2. Roadmap towards Restoration from the Accident

(Step 2 Completed on December 16, 2011)

東京電力 TEPCO

Summery of the Step 2 Completion of "Roadmap towards Restoration from the Accident"

- Confirmed the reactors were brought to a condition equivalent to "cold shutdown" and stabilized (in case an accident occurs, we will be able to keep the radiation dose at the site boundaries at a sufficiently low level)
- The targets other than reactors had been achieved as follows, thus the completion of the Step 2 "Release of radioactive materials is under control and radiation doses are being significantly held down" was confirmed.

Progress status of "Roadmap towards Restoration from the Accident at Fukushima Daiichi Nuclear Power Station" on December 16

[Issue (1) Reactors]: Achieved "condition equivalent to cold shutdown"

RPV bottom temperatures and internal PCV temperatures are , in general, below 100 ℃. Release of radioactive materials from PCV is under control and public radiation exposure by additional release is being significantly held down. The mid-term safety of the circulating water cooling system is secured.

[Issue (2) Spent fuel pools]: Achieved "more stable cooling"

[Issue (3) Accumulated water]: "Total volume of accumulated water has been reduced"

[Issue (4) Groundwater]: The start of water shielding wall construction marked the achievement of Step 2

[Issue (5) Atmosphere/Soil]: Unit 1 reactor building cover completion marked the achievement of Step 2.

[Issue (6) Measurement, Reduction, Announcement]: Full fledged decontamination work has begun according to the cabinet decision of the basic policy based on the Special Act

[Issue (7) Tsunami, Reinforcement, etc.]: Seismic safety assessment of the reactor buildings has completed in all Units. A support structure at the bottom of the Unit 4 Spent Fuel Pool has been installed.

[Issue (8) Living/working environment]: Living/working environment has been improved via the construction of temporary dormitories and on-site rest stations.

Improved working environment that was harsh in the immediate aftermath of the accident via providing healthier meals, installing bathing & laundry facilities, and setting up temporary dormitories & on-site rest stations, thus maintaining worker motivation.:

[Issue (9) Radiation control/Medical care]: Health care has been improved via restoring appropriate radiation controls and organizing a medical care system, etc.

Countermeasures for medical care have been implemented: countermeasures against heatstroke and influenza, radiation control system reinforcements, thorough exposure control, consideration for long-term healthcare.

[Issue (10) Staff training/personnel allocation]: Continue staff training and continue to consider a strategy to effectively procure required staff

Promote staff training, especially for high-demand staff engaged in radiation work, in conjunction with the government and TEPCO.

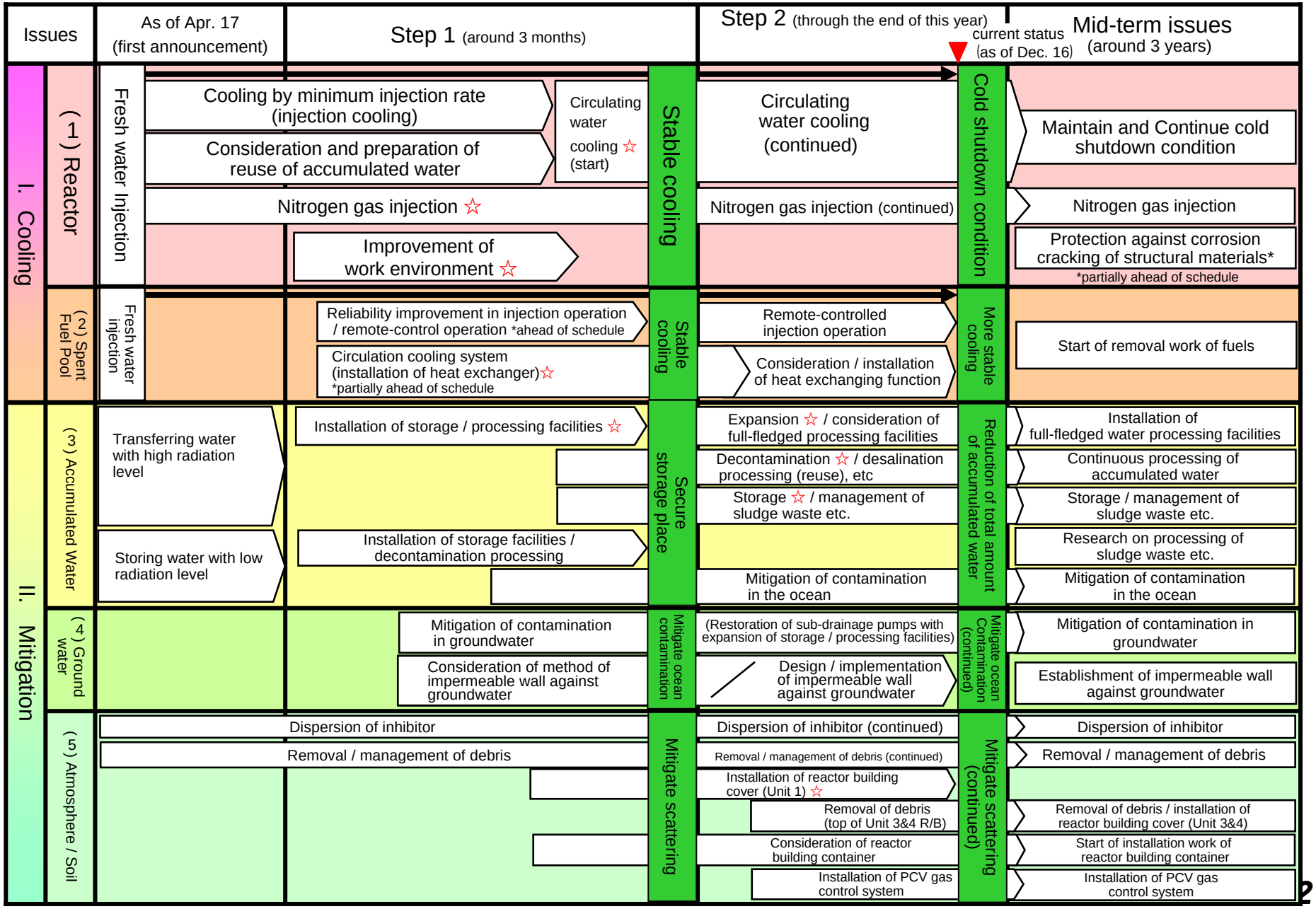
[Action plan for mid-and-long term issues]: Confirmed that the mid-term safety of the circulating cooling system has been secure.

The facility operation plan in light of the mid-term safety was developed, followed by the government review. Hereafter, the government and TEPCO's mid-and-long-term countermeasure conference will be established, which will develop mid-and-long term roadmap and promote necessary on-site work and R&D towards decommissioning.

