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Outline of the New Safety Standards for Light Water Reactors for Electric Power Generation

- Abstract -

February 6, 2013

※This Document is based on the consideration by NRA Study Team as of January 31, 2013

1. Pointed out to the safety regulations before Fukushima

○Severe accident measures against external events have been left to the operator's autonomy without careful review. (Investigation report: The National Diet of Japan)

○There was no legal framework to impose retroactive application to existing nuclear power plants. (Investigation report: The National Diet of Japan)

○In Japan, the nuclear industry lacked the attitude to improve the safety against uncertain risks by actively introducing knowledge from the international community. (Investigation report: The National Diet of Japan)

○Comprehensive risk assessments of earthquakes, tsunamis, and other external events such as fire, volcanoes, and landslides which may cause accidents had not been implemented. (Investigation report: The Japanese Government)

○Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors and Electric Utility Industry Law are related to the nuclear safety regulations.

In order to avoid the adverse effect due to dispersion of the office under the jurisdiction or the application of the multiple laws, the law system should be unified. (Investigation report : The National Diet of Japan)

2. Legal Reform for New Safety Standard
(Issued June 2012)

○Expand the Purpose

- Assumption of large scale natural disasters, terrorism, and war.
- The purpose is to protect peoples' lives, health and property, the environment and national security

○ Safety Regulation for Severe Accidents

- Safety regulation for severe accidents by Law
- Comprehensive safety assessments by licensee to be reported to the government and disclosed to the public

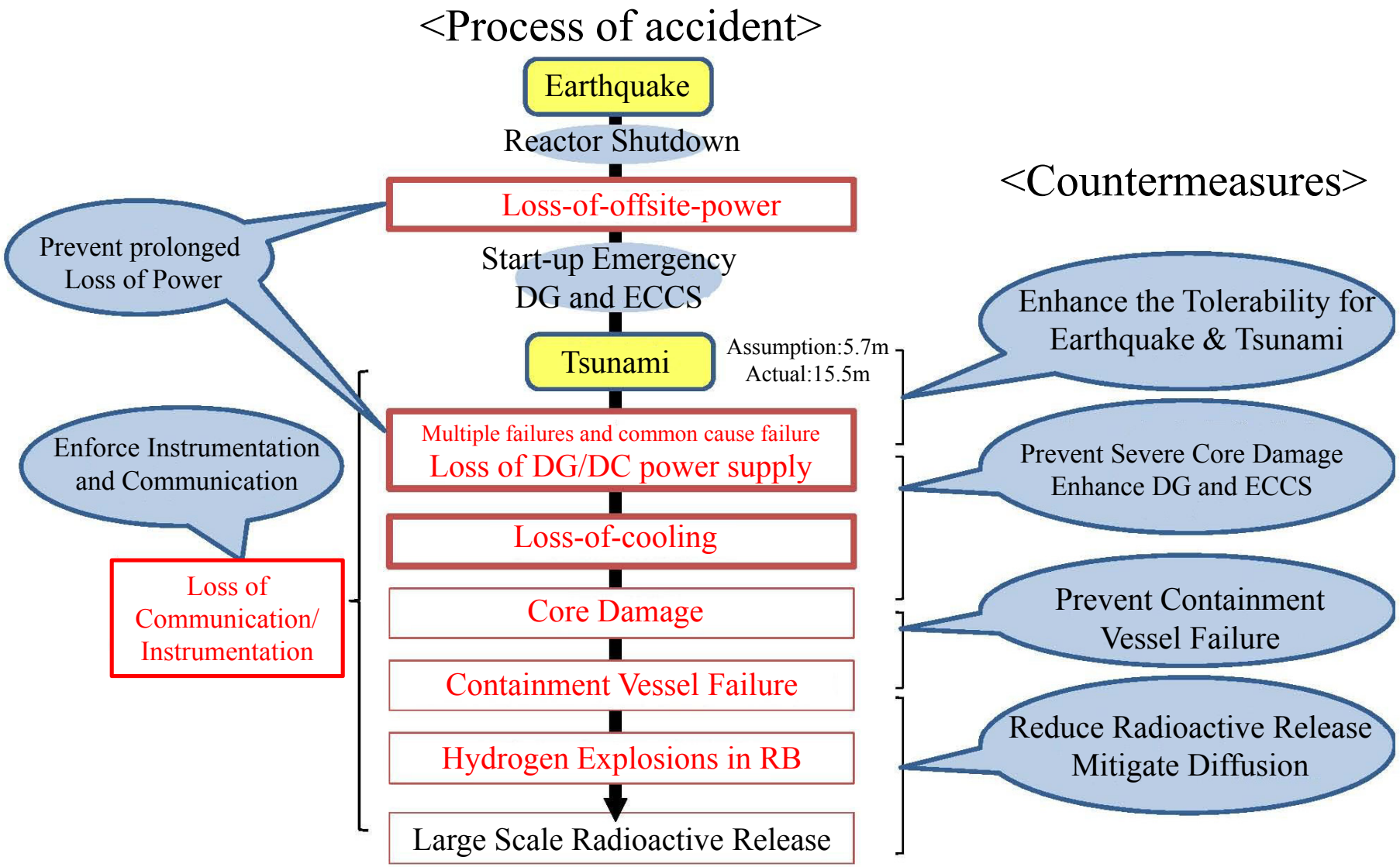
○ Reflection of the latest knowledge to existing NPPs

