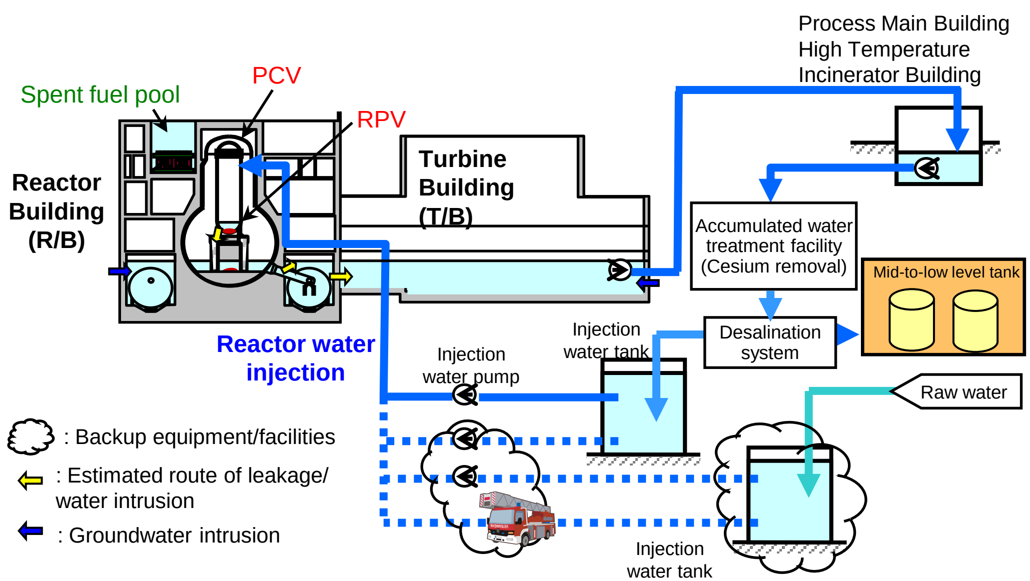
Progress Status of the Mid-and-Long Term Roadmap towards the Decommissioning of Fukushima Daiichi Nuclear Power Plant Units 1-4 of TEPCO

October 22, 2012
Government-TEPCO Mid-and-long Term Response Council

1. "Cold Shutdown Condition" is maintained at Unit 1-3. Measures to complement status monitoring are being implemented.

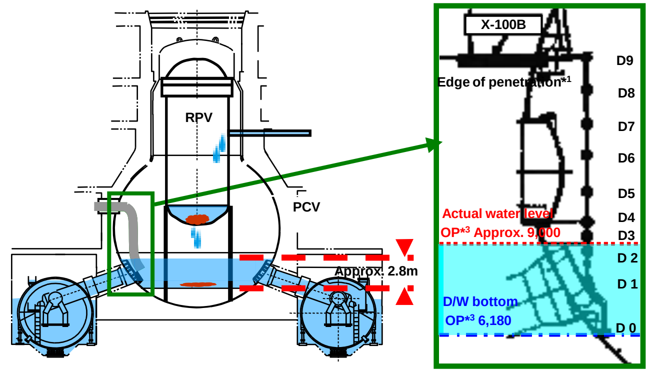
- The RPV bottom temperature and the PCV gaseous phase temperatures at Units 1-3 were approx. 30-50℃ (as of October 19) and fulfill the requirement (100℃ or less).
- The steam generation in the PCV is suppressed by controlling the water injection amounts, which contributes to sufficiently low levels of cesium released from Unit 1-3 Reactor Buildings.
- Adequate backup equipment is secured. (Water injection pumps: 3 systems; water sources: 2, power supply secured by multiple generating lines, fire engines etc.)
- Even if multiple simultaneous failures of water injection equipment should occur, water injection can be restarted within about 3 hours.

[Overview of the circulating injection cooling system for cooling the reactor]



Investigation of the inside of Unit 1 PCV and installation of PCV thermometer and water gauge

- The inside of Unit 1 PCV was investigated with a camera, and the radiation dose and water level were measured (October 9-13).
- The maximum radiation dose was approx. 11.1Sv/h and the water level was approx. +2.8m from the bottom of the PCV.
- A thermometer and water gauge will be installed. The thermometer will be monitored for a month to determine whether or not it can be used for monitoring the cooling condition of the PCV.