Current Status of "Roadmap towards Restoration from the Accident at Fukushima Daiichi Nuclear Power Station, TEPCO" (Step 2 completion)

December 16, 2011
Nuclear Emergency Response Headquarters
Government-TEPCO Integrated Response Office

☆: already reported to the government, Green colored shading: achieved target



Current Status of "Roadmap towards Restoration from the Accident at Fukushima Daiichi Nuclear Power Station, TEPCO" (Step 2 Completion)

December 16, 2011
Nuclear Emergency Response Headquarters
Government-TEPCO Integrated Response Office

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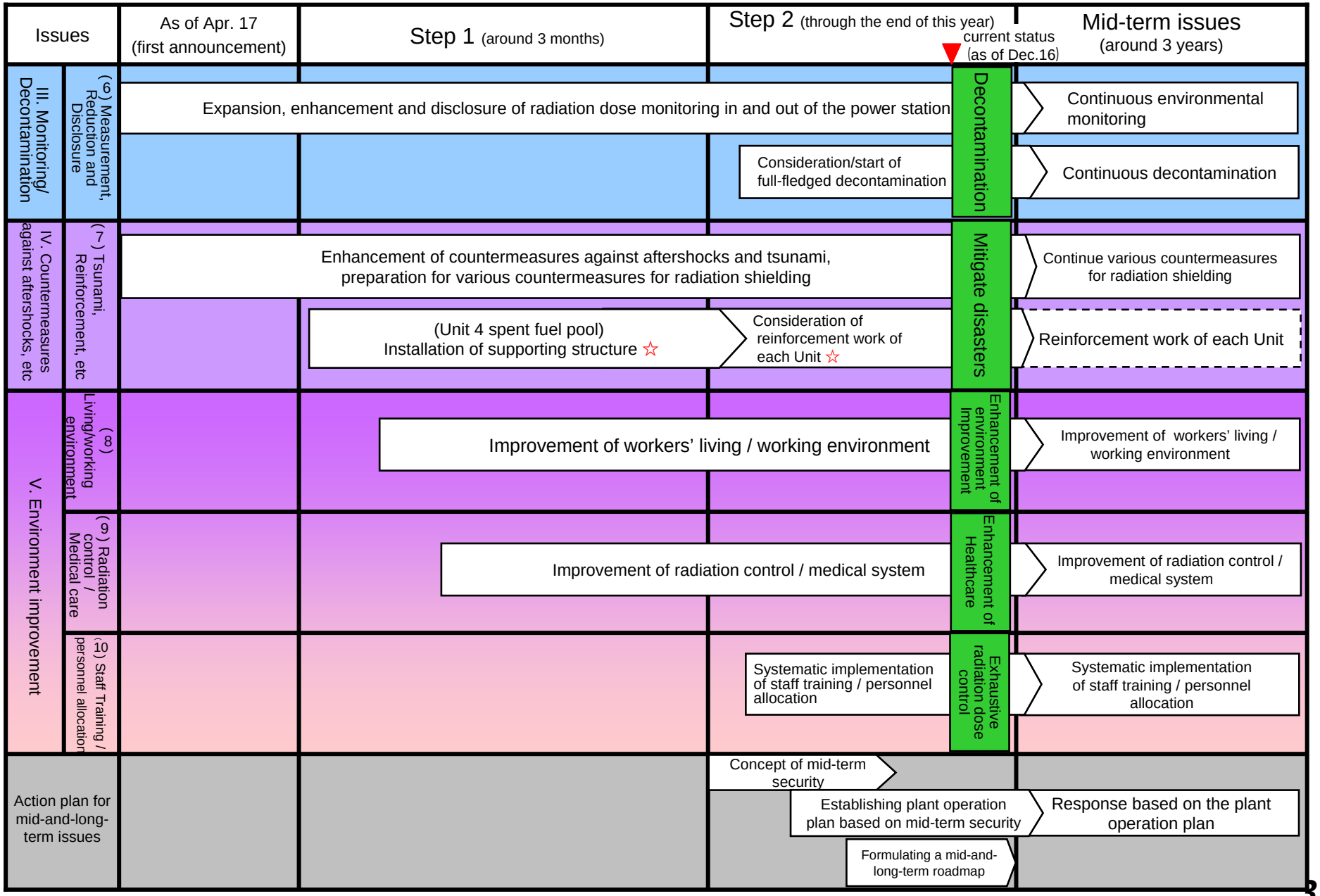


Circulating Water Cooling System

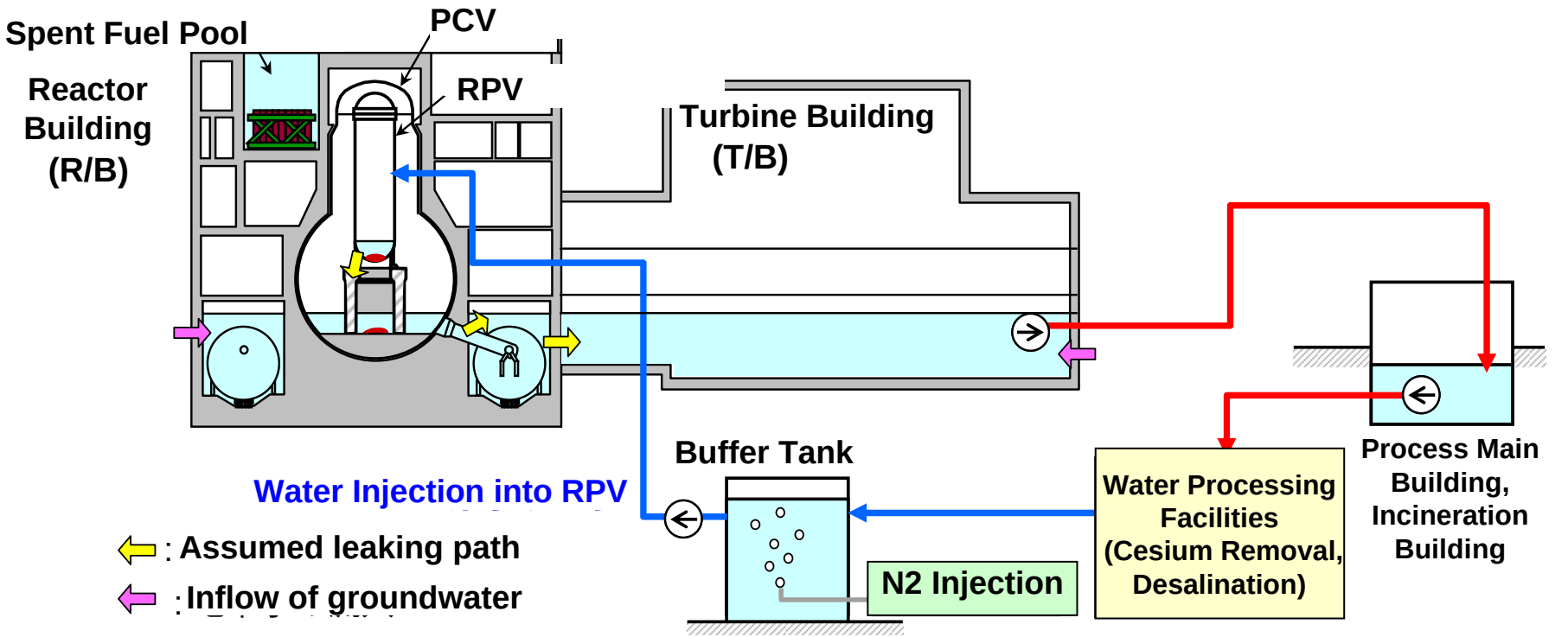
- Cooling water is leaking from RPV to the basement of Turbine building through Reactor building.

  -> **"Circulating Water Cooling System" has been established; contaminated water is reused for reactor water injection after cesium and salt are removed from the water.**

- RPV water injection system consists of pumps, piping and tanks.

  ->These components have **redundancy, diversity and independency.**

- Accumulated water is on the increase due to groundwater inflow into the buildings.

