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

December 3, 2012
Government and TEPCO Council on Mid-to-Long-Term Response for Decommissioning/Management Board

Introduction

- On December 16, 2011, the Nuclear Emergency Response Headquarters established the Government and TEPCO Council on Mid-to-Long-Term Response for Decommissioning in order to formulate a plan for decommissioning of Units 1~4 at TEPCO's Fukushima Daiichi Nuclear Power Plant and to manage the progress. On December 21, 2011 at the first session of the Council, a decision was reached on the "Mid-to-Long-Term Roadmap towards the Decommissioning of Units 1-4 of TEPCO Fukushima Daiichi Nuclear Power Plant ("Roadmap")."
- From that point forward, efforts have proceeded based on this Roadmap, and the Management Board and Research and Development Management Headquarters have been established under the Council on Mid-to-Long-Term Response for Decommissioning. Sessions of the Meeting have been held monthly to manage progress on the Roadmap.
- On July 30, 2012, the second session of the Council on Mid-to-Long-Term Response for Decommissioning was held and the Roadmap was revised to reflect the plan for implementing measures to improve the reliability of equipment and machinery as prepared by TEPCO under the direction of the then Nuclear and Industrial Safety Agency.
- December 2012 is the one year mark since the Roadmap was laid out, providing an opportunity to check the progress made so far and identify the challenges still ahead.

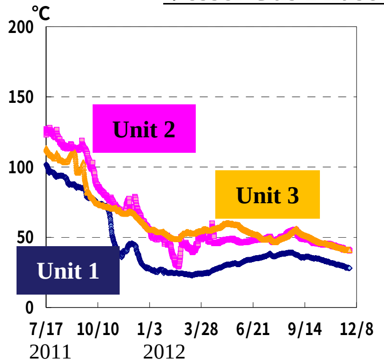
Current Plant Status

○Temperature:
Cooling water continues to be injected into the Unit 1~3 reactors. A low temperature of approximately 30~50℃ is being stably maintained.

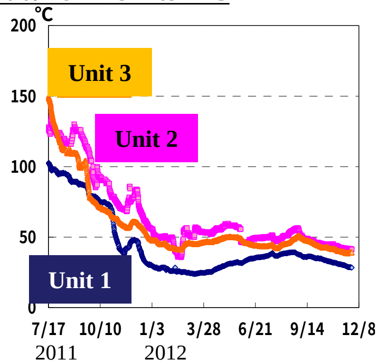
○Emission of radioactive materials:
Emissions of radioactive materials from the reactor buildings at Units 1~3 have decreased. Since February 2012, the level has been 0.03mSv/year when converted to an exposure dose at the site boundary, which is roughly 1/70 of total exposure from natural radiation.

○Confirmation of subcriticality:
Xe-135 is monitored by the containment vessel gas control system to check for subcriticality.

Verification of the Pressure Vessel Bottom Temperature and Containment Vessel Gas Phase Temperature in Units 1~3



Pressure vessel bottom temperature

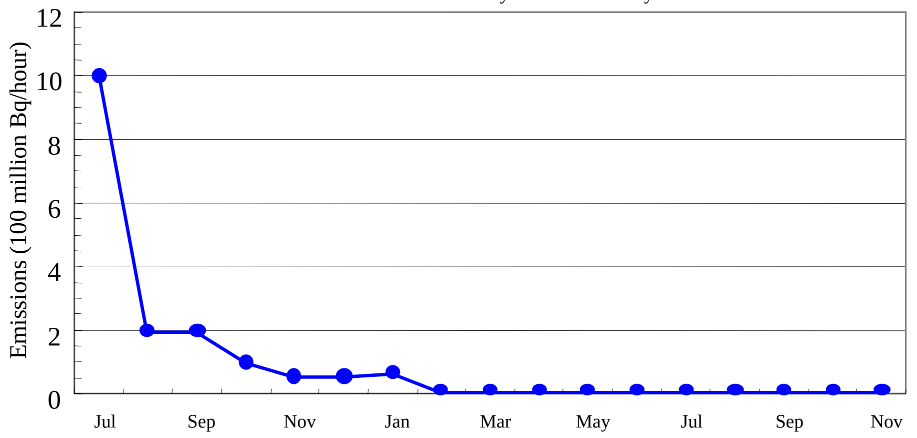


Containment vessel gas phase temperature

Current Emissions from Reactor Buildings at Units 1~3

- ◻ Based on the results of monthly samplings and taking into account variable factors and other contributing elements, total emissions from Units 1~3 have been assessed to be a maximum of approximately 10 million becquerel/hour. Since February, a level has been maintained below this count.
- ◻ Based on this, the radiation exposure at the site boundary is assessed to be 0.03mSv/year. (When surveying exposure at the site boundary, the effect of previously released radioactive materials is taken into account.)
- ◻ This is approximately 1/70 of the annual exposure from natural radiation (average of approx. 2.09mSv/year in Japan※).

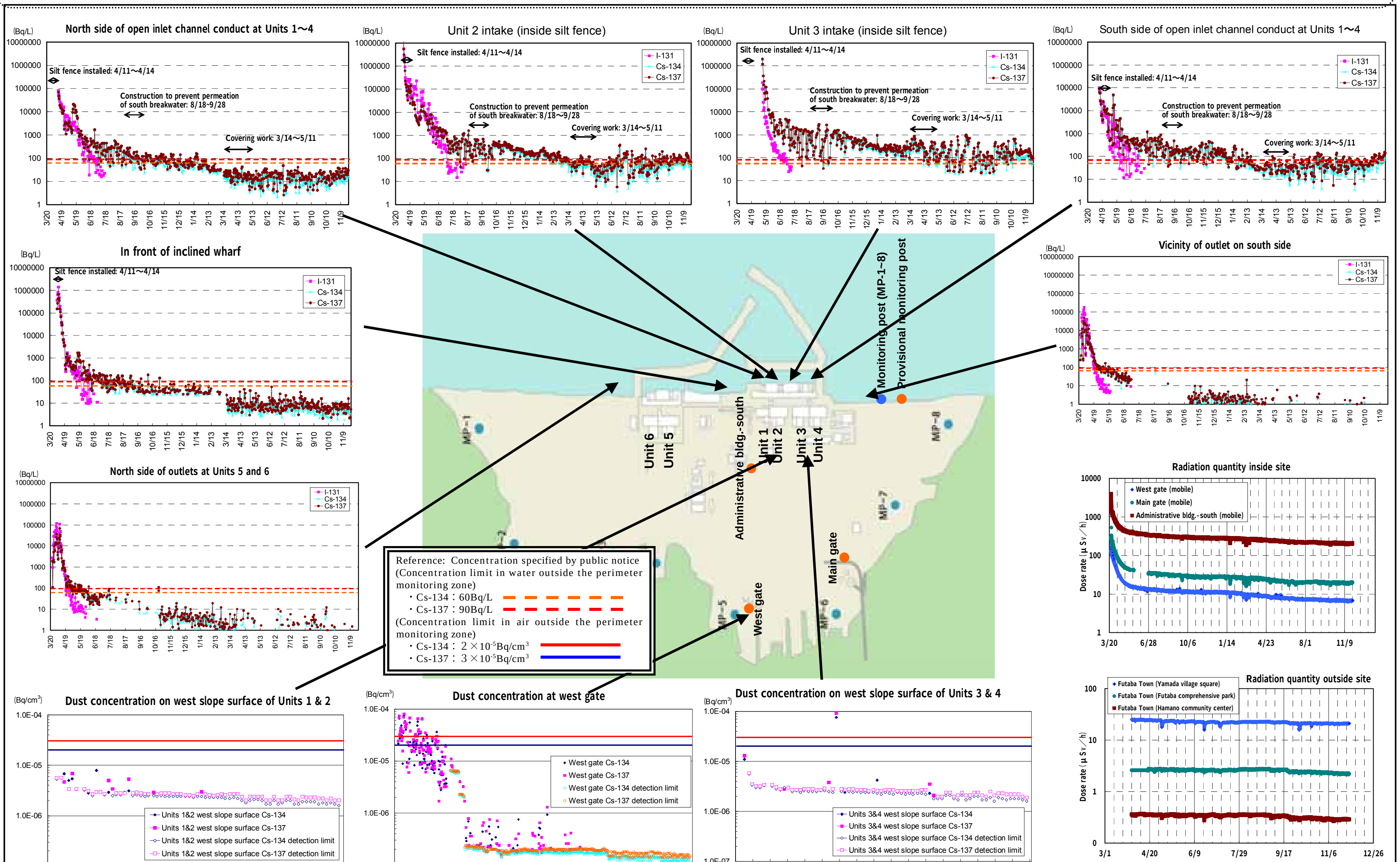
※Source: "Calculations of National Dose of Living Environment Radiation, New Version" by the Nuclear Safety Research Association



<Emissions per hour of radioactive material (cesium) from Units 1~3>

Changes in Concentration of Radioactive Materials in Seawater, Concentration of Radioactive Materials in Dust Within Site, and Radiation Dose Inside & Outside Site

- Sampling is regularly conducted to survey the concentration of radioactive materials in seawater inside and outside the port, the concentration of radioactive materials in dust inside the site, and the radiation quantity inside and outside of the site.
- The concentration of radioactive materials in seawater inside the port did not satisfy the concentration limit for areas outside the perimeter monitoring zone as specified by public notice for some sampling points inside the silt fence at the water intakes for Units 2~4 in September.
- The concentration of radioactive materials in seawater outside the port is stable at a level sufficiently lower than the concentration limit. Even lower concentrations are maintained (less than 1Bq/ℓ) at the 3km and 15km marks out to sea.
- The radiation quantity inside and outside of the site varies depending on the point, and significant variations have not been observed recently.
- Even the concentration of radioactive materials in dust within the site is more or less below the detection threshold and is stable at a sufficiently low level.



※Source: Ministry of Education, Culture, Sports, Science and Technology-Japan URL http://www.mext.go.jp/

1. Cooling of Reactor

By continuing to inject cooling water, reactors are kept in stable condition at low temperature, and efforts are taken to supplement parameter monitoring.

Status of Progress Points

(1) <u>Maintenance and monitoring of low temperature state through continued cooling with cooling water</u>

- Since December 2011, the temperatures of the containment vessel gas phase and reactor pressure vessel bottoms of Units 1~3 have been further reduced through continued injection of cooling water and maintained in a stable condition at a level of approximately 30℃~50℃.
- Controlling the injection of cooling water checks the generation of steam inside the containment vessel. This has kept emissions (cesium) from the reactor buildings at Units 1~3 at a low level.

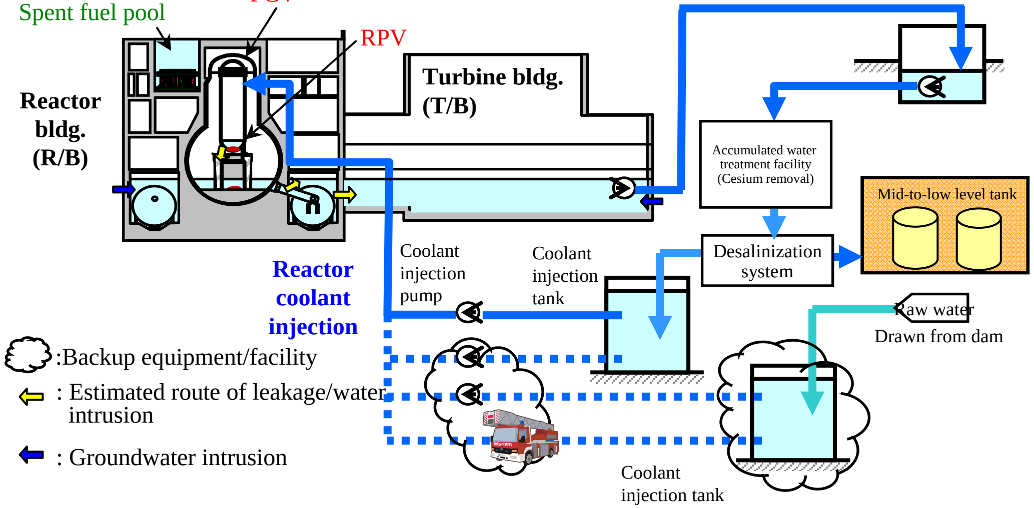
(2) <u>Partial observation of containment vessel interior</u>

- From the standpoint of supplementing the monitoring of reactor parameters, the interiors of the primary containment vessels of Units 1 and 2 were investigated to ascertain temperature, water level, dose and other conditions. Consideration is continuing to be given to conducting a similar interior investigation of Unit 3.
- An alternate temperature gauge for the Unit 2 reactor pressure vessel has been installed and additional temperature gauges installed at Units 1 and 2.