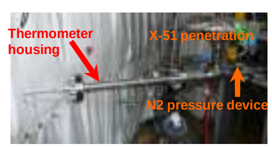


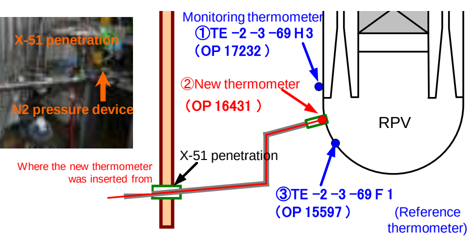
Measurement point	Distance from the bottom of D/W*	Radiation dose (Sv/h)
The edge of penetration	8,595	Approx. 11.1
D9	8,595	9.8
D8	Approx. 7,800	9.0
D7	Approx. 6,800	9.2
D6	Approx. 5,800	8.7
D5	Approx. 4,800	8.3
D4	Approx. 3,800	8.2
D3	Approx. 3,300	4.7
D2 (Water surface)	Approx. 2,800	0.5
D1	—	—
D0	0	—

*D/W (PCV)

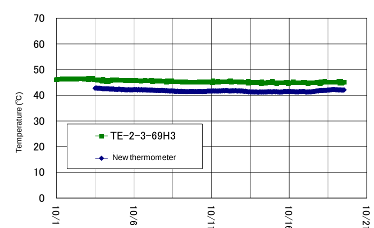
Installation of Unit 2 RPV alternative thermometer

- An alternative thermometer has been installed to replace the broken thermometer in addition to the existing monitoring thermometer (TE-2-3-69H3) (October 3)
- The newly installed thermometer is confirmed to be functioning properly as the temperature indicated by the new thermometer is about the same as that of the existing monitoring thermometer (TE-2-3-69H3) (approx. 43-46℃).
- The temperature behavior of the thermometer will be monitored for a month to determine whether or not it can be used as a monitoring thermometer.
- In the case that this thermometer is broken, it can be removed for repair or replacement.





