Strengthening safety by learning lessons from the accident at TEPCO's Fukushima-Daiichi NPP

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✓ ***Part I Medium- and Long-term onsite and offsite activities***

Part II Key Lessons Leaned

Part III Actions to strengthen safety

Key onsite recovery actions (Stabilization phase, by 2011/E)

1. Cooling

- ✓ Stable cooling to low reactor temperature

2. Minimizing release of radioactive materials to the environment

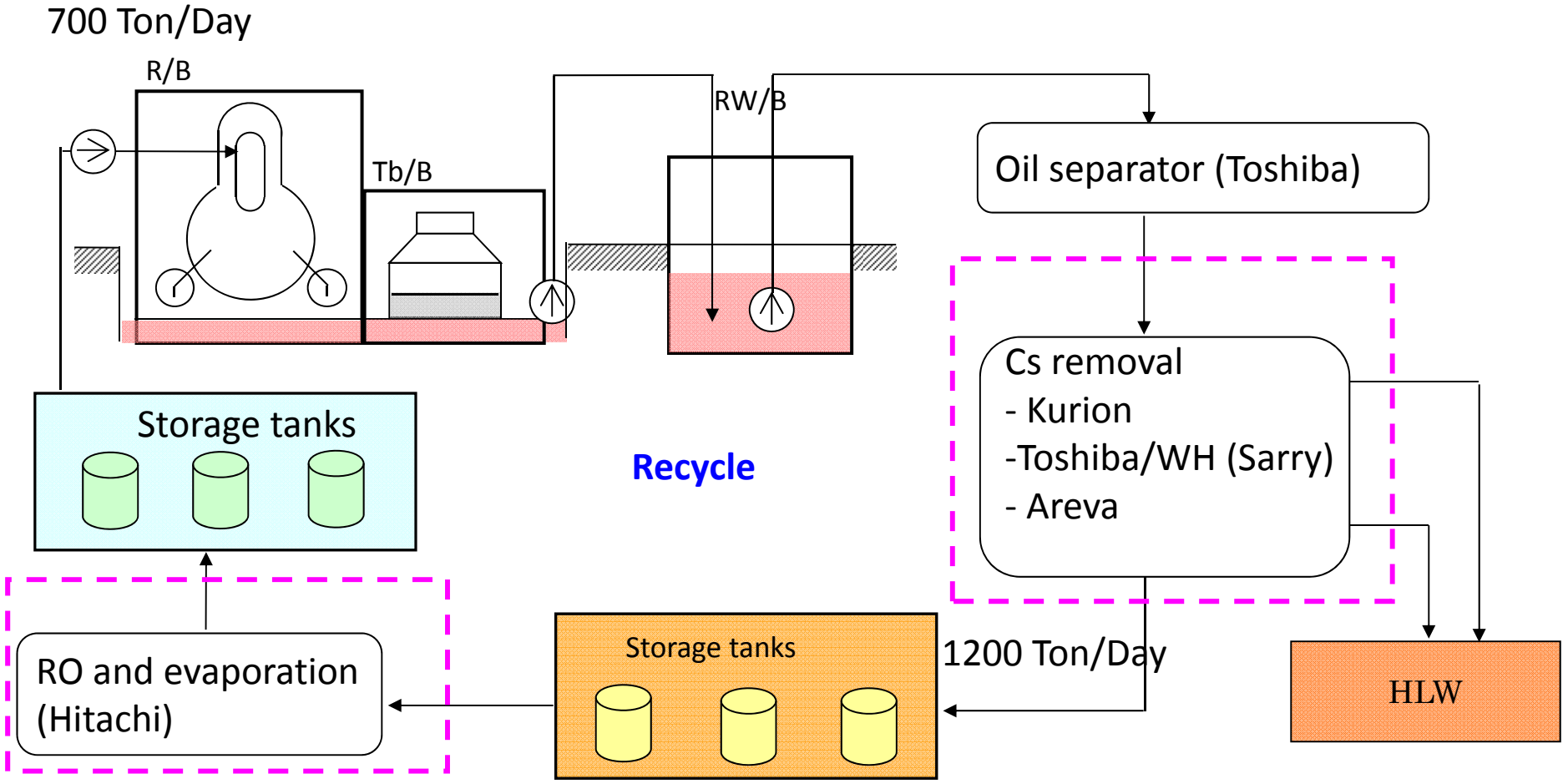
- ✓ Recycling of water recovered from Turbine Building through removal of radioactivity and purification by Reverse Osmosis (1200 tons/day treated, of which 700 tons/day are returned to the reactors)
- ✓ Water inventory control
- ✓ Installation of Reactor Building cover
- ✓ Isolation of surrounding area by walls to prevent spill-over
- ✓ Corrosion control of structures and components

