Addenda to the second update of the Fukushima Daiichi Nuclear Power Station accident (June 1 to August 31, 2011)

IJNS Editor

Abstract: These addenda provide the figures and tables for helping readers to understand the article titled "the second update of the Fukushima Daiichi Nuclear Power Station (NPS) accident" by SHIBUTANI Yu. These figures and tables are mainly referred from "Additional Report of the Japanese Government to the IAEA - The Accident at the Tokyo Electric Power Company Inc. (TEPCO) Fukushima Daiichi NPS - September 2011, Nuclear Emergency Response Headquarters Government of Japan" and the website of Prime Minster of Japan and His Cabinet, Nuclear and Industrial Safety Agency (NISA), Ministry of Education, Culture, Sports, Science and Technology (MEXT), TEPCO and Japan Atomic Industrial Forum Inc. (JAIF).

The contents of this addenda cover (i) summary of 28 learned lessons, (ii)status of each unit of Fukushima Daiichi NPS, (iii) alternative core cooling system, (iv) spent fuel pool alternative cooling system, (v) outline of waste water storage and treatment system, (vi) prevention of environmental release of radioactive materials and monitoring, (vii) environmental effect caused by the accident, and (viii) influence of Fukushima Daiichi accident on electricity supply in Japan.

Keyword: Fukushima Daiichi NPS; waste water treatment system; stress test; restart of NPS

1 Summary of 28 learned lessons

The 28 items of the learned lessons from Fukushima Daiichi NPS accident are summarized in Table 1, where items of lessons and the situation of addressing the learned lessons are classified into five categories from the Government Report to IAEA.

Table 1 Items of individual lessons

Item of lessons	Situation of addressing learned lessons
Category 1 Prevention of severe accidents occurrence	
(1) Strengthen measures against earthquakes and tsunamis	The Nuclear and Industrial Safety Agency (NISA) has undertaken discussions in terms of "defense in-depth," of a design basis that assumes adequate frequency of occurrence, with an adequate recurrence period taken into consideration, and height of tsunami; and of criteria for safety design of structures that allows for the impact force of tsunami waves, etc.
(2) Ensure power supplies	NISA has requested the operators to ensure concrete power supplies, and the operators have already implemented the deployment of power-supply vehicles which supply the requisite power for emergency reactor cooling, the securing of emergency diesel generator capacity for a state of cold shutdown, countermeasures against flooding for important equipment within a reactor building, and assessments of the degree of reliability of power grid.
(3) Ensure reliable cooling function of reactors and Pressure Containment vessels (PCVs)	The operators deployed alternative/external water injection devices, ensured the capacity of freshwater tanks, and arranged feed water lines that take water from the sea.
(4) Ensure robust cooling functions of spent fuel pools	The operators, in order to maintain cooling of the spent fuel pool even when power supplies had been lost, deployed alternative/external cooling water injection devices for the spent fuel pools, ensured the capacity of freshwater tanks, and arranged feed water lines that take water from the sea.
(5) Thorough accident management (AM) measures	Nuclear Safety Commission (NSC) has resumed discussions on upgrading the AM measures. NISA developed an operational safety program and expanded/clarified the interpretation of technical standards regarding emergency response procedures and so on, which will enable the stable cooling of the reactor even should all AC power supply and all seawater cooling functions be lost. NISA plans to implement the work to seek to legislate AM measures based on the result of the examination undertaken by the NSC. NISA also plans to adopt a probabilistic safety assessment approach to develop more effective AM measures.
(6) Response to issues concerning the siting with more than one reactor	The plant operators developed for each reactor independent responsibility systems, systems for accident responses, and procedures. Hereafter, the measure to ensure the engineering independence of each reactor at sites having more than one reactor are planned to be considered.
(7) Consideration of NPS arrangement in basic designs	The sufficient consideration of an adequate layout for the facilities and buildings of NPSs is required at the stage of basic design for new construction, and the embodiment of those considerations is being planned.

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(8) Ensuring the water tightness of essential equipment facilities	The operators took countermeasures against flood damage to important equipment within the reactor buildings. Currently, the operators are reinforcing the water tightness of the reactor buildings and installing watertight doors and so on.
Category 2 Countermeasures to manage severe accidents	
(9) Enhancement of measures to prevent hydrogen explosions	The operators of BWRs will install exhaust ports as countermeasures against hydrogen leakage into reactor buildings by making a hole in the roof of each reactor building, and conduct arrangements for implementing this work. Also, the installation of hydrogen vents atop reactor building and of hydrogen detectors in reactor buildings are planned as mid- to long-term efforts. The operators of PWRs confirmed that hydrogen leaked from a PCV into the annulus is reliably vented to the outside of the annulus by the already installed annulus exhaust system. Also, the installation of equipment to decrease concentration of hydrogen in PCVs, including passive catalytic hydrogen recombiners requiring no power supply, is planned as mid- to long-term efforts into the future.
(10) Enhancement of containment venting system	As initial measures, the plant operators installed standby accumulators for air valves, transportable compressors and other such equipment, all of which enable operation of valves in vent lines even should AC power supplies be lost. In addition to these initial measures, further efforts will be made in future to enhance the PCV vent system by extensively considering technical expertise in Japan and overseas, which include enhancement of the radioactive material removal function.
(11) Improvements of the accident response environment	The operators have taken steps to ensure on-site communication tools, a portable lighting system, and means of securing work environment in the main control room, etc.
(12) Enhancement of the radiation exposure management system at the time of accident	The operators deployed the protective cloth against high radiation doses in the early stages of an accident at NPSs, arranged mutual cooperation among operators for protective cloth against high radiation doses, personal dosimeters, full-face masks, and other such equipment, developed a system by which radiation control staff could concentrate on important operations to ensure radiation control in emergencies, improved employee training for radiation control in emergencies, and other such improvements.
(13) Enhancement of training responding to severe accidents	The operators conducted emergency response training at NPSs witnessed by government staff to prepare workers for a loss of all AC power supplies, a loss of seawater cooling functions, tsunami strikes and other such emergent situations. The government will also request the operators to implement nuclear emergency drills to prepare for the occurrence of severe accidents and their prolongation and escalation caused by primary coolant pipe breaks or other such accidents. Additionally, the government is also examining hands-on nuclear disaster prevention drills which simulate severe accidents that coincide with complex disasters as happened in this accident, and plans to engage in support and cooperation such as necessary advice for the drills performed by local authorities.
(14) Enhancement of instrumentation to identify the status of the reactors and PCVs	Plans are being made for the development and preparation of instrumentation of reactors, PCVs, spent fuel pools, etc. to enable adequate functioning even under severe accident conditions.
(15) Central control of emergency supplies and equipment and setting up rescue team	The operators have been engaged in the establishment and management of emergency response equipment and the creation of implementation forces to operate such equipment. They are also arranging and then preparing for common use among plant operators of masks, protective cloth, and the like to provide protection during work with heavy machinery to dispose of rubble or work having high radiation doses, and otherwise developing systems for mutual cooperation. Plans are also being made for the preparation of emergency response equipment, including robots, unmanned helicopter drones, heavy machinery, decontamination equipment and accident progression prediction systems, as well as for the enhancement of capacity building through training of Self-Defense Forces, police, firefighters, the Japan Coast Guard, and other key personnel. Additionally, the system for responding to crisis management will be enhanced under the new safety regulatory organization through the establishment of staff specializing in responding to emergency conditions.
Category 3 Institution to nuclear emergencies	
(16) Responses to combined emergencies of both large-scale natural disasters and prolonged nuclear accident	Off-site centers have been reinforced by deploying satellite phones, emergency power supplies and reserves of goods. Deploying alternative materials and equipment is also planned so that alternative facilities may be utilized immediately even if the situation necessitates relocating the function of an off-site center. Moreover, regarding the response to a complex disaster, a review of the full readiness and chain-of-command structure will be made across ministries and agencies.
(17) Reinforcement of environmental monitoring	The “Monitoring Coordination Meeting” has been established within the government for the coordination and smooth implementation of environmental monitoring conducted by ministries and agencies, local authorities and TEPCO. The “Comprehensive Monitoring Plan” was developed as an initiative for the immediate future. Based on this Plan, related organizations are engaged in partnership in monitoring by aircraft, monitoring of sea areas and radiation monitoring with a view to facilitating the lifting of restrictions on Emergency Evacuation-Prepared Areas, among other endeavors, and preparation of cumulative dose estimation maps indicating the distribution of radiation doses, etc. Also, in an emergency, the