Thermometer installation condition

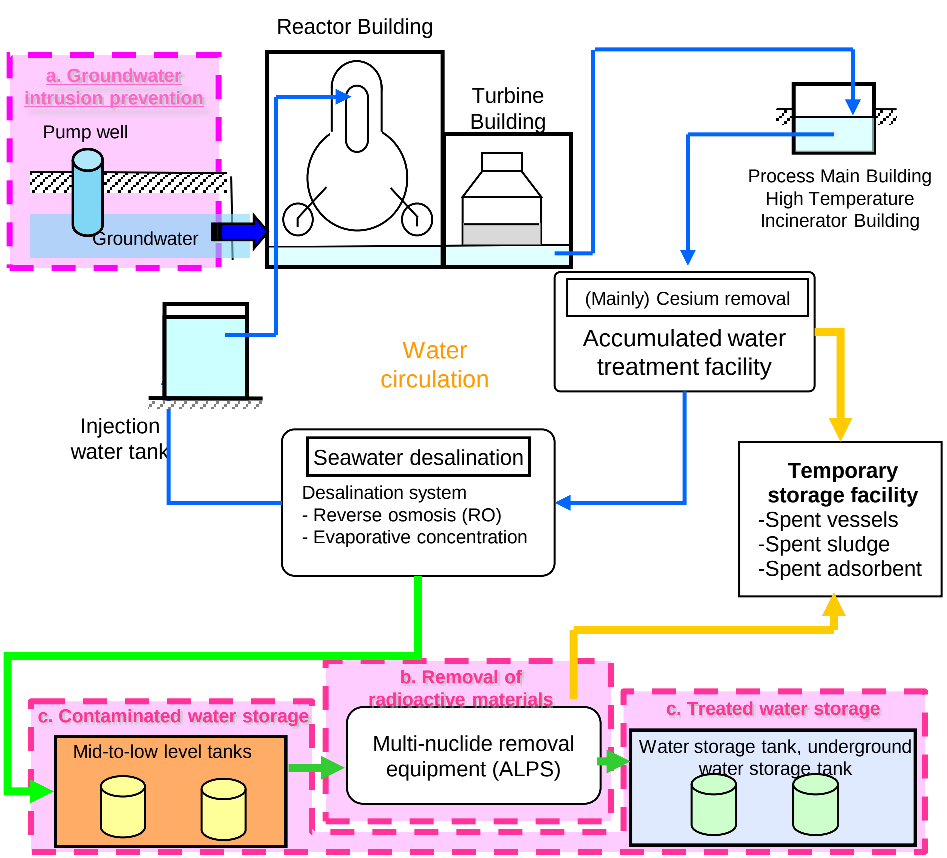


Change in the readings of the existing thermometer (① TE-2-3-69H3) and the alternative thermometer

2. Countermeasures against accumulated water increased by groundwater intrusion

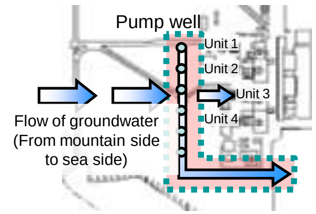
The highly radioactive water accumulated in the building basement is treated to be used for reactor cooling. The contaminated water generated in this process treated and stored.
a. Prevent groundwater flow into the building → Develop a groundwater bypass
b. Remove the radioactive materials in the contaminated water → Install multi-nuclide removal equipment
c. Storage of contaminated water/treated water → Build additional storage tanks in the power station site.

[Accumulated water treatment]

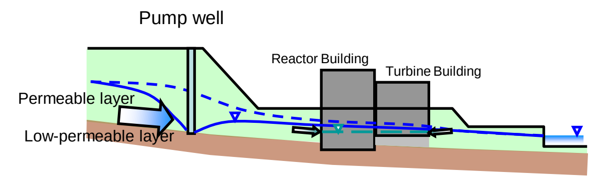


Groundwater intrusion prevention (Groundwater bypass)

- The groundwater flowing from the mountain side is pumped up in the upstream side of the building at the pump well in order to prevent it from flowing into the building (Groundwater bypass).
- Measurement is in progress for the pump well installation which is planned to start in November. After a verification testing using the pilot pump well, the pump well will be in operation.



Top view



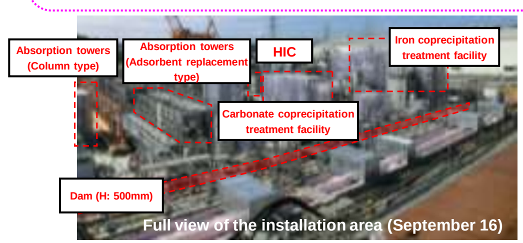
Side view

Removal of radioactive materials (Multi-nuclide removal equipment installation)

- Multi-nuclide removal equipment was installed to further reduce the densities of the radioactive materials included in the accumulated water in the power station site.
- Equipment installation, leakage test using non-radioactive water and a system test have been completed (August 24 - October 1).
- After implementing additional measures to ensure further safety (installation of rainwater protection cover, system separation dam, etc.), leakage test using radioactive water will be performed before the equipment starts operation.

Storage of contaminated water/treated water (Additional tanks)

- A tank operation plan was developed for enabling the storage of treated water, etc. The total capacity of existing storage tanks is approx. 241,000m^3, and approx. 26,000m^3 is available for use (as of October 16).
- Additional tanks are currently being built, and the total capacity will increase to approx. 320,000m^3 by the end of this November.
- Capacity of approx. 80,000m^3 will be added by the end of the first half of FY2013, and approx. 300,000m^3 is planned to be added within the next 3 years (the estimated maximum capacity: 700,000m^3).

