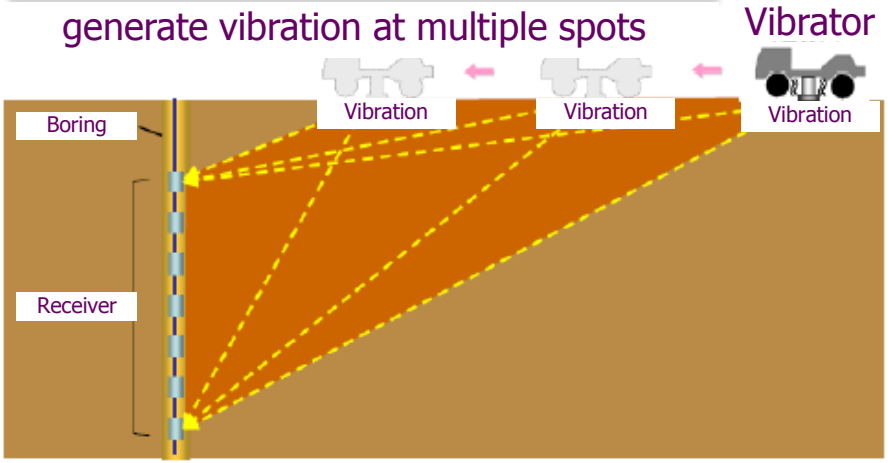
Clarification of requirements for "**displacement and deformation**" in addition to the seismic ground motion

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

Risk of loss of safety functions due to damages of the building and its internal equipment



Example of geophysical exploration



Current Status of Proposed Regulatory Requirements

- The draft requirements had been posted for public comments for 30 days from **April 11 to May 10, 2013**.
- They are expected to **come into force in mid-July 2013**.
  - It is being proposed that compliance be required from **5 years after the enforcement of the requirements for** "back-up measures for further reliability enhancement" such as:
    - ✓ **"Specialized Safety Facility"** against intentional airplane crash, etc.
    - ✓ **"Third station battery system"** (back-up permanent DC)

Summary

- Approximately **100,000** people are still obliged to live away from home due to land contamination.
- New regulatory framework has been established learning from international practices and Fukushima lessons.
- The NRA has proposed the new **Regulatory Requirements** that include requirements characterized by:
  - Measures against **beyond DBAs** including severe accidents,
  - Those against **extreme natural phenomena** beyond design basis,
  - "**Specialized Safety Facility**" against **terrorism** incl. **intentional aircraft crash**, etc., and
  - Use of **plant specific PRAs** for **internal** / **external events**.
- Based on the lessons learned from the Fukushima, we need to construct a new system pursuing **continuous improvement** of safety.

Appendix

Reform of Nuclear Regulatory Organisations

- **Independence**: Separate nuclear regulation function and nuclear promotion function and establish the "Nuclear Regulation Authority (NRA)", as an independent commission body affiliated to the MOE. Chairman and Commissioners are appointed by the Prime Minister after the approval of the National Diet.
- **Integration**: Integrate nuclear regulation functions, namely, nuclear safety, security, safeguards, radiation monitoring and radioisotopes regulation, into the NRA.
- **Crisis Management**: Establish "Nuclear Emergency Preparedness Commission (NEPC)" in a cabinet and implement nuclear emergency prevention measures in close cooperation with relevant organisations.

Current Organisations

- Cabinet Office
- Atomic Energy Commission (AEC)
  - Nuclear Security Policy
- Nuclear Safety Commission (NSC)
- Ministry of Economy, Trade and Industry (METI)
  - Agency for Natural Resources and Energy (ANRE)
  - Nuclear and Industrial Safety Agency (NISA)
    - Nuclear Power Plants Regulation, etc.
- Ministry of Education, Culture, Sports, Science and Technology (MEXT)
  - Research Reactors Regulation
  - Safeguards *
  - Radiation Monitoring *
  - Radioisotopes Regulation, etc. *

Double Checking

- JNES
- JAEA
  - Nuclear Research, etc. *
- NIRS
  - Radiation Research, etc. *

Independent Administrative Agencies
- JNES: Japan Nuclear Energy Safety Organisation
- JAEA: Japan Atomic Energy Agency
- NIRS: National Institute of Radiological Sciences