- Introduction of so called "Back Fit System" which imposes retroactive application of the new standards to existing NPPs.

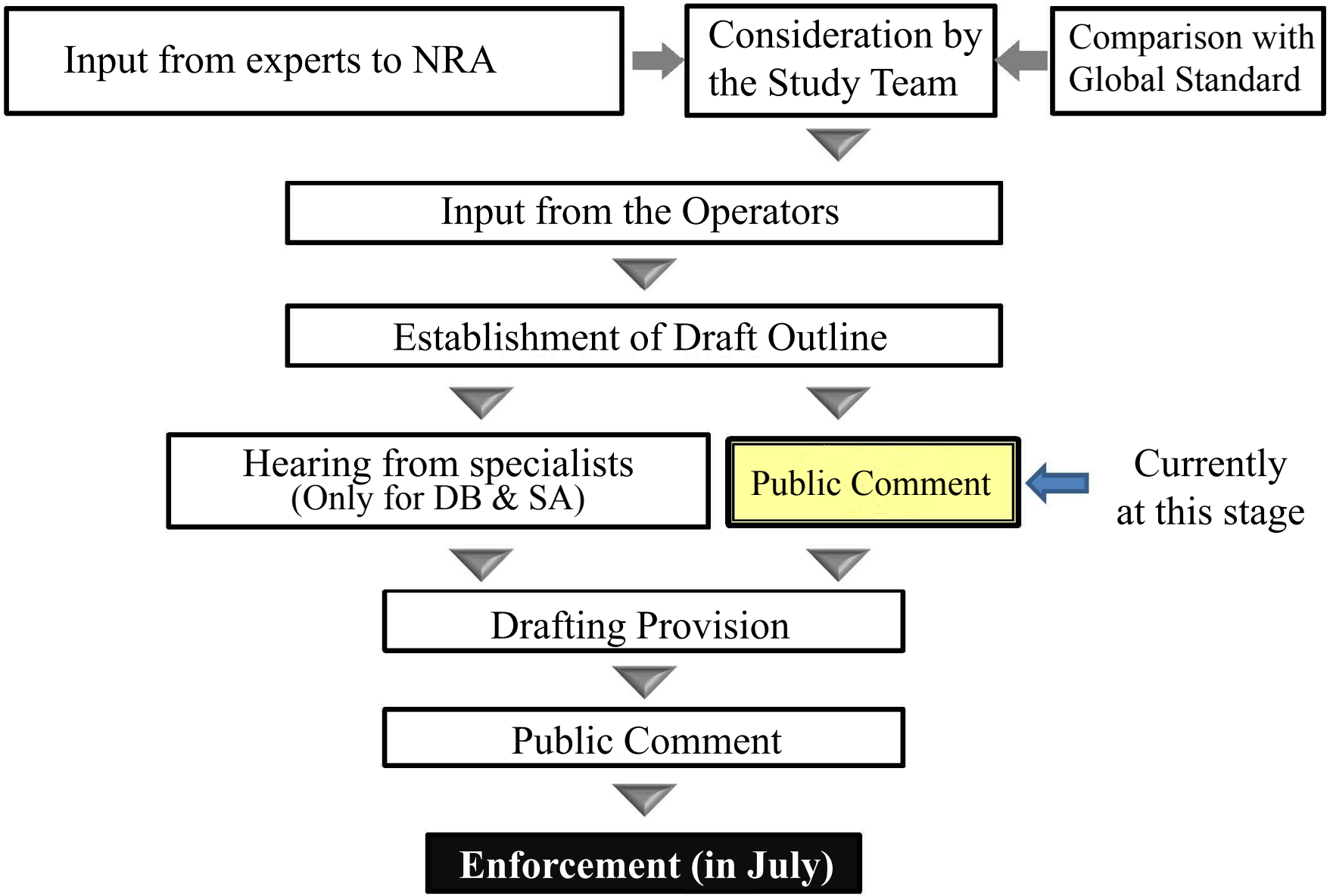
○ Unification of the nuclear safety regulations