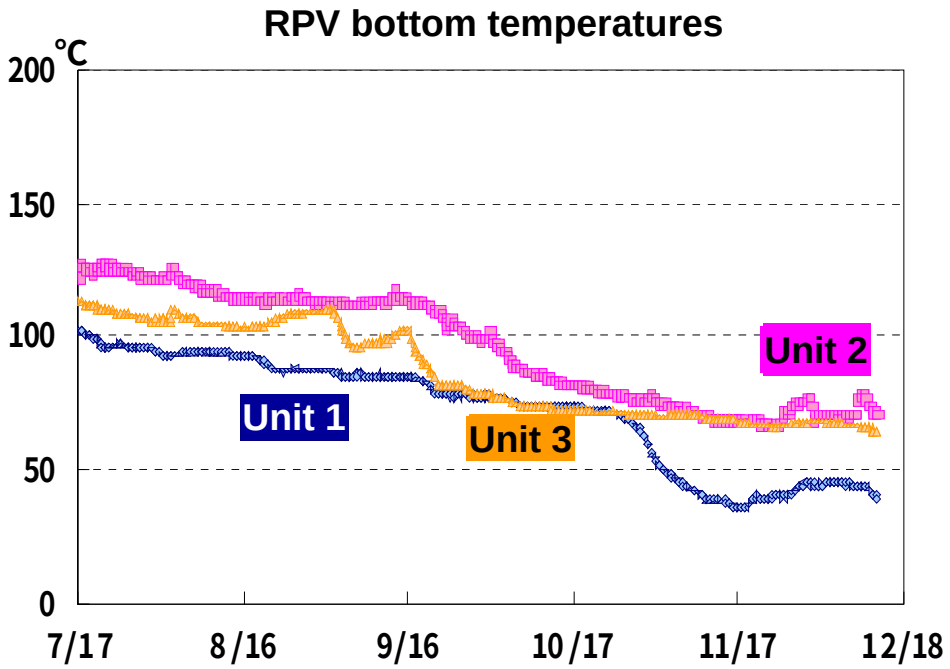


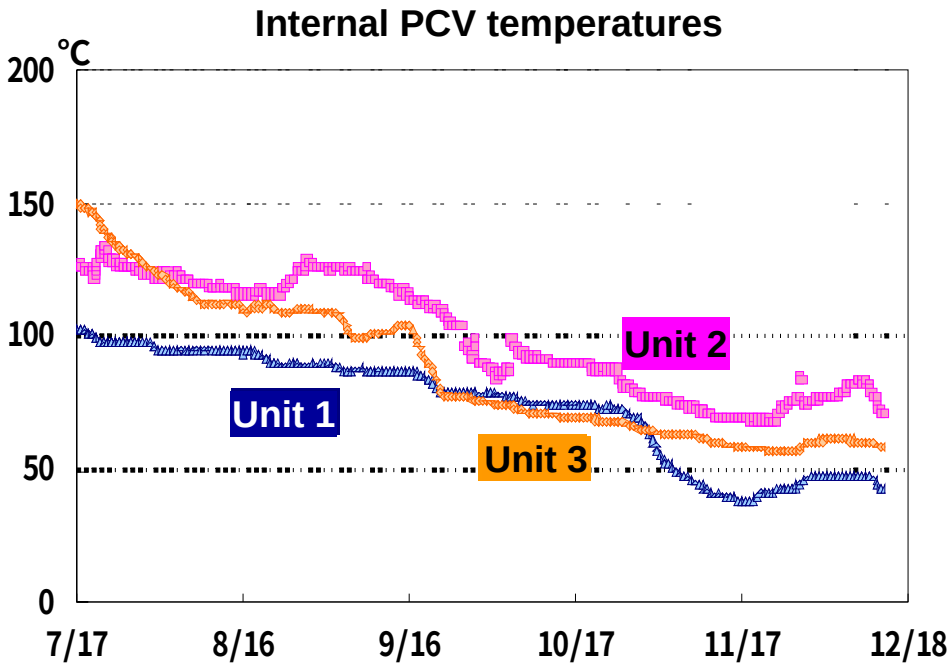
Circulating Water Cooling System Overview

Reactors

Achieved “condition equivalent to cold shutdown”

- “Circulating water cooling” started in Step 1 (Jun. 27, 2011), which reuse the contaminated water accumulated in the buildings etcetera (accumulated water) after being processed for water injection into the reactors.
- Water injection cooling and release-control/mitigation of radioactive materials from the PCVs
  - ✓ Stabilized below 100 degrees via circulating water cooling
  - ✓ Internal PCV temperatures stabilized below 100 degrees even though it is difficult to grasp where the damaged fuels are located in RPV and/or PCV.
  - ✓ If damaged fuels had leaked into the PCV, steam generation would be suppressed due to sufficient cooling, thus the release of radioactive materials from the PCV has kept in control.





Unit 1 Cooling Condition (Steam Generation)

Comparison of the penetration point on the 1st floor

Steam release from the penetration on 1st floor
(photo as at Jun. 3, 2011)

Situation of the penetration on 1st floor
with no steam release
(photo as at Oct. 13, 2011)

Steam release from the penetration point on the 1st floor was observed on Jun. 3, however no longer confirmed on Oct. 13.

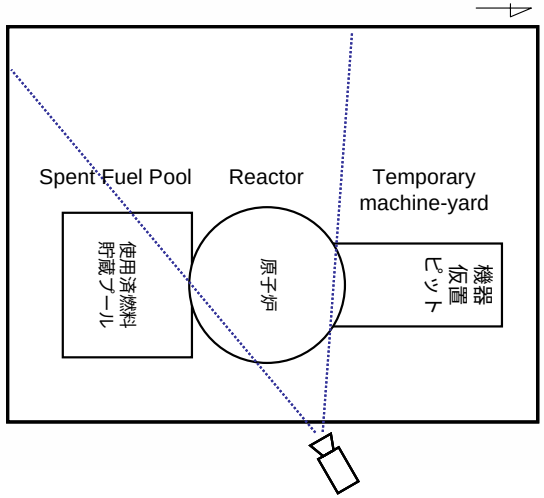
<u>Steam generation has been stopped or so little as to be condensed before leaking into the building, if any. (Therefore inside the PCV should have been cooled.)</u>

Unit 2 Cooling Condition (Steam Generation)

Steam release from right above the reactor on 5th floor
(photo as of Sep. 17, 2011)

Situation of 5th floor of reactor building with no steam release
(photo as of Oct. 20, 2011)

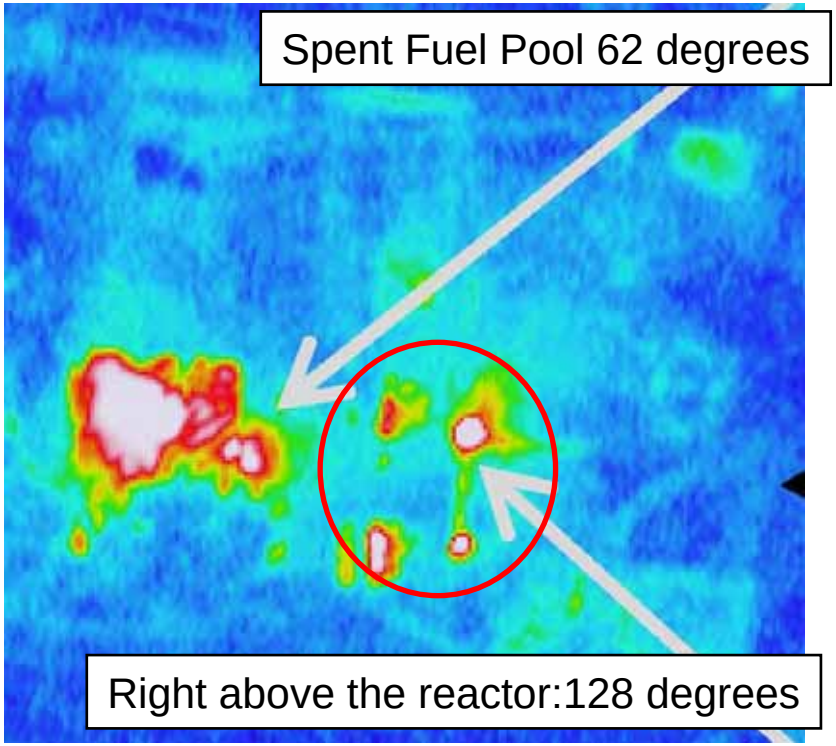
- Steam release was observed on Sep. 17, however no longer confirmed on Oct. 20.
- In addition, the paints of the overhead crane were being stripped off on Oct. 20, which shows that the air is dry (the adhesion of the paints had been weakened via humidity and then the paints were stripped when the air was dried.)