3. Minimizing residual risk

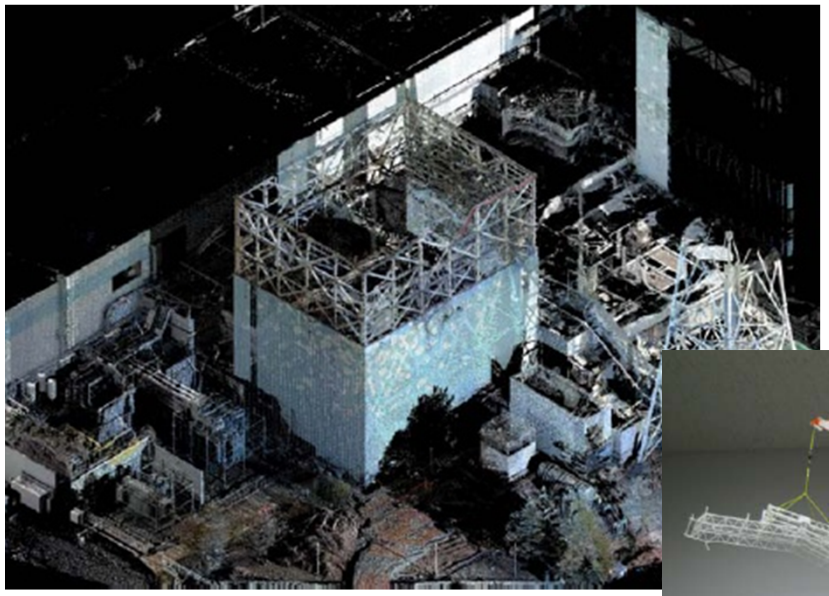
- ✓ Assure structural integrity of damaged Reactor Building in consideration of aftershock and typhoon
- ✓ Assure reliability of power/water supply
- ✓ Control hydrogen concentration