- Integration of the regulations imposed by the Electric Utility Industry Law to the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors.
- Deleting the terms unrelated to safety from the purpose and license permit criteria of the Act to express the stance for safety explicitly.

3. Process of Fukushima Accident & Countermeasure



4. Consideration Step



5. Basic Policy of New Safety Standards

① Exhaustive Defense in Depth Concept

- **Prepare multiple layers effective for each intended function**
- **Secure independence of each layer to achieve intended function without other layers; that is, no expectation for former layers nor latter layers (Denial of former layers / Denial of latter layers)**

② Enhancement of Reliability

- **Enhance Fire Protection/Countermeasures against Internal Water Flooding**
- **Improve Design reliability of Systems Particularly Important to Safety (Avoid dual use of passive components with long time demand)**

③ Safety Countermeasure for Common Cause Failures by Natural Event

- **Strict Review for Earthquake and Tsunami Evaluation**
- **Countermeasure for Tsunami inundation/immersion**
- **Respect for Diversity and Independence (Refrain from too much emphasis on redundancy)**

6. Basic Policy of Countermeasures against SA & Terrorism

① **Prepare multiple layers (Countermeasures), that is**
“Protection of Severe Core Damage,”
“Protection of Containment Vessel Failure”
“Managed Release by venting”
“Suppression of Radioactive Materials Diffusion”

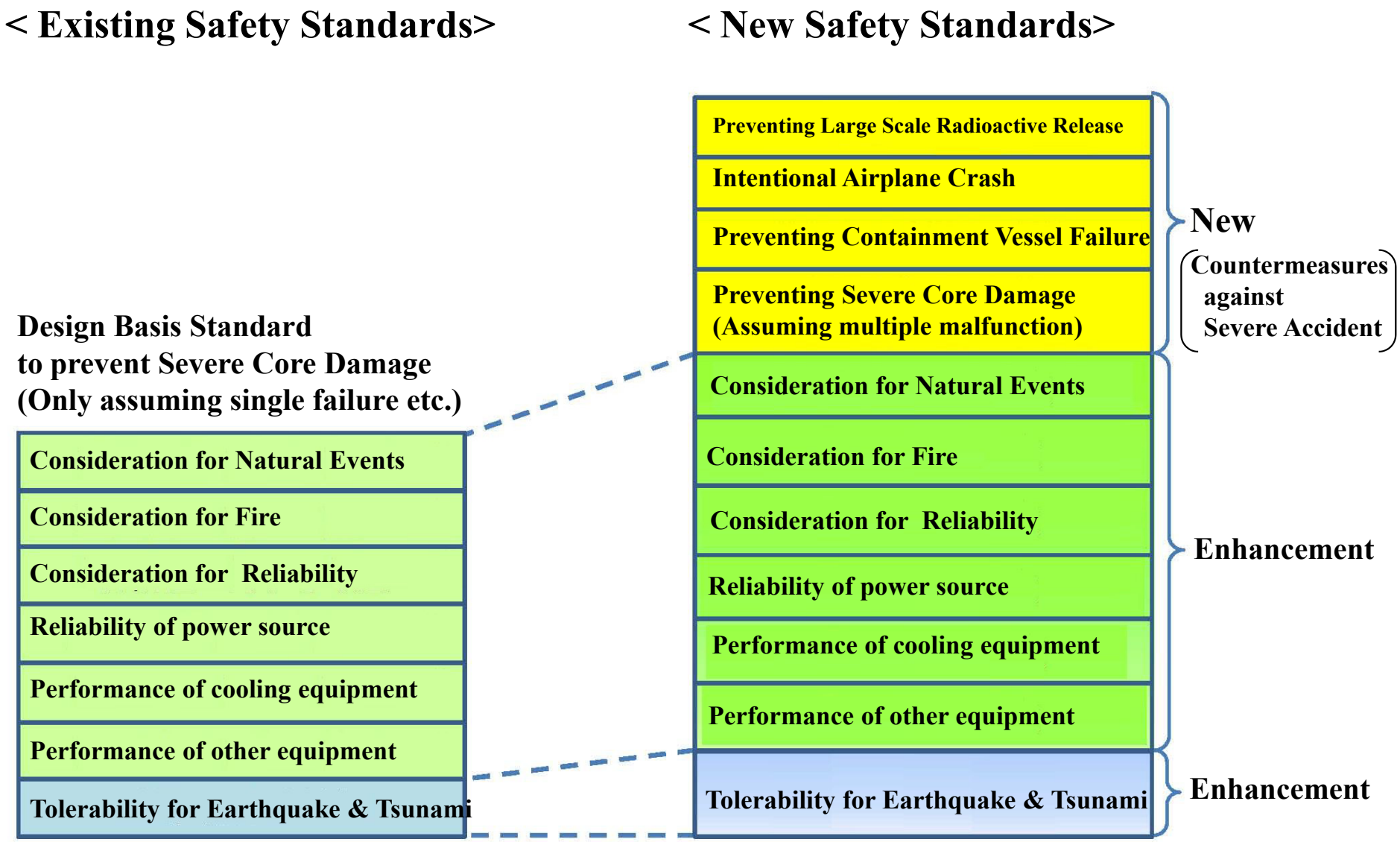
② **In addition to SA management by portable equipment, the same as in the US, install permanent equipment to improve reliability of SA management (Continuous Improvement)**