	government will take responsibility for establishing the system of performing environmental monitoring surely and deliberately. The new safety regulation organization will play a commanding role in environmental monitoring.
(18) Establishment of a clear division of labor between relevant central and local organizations	Roles and responsibilities of relevant organizations will be reviewed to enable prompt and appropriate responses, and measures will be taken to amend Acts and revise manuals when necessary. Also, communication systems, including communication tools and channels, will be reviewed in order to enable the delivery of information quickly and with certainty. Furthermore for the video conference system used at the time of nuclear disaster, it is planned to interconnect relevant governmental organizations, all electric power companies and NPSs to ensure quick and adequate instruction and information collection in emergency situations.
(19) Enhancement of communication relevant to the accident	It is planned to examine ways of disclosing and providing information during significant NPS accidents, to develop a basic manual, and to provide education and training on that basis to relevant organizations regarding information disclosure and provision.
(20) Enhancement of responses to assistance from other countries and communication to the international community	The system for international responses to an accident will be improved as part of implementing the IAEA Action Plan on Nuclear Safety, including the development of lists of equipment effective for accident responses and methods for international information sharing, including through international notifications.
(21) Adequate identification and forecasting of the effect of released radioactive materials	The new safety regulation organization will serve as a control center for environmental monitoring, including the operation of the System for Prediction of Environmental Emergency Dose Information (SPEEDI), and it will consider more effective ways of utilizing SPEEDI.
(22) Clear definition of widespread evacuation areas and radiological protection guidelines in nuclear emergency	Relevant organizations will promote examining the standard of radiological protection, etc. on the basis of lessons learned from this accident. Moreover, the NSC started reviewing “The Regulatory Guide for Emergency Preparedness of Nuclear Facilities”, including the definition of the Emergency Planning Zone (EPZ). Japan will make efforts to reflect the Fukushima experience of accident responses within the review of the standards of International Commission on Radiological Protection (ICRP) and the IAEA standards for nuclear emergency preparedness and radiological protection.
Category 4 Enhancement of safety infrastructure	
(23) Reinforcement of safety regulatory bodies	On the basis of the principle of “separating regulation from utilization,” the nuclear safety regulatory divisions of NISA will be separated from Ministry of Economy, Trade and Industry (METI), and “Nuclear Safety and Security Agency (tentative name)” will be established by April 2012 as an external agency of the Ministry of Environment by integrating the functions of NSC into this new agency. The capabilities of this regulatory agency will be enhanced by centralizing nuclear safety regulatory activities. A dedicated risk management division will be established to enable this Nuclear Safety and Security Agency to take quick initial responses. Efforts will be made to recruit highly qualified personnel from both the public and private sectors to adequately execute the regulatory activities.
(24) Establishment and reinforcement of legal structures, criteria and guidelines	A revision of the legal framework, standards, and so on is scheduled, based on knowledge learned from the accident, including the introduction of a new safety regulatory framework (e.g., back fitting), the enhancement of safety standards and the streamlining of complicated nuclear safety regulatory and legislative systems. The government will actively provide its experience and knowledge from this accident to contribute to a review of the IAEA’s standards and guidelines.
(25) Human resources for nuclear safety and nuclear emergency preparedness and responses	The new safety regulatory body will have among its basic policies securing personnel who are highly qualified with regard to regulatory matters through reinforced training. This body will also deliberate the establishment of an International Nuclear Safety Training Institute (tentative name), as a research institute that will seek to improve the quality of its human resources and engage in international cooperation.
(26) Ensuring the independence and diversity of safety systems	There are plans to respond appropriately to multiple malfunctions having a common cause, to attain further enhancement of the reliability of safety functions such as ensuring the independence and diversity of types, storing locations, and other aspects of emergency power generators and seawater cooling systems and to strengthen ensuring the independence and diversity of safety systems.
(27) Effective use of probabilistic safety assessment (PSA) in risk management	NISA and the Japan Nuclear Energy Safety Organization (JNES) are now engaged in deliberations of revisions to legislation and standards, etc., on the premise of the utilization of PSA. Also, regarding the Tsunami PSA, the Atomic Energy Society of Japan is preparing to make a guideline. In addition, there are now plans to formulate improvements to safety measures, including effective accident management measures based on PSA.
Category 5 Thoroughly fostering a safety culture	
(28) Thoroughly fostering safety culture	Various responses to this accident will be reviewed carefully and Japan is working to rebuild the attitude in which both nuclear plant operators and individuals involved in safety regulation sincerely pursue new knowledge, both as organizations and individuals.

Source: Additional Report of the Japanese Government to the IAEA
Nuclear Emergency Response Headquarters Government of Japan

2 Status of Each Unit of Fukushima Daiichi NPS

The status of the four units in Fukushima Daiichi NPS as of August 31, 2011 is summarized in Table 2. At the time of East Japan Earthquake occurred in March, 2011, the units 1 to 3 were in operation, while unit 4 was shut down for refueling.

Table 2 Status of Unit 1 to 4. (As of August 31th, 2011)