Recycling of water

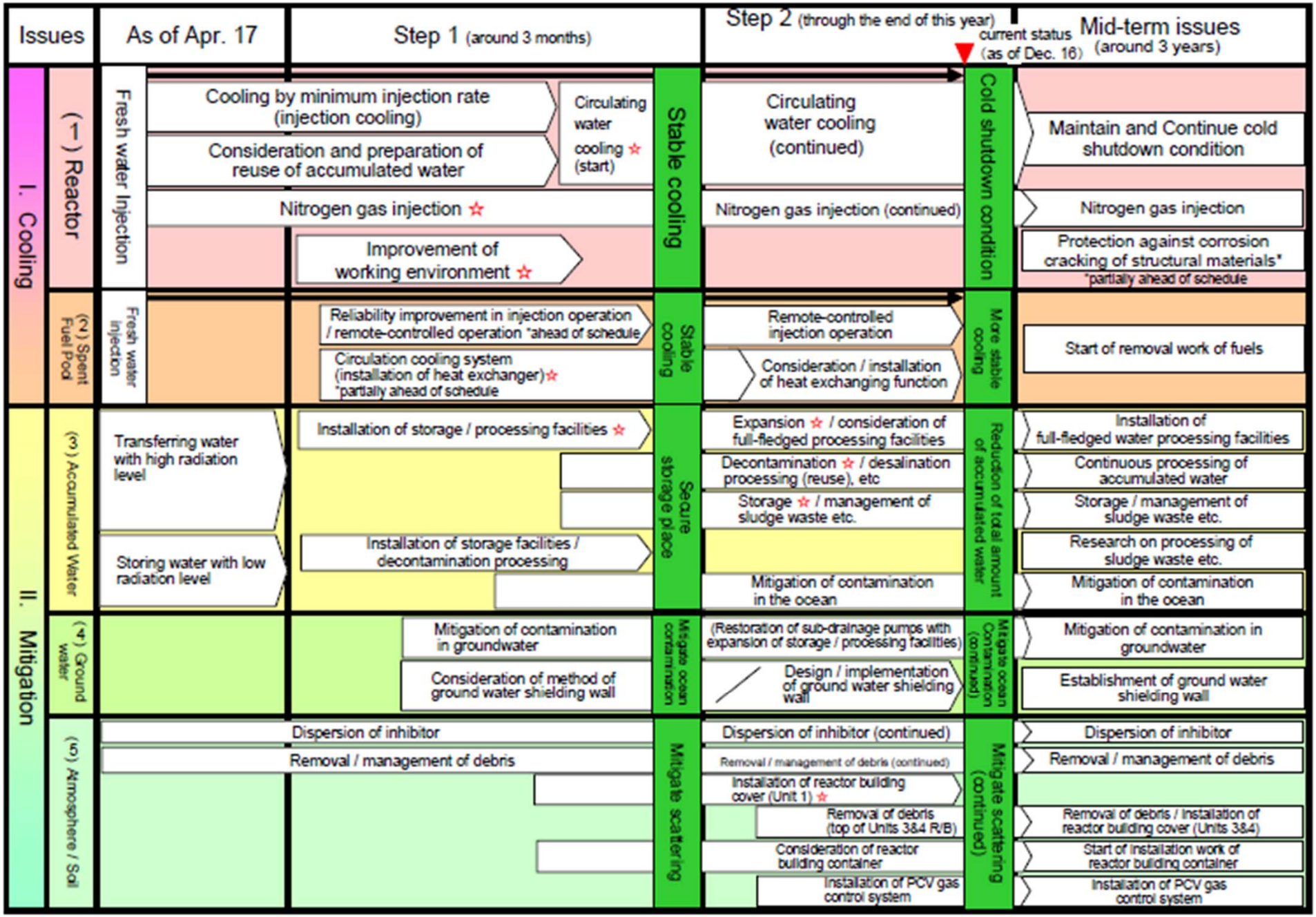
Inventory control to avoid spill-over to the environment, Removal of Cs, Removal of Cloride



Reactor Building Cover



Completed for Unit 1
(2011 October)



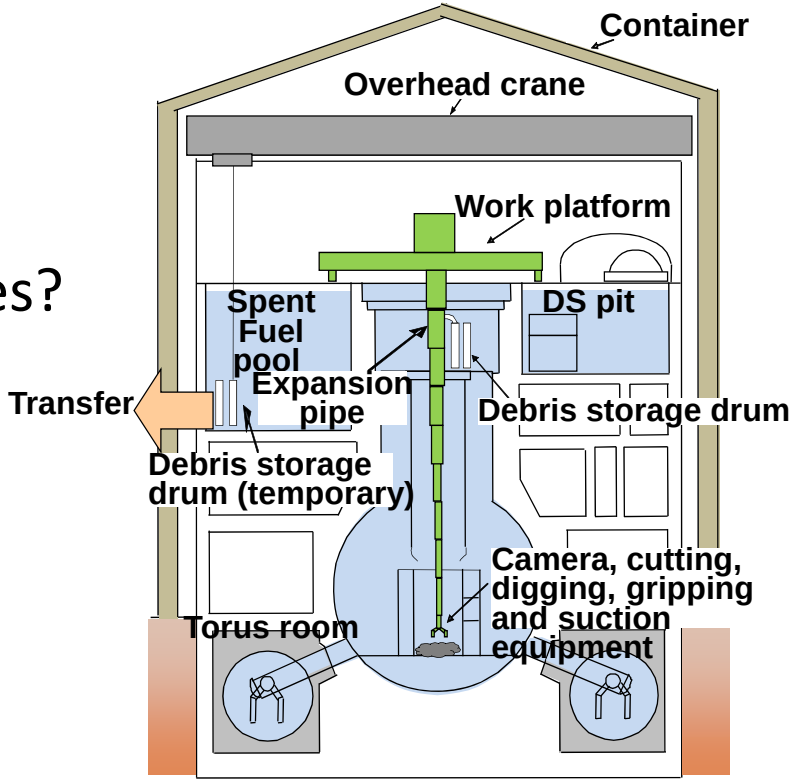
Nuclear Emergency Response Headquarters

Beyond stabilization phase

- Planned actions
  1. Remove Spent Fuel from the Spent Fuel Pools
  2. Remove core debris
  3. Decommission
  4. Dispose generated wastes at final disposal facilities