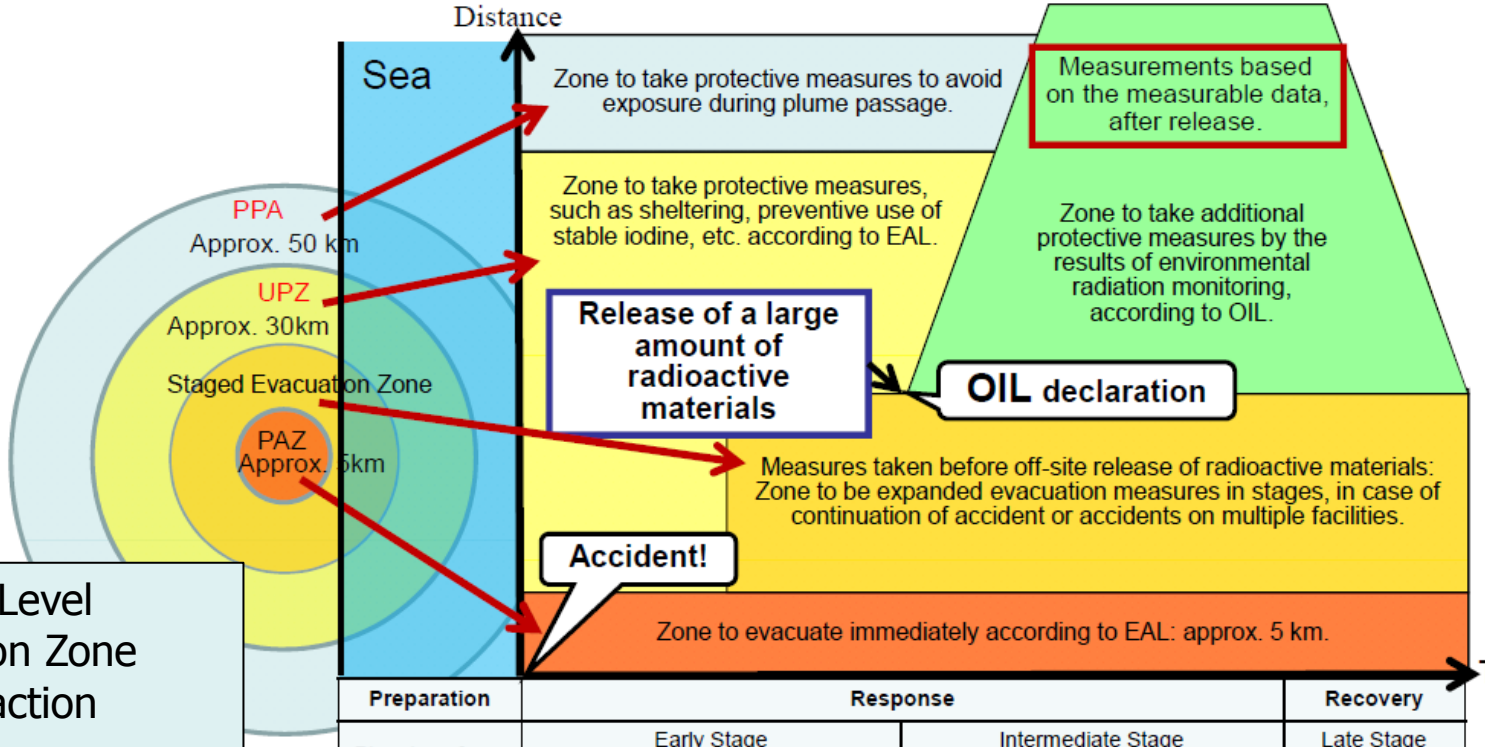
* Transferred by 1st April 2013

New Organisation

- Ministry of the Environment (MOE)
- Nuclear Regulation Authority (NRA)
  - Commission: Chairman and 4 Commissioners
  - Secretariat
- Merged into the NRA after necessary legal arrangements
- JAEA
  - Nuclear Research, etc.
- NIRS
  - Radiation Research, etc.
- JNES

Emergency Preparedness and Response

- In Feb. 27, 2013, the NRA revised the **Nuclear Emergency Response Guidelines** in light of **international standards** and lessons learned from the Fukushima accident.