③ **Enhance Protection measures at Spent Fuel pools**

④ **Enhance function of Emergency Response Facility, improve reliability and durability of communication equipment, and enhance function and reliability of instrumentation including Spent Fuel pools**

⑤ **Install Specified Safety Facility in preparation for intentional Aircraft attack**

7. Perspective of the New Safety Standards



8. Enhancement of Design Basis Standard

Review Design Basis Standard completely,

“Design Basis Standard with No Severe Core Damage assumed”

① **Tornadoes and Bushfires included as Natural Events to be considered**

② **Enhancement of Fire Protection**

③ **Enhance Reliability of Components particularly important to the safety**
(Redundancy of Components with long time demand)

④ **Enhancing external electricity supplies**
(Multiple Power line Systems from Separate Substations)

⑤ **Physical Protection of Heat Removal System**
(Protection of Seawater Pumps)

9. Countermeasures against SA (Severe Core Damage)

Requirements for Countermeasures against Severe Core Damage assuming beyond the Design Basis Accidents.

① Countermeasures for Failure of Reactor Shutdown

② Countermeasures for Loss of Cooling Reactor (at high pressure)

③ Countermeasures for Loss of Depressurization

④ Countermeasures for Loss of Cooling Reactor (at low pressure)

⑤ Countermeasures for Loss of Ultimate Heat Sink (LUHS)

⑥ Securing Support Function (Make-up Water, Electricity Sources)

Examples of Countermeasure against Severe Core Damage

○ Countermeasures for Loss of depressurization (PWR)

Installation of a handle and procedures for opening the decompression valve manually

A manually-manipulated handle for the main steam relief valve

○Securing Support Function (Common to both PWR and BWR)

Installation of alternate power source equipment (Electric Vehicle, Batteries, etc.) in case of SBO

Locating Electric Vehicle on a hill

10. Countermeasures against SA (Containment Vessel Failure)

Requirements for Countermeasures against Containment Vessel Failure assuming Severe Core Damage.

① Countermeasures for cooling, depressurization and radioactive material mitigation (CV Spray)

② Countermeasures for cooing and depressurization of CV (Filtered Venting system)