- AEC's experts' committee on medium- & long- term plan

  - ✓ What are the required technologies?
  - ✓ How and who to develop?
  - ✓ Who is going to manage the overall project?
  - ✓ How long it will take?



Part I Medium- and Long-term onsite and offsite activities

✓ ***Part II Key Lessons Leaned***

Part III Actions to strengthen safety

Lessons Learned

- Government report to the IAEA (September) : update 28 Lessons in 5 specific areas (Prevention of Severe Accident, Severe Accident Management (SAM), Emergency response, Safety infrastructure, culture) and implementation status

  http://www.meti.go.jp/earthquake/nuclear/backdrop/20110911.html

Key points are;

1. Design considerations against natural hazards
2. Design considerations against SBO (Station Blackout) and Isolation from UHS (Ultimate Heat Sink)
3. Completeness/effectiveness of SAM
4. Emergency Management
5. Safety regulation and safety culture
6. Multiple unit installation
7. Spent Fuel Pool design
8. International aspects

- This presentation goes a bit further on key LL
- Government Investigation Committee and other committees and studies would elaborate on root causes

Key Lessons Learned
A) Safety regulation and safety culture

Regulation:

✓Responsibilities not in a single regulatory body

✓Regulatory standards, Independence, competence (Government report to IAEA)

✓Decision by Cabinet (2011Aug15) on reorganization

- Transfer of NISA, NSC, and other authorities (security, transportation safety) to MoE (Environment) except for Safeguard

Regulation/Utility:

✓Use of risk information using Probabilistic Safety Assessment by Owner/operator to address vulnerabilities of its asset