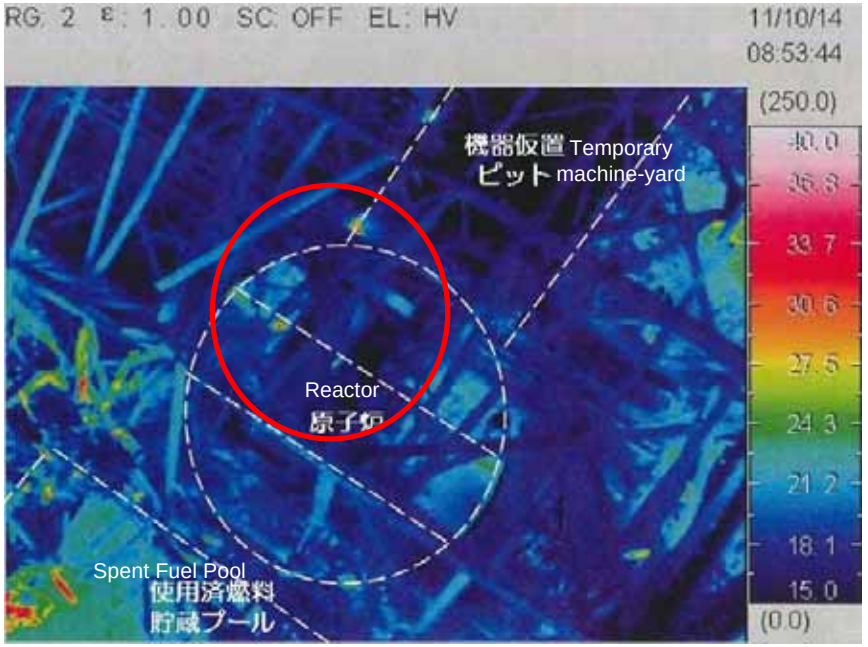
Steam generation has been stopped or so little as to be condensed before leaking into the building, if any.
(Therefore inside the PCV should have been cooled.)

Unit 3 Cooling Condition (Steam Generation)

Thermo graphic monitoring from the sky



As of Mar. 20, 2011 (by Self-Defense Forces)



As of Oct. 14, 2011

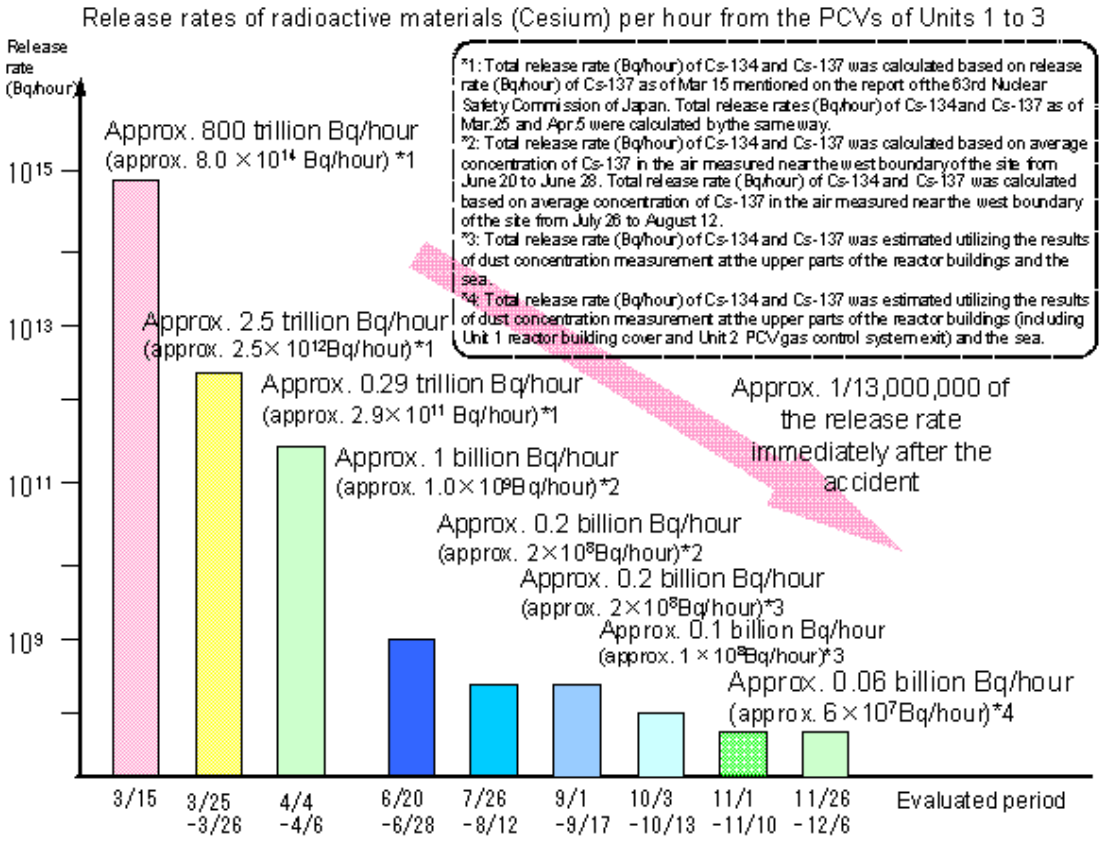
The area of high temperatures as of Oct. 14 is narrowed compared to that as of Mar. 20.

Steam generation has been decreased (the inside of PCV has been cooled.)