Preparation	Response				Recovery
Planning of • EAL • ETE • OIL • PAZ • UPZ	Early Stage		Intermediate Stage		Late Stage
	Event/Response Initiation (for several days)	Crisis Management (for one week)	Consequence management (for several months)	Transition to Recovery (for one year)	Recovery/Long-term Rehabilitation
	Emergency exposure situation				Existing exposure situation
Resident protective action	**Evacuation &KI to PAZ according to EAL,**	**Staged evacuation to UPZ according to EAL etc.**	**Relocation by OIL,**	**Measures for restoration (temporal re-entry)**	**Recovery activities**

EAL: Emergency Action Level
PAZ: Precautionary Action Zone
UPZ: Urgent Protective action planning Zone
PPA: Plume Protection Planning Area(may consider in future)
OIL: Operational Intervention Level
ETE: Evacuation Time Estimates

Off-site Decontamination Activities

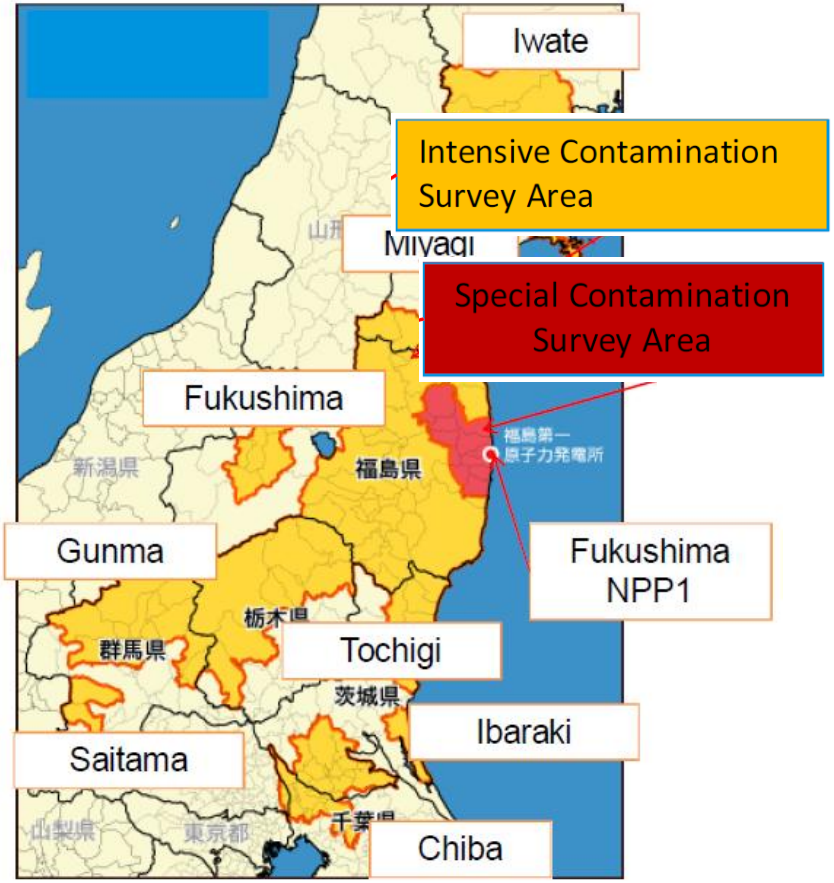
- Decontamination work has been planned/implemented in accordance with the **Act on Special Measures** concerning the Handling of Radioactive Contamination, that came into force on **January 1, 2012**.
- Removed soil, etc. generated from the work is to be collected, transferred, temporally stored, and disposed of safely based on the Act.

Special Decontamination Area

- (Former) Restricted or planned evacuation zone
- Decontamination is **implemented by the government** in accordance with the plan prepared for each municipality taking into account its opinion.

