

III. Efforts to bring the accident under stable control

1. Roadmap towards restoration from the accident at Fukushima Dai-ichi NPS , TEPCO (the “Roadmap”)

On April 17, 2011, TEPCO released the “Roadmap towards restoration from the accident at Fukushima Dai-ichi NPS,” which is comprised of a “Step 1,” a “Step 2,” and midterm issues. The countermeasures indicated in this roadmap have been implemented, and Step 1, which has the target of “the radiation dose is in steady decline,” has been completed. On July 19, 2011, in transitioning to Step 2, the Government-TEPCO Integrated Response Office released the revised Roadmap, with Step 2, which sets as its target “the release of radioactive materials is under control and the radiation dose is being significantly held down,” now underway. As for the targeted timing for the achievement of Step 2, which had been set as between October 2011 and January 2012, it was decided that there’s no need to change it in transitioning from Step 1 to Step2. Among efforts to bring the accident under stable control, the government has requested that TEPCO report issues which have been deemed as requiring confirmation of safety when undertaking implementation. The government will confirm their necessity and safety and receive guidance from the Nuclear Safety Commission as necessary, while also providing instructions to TEPCO (cf. Table III-1-1).

The government is, in cooperation with TEPCO, fully committed to achieve the goal by the above mentioned timing.

An evaluation of the actions implemented under Step 1 and issues for Step 2 appear below.

(1) Evaluation of Step 1

During the period of Step 1, the radiation dose indicated by monitoring posts, etc, were on the decline (cf. Figure III-1-1), in addition, the exposure dose evaluation of the NPS boundary based on the evaluation of the released amount of radioactive materials implemented by TEPCO, indicated significantly smaller amount than that of the initial stage of the accident, therefore, it was confirmed that the goal of Step1 was achieved.

1) Cooling the reactors

Now that the heat generated in the reactors (decay heat) is being removed and the bottom of the RPV is at a stable temperature, water injection is proceeding without increasing the amount of contaminated water (circulation water cooling) through the

operation of the accumulated water treatment facility, the reliability of the water injection (countermeasures to address abnormal events, multiple means for injecting water, etc.) has been ensured, and the risk of hydrogen explosions has been eliminated due to nitrogen injections into the PCVs, the target of “stable cooling” has been achieved (cf. Figure III-1-2, Figure III-1-3, Figure III-1-4).

2) Cooling the spent fuel pools

Since water injection via a permanently-installed line was initiated (May 29) for Unit 1, and water injection was started after the installation of an external injection facility at Unit 4 as an alternative to the permanent line (June 17), the target of “stable cooling” has been achieved for both of Units 1 and 4.

Regarding Units 2 and 3, since circulation cooling by means of heat exchangers was started (May 31 at Unit 2, June 30 at Unit 3), the Step 2 target of “more stable cooling” has been achieved ahead of schedule (cf. Figure III-1-5).

3) Treating accumulated water within the turbine buildings

Since a location to store the water that accumulated in the turbine buildings was secured and treatment facilities to decontaminate highly radioactive water were installed and began operating (June 17), the goal of “securing storage and beginning operation of treatment facilities” has been achieved.

Also, as a countermeasure against marine pollution, purification with zeolite (cesium adsorbent) has been implemented (June 13) along with the installation of silt fences which prevent the dispersion of contaminated water (cf. Figure III-1-6).

4) Preventing the spread of contamination of groundwater

There are ongoing examinations of installing blockage walls and of the flow characteristics of groundwater based on seepage flow analyses.

5) Preventing the spread of radioactive materials in the atmosphere/soil

In reference to “mitigation of release of radioactive materials,” inhibitors have been dispersed and debris has been removed. In addition, work is underway to install a cover over the reactor building of Unit 1 (cf. Figure III-1-7).

6) Measurement, reduction, public disclosure

In reference to “expansion and enhancement of monitoring and disclosure of the radiation doses inside/outside of the NPS”, the scope of monitoring and the amount of

sampling performed have been expanded. Measurement and public disclosure continue to be conducted.

*Radiation dose and other values indicated by monitoring posts, the concentration of radiation in seawater, and other values are in a declining trend. At the same time, since the radioactivity concentration in the seawater at the plant's port is still high, decontamination is being conducted utilizing a circulation-type seawater processing apparatus.

7) Tsunamis, reinforcement, etc.

In reference to "mitigation of further disasters," TEPCO has undertaken the transfer of emergency power sources (April 15) and the stationing of fire engines (April 18) upland. It has also added a redundant water injection line (April 15), and temporary tide embankments were installed (at the end of June) (cf. Figure III-1-8).

8) Living/working environment

In the area of "enhancing improvements to the living/working environment," TEPCO now offers on-site rest stations, and it has newly constructed temporary dormitories in J-Village (cf. Figure III-1-9).

9) Radiation control/medical care

As for the "enhancement of health care," a medical care system is now in place in the seismic isolation building (round-the-clock care with multiple doctors; cf. Figure III-1-10).