Reactors

Having mitigated the release of radioactive materials

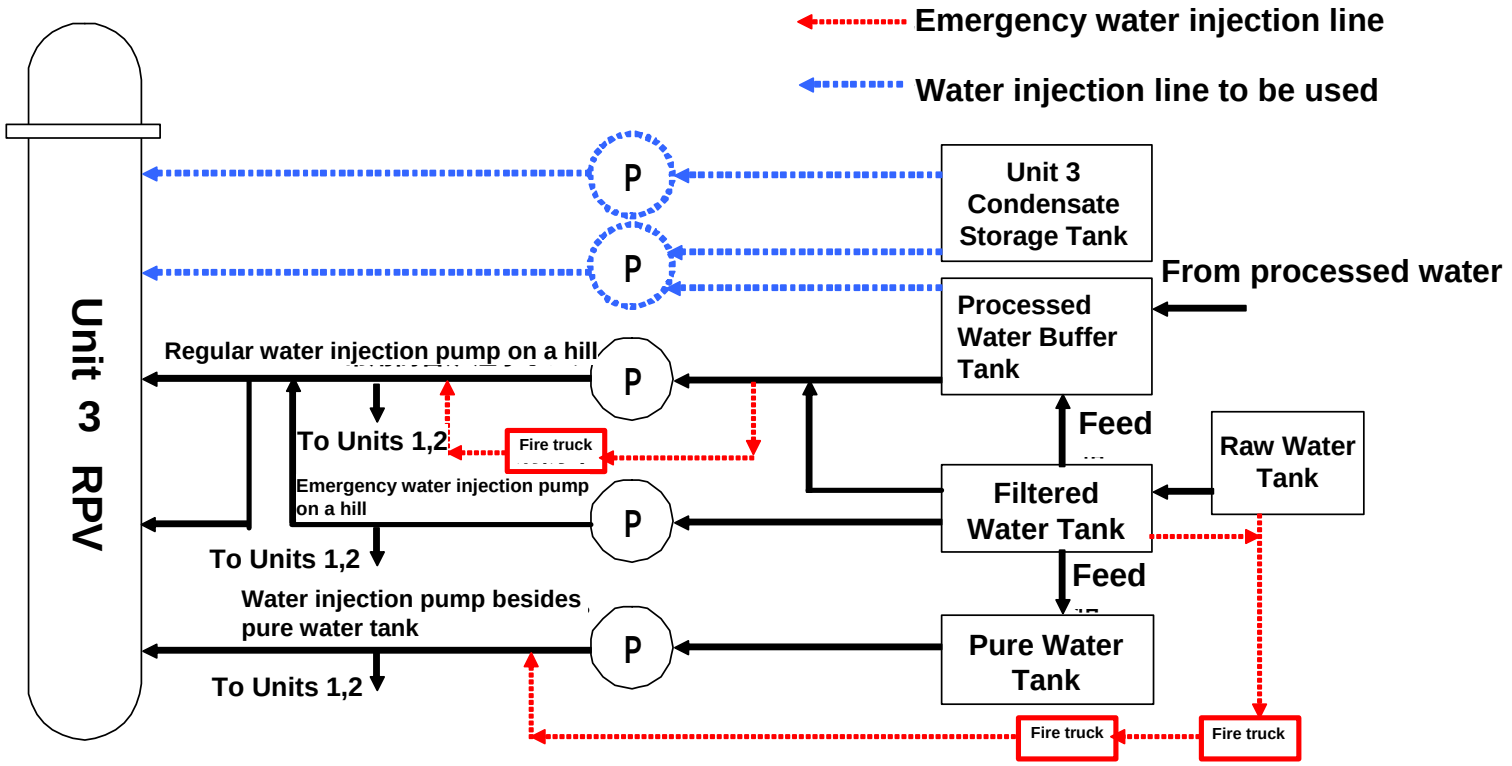
- Utilizing the airborne radioactivity concentration at the upper parts of the reactor buildings etc., the total current release rate (Cs) from Units 1 to 3 is estimated to be approximately 0.06 billion Bq/hour. This is approximately 13 millionth of the release rate right after the accident..
- The exposure dose at the site boundaries due to aforementioned is assessed at 0.1 mSv/year at the maximum (excluding the effect of radioactive materials already released until now.) The legal dose limit is 1 mSv/year.



Having secured mid-term safety of circulating water cooling system

- The facility management plan of TEPCO Fukushima-Daiichi Units 1 to 4 based on the midterm security concept was assessed as appropriate by NISA.
- RPV/PCV water injection system is comprised of water injection pumps, injection lines and tanks which have redundancy, diversity and independency.
  - ✓Water sources are comprised of filtered water tanks, processed water buffer tanks and pure water tanks.
  - ✓Water injection pumps are comprised of regular pumps on a hill, emergency pumps on a hill, pumps besides the pure water tanks and fire engines for emergency backup.
  - ✓Water injection lines are comprised of a line from processed water buffer tank through regular or emergency injection pumps on a hill and a line from pure water tank through a pump besides pure water tank.

Example: Outline of Water Injection Line at Unit 3



Spent Fuel Pool

SFP has achieved the status “More stable cooling”

- Having installed heat exchangers and maintained pool water level, we achieved “More stable cooling” (Step 2 target) at Units 2 and 3 at the end of Step 1.
- Circulating cooling systems for Units 1 and 4 had also been installed, thus the Step 2 target was achieved in all Units on Aug. 10, 2011.
- The desalination facility for Unit 4 has begun operation on Aug. 20, 2011. The desalination facilities for Units 2 and 3 are planned to be installed in turn.
- Even if circulating cooling system stops working, it will take more than approx. 16 days for the water to reach above the top of the spent fuels, thus we have sufficient time to take countermeasures.