		Unit 1	Unit 2	Unit 3	Unit 4
Reactivity	Sub-criticality	No short lived fission products reported			No fuels loaded
Reactor cooling	Core and fuel integrity	Damaged (core melt *1)			No fuels loaded
	RPV structural integrity	Partially damaged and leaking	Unknown		No damaged
	PCV structural integrity	Damage and leakage suspected			No damaged
	Core cooling	Sufficient cooling secured through the alternative core cooling system			Not required
	Temperature of RPV bottom	Below 100℃	Below 130℃	Below 120℃	-----
	Nitrogen gas injection into PCV	Continued from April 6, 2011	Continued from June 28, 2011	Continued from July 14, 2011	Not required
SFP cooling	Fuel integrity in SFP	Unknown	Most spent fuels not damaged *2	Unknown	Most spent fuels not damaged *2
	SFP cooling	Function recovered by alternative cooling system			
	Temperature of SFP water	approximately 30℃	approximately 30℃	approximately 30℃	approximately 40℃
Accumulated water	Increase and accumulation of radioactively contaminated water	High level radioactive waste water is accumulating in the R/B, T/B and RW/B of each unit. (Approx. 96,310m^3 in August 9, 2011)			
	Installation of water treatment facility	- Highly radioactive waste water treatment system installed on June 17, 2011 is now working on a full-scale basis. (Capacity 1,200m^3/day) - Water treated with this system has been reused for core cooling since June 27, 2011.			
Ground water	Radioactive materials in the ground water	Radioactive iodine, I-131, cesium, Cs-134, 137 and Sr-89, 90 were detected from the sub-drain, underground water collected and controlled facility, and the well water in the Fukushima Daiichi site.			
	Mitigation of ground water contamination	Pumps for collecting underground water called “sub-drain” have been restored. Sub-drain is being treated in accordance with the contaminated water management plan.			
Radioactive materials in the atmosphere and soil	Scattering of radioactive materials to the outside of the facilities	The release rate of radioactive materials from Unit 1 to 3 as of July 26 to August 12, 2011 was estimated to be 2.0×10^8 Bq/h (Cs-134 and 137) at maximum. *3			
	Installing R/B cover	Installation work started in June 29, 2011.	Under consideration	Preparation work in progress.	

*1: TEPCO ‘s analysis [announced on May 15 and 23, 2011]
*2: TEPCO judged that most spent fuels were not damaged in the Unit 2 and Unit 4 SFPs based on the detailed analysis of the radioactive materials in the pool water. [announced on May 31, 2011]
*3: TEPCO ‘s evaluation [announced on August 17, 2011]
RPV: Reactor Pressure Vessel, PCV: Pressure Containment Vessel, SFP: Spent Fuel Pool, CS: Core Spray
Reference: TEPCO news release [on-line] http://www.tepco.co.jp/cc/press/index-j.html and
Japan Atomic Industrial forum Inc. [on-line] http://www.jaif.or.jp/english/fukushima/index.html
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3 Alternative core cooling system

Since no regular heat transfer system of all core damaged Units 1 to 3 have been available because of loss of all heat sink function, establishment of building up the alternative core cooling system had been an urgent issue for Fukushima Daiichi NPS to maintain heat removal function of the damage reactor core.

As of August 31, sufficient core cooling of Unit 1, Unit 2 and Unit 3 which were severely damaged by core melt are secured by the alternative core cooling system installed after the tsunami hazard. As seen in Fig. 1, fresh water is mainly transferred from the waste water treatment system to injection water buffer tank, with backed up by filtered water storage tank. The fresh water is injected into the reactor pressure vessel via feed water line by the injection pump. For the purpose of maintaining stable core cooling, the reactor injection line (via feed water line A) has the back up line (via feed water line B), and the main injection pump with motor connected to external electricity is backed up by the other pump with motor connected to emergency diesel generator.

The flow rate equivalent to core decay heat was calculated as 1.1m^3/h for Unit 1, while 1.7m^3/h for both Unit 2 and Unit 3, as of August 31. However, the actual flow rate injected to the cores exceeded these flow rates in order to ensure the sufficient core cooling. (see Table 3) The temperature of RPV bottom showed the trend of decreasing for the past month. (see Fig. 2)

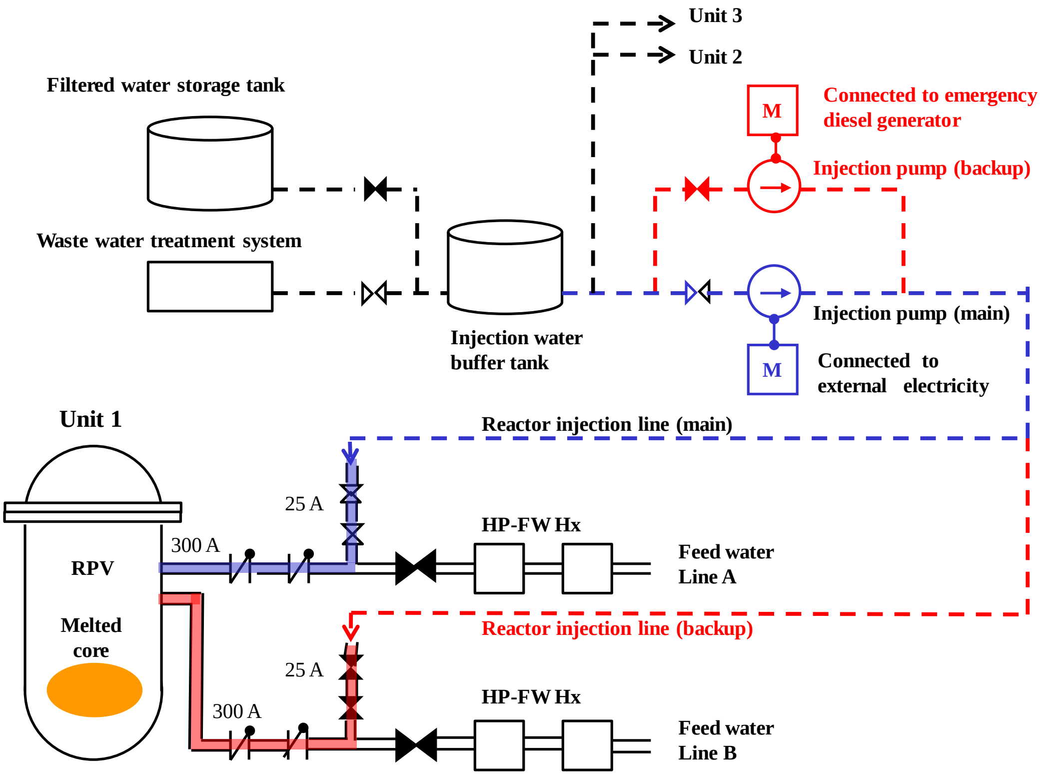


Fig. 1 Alternative core cooling system.
Reference: TEPCO news release [on-line] http://www.tepco.co.jp/cc/press/index-j.html

Table 3 Flow rate injected to the core, as of August 31, 2011

Unit	Decay heat [MW]	Flow rate equivalent to decay heat [m^3/h]	Actual flow rate injected to the core [m^3/h]
1	0.82	1.1	3.6
2	1.2	1.7	3.8
3	1.2	1.7	7.0

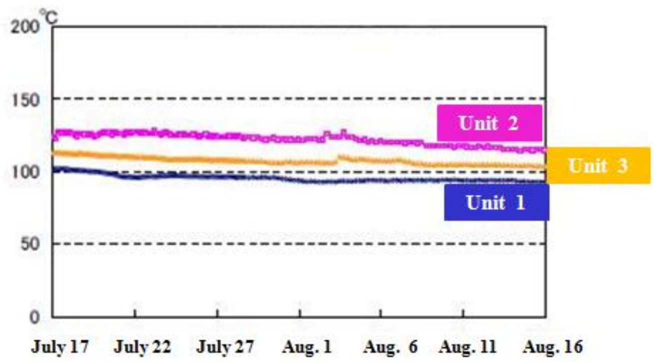


Fig. 2 Temperature of RPV bottom.
Reference: TEPCO news release [on-line] http://www.tepco.co.jp/cc/press/index-j.html

Those results of (i) actual water injection rate more than the level of sufficient core cooling, and (ii) still high temperature of larger than 100℃ have lead TEPCO to introducing another core cooling method of water injection via core spray line as illustrated in Fig. 3.