Chapter III

(2) Issues in Step 2

Issue 1

Cooling the reactors: Evaluation of necessary flow rate of injecting water to achieve “cold shutdown condition”.

As the circulating injection cooling implemented in Step 1 is continued and reinforced and the temperature of the RPVs is monitored, a “cold shutdown condition”* will be achieved. Currently, water injection which exceeds the necessary flow rate equivalent to decay heat, which was derived from simulations, is underway, therefore, the temperature of representative point of RPV remains stable condition (cf. Figure III-1-11, figure III-1-12). Hereafter, by changing the flow rate of Units 2 and 3 on trial, whose temperature of the bottom of RPV is above 100 °C, the temperature inside the reactors will be monitored and the evaluation of necessary flow rate of injecting water to achieve “cold shutdown condition” is being planned.

The company will also stably operate treatment facilities for accumulated water as necessary for “cold shutdown condition” .

In addition, as a measure to prevent accumulation of hydrogen by radiation decomposition, injection of nitrogen is underway.

*The definition of a “cold shutdown condition” is indicated below.

- The temperature of the bottom of the RPV is, in general, below 100°C.
- The release of radioactive materials from the PCV is under control and the public radiation exposure dose resulting from additional releases is being significantly held down.

In order to satisfy the above two conditions, the company is working to ensure the mid-term safety of the circulating injection cooling system (reliability of parts and materials, redundancy and independency, assessment of margin time in abnormal cases, detection of failures and abnormal circumstances, confirmation of restoration measures and time necessary until recovery).

Issue 2

Cooling the spent fuel pools: Achieving more stable cooling in all of the Units 1 through 4

Units 2 and 3 have achieved a state of “more stable cooling” (the target of Step 2),

insofar as heat exchangers were installed and a stable water level of the spent fuel pools was maintained at the end of Step 1. The installation of circulating cooling systems into Units 1 and 4 was set as a target under Step 2. With circulating cooling starting at Unit 1 (on August 10) and at Unit 4 (on July 31), the target has been achieved in all the units.

At the initial stage of the accident, regarding Units 2, 3, and 4, which were injected with water for cooling, in order to prevent corrosion of fuel cladding tubes, etc, currently injection of hydrazine is underway, and hereafter, the operation of demineralizers will be implemented. In addition, as for Unit 4, the operation of demineralizers was started (August 20).

Issue 3

Treating accumulated water: Decreasing the total amount of accumulated water and increasing the treatment volume to increase the water injection into the reactors

The total amount of accumulated water will be reduced by operating treatment facilities to treat the accumulated water in the buildings, and water injection to the reactors using the treated water will be increased. Also, the amount of reuse will be scaled up by expanding and steadily operating treatment facilities for highly contaminated water and then desalinating the decontaminated water. In parallel with this, consideration will begin of full-scale water treatment facilities for highly contaminated water.

The company will also continue to store and manage the sludge waste generated by the treatment facilities for highly contaminated water.

Issue 4

Shielding groundwater: Preventing the spread of contamination into the sea

Efforts will be made to prevent the contamination of groundwater and the spread of contamination in the sea via groundwater. Accordingly, in front of the existing seawalls of Units 1 to 4, a water shielding wall (side of the sea) which consists of waterproof steel pipe sheet pile, will be installed, as well as groundwater drain will be installed between a water shielding wall (side of the sea) and an existing seawall to prevent the leakage of groundwater to the ocean. The extension of the water shielding wall (side of the sea) was approximately 800m, and the length of waterproof steel pipe sheet pile was 22~23m, and embedding to the aquiclude is planned. The work will be launched during Step 2, and the planned work period is approximately two years. (cf. Figure III-1-13).

Chapter III

Issue 5

Preventing the spread of radioactive materials in the atmosphere/soil: Mitigation of release of radioactive materials

In order to reduce the amount of scattering of the radioactive materials deposited on the NPS premises and the radiation dose in the surrounding area, the company will continue to spray an inhibitor and remove debris, install a cover over a reactor building (Unit 1), and remove the debris on the rooftops of reactor buildings (Units 3 and 4). Examining the installation of a reactor building container as a permanent cover will also begin to be considered.

Issue 6

Measurement, reduction, public disclosure: Sufficiently reducing the radiation dose

The company will continue to expand and enhance monitoring, conduct disclosure, and evaluate the amount of radioactive materials being released at present. Full-scale decontamination will also begin.

Issue 7

Tsunami, reinforcement, etc.: Preventing expansion of a disaster

As preparation for abnormal events such as earthquakes and tsunamis, efforts will continue in the areas of preventing disasters from expanding and of avoiding a deterioration of the situation, as well as in the area of various countermeasures for radiation shielding.

Issue 8

Living/working environment: Enhancing improvements to the living/working environment

In order to maintain workers' motivation, the company has improved the working environment by increasing the number of rest stations at the work site among other improvements, while also improving the living environment through the provision of temporary dormitories, meals, and bathing and laundry facilities.