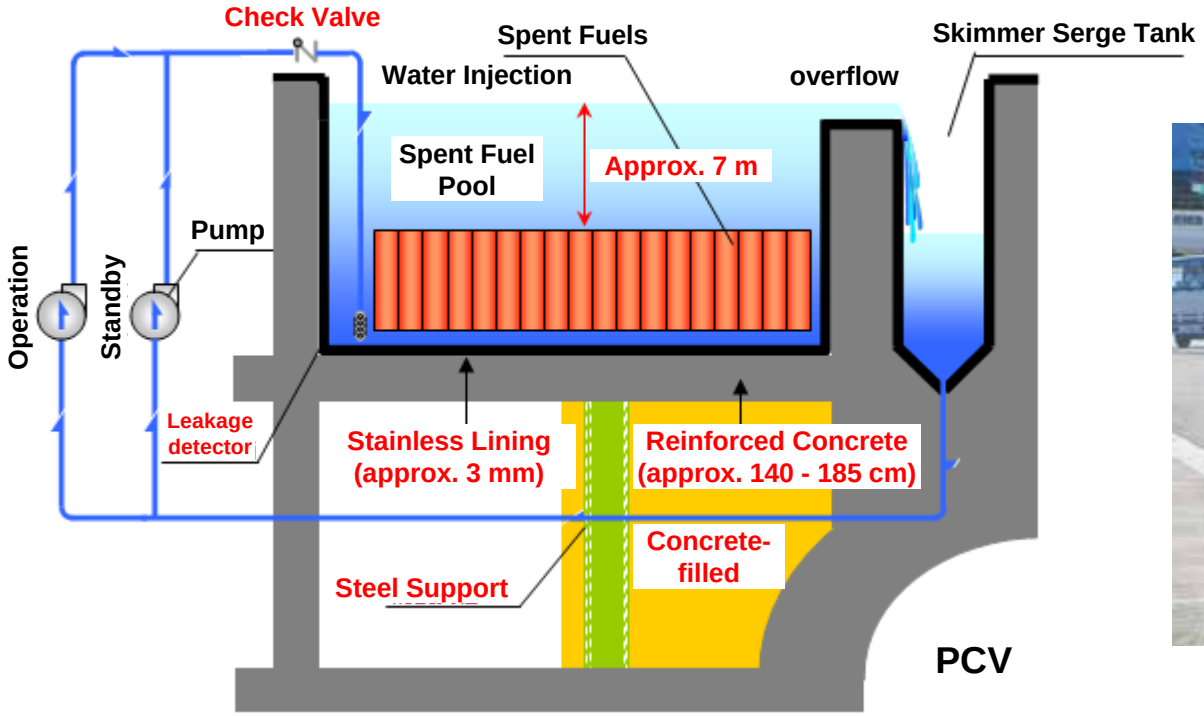


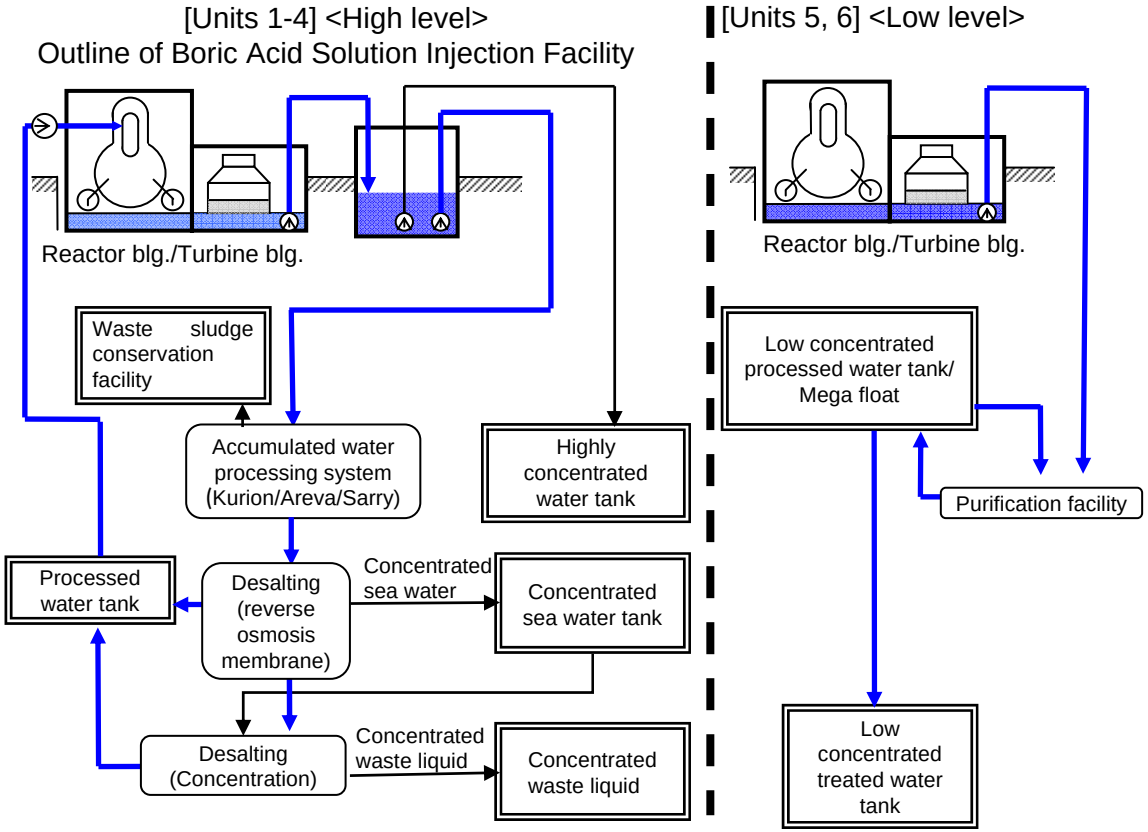
Image of Spent Fuel Pool

Restoration drill of water injection facilities at Fukushima Daiichi (Oct. 12, 2011)

Accumulated Water

"Total volume of accumulated water has been reduced"

- We confirmed "the reduction of total volume of accumulated water" due to processing the accumulated water in the buildings via stable operation of processing facilities. Following countermeasures were implemented to achieve this end.
  - ✓ Reinforcement of high-level contaminated water processing facilities, stable operation and expansion of water reuse after desalination.
  - ✓ Begun consideration of full fledged high-level contaminated water processing facilities.
  - ✓ Storage and management of waste sludge generated from high-level water processing facilities.
  - ✓ Construction of steel pipe sheet pile at the site harbor started in order to mitigate the contamination into the ocean.



Accumulated Water

Accumulated water level has been maintained at target level

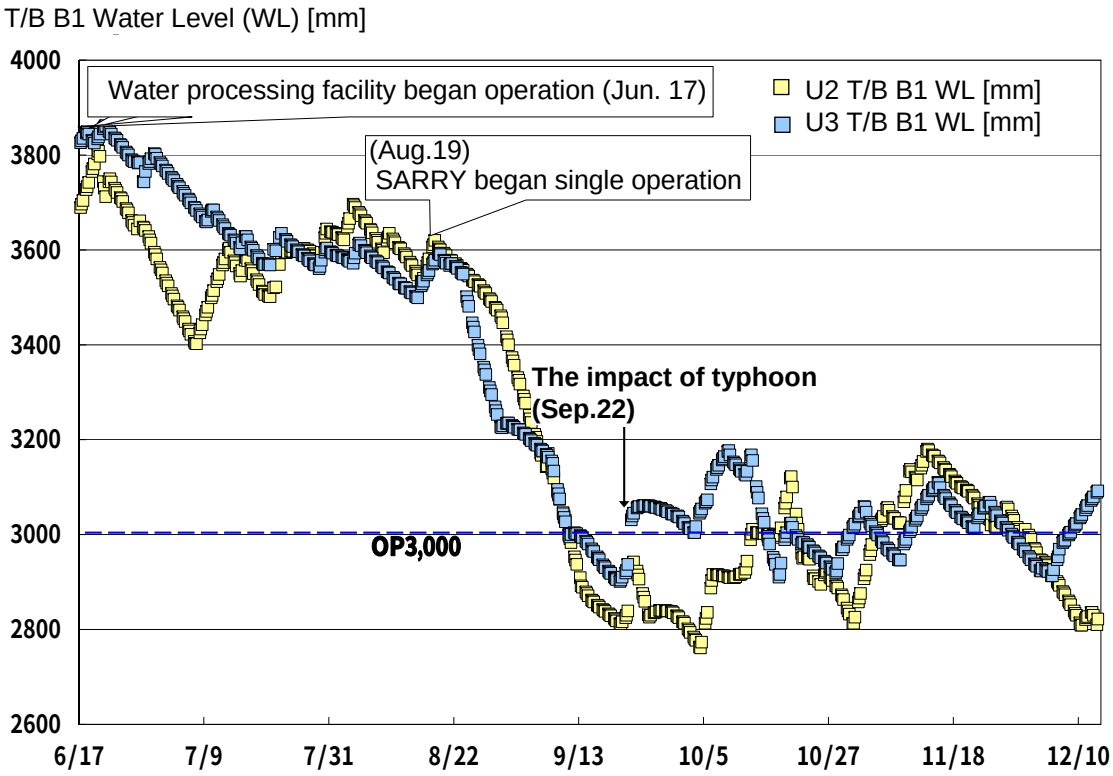
- After full-scale use of SARRY from Aug. 18, 2011, the accumulated water level reached the target level of O.P 3,000, where it is able to withstand heavy rains as well as long-term processing facility outages.
- At this point, we are continuing and enhancing circulating water cooling.

<Status of the accumulated water processing>

- **Accumulated water processing performance**
  approx. 189,610 tons in total (as of Dec.13, 2011)
- **Cs decontamination factor***
  10^6 in the apparatus of Kurion – Areva (as of Aug. 9, 2011)
  6 X 10^3 in the apparatus of Kurion (as of Nov. 29, 2011)
  5 X 10^5 in SARRY (as of Nov. 29, 2011)
- **Chlorine concentration**
  Decreased from 1,700 ppm to approx. 3 ppm (by the reverse osmosis equipment , as Nov. 29, 2011)
  Decreased from 9,000 ppm to less than 1 ppm (by the evaporative concentration apparatus as of Nov. 29, 2011)
  Reinforcement of desalination processing facility by the evaporation concentration apparatus was completed (Oct. 9, 2011)

*Decontamination factor = cesium concentration of a sample before processing / cesium concentration of a sample after processing

Control of Accumulated Water in Turbine Building



Underground water

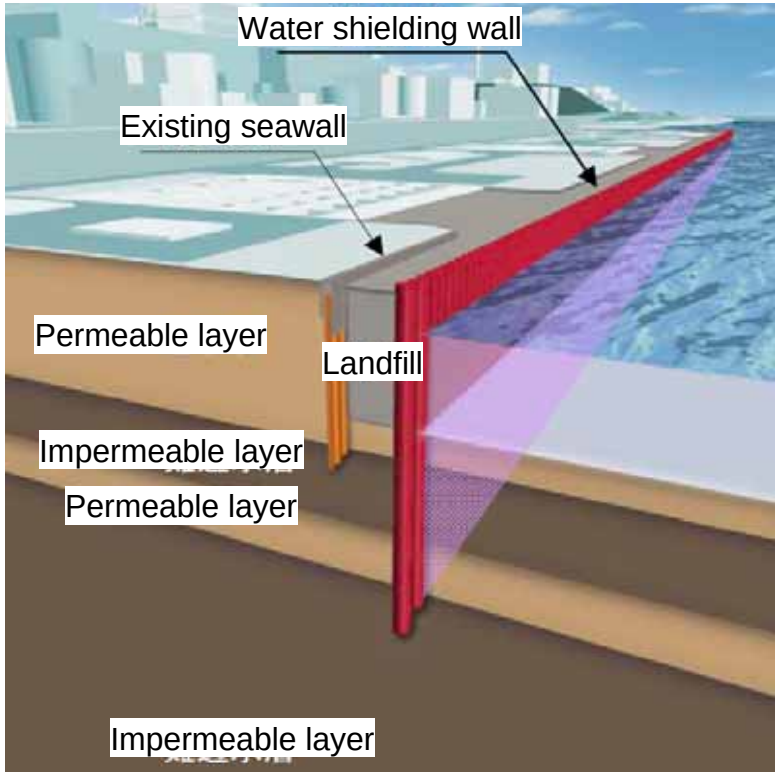
Achieved "Mitigation of ocean contamination"