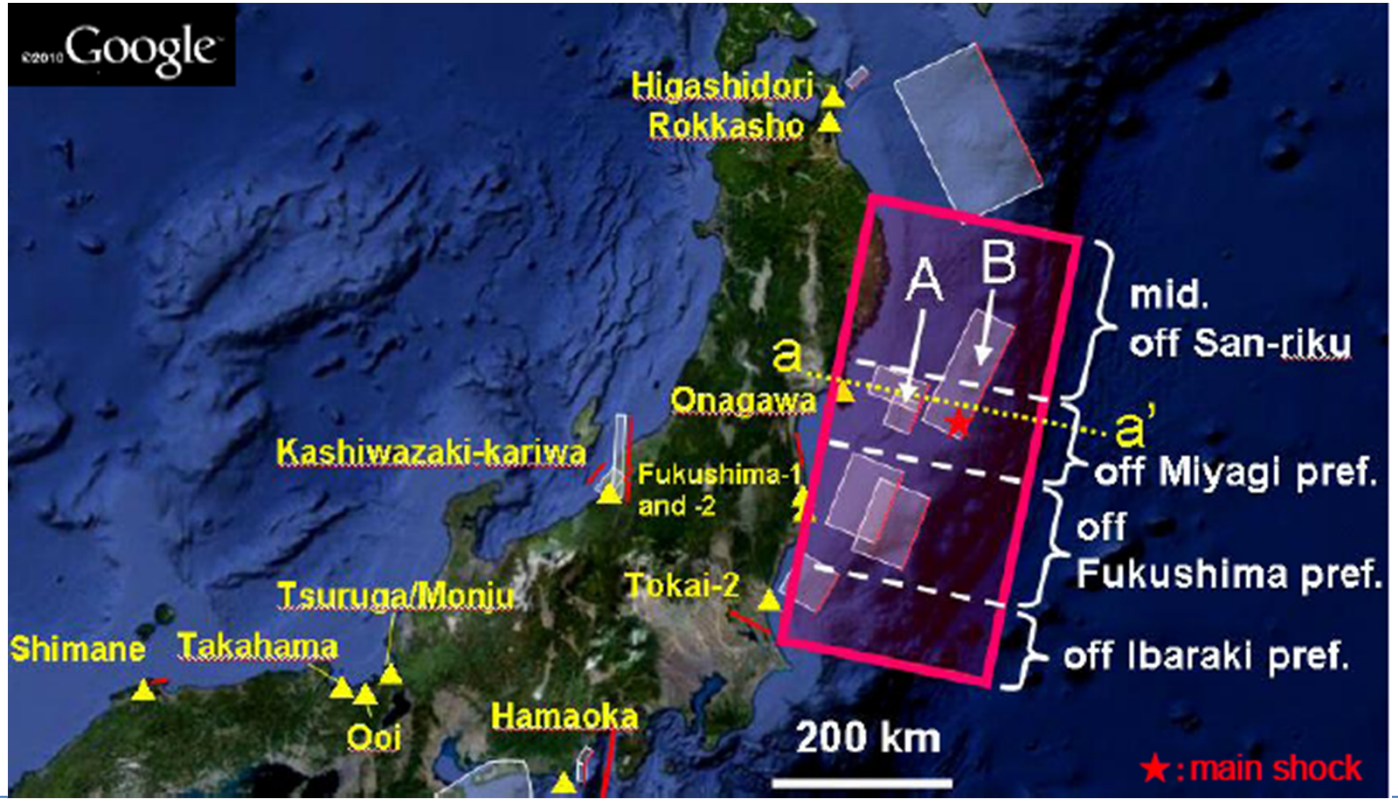
✓Continuous improvement

[Example in hindsight] of SAM through drill and information from outside considering "Accident can happen here"

✓"Sensitivity "to safety-related issues/information

✓Attitude towards & understanding on "uncertainties" in natural science

(3.11 Earthquake)



Statement by the Headquarter for Earthquake Research, 11March2011
…..but occurrence of the earthquake that is linked to all of these regions is "out of hypothesis".
[SOURCE] http://www.jishin.go.jp/main/index-e.html The 2011 off the Pacific Coast of Tohoku Earthquake

Government Report to the IAEA, June2011 : Initiation from B, then propagated westwards to area A, and further to the North and South. The Headquarter had alerted … but had not correctly estimated the size of the source area (400km x 200km) nor the magnitude (M9) nor the amount of slip *[SOURCE] Gov. Report to the IAEA, June2011*

Lessons Learned
B) Workable/effective SAMG (Severe Accident Management Guideline)

1. SAMG not robust enough to cover possible plant damage conditions
   → Consider
   a) integration of three Guidelines (internal event, external event and security-related event), and
   b) implementation of recovery actions in harsh radiation environment

2. Provisions of Onsite or National/Regional Nuclear Crisis Management Center for storage of mobile equipments & drill

(Supporting provision)

3. Accident instrumentation
   [Ex] What is the Water Level in the containment?

4. Prevention of hydrogen detonation/deflagration outside of the Containment Vessel

5. Simulation of plant behaviour (Real-time or faster-than-real time) as a decision aid and knowledge basis

Limited available resources under harsh environment

Loss of communication tool (PHS) and plant safety parameters (SPDS)

1) Use of limited available resources

- ✓ Fire Engines
- ✓ Flashlights/Cables/Tools
- ✓ Batteries taken from cars
- ✓ Mobile small Generators
- ✓ Mobile Engine-driven Air Compressors
- ✓ Mobile pumps/motors