(3) <u>Improved reliability of circulating injection cooling</u>

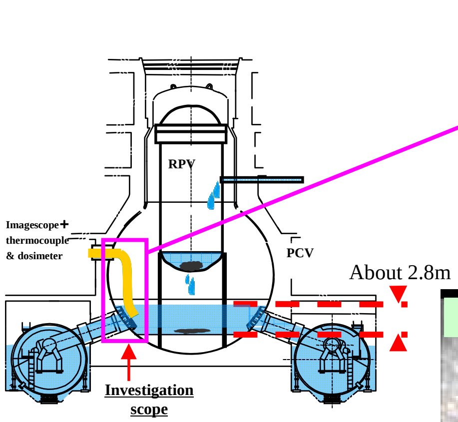
- To address leaks from pressure hoses and other such issues related to piping along the reactor injection line, the hoses have been replaced with more reliable polyethylene pipe.
- Appropriate backup facilities have been secured for the reactor coolant injection system (injection line pump: 3 systems; water source: 2 types; ensuring power sources from multiple buses, etc.). Even if the functionality of multiple systems involved in the injection of coolant into the reactor were to be lost simultaneously due to an accident, the injection of cooling water can be restarted using fire engines within three hours.

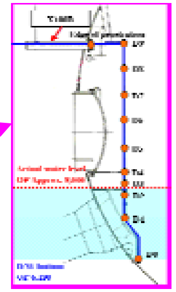
<Overview of System for Cooling Reactor>



<u>Investigation of Interior of Unit 1 PCV and Installation of Temperature and Water Level Gauges</u>

- The interior of the primary containment vessel was filmed with a camera, and the dose, water level and other conditions were investigated (10/9~13).
- It was verified that the dose was a max. of approximately 11.1Sv/h, and the water level was approximately +2.8m above bottom of the containment vessel.
- Additional temperature and water level gauges were installed (10/13). The temperature gauges have been used as the monitoring temperature gauges specified by safety regulations since 12/3.





Note: D/W (PCV)

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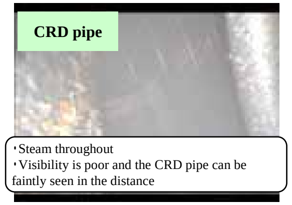
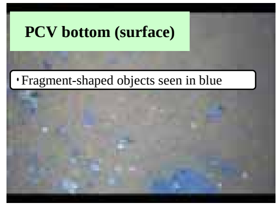
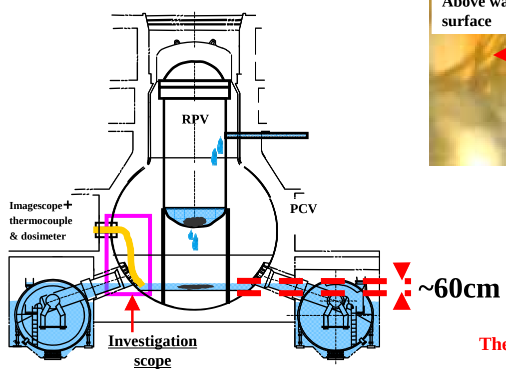
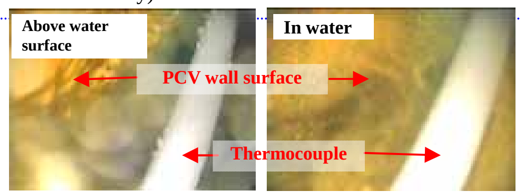


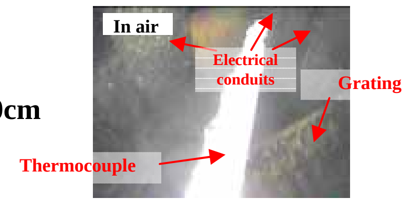


<u>Investigation of Interior of Unit 2 PCV and Installation of Temperature Gauge</u>

- The interior of the primary containment vessel was filmed with a camera, and the dose, water level and other conditions were investigated (1st :Jan 19; 2nd : May 26 - 27).
- It was verified that the dose was a max. of approximately 73Sv/h, and the water level was approximately +60cm above bottom of the containment vessel.
- An additional temperature gauge was installed (Sep 19). It has been used as the monitoring temperature gauge specified by safety regulations since Nov 6.
- There are future plans to enhance monitoring function by permanently installing temperature and water gauges similar to those in Unit 1 (scheduled for end of February).

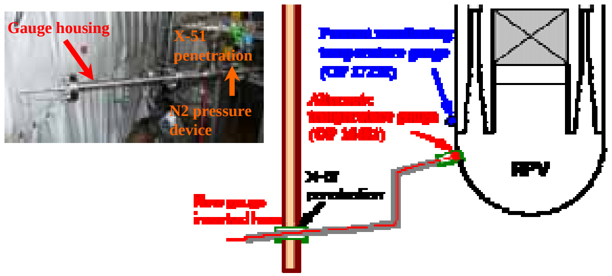




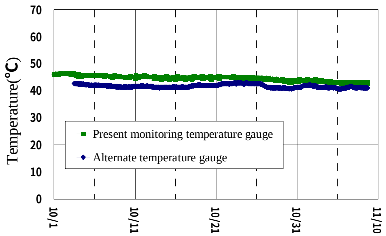


Installation of Alternate Temperature Gauge at Unit 2

- Following the failure of the existing temperature gauge, an alternate temperature gauge (1 unit) was installed in addition to the temperature gauge already installed for monitoring (1 unit) (10/3).
- Because both temperature gauges display almost the same temperature (approx. 43~46℃), it was confirmed that there were no problems with the installation. The gauge has been used as the monitoring temperature gauge specified by safety regulations (11/6).
- If this temperature gauge fails, it can be removed and then repaired or replaced.



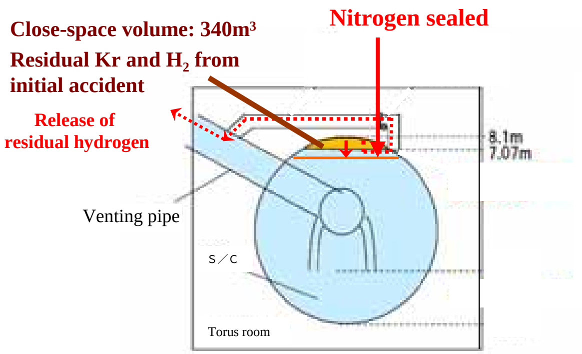
Installation of temperature gauges



Change in readings of present monitoring temperature gauge and alternate temperature gauge

Nitrogen Seal on Unit 1 Suppression Chamber (S/C)

- Because it is assumed that gas from the time of the initial accident, which has a high hydrogen concentration, is remaining in the upper part of the S/C, nitrogen has been injected (10/23~early December) and (to 2%) the hydrogen concentration lowered sufficiently below the combustibility limit concentration※, which has further reduced risk of a hydrogen explosion.



※The combustibility limit concentration is the concentration range in which hydrogen may combust (conditions where hydrogen is 4% or higher and oxygen is 5% or higher). This is not a concentration at which hydrogen will immediately ignite even if the 4% level is exceeded.

Future Challenges and Direction of Responses

※Maintenance of Monitoring Functions for Long-Term Stable In-Core Environment

- An alternate temperature gauge (1 unit) has been installed to serve as the Unit 2 pressure vessel temperature gauge, and the insertion and installation of an additional temperature gauge through the TIP (traversing in-core probe) pipe is being studied in order to improve reliability.
- At Units 1 and 3 also, alternate temperature gauges need to be installed prior to that in preparation for failure of a temperature gauge. Because the dose needs to be reduced in the vicinity of the installation location, possible sites for installation of the alternate temperature gauges are being narrowed down in FY 2012.

※Addressing Risks in Event of Earthquake or Tsunami

- With regard to earthquakes, it has been verified that there is sufficient seismic resistance to withstand an earthquake equivalent to the Tohoku-Chihou-Taiheiyo-Oki Earthquake (JMA seismic intensity scale 6+). Even if some of the equipment were to become unusable, appropriate backup equipment has been secured to be able to restart the injection of cooling water quickly.
- With regard to tsunami countermeasures, a provisional seawall has already been installed in preparation for a tsunami striking due to aftershocks. To provide for a case where a tsunami surpassing assumptions were to hit, dedicated diesel generators have been deployed to ensure power as well as backup coolant injection pumps and cooling water injection pumps on high ground in order to maintain reactor cooling function. Also, power-generating vehicles have been deployed to prepare for any power interruptions.
- In addition, fire engines have been deployed as alternative means for injecting cooling water should multiple backup systems become unusable.
- Moreover, as new information is obtained, it will be thoroughly addressed, including responding to reviews regarding standard earthquake ground motion.

※Avoiding Remote Risk of Hydrogen Explosion

- To prevent any explosion of hydrogen generated from radiolysis of water inside the reactor pressure vessels at Units 1~3, nitrogen is continuing to be charged into the reactor pressure and containment vessels.
- The hydrogen concentration inside the containment vessels of Units 1~3 is monitored and managed so that the concentration does not exceed the combustibility limit concentration (4%) by adjusting the amount of nitrogen charged.
- Using a web camera, it is possible to monitor the pressure of injected nitrogen gas and the injected amount of nitrogen gas at the seismic-isolated building. In the event that unusual conditions are detected within these parameters or during an inspection, it will switch over to the standby facility. This includes valve manipulation or the switching over of the power supply.

2. Treatment of Accumulated Water

Promotion of Multifaceted Response to Water Continuing to Accumulate due to Groundwater Intrusion

Status of Progress Points

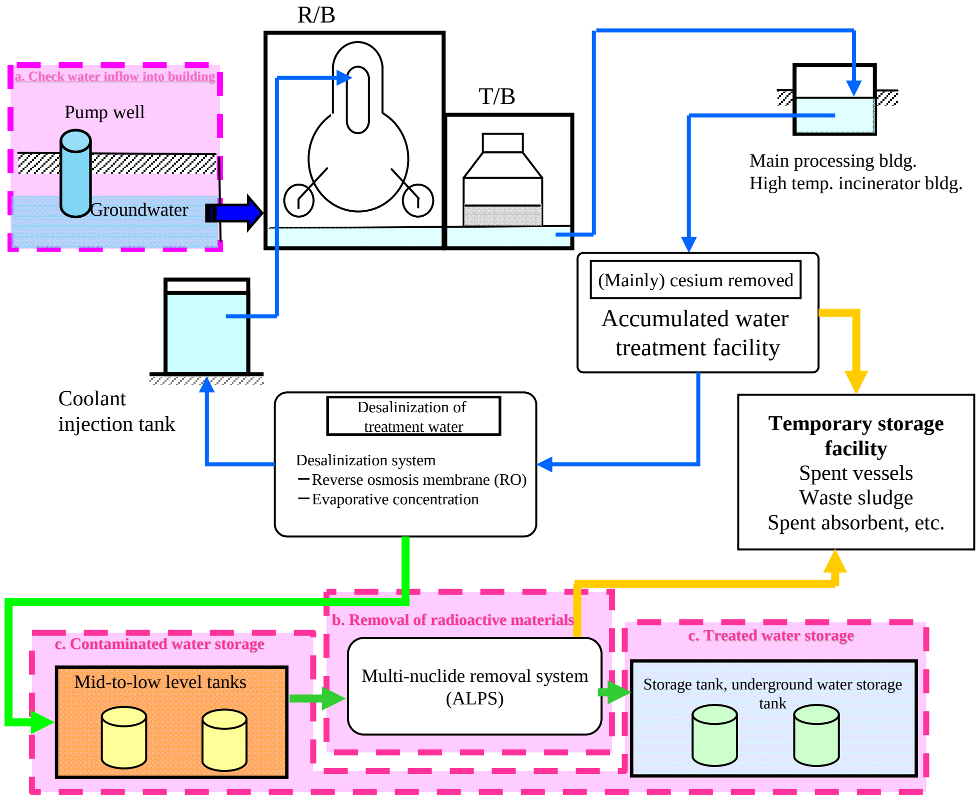
(1) Improved reliability of accumulated water treatment facility

- To address leaks from pressure hoses used for the main route of the accumulated water transfer line, the current hoses have been replaced with more reliable polyethylene and other types of pipe.
- As measures to prevent the spread of any leaks to the external environment, gates, earth dams and monitoring cameras have been installed and discharge channels have been covered with conduits
- Reductions in transfer lines are being studied.

(2) Multifaceted response to accumulated water

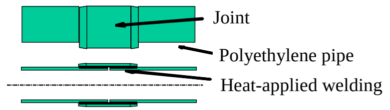
- To reduce the amount of water continuing to accumulate due to the intrusion of groundwater into the reactor buildings, measures to check such inflow by means of underground water bypasses or the restoration of subdrains are being studied and construction is being performed on-site.
- Construction is being performed on-site to set up a multi-nuclide removal system to remove radioactive materials in contaminated water.
- Plans to augment storage tanks are being formulated and additional tanks are being constructed..