③ Countermeasures for cooling melted core fallen to the bottom of CV

④ Countermeasures against hydrogen explosions inside CV

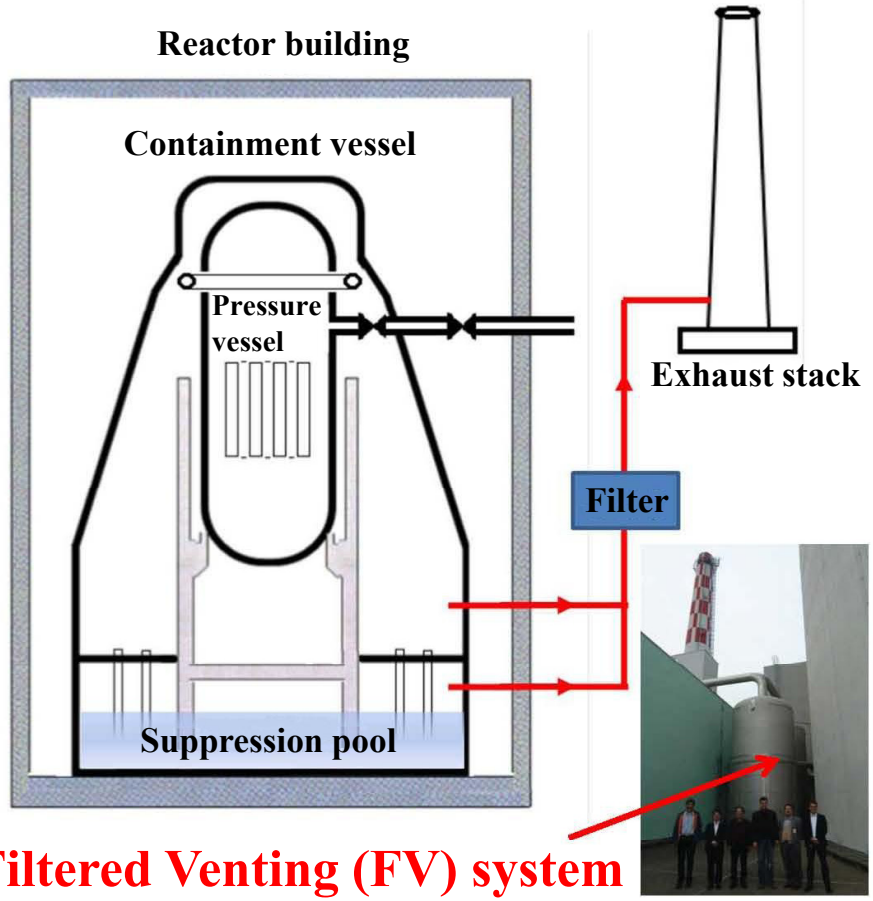
⑤ Countermeasures against hydrogen explosions at the reactor building, etc.

⑥ Countermeasures for cooling of spent fuel storage pools

Examples of Countermeasure against CV Failure (BWR)

○ Cooling and depressurization of containment vessel

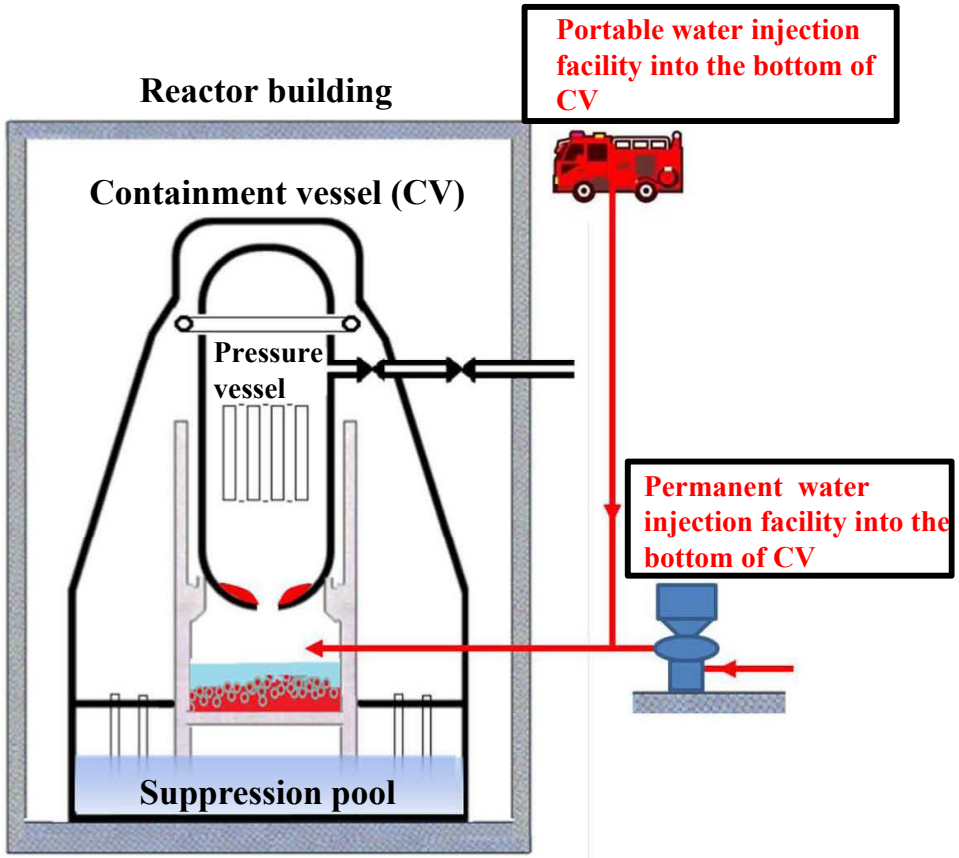
Install FV for the exhaust with reduced radioactive materials while reducing pressure and temperature of CV