Issue 9

Radiation control/medical care: Enhancing healthcare

Thorough radiation exposure control is being implemented via automated recording of each individual's radiation dose, the reporting of the exposure dose in writing, the introduction of photo identification cards for workers, and increasing the number of, and expanding the use of, whole body counters. Actions for mid- and long-term health management, such as measures to prevent heat stroke during the summer, the enhancement of workers' safety training and the establishment of a database, will be implemented or examined.

Issue 10

Staffing/personnel training: Personnel training will be set out as a new issue in the monthly revision of the Roadmap released on August 17.

In looking at future prospects for exposure dose accumulation received in the course of upcoming work to bring the accident to a stable control, the existing number of staff is expected to be enough overall to carry out the work through to the end of Step 2. That said, some individual tasks could result in reaching the radiation dose's management value at an early time. Therefore efforts will include detailed estimates of radiation doses, systematic staffing, and human resource development through collaboration between the government and the plant operators.

Chart III-1-1 List of reports collected from and instructions given to Tokyo Electric Power Co. Inc. from Nuclear and Industrial Safety Agency

Classification	Subject	Collection of Report	Receipt of Report	Date of Evaluation	Directions from Director-General
Leakage of contaminated water	The discharge of waste water, of which the concentration of radioactive materials exceeds the concentration limit by the notification, to the sea from Fukushima Dai-ichi Nuclear Power Plant of Tokyo Electric Power Co., Inc.	April 4	April 4	April 4	April 5
	Regarding the discharge of waste water, of which the concentration of radioactive materials exceeds the concentration limit by the notification, to the sea (Report based on the directions from the Director-General (04.15.2011 Nuclear Number 5, Inspection Division))	-	May 20	-	-
	Regarding the response to the outflow of water containing radioactive materials from the area of the Intake Channel of Unit 3 of Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Co., Inc. (Report based on the verbal instructions from May 11, 2011)	-	May 20	-	May 23
	Delay of Report (Report based on the directions from the Director-General (05.23.2011 Nuclear Number 2))	-	June 1	-	-
	Regarding the plan to prevent outflow of water with high concentration of radioactive materials at Fukushima Dai-ichi Nuclear	-	June 1	-	-

	Power Station, Tokyo Electric Power Co., Inc. (Report based on the directions from the Director-General (05.23.2011 Nuclear Number 2)) Regarding a plan for storing and processing contaminated water with high concentration of radioactive materials at Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Co. Inc. (Report based on the directions from the Director-General (05.23.2011 Nuclear Number 2))	-	June 2	-	-
Cooling of the Reactor	Nitrogen Injection				
	① Nitrogen Injection to the Reactor Containment Vessel of Unit 1 of Fukushima Dai-ichi Nuclear Power Plant, Tokyo Electric Power Co., Inc.	April 6	April 6	April 6	April 6
	② Nitrogen Injection to the Reactor Containment Vessel of Unit 2 of Fukushima Dai-ichi Nuclear Power Plant, Tokyo Electric Power Co., Inc.	June 22	June 24	June 28	-
	③ Nitrogen Injection to the Reactor Containment Vessel of Unit 3 of Fukushima Dai-ichi Nuclear Power Plant, Tokyo Electric Power Co. Inc.	July 8	July 11	July 14	-
	Flooding Operation				
	① Implementation of the measure to fill the Primary Containment Vessel of Unit 1 of Fukushima Dai-ichi Nuclear Power Station with water up to the level above the reactor fuel	April 30	May 5	May 5	May 5
Cooling of the	② Installation of an alternative cooling and clean-up system for the spent	May 20	May 21	May 23	-

pool Treatment of accumulated water III-10	fuel pool in Unit 2 of Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Co. Inc.				
	③ Installation of an alternative cooling and clean-up system for the spent fuel pool in Unit 3 of Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Co. Inc.	June 13	June 15	June 16	-
	① Installation of an alternative cooling and clean-up system for the spent fuel pool in Units 1 and 4 of Fukushima Dai-ichi Nuclear Power	July 11	July 13	July 15	-
	④ Station, Tokyo Electric Power Co. Inc.		July 13		
	Transfer of waste water with high-level radioactivity accumulated in Fukushima Dai-ichi Nuclear Power Station to the Radioactive Waste Treatment Facilities	April 10	-	-	-
	#2 --> transfer to the Main Building of the Radioactive Waste Treatment Facilities	-	April 18	April 19	April 18
	#3 --> The Main Building of the Radioactive Waste Treatment Facilities	-	May 15	May 16	May 15
	#2,3 --> transfer to the High Temperature Incinerator Building				
	Change in the storage level in relation to transfer to the Process Main Building	-	June 4	June 4	-
	Another change in the storage level in relation to transfer to the Process Main Building	-	June 8	June 8	-
	Resumption of transfer to High Temperature Incinerator Building	-	June 17	June 17	-
	Further change in the storage level in relation to transfer to the Process Main Building	-	June 22	June 22	-

Installation of processing facilities and storage facilities for the accumulated water containing a high-concentration of radioactive materials in Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Co. Inc.