＜General Outline of Treatment of Accumulated Water＞



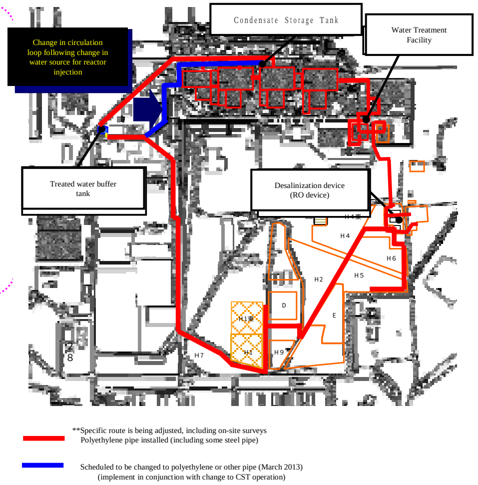
Improved Reliability of Equipment (Conversion to PE Pipe for Pressure Hoses, etc.)

- The conversion to polyethylene pipe has been implemented along the main route of the transfer line for accumulated water and the reactor coolant injection line (PE pipe conversion).
- Even at other locations where other pressure hoses remain, the conversion to PE pipe is scheduled to be completed by the end of December. PE conversion will be performed for any remaining areas (between T/Bs of Units 1 and 2 and other locations) by the end of the first half of FY2013.
- In order to improve seismic resistance and increase the quantity of water held as a coolant injection water source, the water source is to be changed from treated water backup tanks to condensate storage tanks (CST) (scheduled for March 2013).



PE (polyethylene) pipe

※Improved reliability of pipe joints



Prevention of Leaks to External Environment (Closed Conduits for Discharge Channels, etc.)

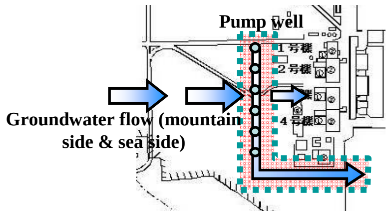
- Even if a leak occurs, gates have been installed on the tank concrete base and earth dams set up around the tank area to prevent any water from flowing to the sea. Moreover, drainage channels, into which water is highly likely to flow, have been converted to closed conduits (completed 8/31).
- Monitoring cameras have been installed in areas where tanks are set up from the standpoint of improving surveillance.


Before conduit covering

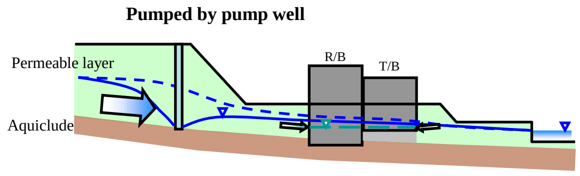

After conduit covering

Measures to Check Groundwater Intrusion (Underground Water Bypass)

- Groundwater flowing down from the mountains is pumped by pump wells upstream of the building and the quantity of groundwater inflow into the buildings is checked by lowering the groundwater level (underground water bypass).
- Currently, measurements are being taken for installation of pump wells with drilling for test pump wells commenced on 11/22. Verification tests will continue to be conducted and the wells are scheduled to gradually be put into operation after installation of the release facility (end of March 2013).



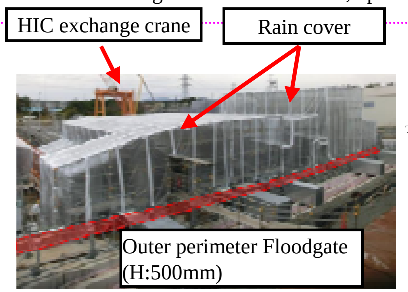
Top view (illustration)

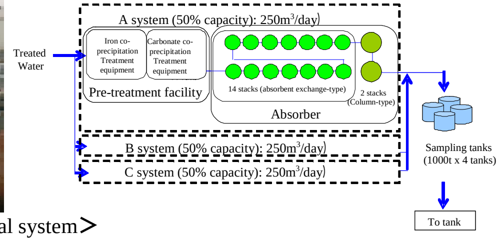


Profile (illustration)

Removal of Radioactive Materials (Installation of Multi-Nuclide Removal System)

- A multi-nuclide removal system is to be installed to control the concentration of radioactive materials (excluding tritium) contained in water stored on site at an even lower level.
- Construction of the system, testing for leaks using water not containing radioactive materials, and system tests have been completed (8/24~10/1).
- Additional measures to further assure safety (rain covers, system isolation gates, etc.) have been completed (11/19).
- Regarding the high integrity containers (HIC) containing removed radioactive waste, an assessment of fall events and such countermeasures are being studied and implemented on the assumption that a container may fall during transfer.
- After the aforementioned assessment and adoption of countermeasures as well as implementation of tests using water containing radioactive materials, operation is scheduled to start.





＜HIC＞

＜Status of installation of multi-nuclide removal system＞

Storage of Contaminated Water/Treated Water (Increase in Number of Tanks)

- Plans for augmenting tanks have been formulated so that treated water, etc. can be stored.
  Currently installed capacity: approximately 271,000m³ with available capacity of approximately 38,000m³ (as of 11/27).
- Tanks will be successively augmented with plans for capacity to be increased to 320,000m³ by the end of December 2012.
- Also, by the first half of 2013, an additional 80,000m³ will be set up, and there are plans to further augment capacity up to a maximum of approximately 300,000m³ in the south area of the site (total: max of 700,000m³)

(Internal area under construction)

(Covered with soil)

(Large steel circular tanks)

＜Status of installation of underground storage water tanks＞

Basic Policy for Treatment of Accumulated Water

- For treating accumulated water, the following requirements will be reviewed and measures based on these will be implemented so that contaminated water will not be easily released to the sea.
  - ✓ Fundamental measures to counter the flow of groundwater into reactor and other buildings, which is the causing an increase in the quantity of water.
  - ✓ Measures to ensure stable operation including alternate facilities when there is a failure and to ensure improvements in the decontamination capacity of water treatment facility.
  - ✓ Measures for further installation of land facilities, etc. for managing contaminated water
- Any release into the sea will not be implemented without the consent of the relevant ministries and agencies .

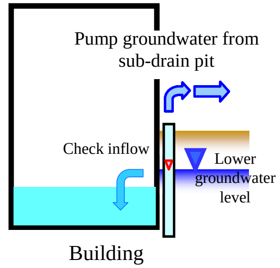
Future Challenges and Direction of Responses

※Continuation of Measures to Prevent Leakage to External Environment

- In preparation for any leaks, gates and earth dams will be set up around tanks installed in the future to prevent leaks into the sea, and patrols and inspections will be conducted to monitor for leaks

※Checking Groundwater Intrusion

- Approximately 400 tons of groundwater flows into the buildings at Units 1~4 daily.
- The following measures are being studied to control the continually increasing amount of water being accumulated.
  - ✓ Studying the restoration of sub-drain pits at Units 1~4 to reduce the level of underground water by pumping sub-drain water.
  - ✓ Confirming the effects of an groundwater bypass, and continuing to study methods for identifying and repairing leaks to cut off leakage in the primary containment vessel and cutting off water leaking between the reactor and turbine buildings.

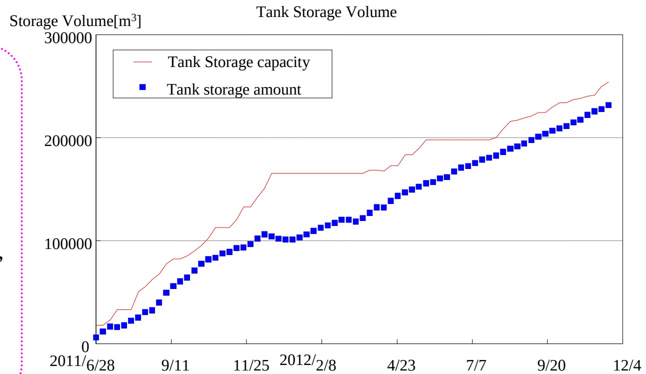


※Removal of Radioactive Materials to Reduce Storage of Accumulated Water and Management Risks

- A multi-nuclide removal system, which will remove radioactive materials (62 nuclides excluding tritium), is to commence operation and operate stably.

※ Storage of Contaminated Water/Treated Water

- Plans are proceeding to augment tanks so that treated water, which is continuing to increase, can be stored.
- In the area south of the site, a location for such installation is being confirmed using surveying, geological surveys and tree trimming, and site preparation and tank installation are proceeding



3. Reducing Radiation Dose and Preventing Contamination from Spreading

Continuing Efforts to Lower to Maximum Extent any Effects of Radiation Outside Site

Status of Progress Points

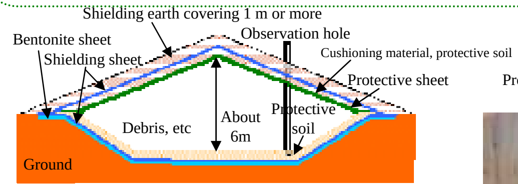
(1) Reduction of dose at site boundaries
- Preparatory work for two soil-covered temporary storage facility for debris has been completed and debris has begun to be received.
- Gas control systems have been installed at Units 1~3 to suppress the release of gaseous waste from the reactor buildings.

(2) Decontamination within site
- Attempts are being made to reduce the dose for the site overall by decontaminating inside the site. A mid-to-long term implementation policy for decontamination is being prepared and decontamination will proceed in line with this policy.

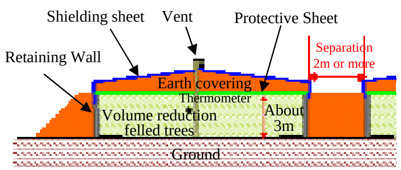
(3) Preventing spread of contamination in the sea
- Marine soil is being covered and a seawater circulatory purification device is being operated with the aim of reducing the concentration of radioactive materials in seawater in the port, and a certain effect has been confirmed.
- Work has begun full-scale on construction of an impermeable wall and construction is currently underway.
- Covering work has been completed using solidified soil to prevent the dispersion of marine soil having a high contaminant concentration in the area in front of the intake channels for Units 1~4 and Units 5 & 6.

Reduction in Effective Dose at Site Boundary

- In order to achieve an effective dose of less than 1mSv/year at the site boundary resulting from radiation from radioactive waste generated after the accident and newly released radioactive materials, an assessment was conducted as of September based on actual results of recent releases of radioactive materials and radioactive waste stored.
- From the assessment results, the maximum value was approximately 9.7mSv/year at the site boundary of the north area, and the effect from direct radiation in the stored debris as well as skyshine※ was high at approximately 9.6mSv/year, so measures have been implemented including the installation of soil-covered temporary storage facilities and so on.
- Preparatory work for two soil-covered temporary storage facility for debris has been completed and debris has begun to be received (9/5~).
- In the future, planned reduction measures (soil covering of debris and felled trees, installation of shields on the multi-nuclide removal system, and moving debris, etc. to locations away from the site boundary) will be implemented, bringing the effective dose at the site boundary to under 1mSv/year by the end of FY2012.



＜Soil-covered temporary storage facility for debris＞



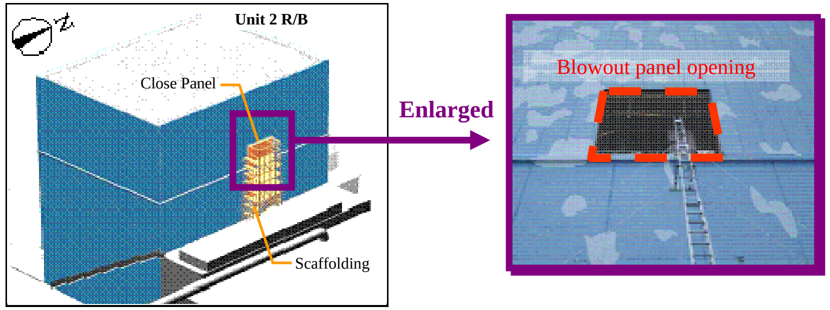
＜Soil-covered temporary storage facility for felled tree＞

※Skyshine: Radiation rays released upward from a radiation source on the ground that are scattered by the atmosphere and return to earth.

＜Debris received (11/1)＞

Closing Blowout Panel (BOP) Opening on Unit 2 Reactor Building

- In order to reduce emissions of radioactive materials from the Unit 2 reactor building, the BOP opening will be blocked off using close panels. Also, this will be performed along with the installation of a ventilation system to ventilate the inside of the building. The design for closing the BOP opening has been finalized and a report made to the Nuclear Regulation Authority on 11/30. Closing of the BOP opening is scheduled to be completed around March 2013.