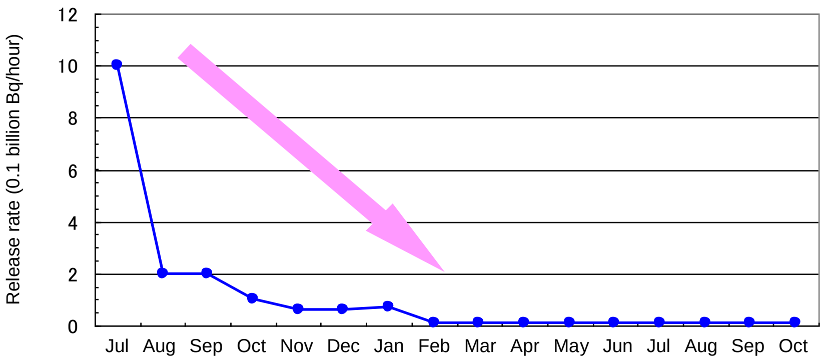


Multi-nuclide removal equipment installation

Underground water storage tank installation

3. Continue implementation of measures to minimize the impact of radiation on the area outside the power station

- The maximum total release rate of cesium (Units 1-3) is approx. 0.01 billion Bq/h with fluctuation factors taken into account, which is about 1/80,000,000 of that of right after the accident. The release rate has been below this value since February.
- The radiation exposure dose at site boundaries is 0.03mSv/year (excluding the effects of the radioactive materials so far released), which is about 1/100 of the annual natural radiation exposure (world average: approx. 2.4mSv/year)



[Release rate of radioactive material (cesium) at Units 1-3 Reactor Buildings per hour]

- The debris, etc. gathered during restoration work is stored in the temporary storage area after being sorted by radiation dose rate and composition (trimmed trees are separated into trunk and branches/leaves). (Concrete/metal: 54,000m³, trimmed trees: 68,000m³ (as of September 28))
- A temporary storage facility shielded by soil and sandbags was built to reduce radiation doses at site boundaries. We plan to move the more highly contaminated debris currently stored near the site boundaries further away from the site boundaries.

Measures to reduce radiation dose at site boundaries

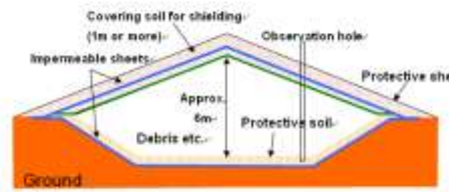
Debris and trimmed trees
- Highly contaminated debris stored near the site boundaries will be moved further away from the boundaries.
- Highly contaminated debris will be stored in the temporary storage facility covered with soil.
- The trimmed trees which may affect the radiation dose at the site boundaries will be covered with soil for radiation dose reduction.

Tanks and equipment
- Equipment layout to mitigate the radiation dose at the site boundaries
- Additional shielding

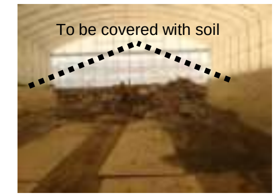
Mitigation of radioactive materials emission
- Covering up buildings
- Protection cover installation on the openings of buildings

Effective radiation dose reduction at the site boundaries

- The most recent radioactive materials emission and radioactive waste storage condition were evaluated in September to achieve the target effective radiation dose (1mSv/year or less) at the site boundaries. As a result, it was found that the maximum radiation dose was approx. 9.7mSv/year at the site boundary in the north area. Installation of a soil-covered-type temporary storage facility is under consideration considering that its impact will be significant (approx. 9.6mSv/year).
- Preparation for 2 facilities has been completed and debris transfer was started (September 5).
- The target radiation dose (1mSv/year or less) will be achieved for the year starting from the end of March, 2013 by implementing further radiation dose reduction measures (covering the debris and trimmed trees with soil, shielding the multi-nuclide removal equipment, moving the storage facilities further away from the site boundaries, etc.) currently being planned.