TEPCO is going to change water to be injected to Unit 2 and Unit 3 on trial basis and monitor temperature inside reactor pressure vessels to find optimal water volume for the purpose of inhibiting contaminated water generation.

Water injection via core spray line, in addition to the feed water line currently used, started in Unit 3 from September 1. The effect of the diversified water injection to regulate the temperature of RPV bottom is being confirmed while adjusting its flow rate.

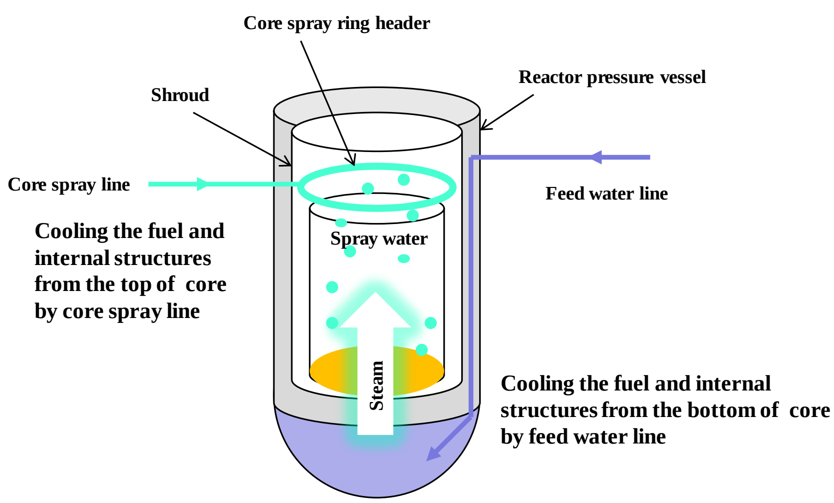


Fig. 3 Water injection via core spray line.
Reference: TEPCO news release [on-line] http://www.tepco.co.jp/cc/press/index-j.html

4 Spent fuel pool alternative cooling system

The alternative spent fuel pool cooling system with a new type heat exchanger (air fin-cooler) has been operated for the purpose of stable cooling (see Fig. 4). As of August 31, the temperature of spent fuel pool water is approximately 30℃ for Units 1, 2, and 3 and approximately 40℃ for Unit 4.

The desalination system of the water in the spent fuel pool has been operated and corrosion inhibitor (hydrazine) has been injected with fresh water to prevent the corrosion effect by raw water used as make up water at initial stage of the accident.

The spent fuels in these pools will be transferred to another facility in the next step.

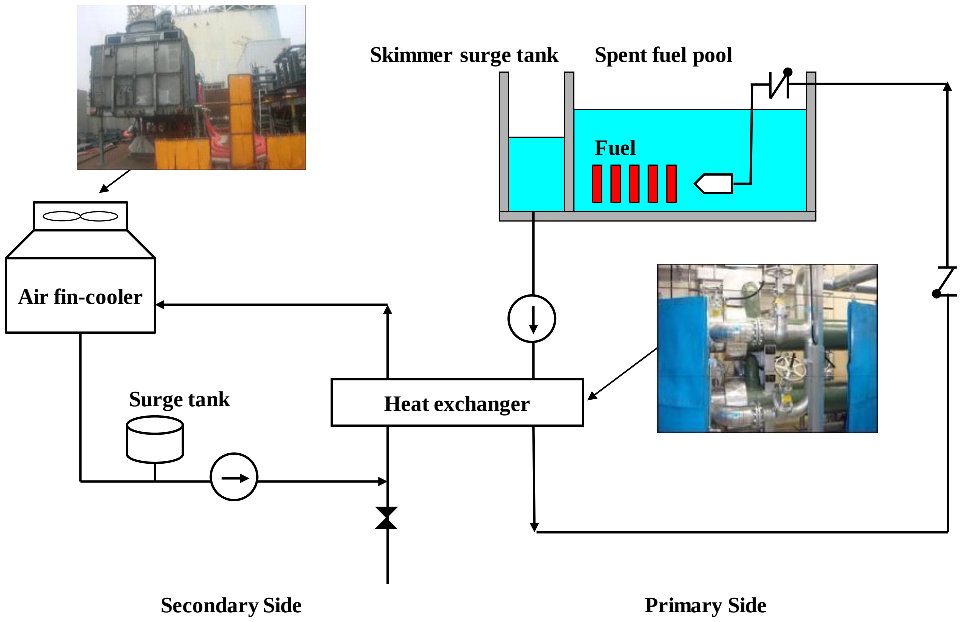


Fig. 4 Alternative spent fuel pool cooling system.
Reference: TEPCO news release [on-line] http://www.tepco.co.jp/cc/press/index-j.html

5 Outline of waste water storage and treatment system

Lack of pure water stored in injection water storage tank is a serious issue for safety to cool the damaged core steadily and reliably until almost permanent core cooling system will be installed in future. To cope with this problem, TEPCO has been using large volume of contaminated water storage in Radwaste building. The whole scheme of make shift reactor cooling system is shown in Fig.5

High level radioactive waste water has been accumulating in reactor building (R/B), turbine building (T/B) and radwaste building (RW/B) of each unit. (Approx. 96,310m^3 in August 9, 2011). In order to reduce the amount of contaminated water and circulate the treated water to cool the reactor core, several facilities of waste water storage tanks, radioactive material treatment systems and desalination systems have been installed.

The accumulated waste water in R/B and T/B has been transferred to the centralized radiation waste treatment facility. Continuous works have been in progress for installing underground tank to store high level radioactive waste water.

The waste water has been fed to oil separator to extract oil in the waste water and then transferred to radioactive material treatment system. The radioactive material treatment system is composed of Unit No.1 (KURION and AREVA) and Unit No.2 (SARRY). Currently, these units No.1 and 2 have been working in parallel operation mode. The cesium decontamination factor achieved by the treatment facilities is 10^6.

The treated water from the radioactive material treatment system has been stored in existing fresh water storage tank. It then transfers to the desalination system using reverse osmosis. Work for installing additional desalination unit using evaporator has been in progress. The resultant purified water has been transferred to injection water storage tank.