Decontamination within Site

- For the purpose of obtaining basic data on decontamination technology, decontamination testing (paved surfaces: dust collecting system/dry ice blast/ultra-high pressure water cutter, etc.; grassland: peeling off top soil/plowing to replace surface soil with subsoil) has been implemented. Based on the results of these tests, optimum decontamination will be implemented in conjunction with decontaminated areas.
- Also, the applicability of decontamination-related technology (GPS surveying, decontamination effect prediction code (DeConEP)) is being verified. The use of such technology will streamline decontamination work.
- To reduce the exposure of workers to radiation, a mid-to-long term implementation policy has been formulated for conducting in a systematic manner decontamination of radioactive materials deposited within the site (October 22, 2012). In line with this policy, individual plans will be formulated and decontamination will continue to be conducted.

※GPS surveying: A method in which an ionization chamber type survey meter and personal computer are connected to record location data and dose rate so as to ascertain dose rate distribution.
DeConEP: Program for projecting the dose rate after decontamination by calculating the overall radiation quantity from in three-dimensional topographical map.


Dust collecting system

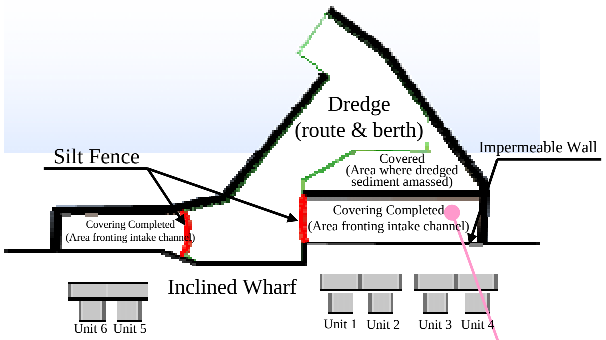

Dry ice blast


Ultra-high pressure water cutter

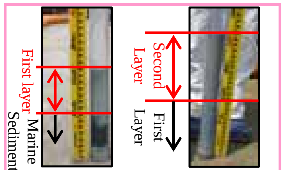
Devices used in test decontamination of pavement surfaces

Reduction in Concentration of Radioactive Materials in Port Seawater

- As marine soil has been covered and seawater circulatory purification devices have been operated with the aim of bringing the concentration of radioactive materials in port seawater below the concentration limit for areas outside the perimeter monitoring zone as specified by public notice at the end of September, levels below the concentration specified by public notification (cesium) have been achieved at eight locations where the flow of seawater is comparatively large.
- Nevertheless, such levels have not been achieved at five locations where the seawater flow is relatively small. Along with continuing purification efforts, the Unit 3 silt fence, which was thought to be one source of contamination for seawater, was replaced (11/14~17).
- With the cooperation of outside research institutes and others, additional investigations are being conducted to estimate factors keeping the concentration from decreasing and to study the necessity for additional countermeasures.



Preventing contamination from spreading in area fronting intake channel



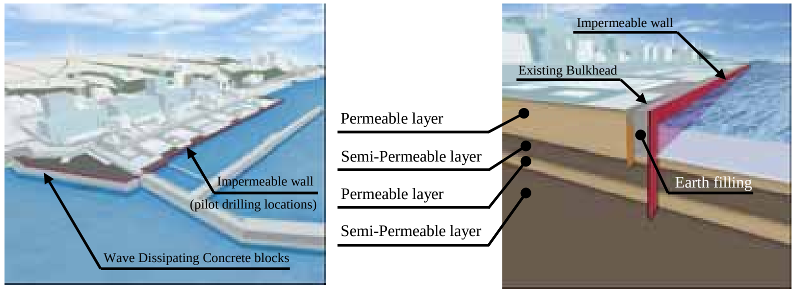
Thickness of 1st Layer confirmed (on April 3)

Thickness 2nd layer confirmed (on April 29)

Covering of Marine Sediment at units 1~4

Installation of Impermeable Wall

- Work is currently underway to install an impermeable wall to prevent the spread of contamination if underground water were to become contaminated and flow into the sea. (Full-scale construction: April 25, 2012~)
- Work is in progress with the aim of completion in mid-2014. (earth filling, etc. (4/25~); pilot drilling in bedrock for placement of steel tube and sheet piles (6/29~); installation of wave-dissipating concrete blocks to reduce wave energy outside port (7/20~))



Aerial view Cross-section view

Illustration of Impermeable Wall

Future Challenges and Direction of Responses

※Reduction in Effective Dose at Site Boundary

- Debris , etc are to be moved to soil-covered temporary storage facilities constructed with shielding capability. Debris will also be moved to locations away from site boundaries. Dose assessments are scheduled to be reviewed.
- To reduce skyshine from water treatment secondary waste (adsorption vessel), shielding will be added to existing storage facilities and such waste will be moved to newly constructed storage facilities away from the site boundary.

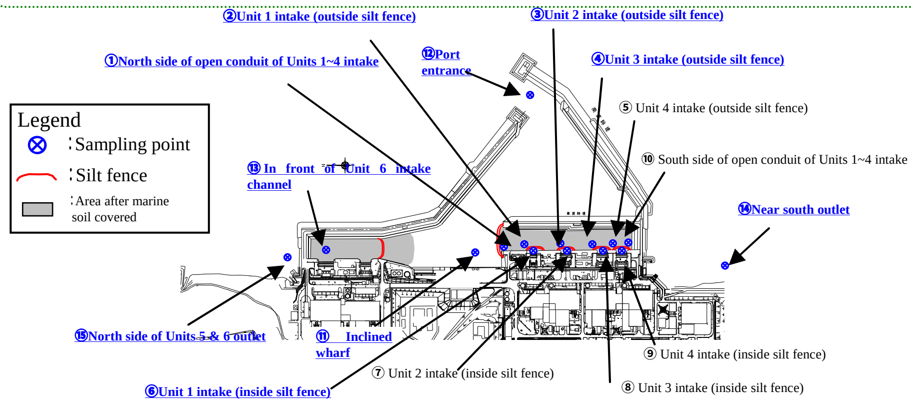
Soil-covered temporary storage facility for debris

Newly constructed water treatment secondary waste storage facility

Existing water treatment secondary waste storage facility

※Radioactive Material Concentrations in Port Seawater & Achievement of Levels Below Public Notice Limits

- Additional investigations have been conducted to study concentrations in underground water and seawater in order to estimate variable factors and review the necessity of additional countermeasures. The review of additional countermeasures including purification and checking the spread of contamination will be implemented by the end of December in accordance with the investigation results.
- To verify levels below concentrations specified by public notice, measurement plans are being laid down, including the selection of target nuclides and the measurement and assessment will be performed by the end of January.



Note: Underlines indicate areas below concentration (cesium) as specified by public notice.

4. Extracting fuel from spent fuel pools (SFP)

Work to extract the fuel from the spent fuel pools is proceeding steadily

Progress status points

- ◆ **Preparations to begin extracting the fuel from within the Unit 4 spent fuel pool (to start by December 2013), which is the primary objective for Term 1, are proceeding steadily.**

(1) <u>Pool circulation cooling, desalination, and ascertaining conditions within the pool such as corrosion, etc.</u>

- ➢ Cooling equipment was restored and the pools are being cooled in a stable manner (Unit 1: August 10, 2011 〜, Unit 2: May 31, 2011 〜, Unit 3: June 30, 2011 〜, Unit 4: July 31, 2011 〜).
- ➢ Pool water is being desalinated (Unit 2, 4 completed. Unit 3 being desalinated.)
- ➢ Conditions within the pool had been ascertained using remote-control cameras and the state of corrosion due to the extraction of new fuel has been confirmed

(2) <u>Removal of debris from the top of the</u> building and construction of a cover in preparation for fuel removal

- ➢ Debris on top of the reactor buildings is being removed (Unit 3: Debris being removed, Unit 4: Debris being gathered） .
- ➢ A fuel removal cover for Unit 4* continues to be built. Construction should be completed to enable fuel removal start a month earlier in December 2013

(3) <u>Common pool repair, Temporary cask custody area construction, etc.</u>

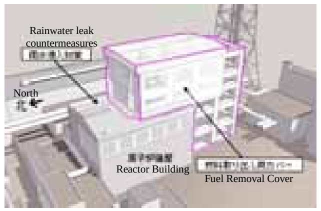
- ➢ Repairs on the common pool in order to store extracted spent fuel and construction of Temporary cask custody area facilities is ongoing

※the fuel removal cover shall be a structure built to support fuel handling equipment, provide a suitable work environment and prevent the dispersion and proliferation of radioactive materials

Goal of fuel removal from Unit 4 spent fuel pool
→Unit 4: Start November 2013, End December 2014

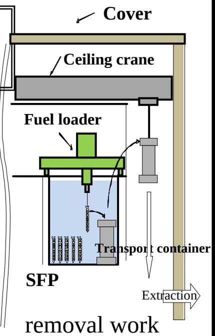
Removal of debris from top of reactor building
(concept image prior to removal)

To be completed in December 2012



Construction of fuel removal cover

To be built from April 2012 until the middle of FY2013

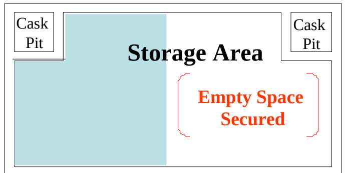


removal work

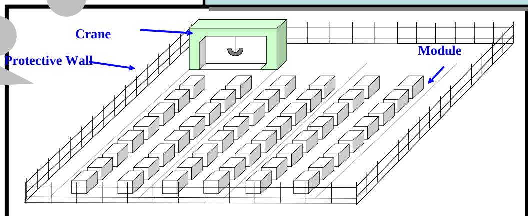
To start in November 2013

Extracted fuel will be moved and stored in the common pool after making space

Common pool



Temporary cask custody area



Storage of spent fuel from common pool

Foundation to be constructed from August 2012

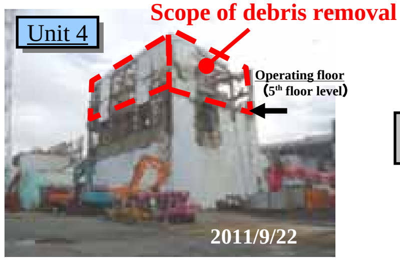
Removal of debris from top of Unit 3, Unit 4 reactor buildings and construction of Unit 4 cover for fuel removal

- ☐ Debris is currently being removed from the top of the Unit 3 reactor building in preparation for fuel removal from the spent fuel pool (to be completed around the end of FY2012)
- ☐ Unstable pieces of steel girder fell into the fuel pool during debris removal at Unit 3. A report on the cause of this incident and reoccurrence prevention countermeasures was submitted to the Nuclear Regulatory Commission (10/3,19 and 11/15). Debris removal work will continue safely and steadily based on this report.
- ☐ At Unit 4 building debris was removed on July 11 and large equipment was removed between July 24 and October 2. debris is currently being gathered (until December). In conjunction, a fuel removal cover continues to be built (to be finished around the middle of FY2013)

<Status of removal of debris from the top of reactor buildings>

Remote operation concept image

Scope of debris removal



Inspecting the soundness of fresh fuel (unirradiated fuel) inside the Unit 4 SFP

- ☐ In order to inspect the status of fuel corrosion to fresh fuel assemblies were removed from the pool and soundness was evaluated (August 27 through the 29th)
- ☐ The inspection revealed no significant information or damage to the fuel rods were fuel structures, and no corrosion was found, and it was therefore concluded that material corrosion will not have a large impact on fuel removal.

＜Fresh fuel extraction and inspection＞

Fresh fuel being extracted from the Unit 4 SFP (7/18, 19)

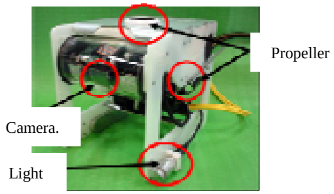
Fuel inspection

Combined fuel rod extraction (partial)

Unit 3, Unit 4 SFP debris dispersion survey

- Underwater cameras and remotely operated vehicles (ROV) were used to survey the dispersion of debris within the spent fuel pools.
- An underwater debris removal plan prior to spent fuel removal shall be proposed based on the results of the survey.