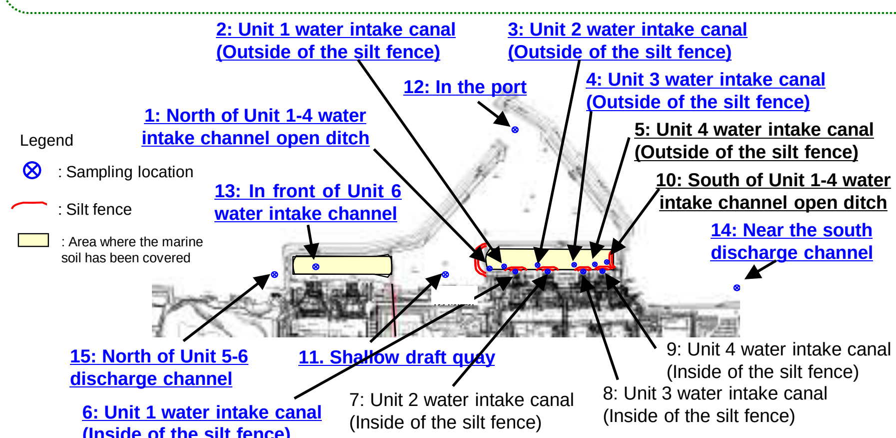
Temporary storage facility covered with soil



Debris storage (September 12)

Reduction of densities of radioactive materials included in the seawater in the port

In order to reduce the radioactivity density (cesium) of the seawater in the port to the density limit specified by the reactor regulation (outside the surrounding monitored areas) by the end of September, the marine soil was covered and the seawater circulating purification system was put in operation. As a result, the cesium densities measured at 8 locations where seawater flow is comparatively large were below the density limit. On the contrary, the radioactivity densities of seawater in 5 locations where seawater flow is smaller were still above the density limit. Density reduction measures such as continuous filtration and replacement of the silt fence (assumed to be the source of contamination) will be implemented while discussing additional measures in collaboration with external research institutions.



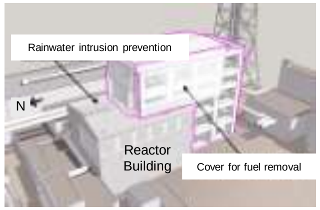
Underlined areas: Radioactivity density below the density limit specified by the reactor regulation

4. Preparation for fuel removal from the spent fuel pool is in progress

Fuel removal from Unit 4 spent fuel pool (planned to start in 2013)

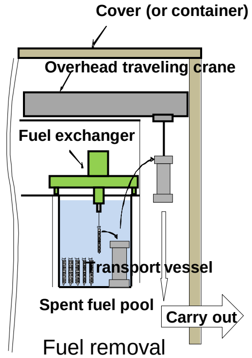
Debris removal from the upper part of the Reactor Building

Planned completion: Mid FY 2012



Cover installation for fuel removal

Started in April 2012, planned completion: Mid FY 2013

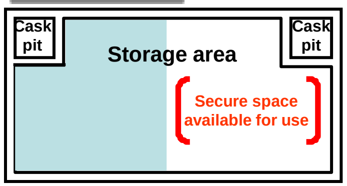


Fuel removal

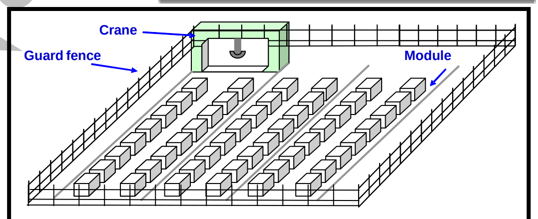
Planned to start in December 2013

After securing space available for use in the common pool, the fuel will be removed and transported to be stored.