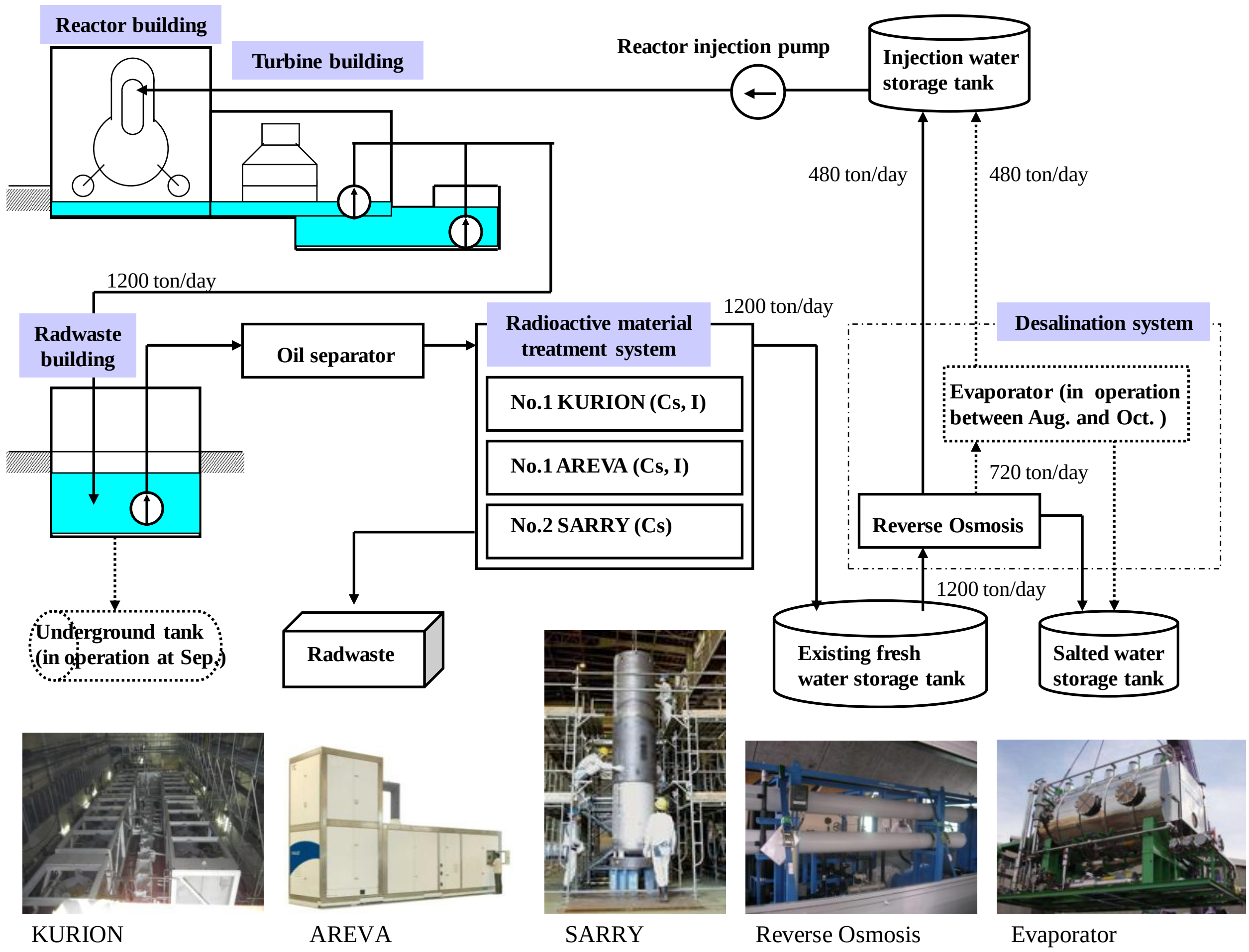
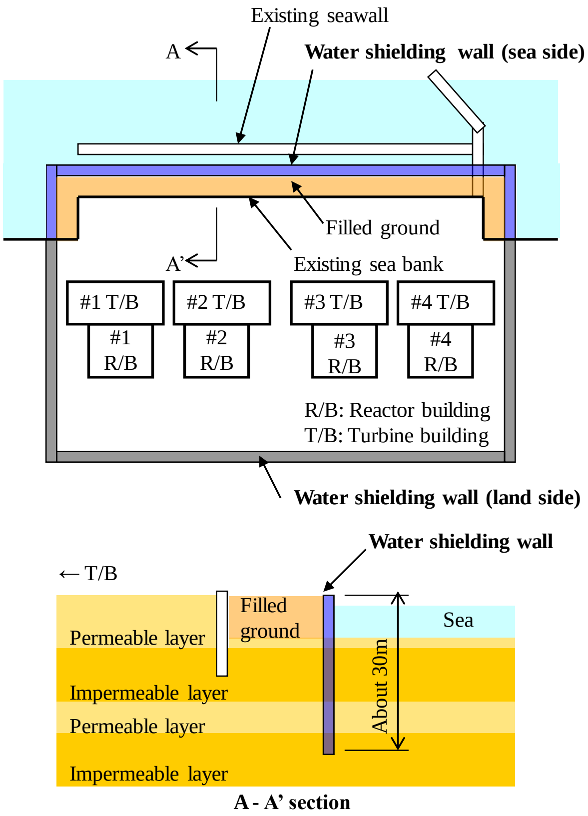


Fig. 5 Outline of waste water storage and treatment system
Oil separator: the oil excluding unit for pre-treatment of radioactive material treatment system
KURION and AREVA: the cesium adsorption Unit No.1 installed at initial stage after the accident
SARRY: the cesium adsorption Unit No.2 introduced for the purpose of increasing the treatment capacity
Reverse Osmosis (RO): the desalination unit used by reverse osmosis technology
Evaporator: additional desalination unit by evaporator
Reference: TEPCO news release [on-line] http://www.tepco.co.jp/cc/press/index-j.html

6 Prevention of environmental release of radioactive materials and monitoring

Civil engineering works have been conducted by TEPCO at the Fukushima Daiichi NPS in order to (i) prevent environmental release of radioactive materials from damaged plant site, as well as (ii) protect the damage plant site from further attack of natural disaster such as typhoon and tsunami. The installation of a water shielding wall (at the seaside) made of steel pipe sheet pile with an adequate water shielding function in front of the existing seawall of Units 1 to 4 is planned as illustrated in Fig.6 (a). In addition, the installation of a water shielding wall (at the land side) surrounding the reactor buildings of Units 1 to 4 is also being investigated and examined. The containment cover of reactor building to prevent the release of radioactive materials is in progress as shown in Fig. 6 (b). The dust sampling equipments has been installed to monitor the radioactive materials as shown in Fig. 6. (c). The work of removing the contaminated debris is in progress to reduce the air dose rate in the environment as shown in Fig. 6 (d).

The release rate of radioactive materials from Unit 1 to Unit 3 as of July 26 – August 12, 2011 was estimated to be 200 million Bq/hr (Cs-134 and 137) at maximum as seen in Fig.7. This release rate is approximately one 10-millionth of the maximum rate on March 15, 2011.



(a) Water shielding wall to prevent outflow radioactive materiasl

(b) Steel structure for containment cover of explosion-ravaged reactor building was built. (Unit 1)

(c) Dust sampling equipments for monitoring radioactive materials were installed in plant.