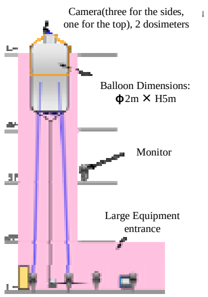
<Pool underwater survey>



Remotely operated underwater survey vehicle (ROV)

Unit 1, Unit 2 operating floor survey

- A survey of the operating floors was conducted in order to help with the deliberation of fuel removal from spent fuel pools.
- At Unit 1 a camera attached to a balloon was used to take footage and to measure dose levels. A maximum dose of 53.6mSv/h was measured at a 1 m from the operating floor.
- At Unit 2 a remote-controlled robot was used to take footage, and measure radiation levels and temperature/humidity levels. A maximum dose of 880mSv/h was measured at the top of the reactor well



Refueling Floor

Desalination of Unit 1〜4 spent fuel pools

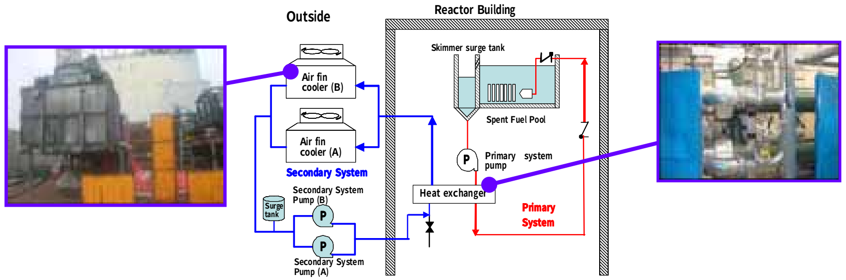
- Unit 1: Saline levels are low enough since seawater was not injected
- Unit 2: Desalination completed on July 2. Water quality being monitored through periodic sampling.
- Unit 3: Being desalinated with desalination equipment
- Unit 4: Desalination completed on October 12. Water quality being monitored through periodic sampling
- Close range chloride ion concentration: Unit 1 5ppm（7/17), Unit 2 28ppm（10/18）Unit 2 72ppm（10/18）, Unit 49ppm（10/18）(Below technical specification limits of 100ppm)

Future issues and the direction of countermeasures

※Handling the risks associated with earthquakes and tsunami

- Alternative coolant injection equipment, such as concrete pump trucks, having been deployed so as to enable sufficient time to restore cooling function if the fuel pools become unable to be cooled due to damage to primary/secondary pump pipes, etc., by an earthquake or tsunami.
  - ✓ In this instance, it has been concluded that a minimum of 16 days (Unit 4) would be required to reach a point where fuel pool water level is maintained at a certain level (2m from top of active fuel: water level at which shielding is deemed effective) since water temperatures will rise and water levels will decrease.
  - ✓ Even if it is difficult to cool the pools using emergency coolant injection equipment, and concrete pump trucks, etc., are used to cool the pools, cooling could be restored in approximately 6 hours even if cooling function is lost
- Furthermore, every effort shall be made to comply with newly gained knowledge, including the handling of changes to the reference ground motion.

<Spent fuel pool circulated cooling equipment overview>



※Issues that may impact work schedules

- The following issues that may impact work schedules must be resolved in order to carry out fuel removal as planned.
  - ✓ Debris removal work: the status of falling debris within the pools and radiation levels have yet to be confirmed which may prolong work and add to it.
  - ✓ Fuel removal cover construction: many uncertainties, such as building damage and radiation levels, exist that may prolong or add to work.
  - ✓ Pool fuel removal work: if more of the fuel than expected is damaged, or if the extent of damage to the fuel is greater than expected, work may be prolonged or added to.

※Unit 1, Unit 2 fuel removal

- Detailed plans shall be proposed based on a survey of debris at Unit 1 while acquiring knowledge and experience through removing debris at Unit 3 and Unit 4, the operability and malfunctions of remote operated equipment and fuel surveys, etc.
- Detailed plans for the inspection, repair, and fuel removal at Unit 2 shall be proposed based on the establishment of remote decontamination technology and upon decontaminating the inside of the building, shielding it and conducting surveys at a point in time when fuel handling equipment can be approached.

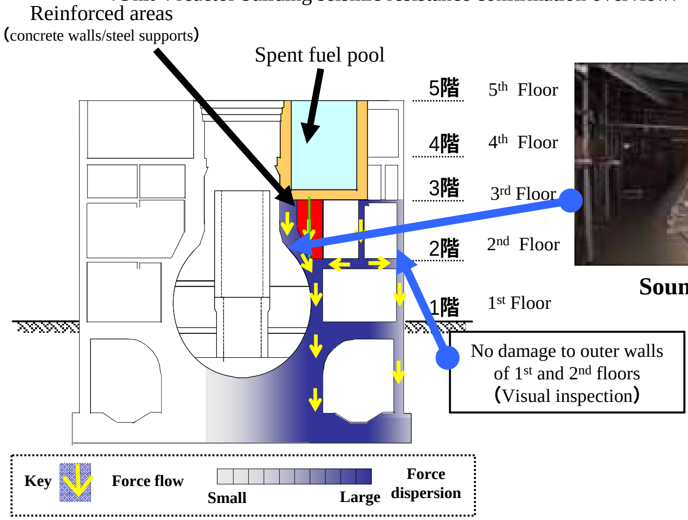
4 Supplement．Unit 4 spent fuel pool/reactor building soundness confirmation

Unit 4 spent fuel pool/reactor building sounds confirmation

Progress status points

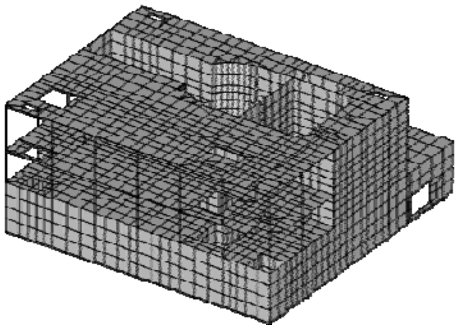
- ☐ It has been confirmed that the seismic resistance of the Unit 4 reactor building, including the spent fuel pool, is sufficient to withstand an earthquake equivalent to the Tohoku-Chihou-Taiheiyo-Oki Earthquake (JMA Seismic Intensity Scale 6+)
- ☐ The bottom of the Unit 4 spent fuel pool has been reinforced.
- ☐ The soundness of the Unit 4 spent fuel pool is confirmed through periodic inspection every quarter（it is confirmed that the building is not meaning, and that there are no more than 1mm crack in width)

＜Unit 4 reactor building seismic resistance confirmation overview＞



Sound shell wall

Concept image of force flow in dispersion in the spent fuel pool （reactor building cross-section）



Analysis model used to evaluate reactor building seismic resistance

Unit 4 spent fuel pool/reactor building seismic resistance assessment

☐ The wall of the spent fuel pool※1 is extremely thick in itself and is supported by extremely thick walls※2 therefore, even if the outer wall and bottom were damaged, it would maintain the same seismic resistance as it had prior to the earthquake. Therefore, it would still be safe even if there was an earthquake equivalent to the Tohoku-Chihou-Taiheiyo-Oki Earthquake (Scale 6+)

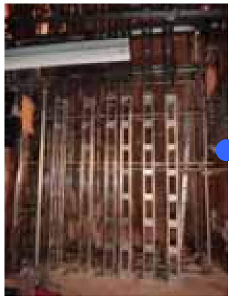
※1 Spent fuel pool wall (reinforced concrete): Thickness: 140cm〜185cm
※2 Walls that support the spent fuel pool (reinforced concrete): Thickness: 160cm〜185cm

☐ It has been confirmed that the reactor building, including the spent fuel pool, has sufficient seismic resistance to withstand an earthquake of scale 6+ even amidst the following conditions.
- Damage
- Removal of debris from the top of the building
- Bearing the weight of fuel handling equipment

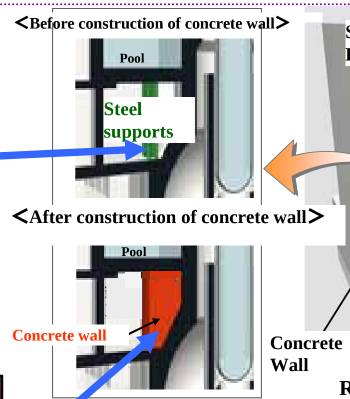
※TEPCO released evaluation results (May 28, 2011) and NISA evaluated the findings and reported them to the NSC (May 30, 2011)
※seismic safety confirmation results that reflect recent conditions have been submitted to the NRC (September 28, 2012)

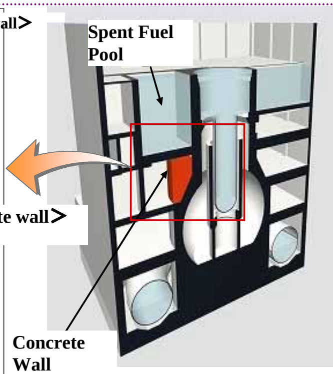
Reinforcement of the floor of the Unit 4 spent fuel pool

☐ In addition to performing a seismic resistance evaluation, seismic resistance margins were increased by over 20% in the vertical direction through reinforcement of the floor of the spent fuel pool (completed on July 30, 2011)



Steel supports
（photographed on June 15, 2011）





Reactor building cross-section

Concrete pouring
（photographed on July 21, 2000 and）

Concrete walls (red) were erected after installation of steel supports (green)

Pool bottom out of plane shear force※1 margin※2

Prior to construction	After construction
143%	179%

20%+ improvement

※1 Out of plane shear stress: Stress that generates shear in the direction that the floor is pushed.
※2 Margin＝criterion value/calculated shear strain

Confirming the soundness of the Unit 4 R/B through periodic inspections.

- The following four items will be inspected to confirm that the building is sound and not tilting. Periodic inspections will continue to be implemented in the future.
- 1st inspection: May 17 〜25, 2012, 2nd inspection: August 20 〜28, 3rd inspection: November 19 〜28, 4th inspection:TBA

(1) It was confirmed that the building is not tilted (Water level measurement)

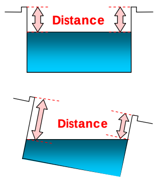
The surface of still water will always be horizontal and level so by measuring the distance between the fifth floor surface and the surface of the water in the spent fuel pool and reactor well in all four corners of the building it was confirmed that the building is not tilted

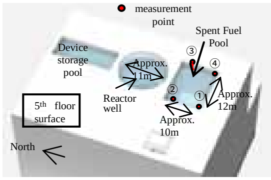
1）If the building is not tilting

Distances will be the same

2）If the building is tilting

Distances will differ





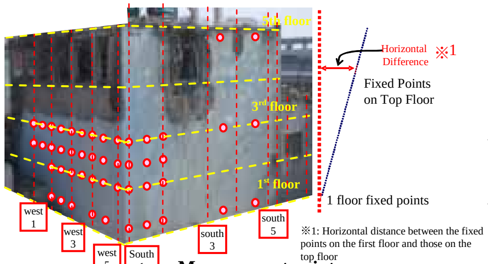
Measurement points (5th floor surface)

Spent fuel pool measurement results Units [mm]

Measurement points	Measured value (11/2012)
①	443
②	444
③	442
④	443

(2) Outer wall surface measurements

Fixed points were signed in the vertical direction to the outer wall surface and the horizontal discrepancies of the outer wall ※1 were measured using optical devices. The measurements taken in May, August, and November were almost the same and it was concluded that the outer wall is not in danger of collapsing.



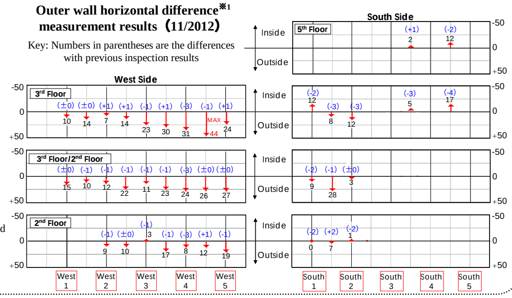
※1: Horizontal distance between the fixed points on the first floor and those on the top floor

Measurement points

Note: The photograph has been altered for security reasons

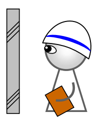
Outer wall horizontal difference※1 measurement results（11/2012）

Key: Numbers in parentheses are the differences with previous inspection results



(3) Visual inspection

The concrete floor and walls of the spent fuel pool framework were checked visually for cracks. It was confirmed that there are no cracks over 1mm in width nor cracks that harbor the possibility of rebar corrosion.