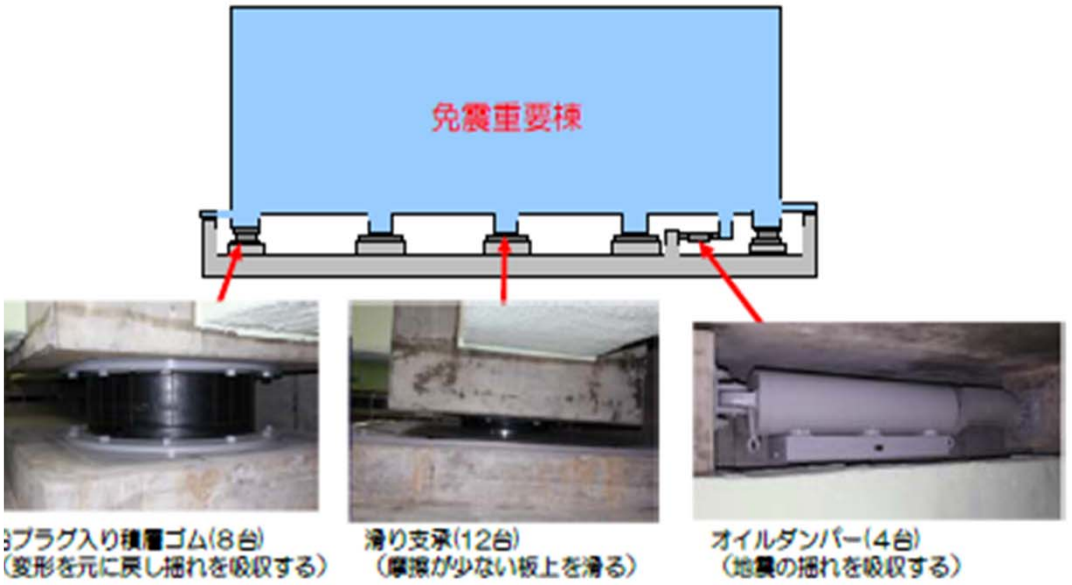
2) Usage limited by scattered debris/tanks

3) Field works under devastation & damage by hydrogen explosions and aftershocks

Lessons Learned
C) Emergency management

- Loss of communication tool and plant information at NPP
- Dissemination of information
  - ✓ Damage to social infrastructure by earthquake hampered dissemination of information to local government and residents
  - ✓ Offsite center: function was lost by loss of electricity and radiation
  - ✓Lack of Information sharing
    - with local residents on dispersion of FP (SPEEDI) and risk of radiation
    - with neighboring countries on release of slightly-contaminated water
  - ✓"Data but not information"
- Effective channeling of emergency supports
  - ✓Systematize domestic/foreign helping hands for logistics/experts

(Onsite ERC by TEPCO: seismic isolation structure)



Lessons Learned
C) Design

What safety design could have saved Fukushima?

1. Protection against natural hazard
   - ✓ Adding safety margin to the results of probabilistic Tsunami hazard analysis
   - ✓ Location of essential safe systems considering Tsunami/Flood
2. Plant capability against SBO and isolation from UHS
   - ✓ Highly reliable assurance of 3 cooling functions (Core, CV, SFP)
   - ✓ Passive systems
3. SAMG (coupled with relevant design provisions)
   - ✓ Mobile equipments in onsite/offsite emergency center
   - ✓ Robust SAMG workable under internal events, external events and security-related events and drill
4. Assurance of aversion of "land contamination"
   - ✓ Dependable scrubbing vent
   - ✓ 2ndary containment filtration/H_2 management system

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✓ ***Part III Actions to strengthen safety***

Actions to strengthen safety

1. Global actions for strengthening nuclear power safety in post-Fukushima era would be built around the IAEA action (endorsed by the IAEA GC September 22), under fully recognizing national responsibility and Operator's primary responsibility for safety