Filtered Venting (FV) system

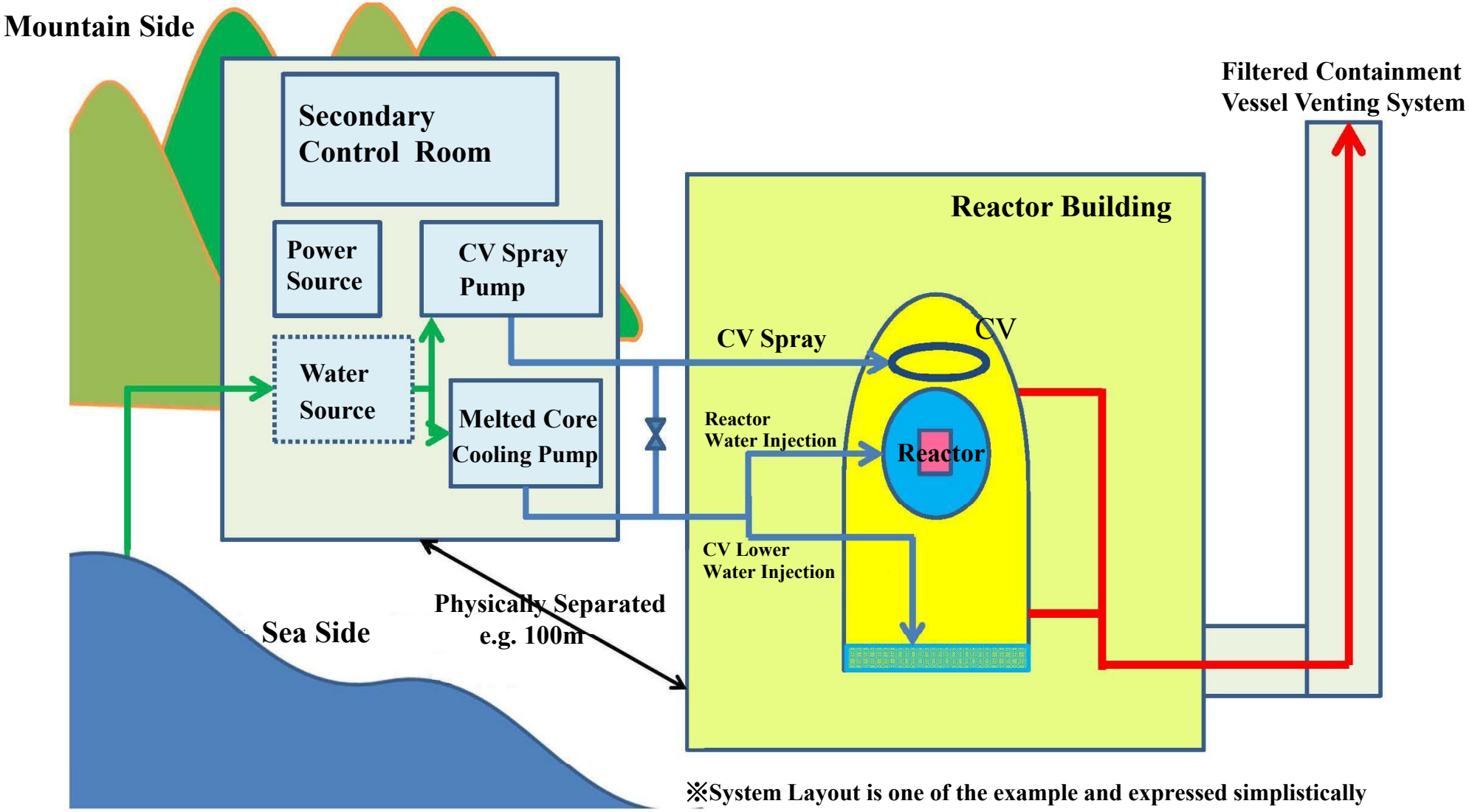
○ Cooling melted core

Deploy water injection facilities into the bottom of CV for preventing CV failure after core meltdown