Common pool



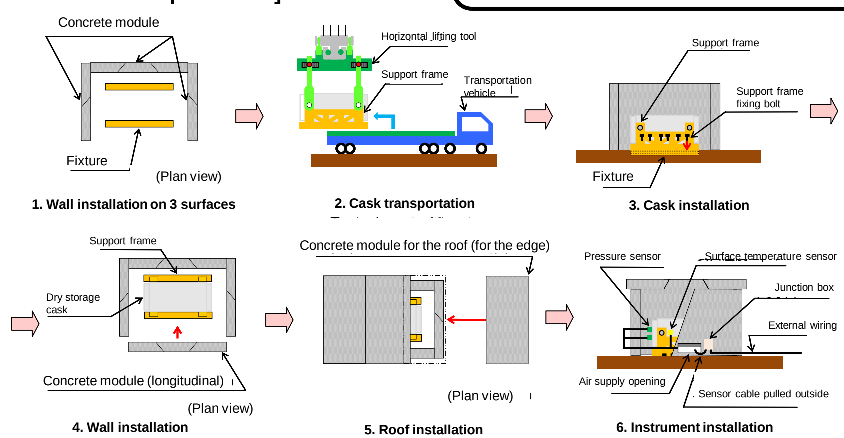
Dry cask temporary storage facility



Spent fuel transportation from the common pool

Current status: Installation (includes preparation) has been ongoing from June 2012

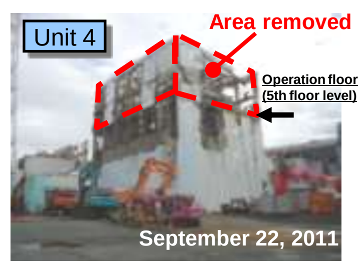
[Cask installation procedure]



Debris removal from the upper part of Units 3-4 Reactor Building and cover installation for fuel removal at Unit 4

- Debris removal from the upper part of Units 3-4 Reactor Building is in progress to prepare for fuel removal from the spent fuel pool.
- At Unit 3, a steel beam which had been unstable during debris removal fell into the spent fuel pool. A report including the cause and recurrence prevention measures was submitted to the Nuclear Regulation Authority (October 3, 19). With the lessons learned from the incident, further safety will be ensured during debris removal.
- At Unit 4, large equipment has been removed (July 24-October 2) and cover installation for fuel removal is on going (to be completed in mid FY 2013).

[Debris removal from the upper part of the Reactor Building]



Soundness investigation of the unused (unirradiated) fuel in Unit 4 spent fuel pool

Two unused fuel rods were taken out from the pool for a soundness investigation to check for corrosion (August 27-29). Since no deformation, damage or corrosion was found with the fuel rods and their structural materials, it was concluded that spent fuel removal will not be affected significantly by material corrosion.

[Removal and soundness investigation of unused fuel]

Unused fuel being taken out at Unit 4 spent fuel pool (July 18-19)

Fuel soundness investigation

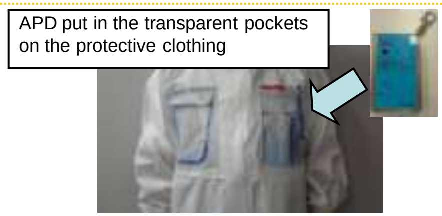
Tie-rod being removed from fuel assembly

5. Securing a sufficient number of workers and work safety

Ensuring the APD usage and collaboration with cooperative companies

- Recurrence prevention measures are implemented in response to the inappropriate APD usage
1: TEPCO supervisors or main contractor employees check for APD usage when they visit the work site without prior notice.
2: Wear protective clothing with its chest area transparent to facilitate checking.
3: Identify employees who must have an APD (target of checking)
- Reduce burden on workers by implementing work environment improvements such as the non-requirement of face masks and breathable tyveks.
- A survey on working conditions was performed to understand the actual conditions of the working environment, working conditions and employment conditions. (The questionnaires were sent out on September 20, and the results will be summarized in late November.)

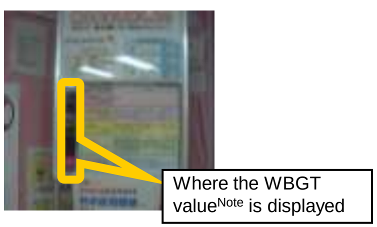
1. Checking for APD without prior notice