June 1

June 8

June 9

June 9

Regarding the situation of storage and treatment of accumulated water containing high concentration of radioactive materials at Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Co. Inc.
(Report based on the directions from the Director-General (06.08.2011 NA No.6))

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(First Report)
June 29
(Partially revised on June 30)
(Second Report) July 6
(Third Report) July 13
(Fourth Report) July 27
(Fifth Report) July 27
(Sixth Report) August 3
(Seventh Report) August 10

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		Report regarding treatment facilities and storage facilities of accumulated water containing high concentration of radioactive materials at Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Co. Inc. (installation of the second Cesium Adsorption Device etc.)	-	August 3	August 9 (P)	-
Improvement in the work environment	①	Implementation of the Measure for reducing the concentration of radioactive materials in Unit 1 Reactor Building of Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Co. Inc.	May 2	May 3	May 8	Directions to report: May 6 Controlling Radiation Exposure: May 8
III-12	②	Improvement of work environment inside the reactor building of Unit2 at Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Co. Inc.	June 8	June 15	June 17	-
Anti-scattering measure	①	Regarding the collection of a report on installing a cover for the reactor building and its associate facilities of Unit 1 at Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Co. Inc.	June 22	June 23	June 24	-

Fig. III-1-1 Dose Rate at NPS Boundary

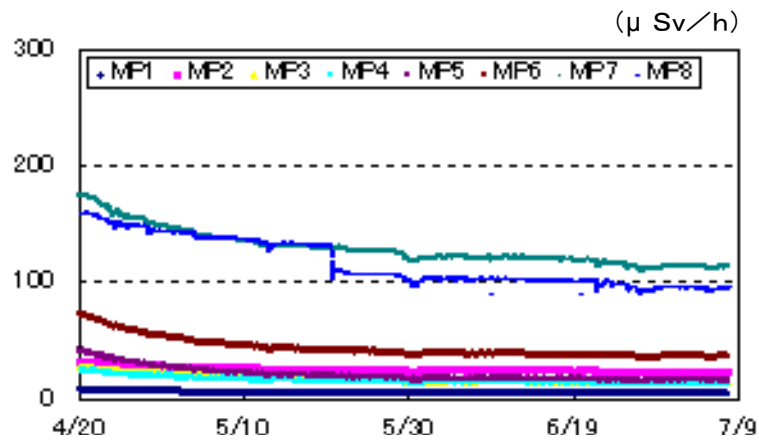