- By controlling accumulated water flows into underground water, we implement/start preventative measures to mitigate underground water contamination as well as to halt the spread of contamination into the ocean.
  - ✓ Mitigate the leaking of accumulated water in the building by ensuring that the level of accumulated water is lower than the sub drain water level (confirm via a radioactive materials density analysis of the sub drain).
  - ✓ Start the placement of the water shielding walls in front of the existing seawall of Units1-4 (this will prevent the spread of contaminated underground water from flowing into the ocean)

Image of water shielding wall

Overview

Cross-section



Atmosphere/Soil

Countermeasures to Prevent Diffusion of Radioactive Materials

- Spraying dust inhibitor agents to mitigate spreading of powder dust containing radioactive materials.
- Completed Unit 1 reactor building cover installation (Oct. 28, 2011).
- Radiation dose at the site is being held down due to rubble removal.
  - ✓ The removed rubble and waste resulting from restoration work such as cut down trees due to site clearing were transported after we classified them by type and radiation emitting amount at storage area.
  - ✓ The rubble were placed in containers and stored indoors in accordance with their radiation emitting amount.
- Completed PCV gas control system.
  - ✓ Started operation of PCV gas control system in Unit 1 (Dec.15, 2011), Unit 2 (Oct.28, 2011) and Unit 3 (Mar. 14, 2012).

Unit 1 reactor building cover installation

Containers storing rubble

Spraying dust inhibitor agents to the buildings and site ground

Silt fence installation

Removal of rubble

Achievement of Decontamination

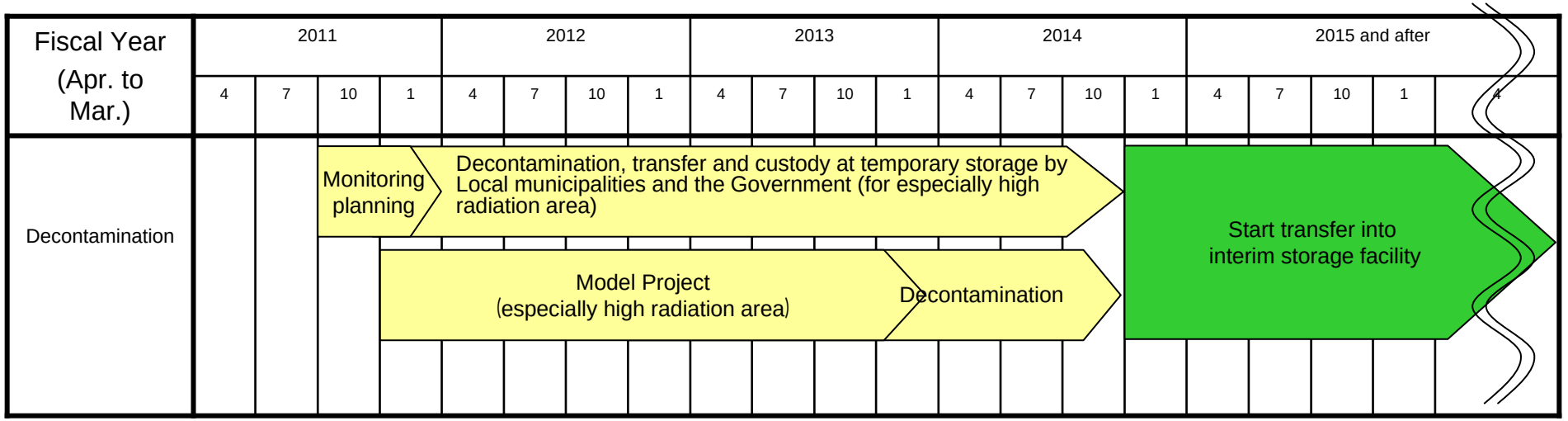
- Monitoring was conducted by the central government, prefectures, municipalities and TEPCO.
- Full-fledged decontamination was considered and commenced.

[Government's implementation]

- ✓ Determined the "Basic policy towards implementing decontamination" and the "Basic stance towards the urgent implementation of decontamination" which sets forth the target and stance for two years onwards.
- ✓ Promulgated the "Act on Special Measures concerning the Handling of Environmental Pollution by Radioactive Materials Released due to the Accident at the Nuclear Power Stations in connection with Tohoku-Chihou-Taiheiyo-Oki Earthquake on March 11, 2011" (Aug. 30, 2011).

[Activities that TEPCO is participating in]

- ✓ Based on the results of the wide area monitoring and detailed monitoring and TEPCO's knowledge (radiation control and construction supervising, etc.), in order to facilitate the Government's demonstration of the decontamination model project in the restricted area, TEPCO will cooperate with the Japan Atomic Energy Agency (JAEA), a contractor of this project.

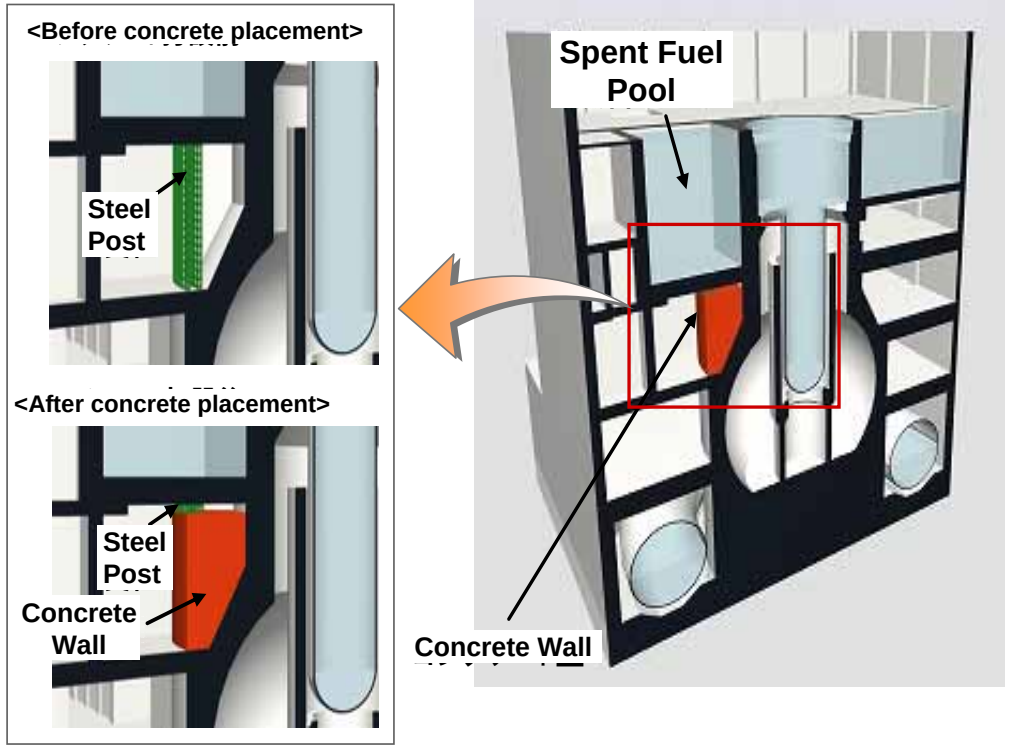


*Extract from "The basic concept of the interim storage facility required in dealing with environmental contamination due to radioactive materials resulting from the accident at Fukushima Daiichi Nuclear Power Plant, TEPCO" (Ministry of the Environment, Oct.29. 2011).