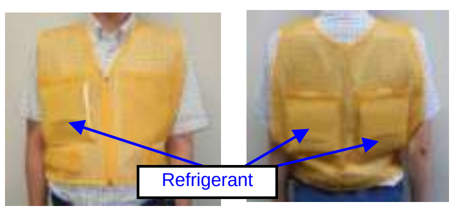


2. Protective clothing with its chest area transparent (From October 15)

Heat stroke prevention

As a result of implementing the following heat stroke prevention measures, the number of heat strokes has significantly reduced compared to FY 2011. (FY 2012: 7/ FY 2011: 23)
* The number of emergency medical transports in July and August increased compared to 2011 throughout Japan (announced by the Fire and Disaster Management Agency)
- Early implementation of heat stroke measures (from May) in order to be well prepared for the extremely hot season.
- Installation of an electronic display panel indicating WBGT value[Note]. Working hours, frequency and length of breaks and work load are adjusted according to the WBGT value.
- Prohibition of work during the period from 2:00 PM to 5:00 PM under blazing sun.
- Encourage wearing the cool vest.





[Note] WBGT value: An index of humidity, radiant heat and air temperature which has a significant impact on the heat balance of a human body.

6. Research and development for fuel debris removal and radioactive waste processing and disposal

Decontamination of the inside of buildings and development of the comprehensive radiation dose reduction plan

- In order to reduce the radiation exposure among workers in the buildings, effective decontamination methods and target locations are being considered.
- Effective contamination methods are being studied based on the JAEA analysis results of wall/floor samples collected from the buildings.
- The locations targeted for decontamination are considered based on the contamination conditions of the work area.

Investigation and repair of the leakage on the bottom of the PCV

- The basic technology development WG for the suppression chamber (S/C) water level measurement robot and the basic technology development WG for an underwater swimming robot were established under the remote technology task force.
- Robot development is in progress for operation in high radiation dose areas. In order to determine the specifications of the robot, the inside of PCV and the triangle corner and the torus room in the Reactor Building are investigated and the radiation dose, accumulated water level and ambient temperature are obtained.

Development of remote decontamination technology for the inside of buildings

A remote decontamination system adequate for the contamination conditions of the work site is to be developed to investigate the leakage location and improve working environment.
[Main points of technology development]
- Development of effective decontamination technology based on the contamination conditions
- Development of remote decontamination system to be used under difficult environmental conditions (high radiation dose, narrow space, etc.)

Development of technology specialized in identifying the leakage location of the PCV

Technology specialized in identifying the leakage location of the PCV is to be developed.
[Main points of technology development]
- Development of remote decontamination system to be used under difficult environmental conditions (high radiation dose, narrow space, etc.)

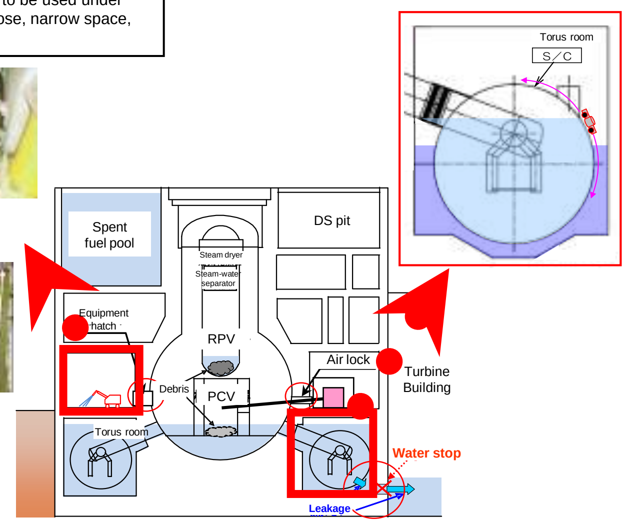
High-pressure water cleansing

Stoppable paint

Self-propelled brushing

Surface chipping

Decontamination technologies (Examples)

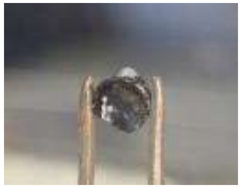


Understanding and analyzing the condition of the inside of the reactor

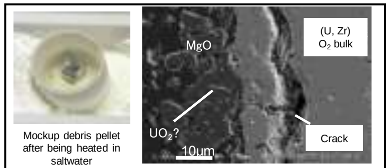
- Enhancement of the analysis code used to simulate the condition of the inside of the reactor
- International benchmark Fukushima nuclear accident analysis project was established in collaboration with OECD/NEA, and the first meeting and workshop will be held on November 6-9, 2012 in Tokyo.