Fig. III-1-2 Temperature at Bottom of Reactor Pressure Vessel

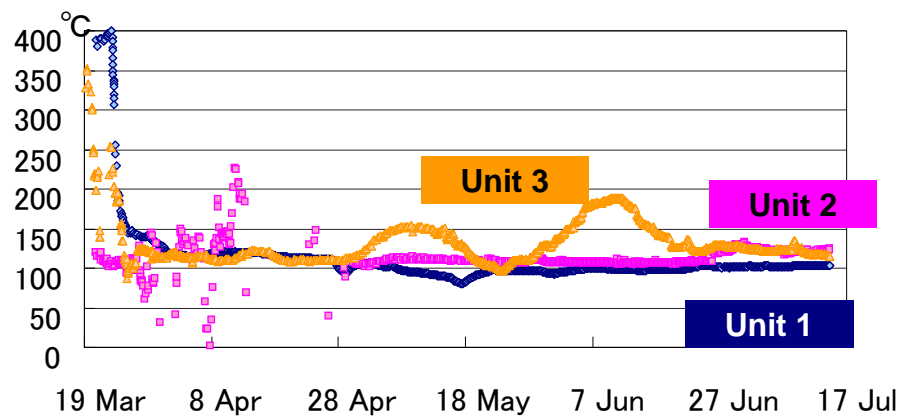


Fig. III-1-3 Outline of Circulating Injection Cooling

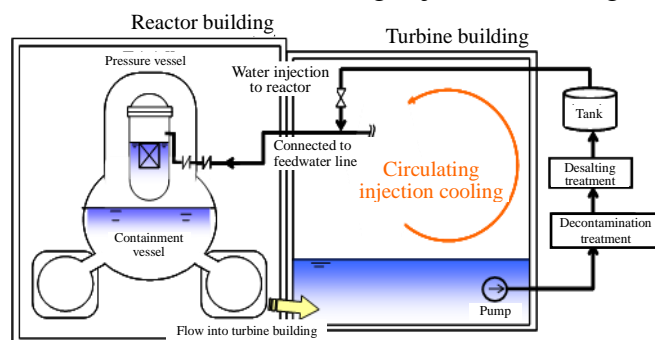


Fig. III-1-4 Outline of Nitrogen Injection System for Unit 1

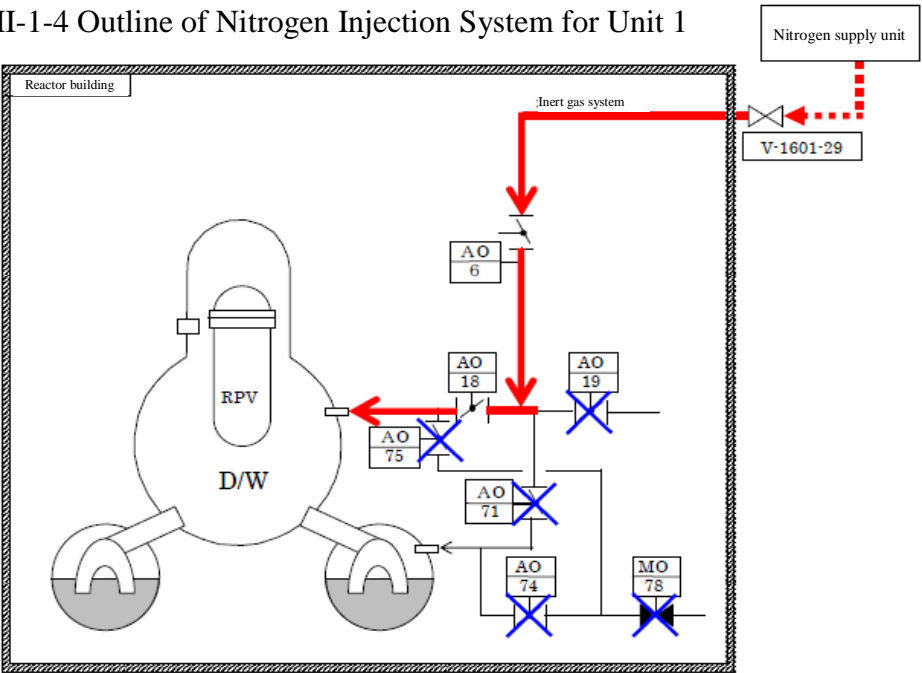


Fig. III-1-5 Installation of Heat Exchanger

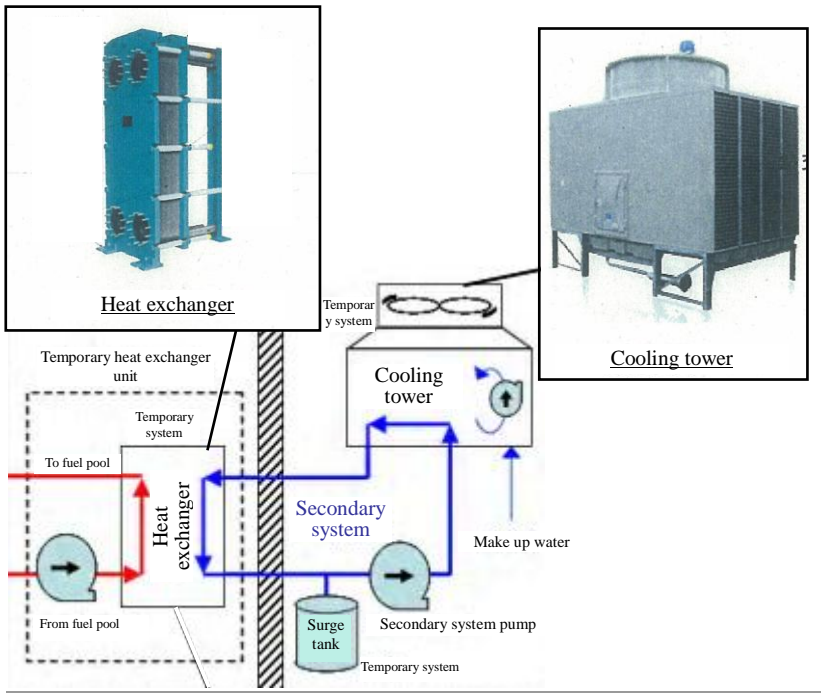


Fig. III-1-6 Treatment Facilities for Accumulated Water

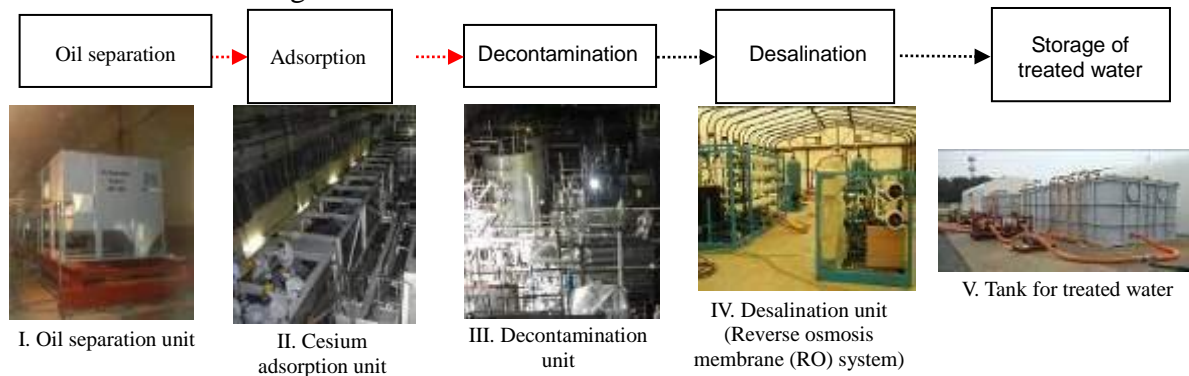


Fig. III-1-7 Outline of Installation of Reactor Building Cover for Unit 1

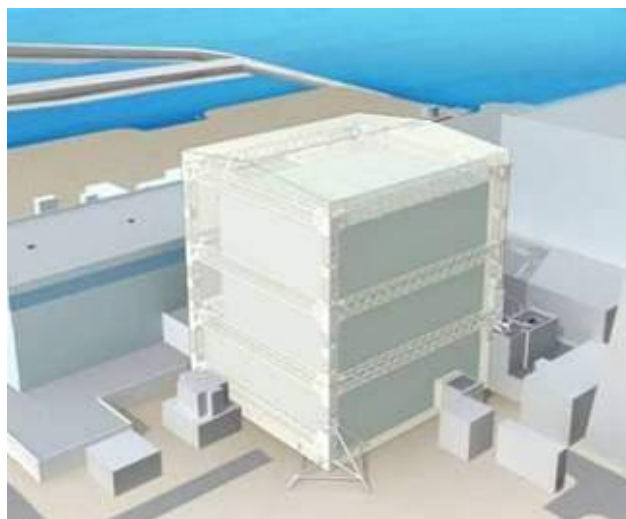


Fig. III-1-8 Installation of Temporary Tide Barriers





Fig. III-1-10 Emergency Medical Rooms in Units 5 and 6



Fig. III -1-11 Temperature at Bottom of Reactor Vessel

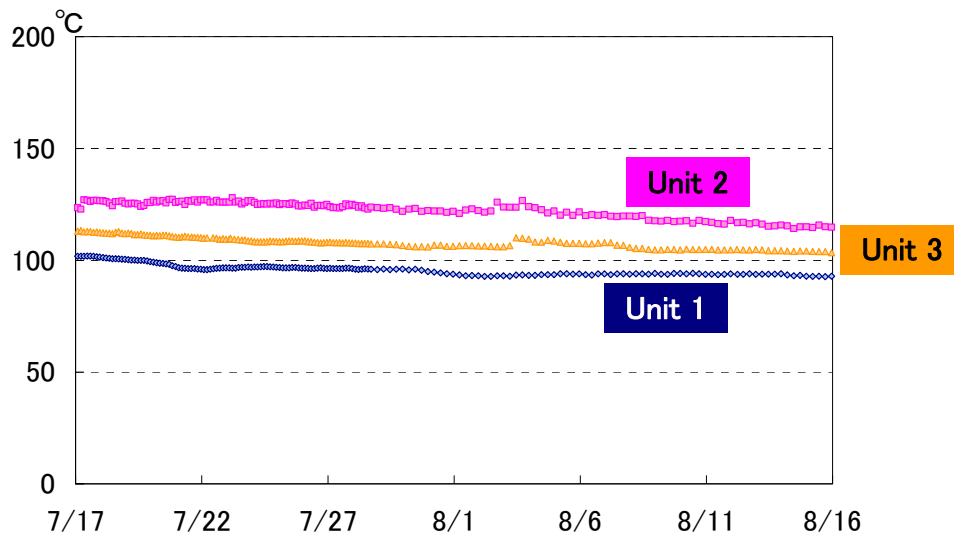


Fig.III-1-12 Reactor Injection System Outline (Unit 1)