(d) Removal of debris contaminated and scattered by explosion is in progress to reduce the air dose rate. (Unit 4)

Fig. 6 Work for preventing environmental release of radioactive materials and reducing the air dose rate.
Reference: TEPCO news release [on-line] http://www.tepco.co.jp/cc/press/index-j.html

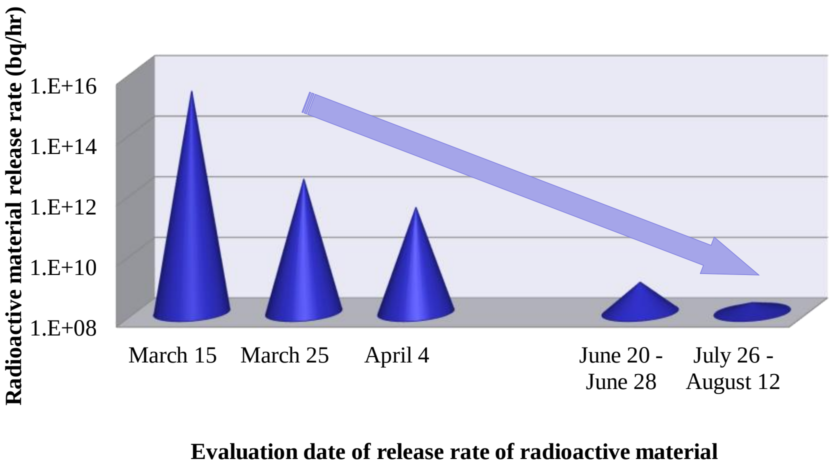


Fig. 7 The release rate of radioactive materials from Unit 1 to Unit 3.
Reference: TEPCO news release [on-line] http://www.tepco.co.jp/cc/press/index-j.html

7 Environmental effect caused by the accident

The surrounding area of Fukushima Daiichi NPS had been seriously contaminated by the radioactive materials release caused by not only the venting of pressure containment vessels of units No.1 to 3 but also subsequent hydorgen explosion in the reactor buildings of Units No.1 to 4. The Japanese government had to expand the evacuation areas gradually from the EPZ (8 to 10 km radius from reactors) set by the Act on Special Measures Concerning Nuclear Emergency Preparedness initially to the four different areas as depicted in Fig. 8 finally, depending upon the degree of radioactive contamination. The four areas of different evacuation order by government are summarized as below;

(i) Evacuation area: The residents in this area within 20 km radius were required to evacuate instantaneously.
(ii) Deliberate evacuation area: Area in which the cumulative dose might reach 20 mSv within a year from the occurrence of the accident. The residents in this area have almost completed evacuation to date.
(iii) Evacuation prepared area: Area in which a response of “stay in-house” and/or evacuation was required in case of emergency, efforts are currently being made to lift the designation.
(iv) Specific spots recommended for evacuation: Specific spots in which the cumulative dose might reach 20 mSv within a year from the accident occurrence depending on a life style. These spots which have no areal spread have been found since June. To date, 227 spots have been established, covering 245 households.

The radioactive materials released to the environment also had effected agricultural and livestock products, drinking water and others as shown in Table 4.

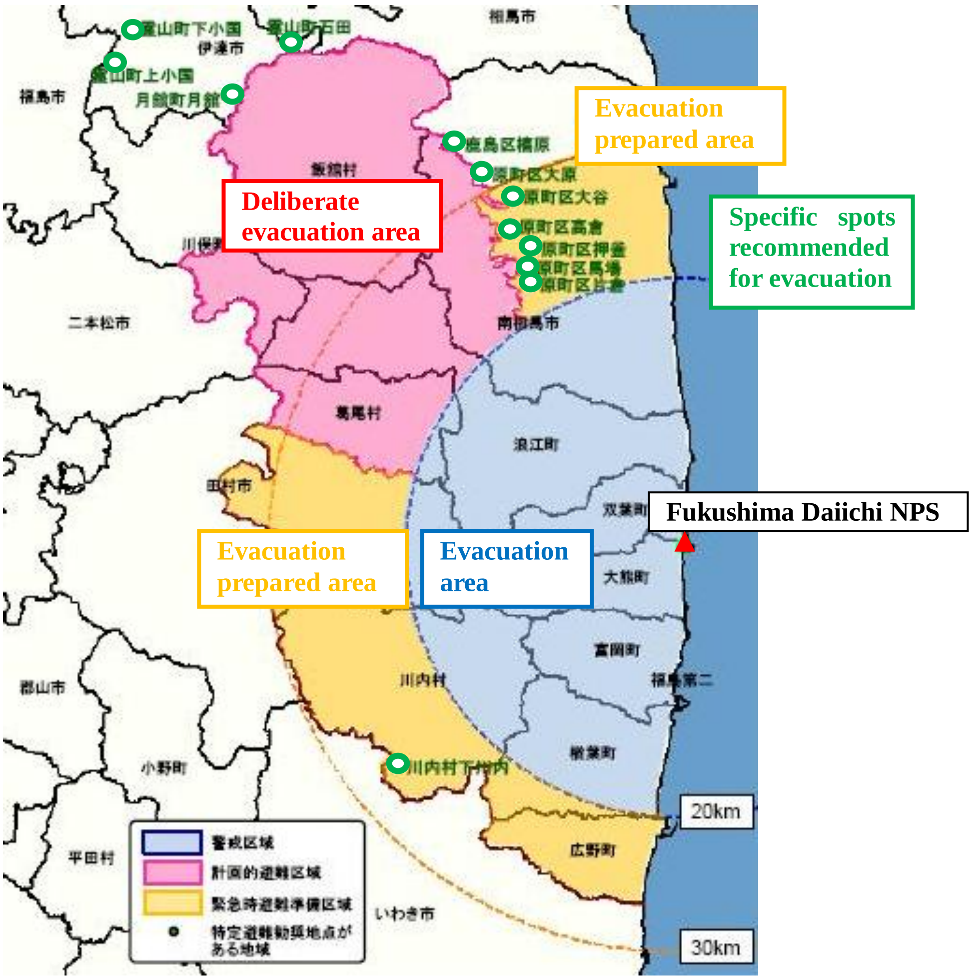


Fig. 8 Evacuation area and other special area as of August 3, 2011.
Reference: http://www.kantei.go.jp/saigai/genpatsu_houshanou.html, http://radioactivity.mext.go.jp/ja/

Table 4 Various kinds of environmental effects caused by the accident as of September 8

Kind of environmental effect	State of contamination and countermeasures of decontamination
Air dose rate and Radiation level of dust	- Air dose was decreasing gradually after the accident and have reached a stable state in all places. - NSC evaluates the Environmental Monitoring Results which have been published by MEXT almost every day. - All preschools and schools which are located within 30km radius should be monitored carefully. - Countermeasures for reducing dose rate in schoolyards has been conducted such as stripping off top/bottom soil.
Radioactivity in the soil	- MEXT started soil survey activity for the purpose of making a soil contamination map that will cover whole Fukushima Prefecture and its neighboring area.
Agricultural and livestock products	- Radioactive substance in excess of provisional standard was found in some products from some areas. - Instruction of shipment/intake restraint has been imposed on designated products. - Contaminated beef has been leaked to the market. Japanese government ordered to suspend all beef cattle shipments from Fukushima Prefecture.
River (drinking water)	- The ministry of health panel studying radioactive levels in tap water concluded that it contains no safety risks for the time being. The panel also recommended that authorities should maintain their regular safety inspections for several more months.
Wastes	- Radioactive substance was found in sludge from sewerage processing plant and debris in many area.NSC established guideline for dealing with contaminated waste.
Sea	- No radioactive substance was detected in all seawater samples taken from some locations beyond 30 km off shore by the latest survey conducted on July 22.

Reference: TEPCO news release [on-line] http://www.tepco.co.jp/cc/press/index-j.html
Japan Atomic Industrial forum Inc. [on-line] http://www.jaif.or.jp/english/fukushima/index.html Modified by IJNS Editor

8 Influence of Fukushima Daiichi accident on electricity supply in Japan

All nuclear power plants located along the coast of Tohoku area have been automatically shutdown by the large earthquake on March 11, 2011. There had been several nuclear power plants which were severely damaged by the tsunami eventually being committed core meltdown. The environmental effects caused by the radioactive release from Units 1, 2 and 3 of Fukushima Daiichi NPS had triggered the public concern over the safety of all NPSs in Japan. As a result, all of three units of Hamaoka NPS of Chubu EPCO had been shut down by the request of former Prime Minster Naoto Kan, and Genkai NPS of Kyushu EPCO, Ohi NPS of Kansai EPCO and other NPSs have been one by one in difficult state to start again after the outage of periodic inspection.