Tsunami & Reinforcement, etc.

Achievement of "Mitigate disaster impact"

- Via the seismic assessment of all Units' reactor buildings, seismic safety minus additional reinforcements has been confirmed.
- Support structure has been installed at the bottom of Unit 4 Spent Fuel Pool.
  - ✓ Support structures have been installed at the bottom of SFP to broaden the margin of safety, even though the soundness of facilities was confirmed.
- A temporary tide barrier was installed as a countermeasure against tsunamis caused by earthquakes. (May 18 ~ Jun. 30, 2011)
- Several kinds of countermeasures for radiation shielding were implemented.
  - ✓ Countermeasures were implemented to mitigate radioactive material emissions and to shield radiation in the event of a prolonged suspension of water injection to the reactor or the spent fuel pool.
  - ✓ We installed facilities that will put slurry (a mixture of water and solid material such as sands) through the upper part of the reactors and spent fuel pools in order to mitigate radioactive material emissions as well as to shield radiation.



Support structure for piping

Installation of temporary tide barrier

Living/Work Improvement

Achievement of “Work Environment Improvement”

- Setting up of rest stations for workers in each area as well as water coolers, toilets and air showers.
- Improving the living environment of Fukushima Daini gymnasium, where the workers are residing, and completed construction of temporary dormitory able to accommodate 1,600 persons.
- Having improved meals such as providing lunchboxes for lunch and supper from May 2011.

Inside the rest place in former Emergency Response Room

Bunk beds in gymnasium at Fukushima Daini

Toilet in rest place

Drinking water at rest place in former Emergency Response Room

Shower room in gymnasium at Fukushima Daini

Air shower in rest place

Achievement of "Health care improvement"

- Improving health care
  - ✓ Conducting additional health checkups every month for those workers whose exposure dose exceeds 100 mSV and who engage in emergency work for over a month. Implementation rate of special health checkups in October 2011 was 86.5 % (as of Nov. 16, 2011).
  - ✓ Routine check ups of recent health conditions and the tracking of the medical history of new site workers has begun
- Increase the number of whole body counters (WBC) and conduct periodical measurements of the internal exposure dose of workers
  - ✓ The number of WBC was increased as planned (12 units have already been installed as of Oct. 3, 2011)
  - ✓ From September 2011, once-a-month internal exposure measurements were started.
- Exposure control has being enhanced.
  - ✓ At the beginning of Step 1 some workers were exposed to dosage amounts exceeding the limit. Hence exposure controls were tightened and countermeasures were developed to prevent recurrences.
  - ✓ Automated record-keeping of personal radiation dosage data was started via installing access control system utilizing a bar-code and introducing worker photo identification.
- Medical system improvement will be continued
  - ✓ Medical room and care system was established, where multiple doctors, nurses and radiation specialists are on duty at any given time in a 24 hour period 7 days a week.
  - ✓ By improving the medical and decontamination facilities, we are able to ensure speedy patient transportation and direct transportation to hospitals for emergency patients who have not been contaminated

WBC installation

Medical room inside the Main Anti-earthquake building

influenza Vaccination

Achievement of "Systematic staff training and allocation"

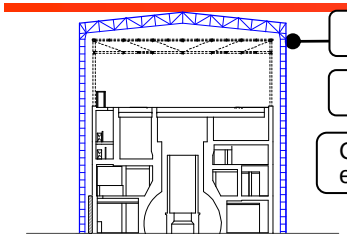
- Promoting staff training in conjunction with the Government and TEPCO
  - ✓ Conduct training for high-demand staff engaged in radiation related work
  - ✓ TEPCO has been conducting "radiation survey staff training" targeting employees and TEPCO group company employees and has already trained approx. 4,400 personnel
  - ✓ The government conducted "Radiation Survey Staff Training" and "Radiation Protection Staff Training"
  - ✓ In accordance with affiliated companies' needs, launched a new framework to find workers nationwide through the Japan Atomic Industrial Forum (JAIF).
- Striving hard to secure adequate number of staff
  - ✓ Since this October 2011, TEPCO has reshuffled 70 employees (as of Dec. 9, 2011) who were exposed to high levels of radiation.
  - ✓ From the perspective of being able to procure staff continuously, TEPCO implemented a questionnaire survey to improve the work environment. Based on the results, TEPCO implemented improvements such as the reduction of the full-face mask area, speedy radiation monitoring by utilizing the gate monitor, and expansion of the parking area at J-village, etc.
  - ✓ Developing measures to reduce exposure dose in the Main Anti-Earthquake Building.

Radiation Survey Staff Training

Screening Training

Overview of Major Countermeasures in the Power Station, Final Edition

Underlined: deleted countermeasures, ☆: already reported to the government



Reactor building cover (5, 50, 54, 55, 84) ☆

Full-fledged container (50, 56)

Cooling of spent fuel pool by external water injection (18, 22, 28)

Sampling of steam/pool water and measurement of radioactive materials (19)

Circulation cooling of spent fuel pool (23, 24, 25, 27) ☆

piping

pumps

heat exchangers, water processing facilities

Water processing facility

Desalination

De-contamination

Adsorption

Oil separation

Tank

Storage/process of low radiation-level water (33, 34, 35, 40, 41, 44, 46)

Storage: tanks, megafloats
Process: decontamination by zeolite

Lower the amount of steam generated (4)
Maintain and enhance countermeasures in Step 1 if needed (17)

Nitrogen gas injection (2, 11, 15) ☆

Reactor Building

PCV gas control (86)

PCV venting (with filtration) (10)

Flooding up to top of active fuel (3, 9)

Primary Containment Vessel (PCV)

Reactor Pressure Vessel (RPV)

Cooling at minimum water injection rate (7, 12, 14)
Reuse of processed water (45)
(Implement circulating water cooling) ☆

Processing high radiation-level water (31, 38, 43) ☆

Storage / management of sludge waste etc. (81) ☆

Consideration of full-fledged water processing facilities (82)

Storage of high radiation-level water (30, 32, 37, 39, 42) ☆

Turbine Building

Steam Turbine

Additionally-installed Tank

Centralized Waste Processing Building

Heat Exchanger

Installation of heat exchangers (13)

Condenser

Injection of fresh water with pumps (1)

Suppression Chamber

Processing of sub-drainage water after being pumped up (36)

Sealing the leakage location (6, 16)

Dispersion of inhibitor (47, 48, 52)
Removal / management of debris (49, 53, 87)
Consideration of countermeasures for contaminated soil (51)

Preventive measures against leakage of high radiation-level water (29)
Prevent contamination in the ocean (64)
Isolation of high-level radioactive water (65)

Prevent contamination of groundwater (66, 67);
Consideration of impermeable wall against groundwater(68, 83)

Seismic assessment (20) ☆,Continued monitoring (21),
(Unit 4) Installation of supporting structure under the bottom of spent fuel pool (26) ☆

Improvement of living/working environment of workers(74, 75);
Improvement of site environment(76) ☆

Enhancement of radiation control and medical system (77, 78, 79, 80);
Systematic implementation of staff training / personnel allocation (85)

Install various interconnecting lines of offsite power(8);
Enhance countermeasures against tsunami (69, 70);
Consideration of reinforcement work of each Unit (71) ☆;
Various countermeasures of radiation shielding (72, 73)

Continue/Enhance monitoring (55-62),
Consideration / start of full-fledged decontamination (63)