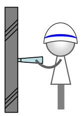


Visual inspection

Walls supporting the spent fuel pool

(4) Confirmation of concrete strength

The strength of the concrete of the spent fuel pool frame was measured through a nondestructive inspection (Schmidt hammer method) and it was confirmed that all measuring points exceed standard design strength（22.1N/mm²）



Nondestructive inspection (Schmidt hammer method)

Concrete strength confirmation results [N/mm2]

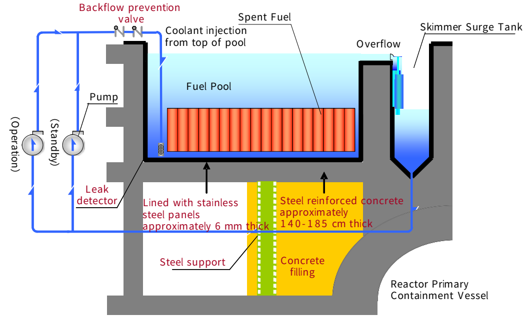
Measurement points		Concrete strength (11/2012)	Standard design strength
Wall	1st fl	39.5	22.1
	2nd fl	35.9	
	3rd fl	36.9	
	4th fl	35.5	
Pool floor (bottom)		33.0	

※ Schmidt hammer method: Strike the concrete lightly with a hammer and estimate the strength of the concrete by the sound that is reverberated

Spent fuel pool construction/mechanism

- The spent fuel pool construction/mechanism is designed not to leak through the four following countermeasures
- ✓ The inside of the pool is lined with stainless steel plates.
- ✓ There are no pipes or water drainage holes in the size or the bottom of the pools.
- ✓ If pool water leaks due to damage to pipes it can be detected as a abnormal drop in the water level of skimmer surge tanks
- ✓ Pipes that inject coolant into the pools are equipped with backflow prevention valves that do not require power so even if a pipe burst, pool water would not flow backwards and discharge due to closing of the backflow prevention valve.

Spent fuel pool concept image



Future issues and the direction of countermeasures

※Continual confirmation of Unit 4 reactor building soundness through periodic inspections

- The inspections noted the left are periodically implemented (four times a year) in order to continually monitor the soundness of the building and receive confirmation by external experts

※ Handling the risks associated with earthquakes and tsunami (mentioned again)

- Alternative coolant injection equipment, such as concrete pump trucks, having been deployed so as to enable sufficient time to restore cooling function if the fuel pools become unable to be cooled due to damage to primary/secondary pump pipes, etc., by an earthquake or tsunami.
- ✓ In this instance, it has been concluded that a minimum of 16 days (Unit 4) would be required to reach a point where fuel pool water level is maintained at a certain level (2m from top of fuel: water level at which shielding is deemed effective) since water temperatures will rise and water levels will decrease.
- ✓ Even if it is difficult to cool the pools using emergency coolant injection equipment, and concrete pump trucks, etc., are used to cool the pools, cooling could be restored in approximately 6 hours even if cooling function is lost
- Furthermore, every effort shall be made to comply with newly gained knowledge, including the handling of changes to basic earthquake ground motion.

※Risk assessment of losing spent fuel pool water

- A trial evaluation of fuel cladding tube temperature was formed in the hypothetical case that spent fuel water was instantly lost
- ✓ While temperatures stabilize at a certain temperature if airflow can be maintained, if there is no airflow there is a possibility that the temperature will quickly rise. It was reaffirmed that maintaining pool water level is an important issue.
- ✓ Furthermore, if pool water was lost the radiation levels around the reactor building would only reach several mSv/h thereby allowing continual coolant injection work around the pools. The basic idea is to remove heat through coolant injection but from the standpoint of safety redundancy chemical extinguishants have also been prepared.

5. Fuel debris removal

Preparations for fuel debris removal

Progress status points

(1) Development of remotely operated decontamination technology and methods in order to secure access to the building

- Decontamination methods are being examined in order to reduce the exposure of workers inside the building

(2) Preparations for inspecting the inside of the PCV (identifying and repairing leaks, sampling surveys, etc.)

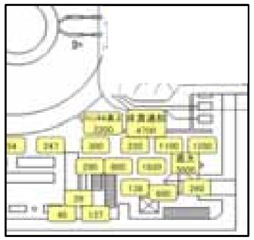
- Deliberations have begun on the development of a robot under the supervision of the remote technology task force in preparation for identifying and repairing PCV leaks
- Surveys of the torus and the triangle corner inside the reactor building will be implemented in order to contribute to robot development.

(3) Ascertaining conditions inside the core by leveraging analysis codes, and fundamental research for ascertaining the characteristics of fuel debris

- Simulation analysis codes are being analyzed and being made more advanced in order to ascertain conditions inside the core.
- Fundamental research has begun on ways to ascertain debris characteristics in order to help with field debris removal/storage/processing/disposal

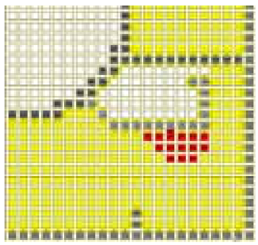
Proposing plans for decontaminating the inside of the buildings and for reducing overall dose levels

- A survey of the degree of contamination inside reactor buildings has been conducted (dose rate survey/contamination sampling/analysis) and remote decontamination devices are being developed in accordance with the state of contamination.
- A dose rate map for inside the building has been created using dose rate survey results and a decontamination plan is being created. The JAEA has been asked to perform a detailed analysis of the contamination samples and effective decontamination methods are being deliberated.
- Detailed plans that include decontamination/shielding/equipment removal are starting to be created in order to contribute to reducing dose levels inside the reactor buildings.



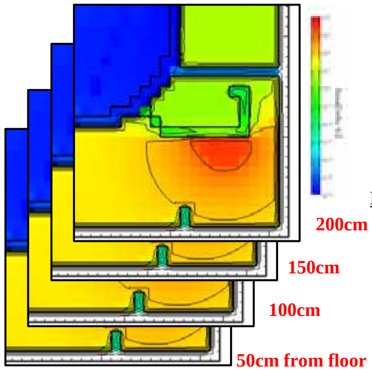
Measurement data (example)

Floor and wall surface dose data obtained through the surveys and the gamma camera data (currently being evaluated) are entered into 1m X 1m cells to create a three-dimensional model.



Surface dose rate entry (two-dimensional example)

An analysis code is then applied to the model. A two-dimensional air dose dispersion map is then output it with height direction as a parameter.



Outputted air dose rate dispersion map concept image

Dose dispersion map creation concept image

Identifying and repairing leaks within the containment vessel

- A suppression chamber (S/C) water level measurement robot fundamental technology development WG and underwater robot fundamental technology development WG has been established under the remote technology task force and deliberations have begun.
- A list of containment vessel boundary parts that include those areas that need to be subjected to a damage evaluation will be evaluated to determine whether or not damage was caused by a severe accident (earthquake, temperature, etc.) and the possibility of damage to each part will be determined. Upon doing this, areas that need to be surveyed will be extracted and methods for accessing the aforementioned areas will be examined.
- Existing technology has been examined and methods for designing and maintaining (stopping leaks) survey devices that can inspect envisioned leak locations are being deliberated.
- Robots are being developed perform work in high-dose areas. In order to solidify robot specifications, the triangle corner in the reactor building and the Torus will be surveyed and various data, such as radiation levels, the level of accumulated water and atmospheric temperature, etc., shall be sampled.
- Water tank tests were performed on materials for stopping water between buildings and the effectiveness of plastic grout was confirmed (March 2012)

■ Development of remote decontamination technology for inside buildings

◆ Details

Remote decontamination devices that fit the contamination conditions in the field will be developed in order to improve work environment conditions for finding and repairing leak

◆ Technological development points

• Developing and preparing effective decontamination technology that fits contamination conditions

• Developing remote decontamination technology that can be used under the harsh conditions of high dose rates and narrow spaces

High-pressure water cleaning

Sandblasting

Blasting with dry ice

Decontamination technology (example)

■ Developing technology to identify leaks in the containment vessel

◆ Details

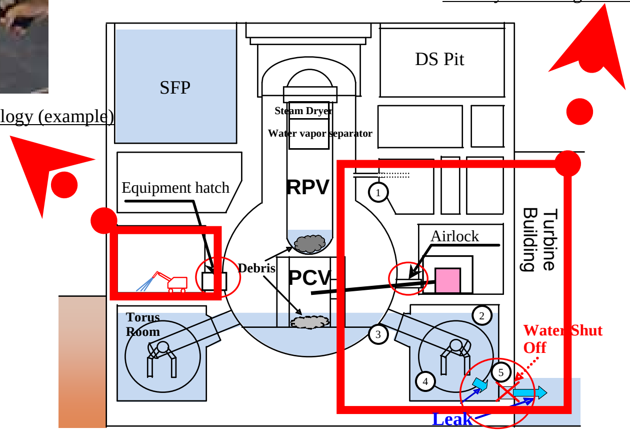
Technology for remotely identifying leaks in the containment vessel, etc., will be developed.

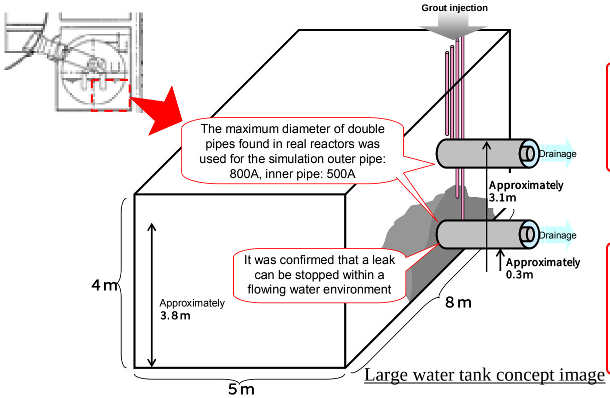
◆ Technological development points

Developing remote survey technology that can be used under the harsh conditions of high dose rates and narrow spaces

Diagram number	Survey location	Primary technological development focus
(1)	D/W outer wall panels, etc.	Remotely operated gas leak detection technology
(2)	S/C top equipment, etc.	Technology that balances movement upon narrow catwalks with the ability to survey at arbitrary heights
(3)	D/W vent pipe welds	Technology for accessing narrow areas
(4)	S/C bottom	Technology for adhering to and running along outer walls, and observing in dirty water
(5)	Penetrations seals	Technology for detecting leaks in dirty water

Primary technological development focuses

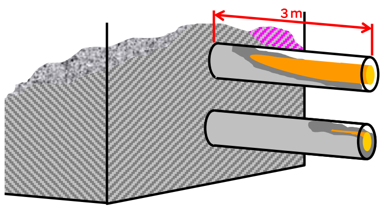




Large water tank concept image

【Confirmation Items】
(1) The ability to stop leaks from double layered pipes
(2) The ability to layer water stopping material
(3) Adhesion of water stopping material to itself

【Test results】
(1) It was confirmed that plastic grout can be used to stop water environments where the water is flowing
(2) No luck was had with layering
(3) The material adhered well to itself without gaps



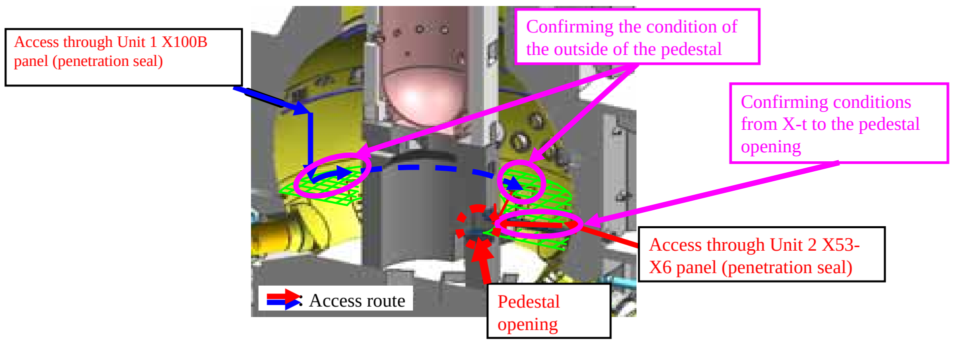
After injection of water stopping material (after the leak has been stopped) (concept image)

Layering of water stopping material after injection

Overview of water tank tests on water stopping material for between buildings

Survey of the inside of the containment vessel in preparation for fuel debris extraction

- The development of a device for ascertaining the condition of fuel debris and the pedestal is being deliberated.
- The specifications of a device that can measure dose and temperature, and take photographs of the opening of the pedestal, etc., after being inserted through the penetration seals of the Unit 1 and Unit 2 containment vessels are being deliberated.