METI Minister Banri Kaieda at TV broadcasting emphasized that there were no safety problems restarting NPSs and continuing their operation, by adding that restriction of electricity usage for industry would worsen economic situation in Japan. He also expressed his concern by saying that if the NPS currently undergoing periodic inspections could not be restarted before the summer, electric power companies would encounter tight rope operation to balance the supply and demand every mid-day in hottest time zone. However, only 13 units out of 54 are in operation, as of August 31, 2011 as shown in Fig. 9.

As issue for the Japanese government to meet with the shortage of electric power supply caused by so many shut down of NPS is how to set up a “reasonable” official procedure to admit the restart of dormant NPSs. The solution is so-called “stress test” by hiring original idea from EU (see Fig.12). The objective of stress test is to evaluate all NPSs to be reinforced to prevent both major damage from earthquakes and subsequent tsunami and the loss of safety functions.

As a result, available capacity of all NPSs in Japan in the summer season of 2011 had reduced from the initially expected capacity factor of 80 % to actual one of 23 % as shown in Fig.10. TEPCO and other electric companies asked both the household and the commercial-scale utility customers to save electric power usage by broadcasting and through the website, par example “Electric Forecast” as shown in Fig.11.

NISA directed all electric power utilities to implement comprehensive safety assessments of their nuclear power stations. The stress tests will be conducted for all nuclear power stations except Fukushima Daiichi NPS.
The stress tests consist of two-stage evaluation: the preliminary assessments focusing on restarting plants after periodic inspections, while the secondary assessments for all plants including those already restarted. The detailed

comparison between the both assessments is explained in Table 5. A detailed evaluation of the basic designs of nuclear reactors, etc. and review of the relationship between reactor types and the causes of the accident will be carried out, and the safety and reliability of existing reactors will be evaluated on the basis of technological progress in nuclear reactor design and comparisons with the latest technologies. The results of both the preliminary and the secondary assessments will be reviewed by NISA and then reported to the Nuclear Safety Commission.

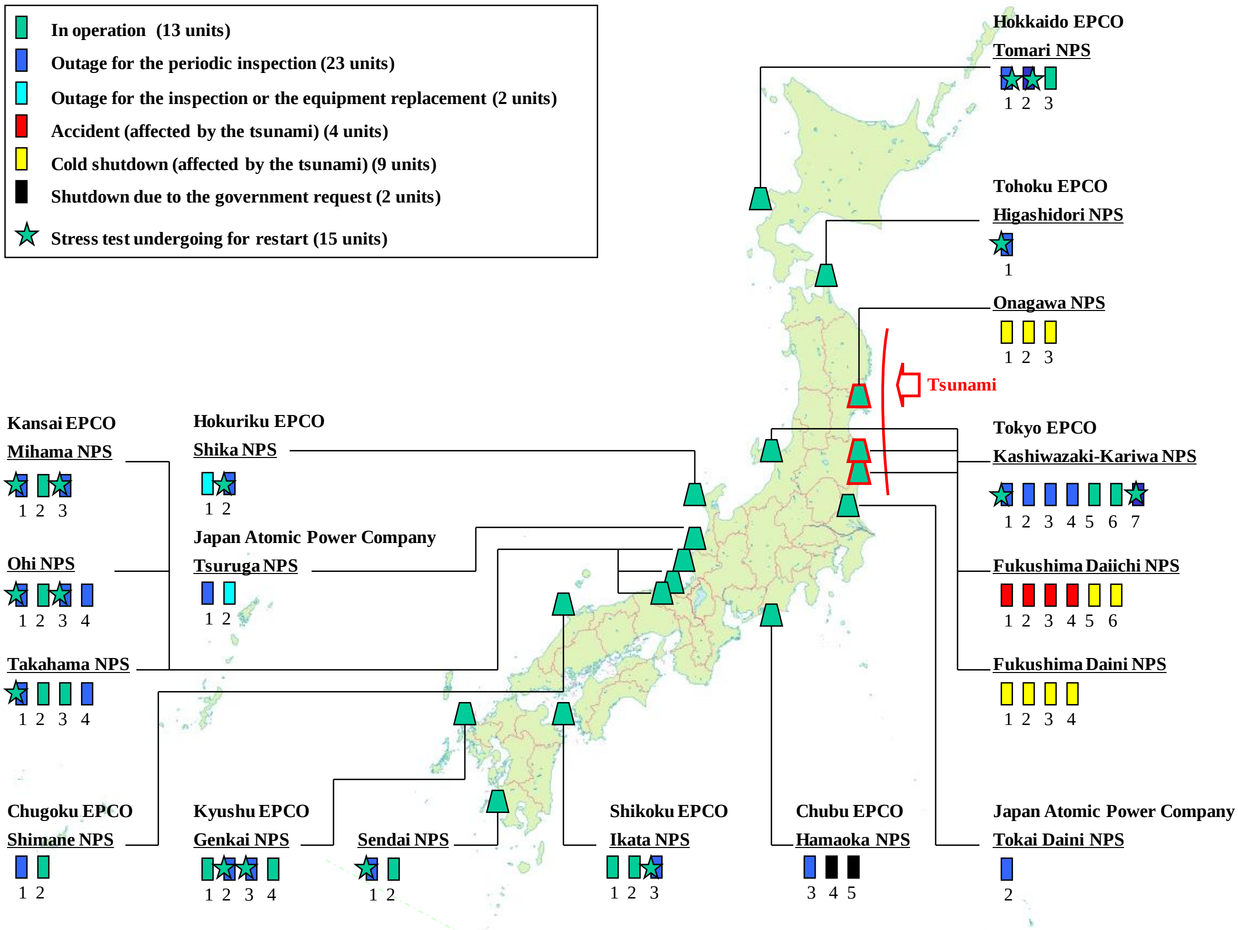


Fig. 9 Current status of the nuclear power plants as of August 31, 2011.

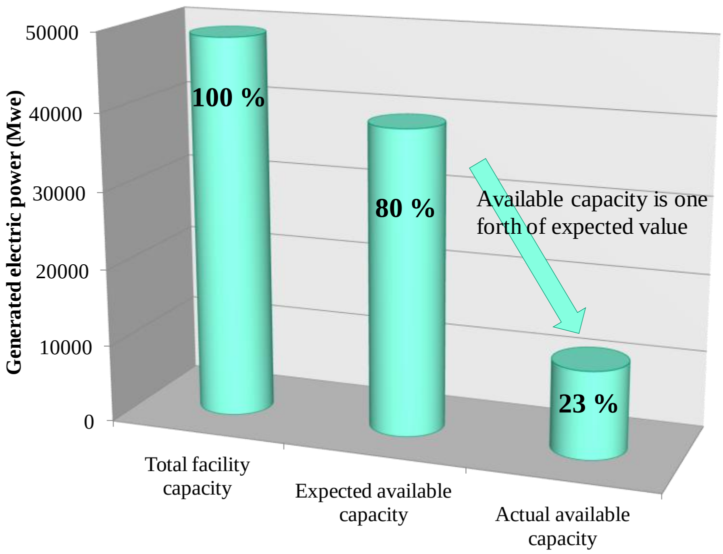


Fig. 10 Drastic reduction of electricity supply by nuclear power plant as of August 31, 2011.