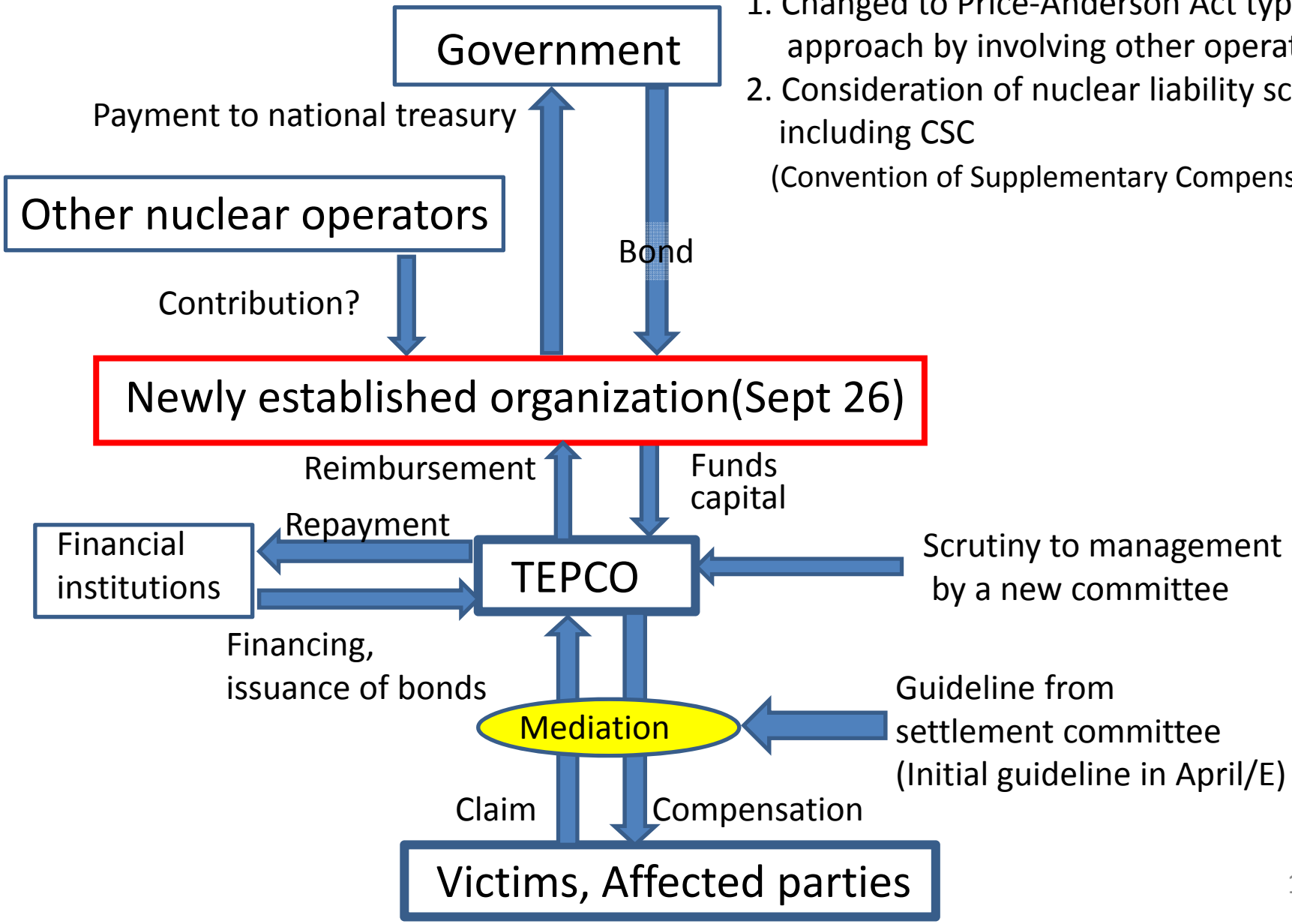
2. In specific country and NPP
   - ✓Overall assessment of NPP safety and reflection of Fukushima LL in the light of principles in INSAG-12 (safety culture, defense-in-depth etc)
   - ✓Specific plant assessment to identify vulnerabilities and for continuous safety improvement
   - ✓International peer review for comprehensiveness, objectivity and confidence building

3. Cooperation in building safety infrastructure in new entrants

Including cooperative scheme for liability, especially CSC (Convention on Supplementary Compensation)

4. …and to restore public confidence through transparency

New compensation scheme in JAPAN



1. Changed to Price-Anderson Act type approach by involving other operators
2. Consideration of nuclear liability scheme including CSC
(Convention of Supplementary Compensation)

CONCLUSIONS

1. **Stabilization phase to end this year at Fukushima, followed by offsite remediation and onsite 3D (Decontamination /Defueling/Decommissioning)**

2. **Strengthening safety by learning lessons in**
   - ➢ Regulation and Safety culture
   - ➢ Workable/effective SAMG
   - ➢ Design

   AND further by international cooperation in building safety infrastructure in newcomers and global liability scheme

Thank you for your attention