Pre-survey items and access routes (tentative)

Ascertaining and analyzing conditions inside the core

- Analysis and advancement of analysis code to simulate conditions inside the core were implemented.
- An international benchmark analysis project for Fukushima accident analysis was launched in cooperation with the OECD/NEA. The first meetings and workshops were held in Tokyo (November 6-9)

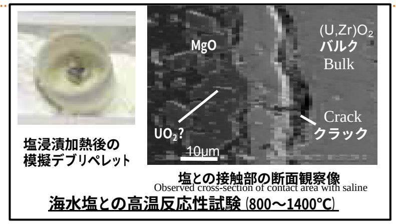
Photo from the workshop

Preparations for ascertaining the characteristics of fuel debris and processing

- Assessing physical attributes of fuel debris that will impact the development of devices used for extracting it
- Simulated debris was manufactured in order to obtain fundamental data regarding the temperature reactions with seawater salt
- A processing scenario draft was created in regards to processing after fuel debris has been extracted (storage, processing, disposal, etc.) and the pros and cons of a part of the process (debris storage) were evaluated

Outer appearance of simulated debris

Simulated debris pellet after being soaked in saline and heated



High temperature reactivity tests with saline (800-1,400 C)

Future issues and the direction of countermeasures

※Continual deliberation of mid-term issues regarding fuel debris extraction

- In order to extract fuel debris it is necessary to develop technology for surveying and making repairs under harsh environmental conditions, as well as collecting knowledge from within and outside Japan regards to ascertaining unknown conditions inside the core and the state and characteristics of fuel debris.
- In order to develop devices and equipment the technology catalog will be leveraged and a public appeal will be made for technology owned by private corporations and research institutions both within and outside of Japan.
- Through coordination with international agencies information will be disseminated from Japan and knowledge and experience in regard to developing difficult technology will be gathered.
- Further in the field investigation of existing technology will be conducted and feedback given to R&D aimed at developing technology for surveying and repairing leaks in the containment vessel and ascertaining of plant status as quickly as possible.
- Deliberation of alternative methods for flooding if containment vessel boundaries cannot be constructed.

6. Processing and disposal of radioactive waste

Measures for managing and processing/disposal of radioactive waste

Progress status points

(1) Suitable management of radioactive waste

- Storage areas will be prepared for suitably managing radioactive waste, such as debris and felled trees, after estimating the current amount of reactive waste and the amount of radioactive waste generated from future work processes.
- Construction of the solidified waste incinerator facilities for used protective clothing has begun.

(2) Research and development for radioactive waste processing/disposal

- Research and development has begun to ascertain the characteristics of waste in order to processing and disposal of radioactive waste in cooperation with the JAEA (Japan Atomic Energy Agency), etc.

Efforts aimed at managing, processing and disposal of radioactive waste

(1) Suitable management of radioactive waste

- Debris collected in conjunction with debris removal work is being stored in temporary storage areas in accordance with material characteristics and dose rates, and felled trees are being temporarily stored after separating branches and leaves from the trunks as much as possible.
  （concrete/metal:54,000m^3 , felled trees: 69,000m^3 （as of October 31)）
- Spent vessels and waste sludge which is secondary water treatment waste generated by cesium absorption devices（KURION, SARRY） and decontamination devices（AREVA） . Spent vessels are being stored in concrete box culverts in the spent vessel temporary storage facility, and sludge are being stored in main processing building pit, respectively.
- Used protective clothing is being put into packages or containers and temporarily stored, and an advanced survey related to solidified waste incinerator facilities has begun.

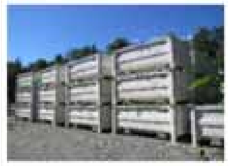
(2) Research and development for processing/disposal of radioactive waste

- The characteristics of waste generated after the accident needs to be ascertained because it has characteristics different from conventional waste, such as being contaminated with radioactive nuclides originating from damaged fuel and containing a lot of saline that would have a detrimental impact on processing/disposal performance.
- Samples of accumulated water and treated water have been analyzed and an evaluation of the radioactive concentration contained in secondary waste is being conducted based on those results. Samples from debris and felled trees are also being analyzed.
- New analysis technology required for ascertaining the characteristics of waste after the accident is also being developed simultaneously.

Debris/felled tree management status (as of October 31, 2012)

Storage area	Air dose rate at area border (mSv/h)	Type	Storage method	Storage amount※1	Comparison with previous report (Sep 28, 2012)	Area occupation rate
Solid waste storage building	0.05	Concrete, metal	container	2,000 m^3	－ m^3	35 %
A：North side	0.45	Concrete, metal	temporary storage facility	7,000 m^3	- 4000 m^3	64 %
B：North side	0.05	Concrete, metal	container	4,000 m^3	－ m^3	98 %
C：North side	0.01	Concrete, metal	external collection	28,000 m^3	－ m^3	82 %
D：North side	0.02	Concrete, metal	tarp covered	2,000 m^3	－ m^3	86 %
E：North side	0.01	Concrete, metal	tarp covered	3,000 m^3	－ m^3	86 %
F：North side	0.01	Concrete, metal	container	1,000 m^3	－ m^3	99 %
L：North side	Less than 0.01	Concrete, metal	soil covered temporary storage facility	4,000 m^3	+ 2000 m^3	46 %
O：Southwest side	0.08	Concrete, metal	external collection	3,000 m^3	+ 3000 m^3	17 %
Total (concrete, metal)				54,000 m^3	+ 1000 m^3	62 %
G：North side	0.01	Felled trees	external collection	18,000 m^3	－ m^3	83 %
H：North side	0.02	Felled trees	external collection	16,000 m^3	－ m^3	93 %
I：North side	0.02	Felled trees	external collection	11,000 m^3	－ m^3	100 %
J：South side	0.06	Felled trees	external collection	12,000 m^3	－ m^3	77 %
K：South side	0.04	Felled trees	external collection	5,000 m^3	－ m^3	100 %
M：West side	0.01	Felled trees	external collection	7,000 m^3	+ 1000 m^3	35 %
Total (Felled trees)				69,000 m^3	+ 1000 m^3	76 %

※1 Totals do not add up because numbers under 1,000m^3 have been rounded


Debris (storage container)


Debris (tarp covered)


Felled tree (gathered outside)

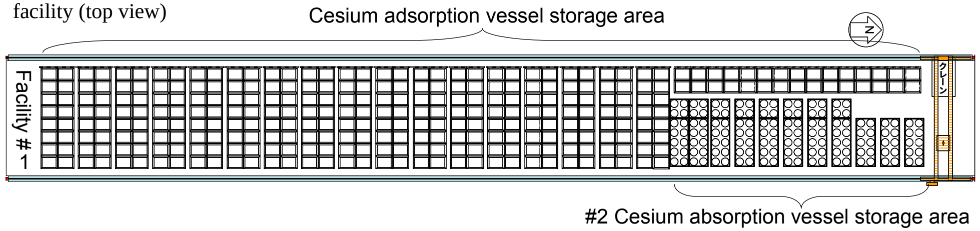
※ Refer to page 7 “3. Reducing Radiation and Preventing the Spread of Contamination” for information on the outer appearance of soil covered temporary storage facilities

Status of management of secondary waste from water treatment (as of November 27, 2012)

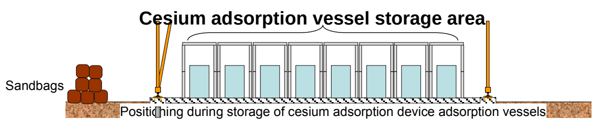
Amount of generated waste		Storage capacity
Waste sludge	597m3	700m3
Spent vessel	460	1,137


Cesium adsorption vessel temporary storage facility (outer appearance)

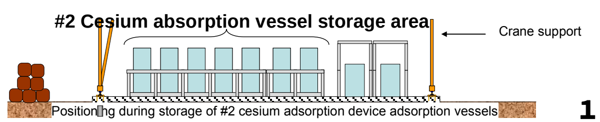
Cesium adsorption vessel temporary storage facility (top view)



Cesium adsorption vessel temporary storage facility (cross-section)



Cesium adsorption vessel temporary storage facility (cross-section)



Future issues and the direction of countermeasures

※Continued suitable storage of radioactive waste that will increase in the future

- Consideration of the construction of radioactive waste temporary storage facilities that are shielded
- In order to prepare areas for suitably managing radioactive waste in accordance with volume and radiation levels, a “Radioactive Waste Management Plan” will be created by the end of FY2012.

※Continual consideration of how to process and dispose of radioactive waste that will increase in future

- Waste generated from the accident has characteristics that differ from conventional nuclear power station waste (radioactive composition, saline content, etc.), so ascertaining the characteristics of waste and evaluating the amount is the most pressing issue in order to gain an outlook on safe processing/disposal and deliberate a systematic and regulative framework that will be necessary in the future.
- Therefore, while continuing with nuclide analysis in order to ascertain the characteristics of debris and secondary waste from water treatment, analysis issues, such as how to extract nuclides and how to remove harmful nuclides, will be deliberated and analysis technology established.
- While investigating and organizing documentation related to processing/disposal concepts and safety evaluations needed to deliberate on the outlook for safe processing/disposal, information and results about waste characteristics obtained through analysis are being used to create a database.
- R&D issues needed to process/dispose of waste safely are being looked at carefully and a research and development plan will be created by the end of FY2012.
- Research and development will proceed with the cooperation of domestic research agencies as well as international agencies.

＜Pressing issues＞

Ascertaining characteristics and evaluating volume

・Characteristics differ from conventional waste, such as debris and sludge
・Ascertain fundamental information that can contribute to technological development

＜Output＞
・Radiation concentration for each nuclide
・physiochemical characteristics, etc.

Examples of differences with conventional waste
・Ordinary nuclides：Co-60, C-14, etc.
Now →：Cs-137, Sr-90, etc.
・Seawater is mixed in and the concentrations of Na and Cl are high
Now → Impact assessment on processing/disposal necessary
・Waste for which the chemical composition is unknown, such as sludge, exists
→Needs to be identified to be analyzed

＜Mid-term issues＞

Establishing processing plans

・Based on existing technology
・Establishing technology for separating, reducing volume, conditioning, and turning into waste
・Establishing a systematic and regulative framework

＜Output＞
・Storage oriented processing methods
・Waste package production methods, etc.

Establishing disposal plans

・Based on existing disposal concepts
・Establishing a systematic and regulative framework

＜Output＞
・Waste disposal methods (required varying depths and artificial barrier configuration, etc.)

6 supplement. Enhancing research and development structure

Future measures for enhancing research and development structure

Future issues and the direction of countermeasures

※Future Plan for research centers

- “Facilities for analyzing radioactive material” and “Developing remotely operated equipment/devices and building facilities to test them”, which are needed in order to steadily move ahead with the mid-to long-term roadmap, are being deliberated.
- Based on the Basic Policy for Recovery and Reconstruction of Fukushima we aim to become the future focal point of International Research in consideration of contributing to employment and the economy of the local region

※Research and development management organization requirements

- The “Results of Deliberation regarding Midterm Measures for the TEPCO Fukushima Daiichi Nuclear Power Station” compiled by the Atomic Energy Commission subcommittee in December of last year suggests that the research and development promotion headquarters should be managed as a full-time organization in order to effectively proceed with the management of research and development over the long term.
- An optimal system for dealing with issues that have become clear, such as effectively and efficiently implementing restriction valid projects and international cooperation with overseas research agencies, should be constructed and is being deliberated.

※Securing/training personnel from a mid-term

- Coordinate with universities and research agencies to secure and trained personnel needed to engage in research and development and operate decommissioning equipment on-site 10 to 20 years from now.
- Select universities and research agencies that have the potential to focus on important fields such as ascertaining the characteristics of field agree and evaluating/analyzing accidents, and moving forward with fundamental research.

7. Securing personnel and ensuring work safety

Efforts aimed at securing personnel and ensuring work safety continue

Progress status points

Based on the awareness that it is vital to prepare an environment within which workers are highly motivated as the long process of decommissioning begins, we will make efforts to ascertain needs in the field while continuing to improve the work environment and labor conditions by periodically conducting questionnaires of workers and exchanging information with contractors.

(1) Securing necessary personnel

➢Personnel management

- Over the last three months (July through September) the number of people per month that were registered to engaging work if even for one day was approximately 8000 (TEPCO employees and contractors), which exceeds the number of people that had engaged in work (approximately 5500 (TEPCO employees and contractors)).

➢Improving living/working environments

- The office cafeteria and the contractor center welfare building cafeteria at Fukushima Daini NPS, which is the base of operations for workers engaged in the decommissioning of Fukushima Daiichi NPS, will be reopened.
- Rest areas will be established
- Dose levels in places where workers remain for given periods of time (rest areas, bus stops, etc.) will be reduced

(2) Ensuring work safety

➢Radiation control

- Full-scale vehicle screening and decontamination will begin.
- Countermeasures to prevent the dishonest use of APD will be implemented.
  (Random inspections, introduction of protective suits that have clear chests, APD carrier identification, and carry confirmation)
- In order to reduce the burden on workers eliminating the necessity for masks and introducing dust filters will be gradually implemented.