Intensive Contamination Survey Area

- Equivalent to over 1 mSv/Year
- Decontamination is **implemented by each municipality** in accordance with its plan prepared based on the result of survey, etc.
- **The government takes financial and technical measures.**



Japan's Progress Report, NRA, 4th Meeting of STG-FUKU, 8 Oct. 2012.

"Interim Storage Roadmap"

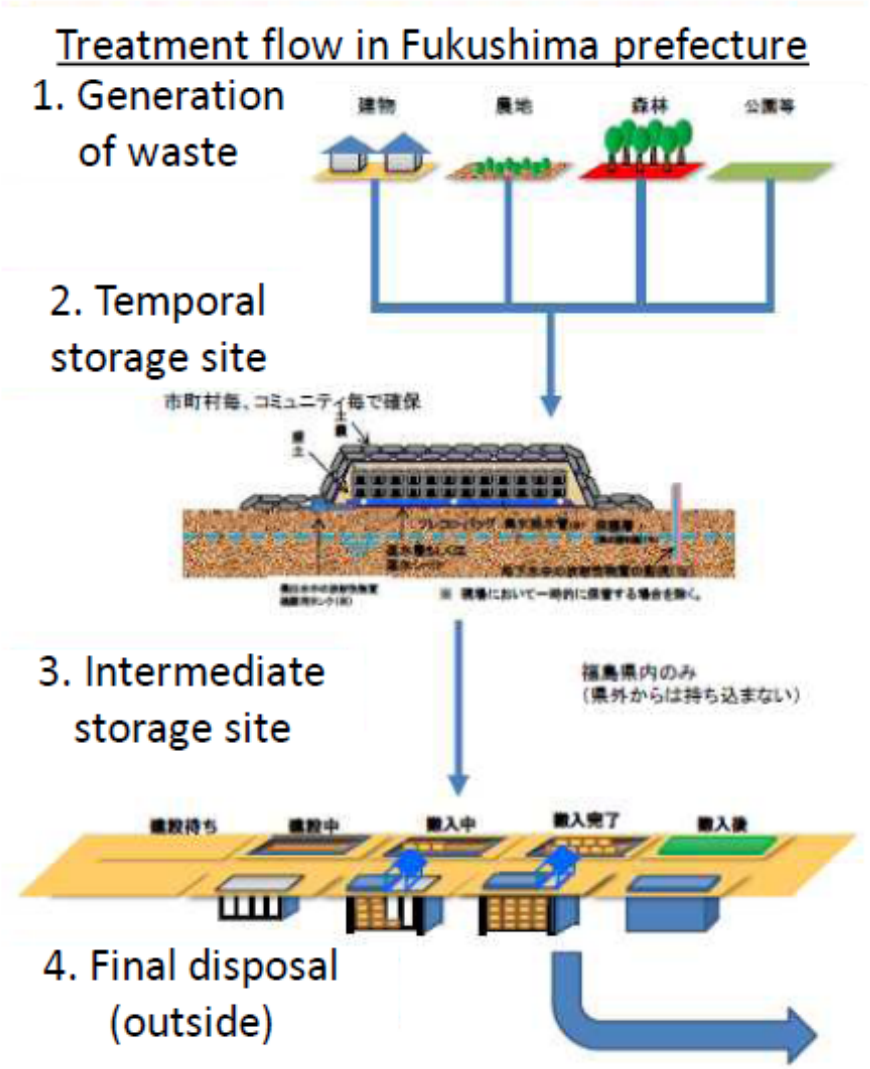
- Temporal storage: about 3 years
  - Placed In each municipality or community
  - In Special Decontamination Areas: MOE builds facilities
  - Other areas: municipalities builds ones with financial and technical support from MOE
- Operation of Interim Storage Facilities:

(start in 3 years, for less than 30 years)

  - Placed in Fukushima Pref. (for waste and soil generated in the pref.)
  - Select site in FY 2012

  Negotiation has started with 8 municipalities since January
  - Final disposal: outside Fukushima Pref.
  - Other pref. : use existing waste disposal facilities in each pref.

Released by MOE on Oct 29, 2011



Japan's Progress Report, NRA, 4th Meeting of STG-FUKU, 8 Oct. 2012.