Characterization of fuel debris and preparation for fuel debris processing

- The physical properties of fuel debris which affect the development of equipments used for fuel debris removal will be identified and an organized chart of fuel debris physical properties will be created.
- Mockup debris will be manufactured to obtain basic data on high temperature reaction to the sea salt.
- A draft scenario of fuel debris handling process (storage, processing and disposal) will be created and trade-off evaluation regarding a part of the process (debris storage) will be done.



Appearance of mockup debris



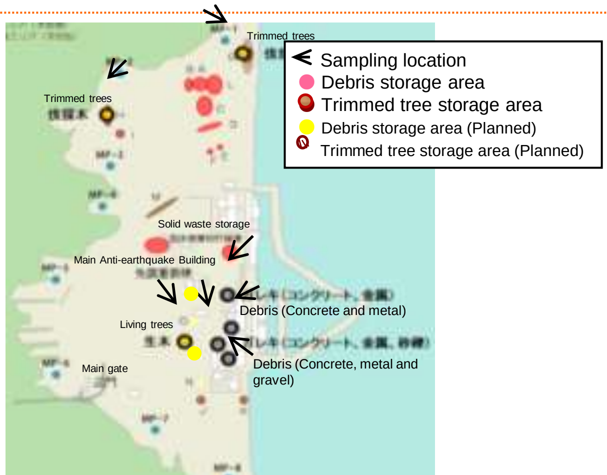
Mockup debris pellet after being heated in saltwater

Cross section of the portion exposed to salt

Testing high temperature reaction to sea salt (800-1400°C)

Radioactive waste processing and disposal

- In order to examine the characteristics of the secondary waste generated by water treatment, samples of accumulated water and treatment water were analyzed. Based on the results, the densities of the radioactive materials included in the secondary waste are being analyzed.
- Sample collection and analysis are in progress to examine the characteristics of debris and trimmed trees in the power station site.



Debris/trimmed trees sampling locations

Sample example (Trimmed tree)

Sample example (Concrete)

7. Strengthening of Research and Development management

Future plan for research centers

- Conceptual design and basic design for the “Radioactive material analysis” and “facility for remote control equipment development and demonstration” necessary for advancing the long-and-mid term roadmap are ongoing.
- In accordance with the Basic Policy for Recovery and Reconstruction of Fukushima, the research centers are aimed to be international institutions in the future contributing to the local employment and economic growth.

Research and Development Management Headquarters

- Based on the “Results of consideration on the long-and-mid term measure implementation at TEPCO Fukushima Daiichi Nuclear Power Station” developed by a special committee of the Japan Atomic Energy Commission last December, the Research and Development Management Headquarters was recommended to be operated as a special organization in order to efficiently advance research and development over a long period of time.
- The best possible organization will be developed to achieve the stated goals (effectively and efficiently advancing research and development projects, international collaboration with overseas research institutions, etc.) which have been clarified.

Securing and fostering human resources from a long- and-mid term perspective

The manpower necessary for field work and research and development to achieve reactor decommissioning in 10 to 20-year time frame will be secured and fostered in collaboration with universities and research institutions.

[Terms]
- Penetration: Penetration area in the PCV, etc.
- Cask: Transportation vessel for spent fuel.
- Nonrequirement of face mask: Setting areas where face mask is not required.
- Breathable tyveks: Protection clothing which lets more air through compared to the regular type (for more comfort).
- Suppression Chamber (S/C): Stores cooling water in the lower part of the PCV. When the pressure inside the PCV increases due to the reactor water and steam released, the suppression chamber reduces the pressure by directing reactor water and steam through the vent pipe. Also used as water source, etc. for the emergency reactor core cooling system.
- Triangle corner: Staircase to go through to get to the Torus Room.
- Torus Room: Room where S/C is stored in.
- OECD/NEA: Organisation for Economic Co-operation and Development/Nuclear Energy Agency