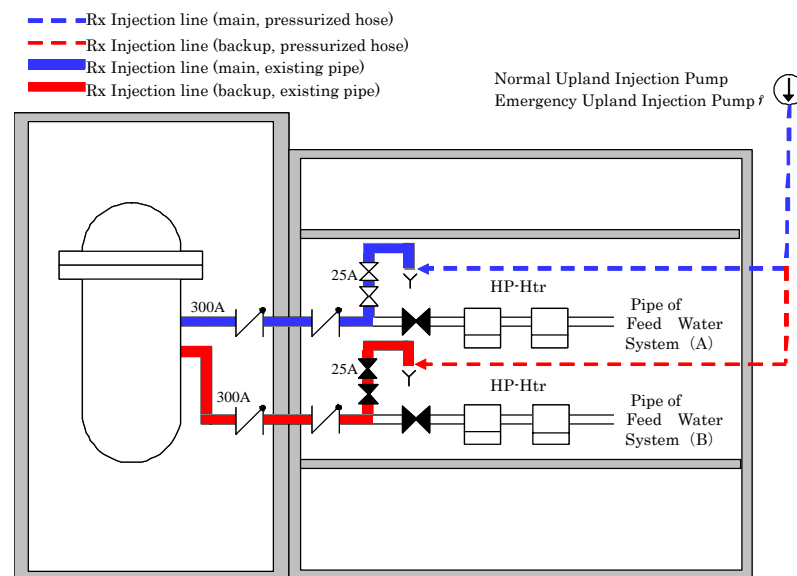
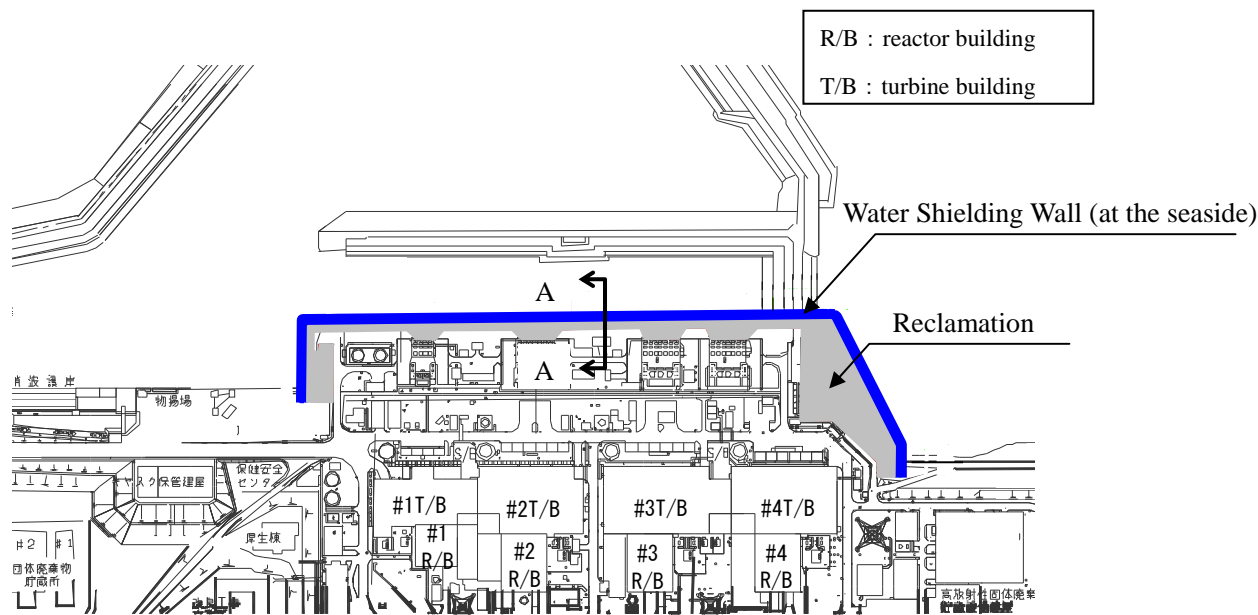
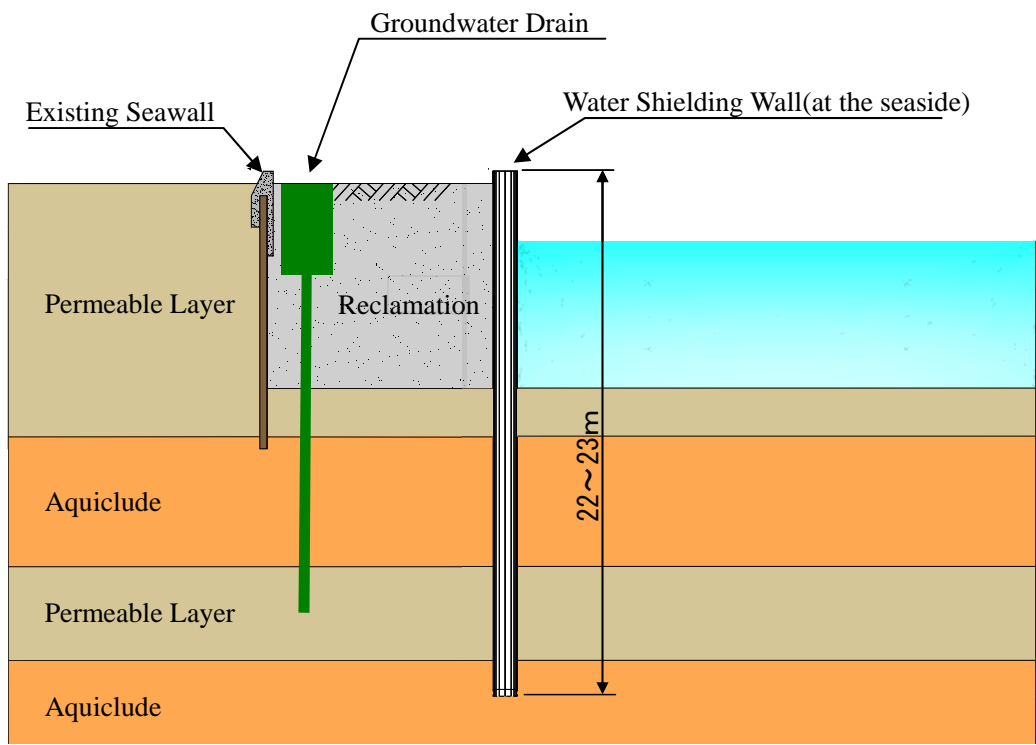