11. Countermeasures against Intentional Airplane Crash

Specific Safety Facilities to manage Severe Core Damage caused by Terrorism Attack such as Intentional Airplane Crash Accident



※System Layout is one of the example and expressed simplistically

12. Countermeasures against Large Scale Release

Requirements for Outdoor Water Spraying Facilities, assuming Containment Vessel failure

(suppress diffusion of radioactive materials by spraying into reactor building)

High Capacity Foam Water Cannon

Water Spraying drill with High Capacity Foam Water Cannon

Source of the Pictures

Left : http://www.teisen.co.jp/product/archives/126001.html

Right : http://www.fdma.go.jp/html/hakusho/h23/h23/html/2-1-3b-3_2.html

13.Enhancement of Tolerability for Earthquake & Tsunami

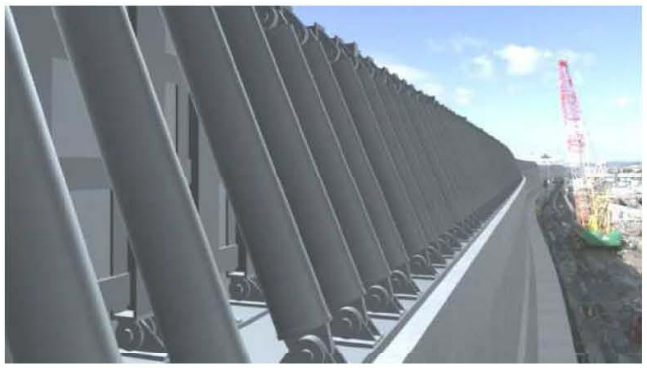
Strict Review for Earthquake and Tsunami evaluation, especially Tsunami

Strict Criteria for Tsunami ⇨ **Requirement for Tsunami protection facilities such as Watertight Door based on "Design Basis Tsunami" exceeding past maximum Tsunami**

Expand the scope for high seismic resistance ⇨ **Tsunami Protection Facilities should be the highest "S Class" as same as Pressure Vessel**

＜Examples of Tsunami Countermeasures (Multiple Protection against Tsunami)＞

- **Tsunami Protection Wall (preventing inundation at site)**

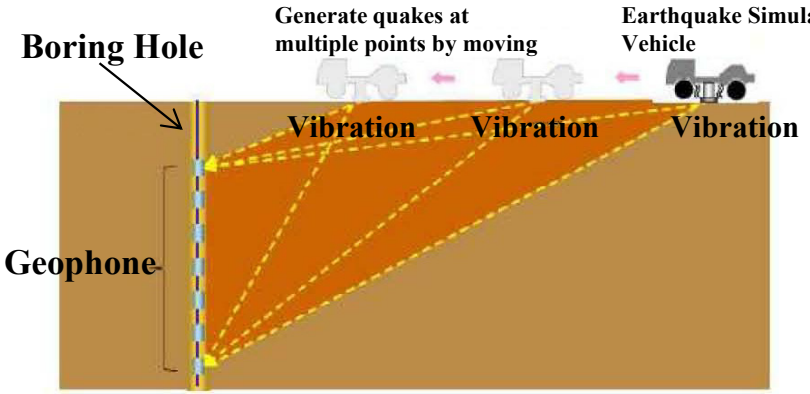


- **Watertight Door (preventing immersion of buildings)**

Strict Judging Criteria of Active Fault	**Capable fault should be judged in the light of past activity after Late Pleistocene (in last 120,000-130,000 years ago) , if necessary expanded up to Middle Pleistocene (400,000 years ago).**
Precise Design Basis Earthquake	**Understand underground structure of the site three-dimensionally**
Judging Criteria for "shears or deformation" added to vibration	**"S Class" should be built at the Ground without any evidence of outcrop by active faults**

<Example of Underground Structure Investigation>

Figure out underground structure by analyzing the geophone data of generated quakes by earthquake simulation vehicle



Earthquake Simulation Vehicle