➢Health management

- Securing and deploying medical staff at treatment centers
- Countermeasures to prevent the infection and spread of influenza and the norovirus
- Expanded scope of cancer testing
- Establishment of a health consultation desk
- Mental health countermeasures

➢Safety management

- Implementation of heatstroke prevention countermeasures

➢Labor environment

- Establishment of various consultation desks
- Exchange of opinions with contractors

Improving living/working environments

Meals

- ☐ Immediately following the accident food provisions (retort foods) were distributed.
- ☐ The office cafeteria and the contractor center welfare building cafeteria at Fukushima Daini NPS, which is the base of operations for workers engaged in the decommissioning of Fukushima Daiichi NPS, will be reopened. （June 18, 2012～）

Rest area establishment

☐Immediately after the accident the seismic isolated building was the only place available to rest, but the multitude of people prevented workers from resting.

☐Through the new establishment and merging of rest areas there are currently 16 rest areas available (enough for approximately 1400 people) (November 2012) （H24.11）
（requested through the questionnaire）

Dose reduction

☐Construction to reduce those levels has been implemented on part of the seismic isolated building and is now being operated as a non-controlled area (from May 1, 2012)

☐Worker exposure will be reduced by erecting shielding, etc., at rest areas and in the seismic isolated building, etc. where workers spend long periods of time in order of priority. And, construction to reduce dose levels at rest areas in front of the office building/seismic isolated building that have a great impact on the exposure of workers will be continually implemented in order of priority (requested through the questionnaire)

☐In order to reduce exposure at bus stops as much as possible steel plates have been installed and exposure dose levels on the bus had been reduced to approximately ¼ （8/20～9/26） . The guard post at the front gate will be decontaminated in the future (now being scheduled, should be completed by the end of this year)

Main office building window shielding

Concrete removed from top of office building

Commuter bus stop (after shielding)

Radiation control

Full-scale vehicle screening and decontamination will begin

☐ Full-scale operation began on August 10 after lifting of the hazard zone designation on Naraha-machi. Furthermore, an entry and exit facility is now being constructed near the main gate of Fukushima Daiichi NPS (to be completed at the end of June 2013).The entry and exit of vehicles will be managed from this facility thereafter.

Vehicle screening and decontamination

Radiation Control

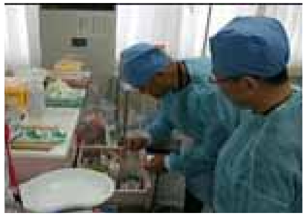
Improved management of radiation protection equipment

- IN order to prevent the recurrence of the dishonest use of alarm personal dosimeters (APD) workers engaged in high exposure work are required to wear protective clothing with clear chests (10/15～) . All workers will be required to do the same starting in February 2013.
- In order to reduce the burden on workers areas in which full face masks are not required are being gradually enlarged upon confirming the concentration of radioactive materials in the air (requested through the questionnaire). Currently full face masks are not required at the front gate and the area in front of the seismic isolated building and the Unit 5, Unit 6 service building (from November 8, 2011), the area in front of the corporate center welfare building (from June 1, 2012), vehicle contamination screening area (from August 9, 2012) and entry/exit management facility construction site
- Some areas now only require light dust filter masks which have less inhalation resistance than charcoal filter masks (all areas outside from March 1, 2012). In the future Units 1 through 4 and areas inside surrounding buildings will improved similarly.

Health Management

Securing and deploying medical staff at treatment centers

- On April 1, 2012 four male nurses were employed and deployed to the 1F emergency medical center and J Village clinic.
- Doctors and nurses are on 24 hour rotations at the 1F emergency medical center and J village clinic.



Doctor and nurse at the Unit 5/6 emergency medical center

Unit 5/6 emergency medical center

Preventative Medicine

- Inoculations (free) are being given at J Village to prevent the infection and spread of influenza
- Full face masks and the sanitization of door knobs, etc. is being implemented to prevent the infection and spread of the norovirus.

Long-term health management

- Ministry of Health, Labour and Welfare cancer screenings, etc. will be extended to workers that have suffered exposure of over 50mSV.
- Health consultation desk has been established. (February 28, 2012)

Mental health countermeasures

- A medical team from the National Defense Medical College has begun mental health support activities (July 10, 2011)

Safety Management

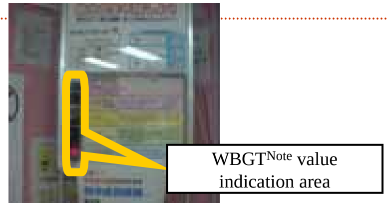
Heatstroke prevention countermeasures

- The following measures have been implemented to prevent heatstroke and as a result compared with 2011 the number of cases of heatstroke has greatly decreased. These measures will be continued in the future.

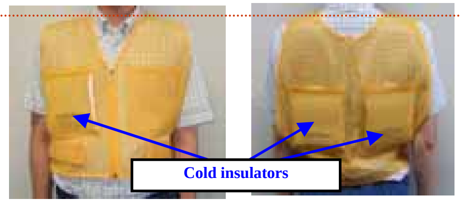
（7 cases in 2012/23 cases in 2011)

※The number of instances of heatstroke requiring transportation to a hospital in July and August for the entire nation increased compared to 2011 (according to statement by the Ministry of Internal Affairs and Communications Fire Defense Agency)

- ✓ These countermeasures implemented early in the year (from May) in order to make all efforts to counter the intense heat of summer.
- ✓ Electrically lit panels that indicate WBGT valuenote has been introduced to enable work hours, break frequency/length, and work intensity changes in accordance with the indicated value.
- ✓ From July through September work between the hours of 2 PM and 5 PM on the hot scorching sun will be prohibited as a rule.
- ✓ A friendly greeting campaign has been started in order to get people used to wearing cool vests
- ✓ Health checks prior to work and during breaks are being implemented
- ✓ Equipment that reduces work burden (coveralls with good breathability, etc.)is being employed



WBGT value indicated in lit display



Cool vest

Note: WBGT value: Composite temperature used to estimate the effect of temperature, humidity, wind speed (wind chill), and visible and infrared radiation (usually sunlight) on humans

Labor Environment

Efforts to optimize employment

- Establishment of “Working Condition Consultation Desk” (May 17, 2003)
- Informal talks with primary contractors (June 25 through July 18, 2012)
- Exchange of opinions with former contractors (August 28, 2012)
- “Questionnaire regarding Working Conditions” implemented to ascertain work conditions. (Results released on December 3)

General Measures

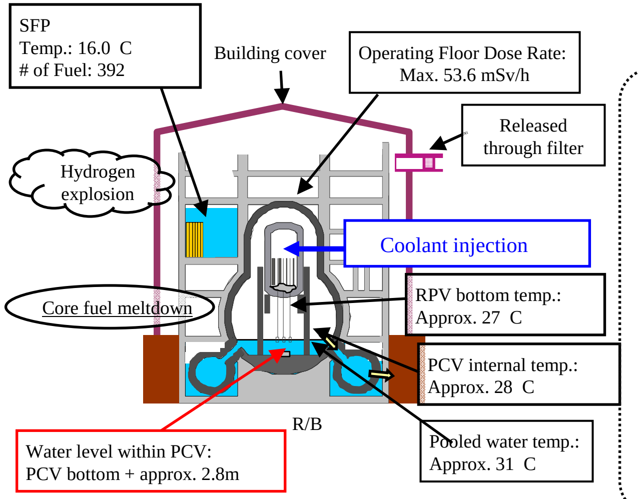
- In order to examine the status of improvements and ascertain improvement needs a “Questionnaire Regarding the General Working Environment "is being implemented twice a year

Future issues and the direction of countermeasures

- Considering the local community in regard to securing personnel in the long-term
  - At current time it is not expected that a lack of personnel will hinder on-site work. In the mid to long-term high dose work, such as installing the reactor building containers and extracting fuel debris, will begin so in order to secure personnel in a stable manner we will continue to consider employing people from the local community while training specialized personnel and engaging in suitable radiation control.
- Continued efforts aimed at improving the working environment and working conditions
  - Along with continually and thoroughly striving to improve the working environment and eradicate unsuitable working conditions and employment contracts, we will also examine the status of improvements.
- Other
  - Various countermeasures, such as securing a midpoint for workers, are being deliberated as we aim for recovery of J Village.

(Reference) Current conditions of each Unit and their issues

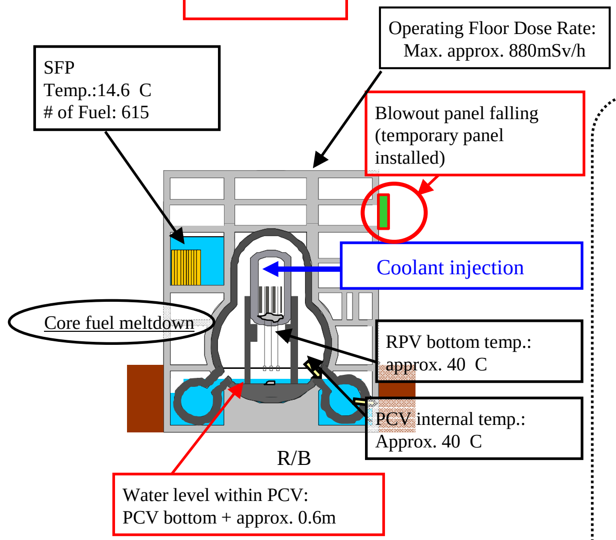
Unit 1



[Major issues facing Unit 1]

• Deliberation on method of removing spent fuel from fuel pool.
(handling of R/B 5F debris and extant building cover)
• Identifying leakage areas within building and PCV toward waterproofing work.
• Visual confirmation inspection of PCV internals (analysis assumes the amounts of fallen fuel debris and PCV deterioration are highest here among all Units).

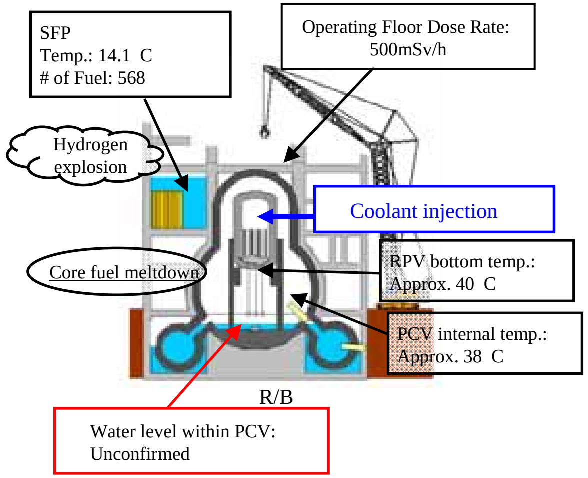
Unit 2



[Major issues facing Unit 2]

• Sealing off building openings which were created when the blowout panel fell off during the accident, so as to further reduce released radioactive material quantities.
• Maintaining RPV internal temp. measurement device function (extant temp. measurement devices have been lost one by one, and there are currently only two active).
• Deliberation on method of removing spent fuel from fuel pool.
(handling of contamination within building and extant building/cranes)
• Identifying leakage areas within building and PCV toward waterproofing work.

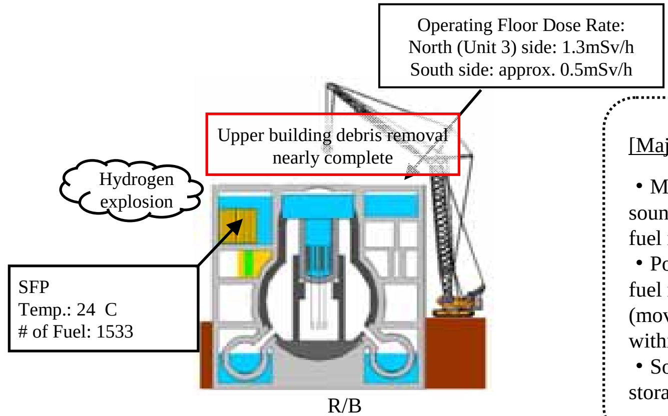
Unit 3



[Major issues facing Unit 3]

• Preventing recurrence of debris falling problems during building upper portion debris removal.
• Deliberating method of inspecting inside of PCV under high dosage environment.
(Units 1/2 have already been inspected, but inspection for the higher dosage Unit 3 has yet to take place)
• Identifying leakage areas within building and PCV toward waterproofing work.

Unit 4



[Major issues facing Unit 4]

• Maintaining and confirming building soundness, alongside early completion of fuel removal.
• Port preparations toward bringing in of fuel removal cover materials.
(moving docked megafloat to secure space within port)
• Soundness evaluation toward long-term storage of spent fuel within fuel pool.

*Plant-related parameters (temp.) are values as of 11:00 on Nov. 30, 2012

[Guide to acronyms]
RPV: Reactor Pressure Vessel
PCV: Primary Containment Vessel
SFP: Spent Fuel Pool

Map of TEPCO Fukushima Daiichi NPS grounds