Fig. III-1-13 Outline of Water Shielding Wall



(1)Ground Plan



(2)A-A Section

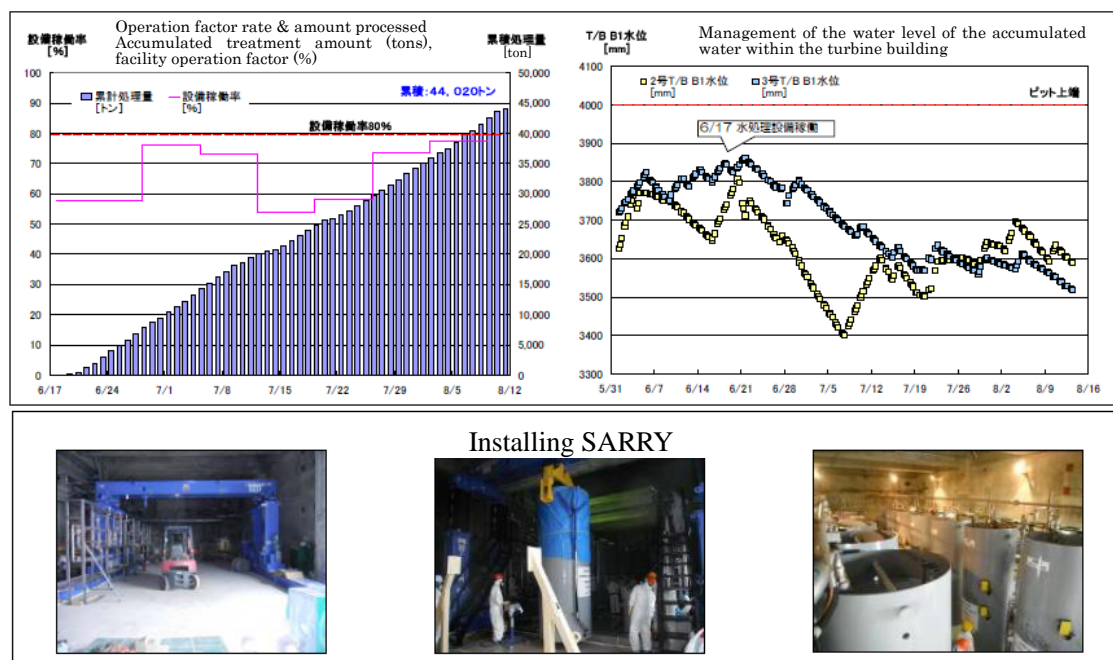
2. The treatment of contaminated water

In order to reduce the overall amount of accumulated water as well as increase the flow rate to the reactors using treated water, maintenance and management (formulating plans to improve reliability, securing adequate flow rate by setting up bypass lines, etc.) has been implemented for stable operation of the treatment facilities. For the purpose of further stable treatment, a cesium adsorption treatment facility (SARRY) has been installed as a second-line treatment facility and has begun treatment. Evaporative concentration equipment is also being utilized to reinforce the desalination of the treated water.

The cumulative amount of accumulated water that has been treated is approximately 66,980 tons at present (as of August 31). The cesium decontamination factor* of the treatment facilities is 10^6 and the chloride concentration has been reduced from 6,600 ppm to about 20 ppm (both figures as of July 28) (Figure III-2-1).

**Decontamination factor*: The comparison of concentration of cesium in the sample before treatment with the concentration of cesium in the sample after treatment.

Figure III-2-1 Cumulative amount of accumulated water



3. Radiation control and medical care, etc.

In the area of improvements to the working environment, in conjunction with installing rest facilities in the NPS in series, a system of medical care at the seismic isolation building (a 24-hour service operated by multiple doctors) was prepared during Step 1. To accelerate the provision of emergency medical transportation, the rules of patient survey etc. at the Unit5/6 emergency care room was confirmed. It also decontaminated the patient transportation vehicle and began preparing a decontamination facility at the Unit 5/6 emergency care room.

As for individual dose control, immediately after the earthquake considerable time was required to determine the individual dose due to a shortage of whole-body counters (WBCs). However, in order to achieve a more prompt evaluation of internal exposure dose and steadily implement measurement on a regular basis, the installation of additional WBCs is in process (after establishing a WBC building in J Village, six WBCs were set up there (August 11)).

In terms of livelihoods, temporary dormitories have been established additionally, and about 1,200 staff members have already moved in at present (as of August 15). Moreover, on-site rest facilities have been established at a total of 16 points (for about 1,200 people and about 3,500 square meters) (as of August 15). Air shower and toilet as well as drinking water are installed in some rest facilities.

Furthermore, staff members wear the equipments shown in Figure III-3-1 to prevent heat stroke while they are at work.

Figure III-3-1: Examples of countermeasure against heat stroke



Cooling vest



Mask with a blower



An example of wearing a cooling scarf



An example of wearing a refrigerant (frozen) at the back of the neck