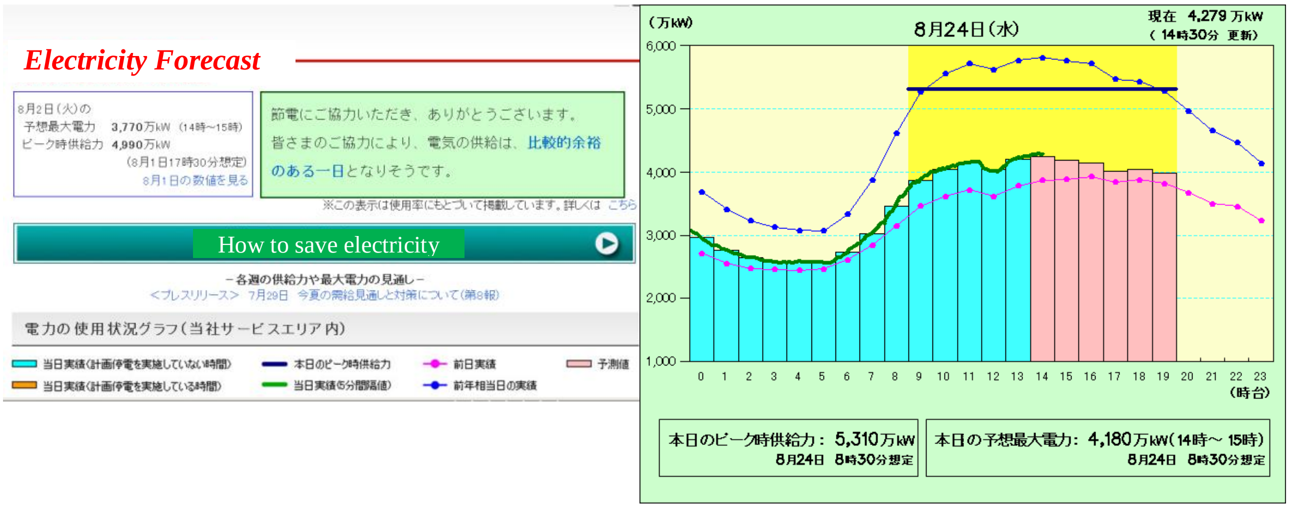
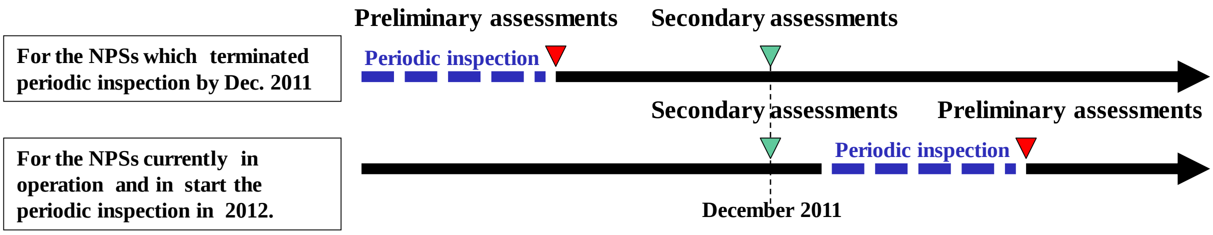
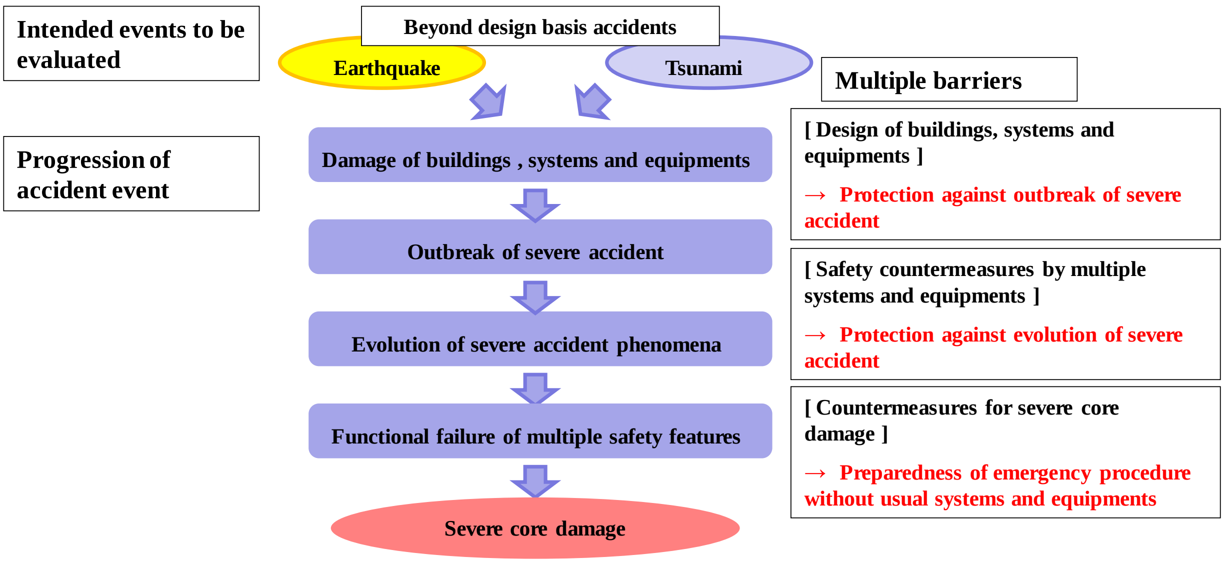


Fig. 11 Electricity Forecast on website by TEPCO.
Reference: TEPCO [on-line] http://www.tepco.co.jp



(a) Execution schedule of stress test



(b) Intended events and evaluation flow to confirm safety margin of NPSs

Fig. 12 Stress tests to confirm overall safety margins and clarify threshold limit of functions.
Reference: http://www.nisa.meti.go.jp/earthquake_index.html

Table 5 Differences between the preliminary and secondary assessments

	Preliminary assessments	Secondary assessments
Target equipment	Important safety-related equipments and facilities	Facilities and equipment that could cause or prevent major damage to fuel
Evaluation of buildings, systems, equipment, etc.	Evaluating safety margins by comparing stresses imposed by an earthquake or tsunami to buildings, systems, equipment, etc., with design basis allowable values	Evaluating safety margins by comparing stresses imposed by an earthquake or tsunami to buildings, systems, equipment, etc., with actual values causing loss of functions (determining the degrees of stresses beyond design basis scenarios, at which buildings, systems, equipment, *etc*., would lose their functions)
Evaluation of safety measures for the facility in its entirety	Determining degrees of damage or functional loss to buildings, systems, equipment, etc., that cause major damage to fuel	Determining degrees of damage or functional loss to buildings, systems, equipment, etc., that cause major damage to fuel
Evaluation of measures to prevent major damage to fuel	Evaluating the effectiveness of measures to prevent major damage to fuel	Evaluating the effectiveness of measures to prevent major damage to fuel